

**NUTRITION SCIENCE AND PRACTICE: EMERGING
ISSUES AND PROBLEMS IN FOOD CONSUMPTION,
DIET QUALITY AND HEALTH**

BY

PROF. HENRIETTA NKECHI ENE-OBONG

Mr. Vice-Chancellor;
Principal Officers;
Fellow Academics;
My Family members;
Lions and lionesses
Distinguished Ladies and Gentlemen:

Preamble

I feel highly honoured to be given the privilege and opportunity to deliver my inaugural lecture. I consider it a privilege to share my works and experiences with the community that has nurtured me for not less than 33 years. I thank God for making this day a reality. I stand here before you as a living testimony of one the Lord has shown mercy and favour. I say this because of the type of husband He gave me. My Husband has been my mentor, encourager, motivator and supporter. I will like to publicly appreciate him and thank him for his love, understanding, and the sacrifices he has made to see me where I am today. I will like to appreciate my mother who by the special grace of God took it as a challenge to train us when our father was physically challenged and even after his death. Mama, thank you. You have not laboured in vain. My children (Etete, Eno, Udo-Obong and Kokoete) cannot be let out. It is not usually easy for the children when they have to cope with a career mother. I want to thank them for their understanding, patience and sacrifices.

I came to this great University when I was admitted to study Vocational (Home Economics) Education. I was not excited about the course because I did not know what it was all about. As one of the best science students in my school, Marymount College, Agbor, Delta State, I was thinking of Medicine, Mathematics, Engineering, etc. Home Economics was not even offered as a subject in my school. Vocational Education was my late father's choice for me. I had another admission the same year to study Science at the University of Benin but my father refused my picking up the admission. Hear his words "I do not see you as a good Doctor. I think that course at Nsukka will sell like hot cake in the future." I now know my father had foresight and he was right. Home Economics is more important now than ever. This may be the topic for another inaugural lecture, but not by me.

I had no choice but obeyed my father. However, I did not give up the idea of changing. After my first year I applied for a change of degree programme. I encountered another obstacle. My Head of Department, Prof. Agusiobu (late) refused to release me. His words "Henrietta, I cannot release a good student like you." Since there was nothing I could do, I picked up interest and made a Second Class Honour (Upper Division). As a lecturer, I come in contact with students who perform so poorly because they did not like the course they were made to study. I do accept that interest has a great role to play in ones performance. However, when the reason is that the course is a low status or cheap course, the question I always ask is, "why did you not make a Class First in the course"? My philosophy is to make the best out of every situation. Every course is important and more so if you acquire the basic skills and excel in them.

Before the end of my NYSC, I had secured a place at Queen Elizabeth College, University of London to do an M.Sc in

Human Nutrition. My husband was then a Junior Fellow and had planned to sponsor my study. Unfortunately, the University of Nigeria Administration suspended the monthly payment to Junior Fellows. I was forced to drop the idea and found myself in a clothing factory for the next one year. We returned to UNN in 1979 immediately after my husband's Ph.D defense with a six weeks old baby. I started teaching at St.Cyprian's Teacher Training College, Nsukka in 1979, and later joined the University in 1982. Today I have no regrets and I dedicate this inaugural lecture to my late father, Chief Lawrence Obazei. How I wish that you here today, know that this had been your dream. May you continue to rest in the Lord until we meet to part no more, Amen.

Understanding Nutrition

I will like to start this lecture by briefly discussing Nutrition as a field of study. This is because the field has been greatly misunderstood. Just like Home Science/Economics, to the layman, nutrition is perceived as a subject concerned with the cooking of delicious meals. Food preparation is an essential part of the food chain and is only an aspect of the programme. Again, some believe it is a course exclusively for females, hence in nutrition departments one tends to see more females than males. Besides, being the first Professor in my Department to give an inaugural lecture, I consider it proper to correct some of these misconceptions.

Nutrition is the science that deals with the intake of food and how the body handles the substances (nutrients) in the foods consumed for growth, development and maintenance of life. Human nutrition is a complex scientific domain. The science and practice of nutrition involves a spectrum of other basic and applied scientific disciplines. These include: molecular biology, genetics, biochemistry, chemistry, physics, food science, microbiology, physiology, pathology, immunology, psychology,

sociology, political science, anthropology, communication and economics. This is why students of nutrition find themselves taking courses in almost all these areas of study. The student of nutrition is expected to integrate different concepts from these different disciplines. Therefore, to understand, study, research and practice nutrition, a holistic integrated approach from molecular to societal level is needed (Vorster and Hautvast, 2002).

The relationship between nutrition and health cannot be over emphasized. Although many other lifestyle and environmental factors in addition to nutrition influence health and well-being, nutrition is a major modifiable and powerful factor in promoting health, preventing and treating disease and improving quality of life (Vorster and Hautvast, 2002). It is a key universal factor that affects as much as it defines the health of all (Brundtland, 1999). This is why the saying “you are what you eat.” The eradication of hunger ranks high among international goals because good nutrition is essential for the health and human capacity needed to achieve so many of the other Millennium Development Goals (MDGs). Well nourished people learn better, produce more, and can more effectively fight off disease (Obaid, 2004). Malnutrition erodes human capacity and reduces productivity. It affects survival and health, education, and the economy of the nation. Hence, nutrition is now seen as a basic human right, not only essential for human development, but also as an outcome of development.

Nutrition Practice

Nutrition practice has a firm and well developed research and knowledge base as we have seen earlier. The role of the nutrition professional is therefore to apply nutrition principles to promote health, and well-being, to prevent disease and /or restore health (treat disease) in individuals, families,

communities and the population at large. Nutrition practice could be in the area of:

1. *Clinical Nutrition/Dietetics*: Professionals in this area work in the hospitals, clinics, or private practice. They counsel individuals from a biomedical-disease-behavioral paradigm.
2. *Community Nutrition*: Professionals in this area have additional skills from the psychosocial and behavioral sciences. They design, implement and monitor appropriate community-participatory programs to address nutrition problems.
3. *Public Health Nutrition*: These cover the health and care practice areas. They are also interested in food security and environmental issues of public health interest. These professionals are responsible for nutrition surveillance; and the design, implementation and monitoring of dietary guidelines that address relevant public health problems. They are also involved in the formulation and application of nutrition policy in a country.

There could be overlap in the practice areas of these specialities.

Career/Job opportunities for the Nutritionists

Nutrition Educator: The nutritionist can work as an educator, employed to teach in the secondary school, teacher training colleges, polytechnics and universities. The graduate may also be employed as an **extension staff** in the Ministry of Agriculture to teach rural or urban people nutrition and the application of nutrition principles. He/she may be employed by broadcasting houses (**Journalism**) to teach nutrition to the masses through the mass media, write a newspaper or magazine articles on nutrition related topics. He/she may set up private **consultancy** to advise and teach people who need help.

Research Nutritionists: Research nutritionists may be employed in Research Institutions, Agricultural Stations and

Medical Research Institutions to help in the evaluation of nutritional quality, acceptability and toxicity of newly developed specie of plants and animals that can be used for food and various products. They may be involved in recipe standardization and other aspects of food testing.

Public Health Nutritionists: Public Health Nutritionists carry out the nutrition program of health agencies by engaging in organized community efforts to educate individuals and groups in the improvement of nutritional practices.

Industrial Nutritionist: The nutritionist may select a career in industry, particularly Food and Drug industries. His/her job is to test the foods produced and advise on their nutrient content. In addition to this, he/she may help to organize and run the canteens belonging to the industry. They could function as Medical Delegate for food companies such as Nestle, Cadbury, WAMCO, Unilever, etc, where they help to promote the sales of products.

Clinical Nutritionist/ Dietitian: These are concerned with the use of nutrition measures for the maintenance of health; management of disease and trauma; and prevention of disease. They can perform different functions as:

- **Administrative Dietitians:** These are in charge of food ordering and supplies, personnel, maintenance of records and equipment and responsible for the food served to the entire hospital population (patients, employees, and professional staff members).
- **Therapeutic Dietitians:** These are in charge of the planning and service of modified diets. They visit patients, confer with doctors, instruct the patients about the nature of his/her diet while in the hospital.
- **Clinic Dietitians:** They guide and teach patients individually or in groups in an out patient clinic how to

fulfill their nutritional needs at the time of their discharge. They work mainly with patients that are not hospitalized.

- **Research Dietitians:** These individuals direct special studies that involve meticulous records of all the food intake of patients and all that his/her body secretes and excretes. From such experimentation, modification in diets may be discovered.
- **Consultant Dietitians:** These are dietitians who set up special services for patients and clients who require dietary management, which involves diet therapy, dietary guidance and comprehensive dietary counselling. They may also enjoy doing free-lance work.
- **Teaching Dietitians:** These function in institutions where Dietetics is offered at undergraduate and postgraduate levels. They can also help to monitor and teach nurses, medical and dental students as well as dietetic interns.

Commercial Food Service Managers: These are employed in commercial concerns such as airlines, hotels, restaurants, departmental meals, schools, etc. Their responsibility is to produce high quality meals; realize maximum profit and have the ability to gain and hold the patronage of the public.

Nutritionists in Government and Non-governmental Development Organizations: Nutritionists in agencies such as Food and Agriculture Organization (FAO), United Nation International Children's Fund (UNICEF), World Bank (WB), World Health Organization (WHO) are involved in the formulation and harmonization of food and nutrition policy; sponsoring research; monitoring and evaluation of nutrition programs in different countries of the world.

Nutrition Entrepreneurs: Individuals in this category are creators of employment, goods and services. The course provides graduates with skills that will enable them to be self-employed. They can establish catering outfits, health food shops, health monitoring outfits and consultancy services.

Emerging Nutritional Issues and Problems in Nigeria

Malnutrition is widespread in Nigeria. In the past, emphasis was on protein-energy malnutrition (PEM) which affected all age groups in varying degrees, especially the vulnerable groups. These conditions were commonly seen during the civil war as *kwashiorkor and marasmus*. Typical signs are varying degrees of wasting, growth failure, body weakness and predisposition to diseases. However, recent reports have shown that despite the oil boom and relative growth in our economy, PEM persists and is still of public health importance.

Under nutrition and micronutrient Deficiencies

According to WHO (2006), 1 out of 6 infants are born with low birth weight. One out of 4 pre-school children suffers from under nutrition. Ten million children die every day before the age of 5 and 1 out of 2 deaths is attributable to under nutrition. The recently conducted Nigerian Food Consumption and Nutrition Survey showed that PEM is still very much with us. National data showed the prevalence of stunting (chronic, longstanding malnutrition), wasting (acute, ongoing malnutrition) and underweight to be 42%, 9% and 25%, respectively among under-5-year old children (Maziya-Dixon *et al.*, 2004). Back here at home, we assessed the nutritional status of school children in Enugu State and found that 27.7%, 25.5% and 29.9% were stunted, wasted and underweight, respectively

(Ene-Obong and Ejekwu, 2007). The prevalence of chronic energy deficiency as measured by the Body Mass Index (BMI) of women of reproductive age was about 12% (Maziya-Dixon *et al.*, 2004). Chronic energy deficiency has serious implications for morbidity and low productivity of women and is associated with low birth weight and consequently high infant mortality.

Alongside PEM are micronutrient deficiencies (hidden hunger). One out of 3 people in the world are affected by one or multiple micronutrient deficiencies (WHO, 2006) and are, as a consequence, more susceptible to infection, birth defects and impaired physical and psycho-intellectual development. Micronutrient deficiencies of international interest include vitamin A, iron, iodine and zinc. Their deficiencies among the Nigerian population have been documented. The Nigerian Food Consumption and Nutrition data showed that 29.5% of children had marginal vitamin A deficiency, while 13% of mothers and 19.2% of pregnant women were at risk of vitamin A deficiency. The study also showed that 20% of the children were both iron and zinc deficient, while 14.5%, 8% and 4% had mild, moderate and severe iodine deficiencies (Maziya-Dixon., 2004). Our study of adolescents showed that despite adequate intakes of vitamin A, 40% of male and 32% of female adolescents had low plasma concentration of vitamin A ($<20 \mu\text{g/dL}$) (Ene-Obong *et al.*, 2003).

Over nutrition/Non-communicable chronic Diseases (NCCDs)

Added to the problem of under nutrition, as seen above, is the emerging epidemic of diet related non-communicable chronic diseases hitherto seen only in industrialized and developed countries. These conditions have been associated with excessive consumption of one or more nutrients. They include diabetes, hypertension, obesity, cardiovascular disease (CVD), cancers, osteoporosis and dental disease (Table 1). The coexistence of

under- nutrition and over -nutrition within the same population is referred to as the “**double burden of diseases**” (WHO, 2003).

Table 1: Nutritional problems as found in developed and developing country

Problem	Causes	Developed World	Developing World
Anemia	Insufficient bioavailable iron	*	*
Metabolic bone diseases	Insufficient calcium Excess P, prior vitamin D status		*
Insufficient food	Calories protein and other nutrient		*
Low birth weight < 2.5kg	Poor prenatal care and nutrition in pregnancy		*
Goiter/ cretinism	Insufficient iron and or selenium		*
Vitamin A deficiency	Insufficient pro-vitamin A – rich foods		*
Overweight/ obesity	Excess caloric intake e.g. fat	*	*
Heart disease and stroke	Excess saturated fat cholesterol, sodium and low folate	*	*

Cancer	Excess fat, low intake of complex carbohydrate, fruits and vegetables	*	*
Non-insulin dependent diabetes	Excess calorie intake	*	*

Recent studies suggest that nutrition related chronic diseases are increasingly becoming a major health threat, particularly in those regions in rapid nutrition transition (Murray and Lopez, 1994). NCCDs accounted for 60% of global deaths and 47% of the global burden of disease (WHO, 2002, 2005). It is expected that by 2020, NCCD will account for 73% of deaths and 60% disease burden (Shetty, 2002). According to Schmidhuber and Shetty (2005), NCCDs account for at least 40% of all deaths in developing countries and represent an even greater proportion of loss of disability adjusted life years (DALYs). In Africa, they constitute 23% of all deaths (WHO, 2005). They constitute an immense and growing global health problem imposing additional economic and health burden on developing countries.

Although there are few data on the prevalence of NCCDs in the Nigeria, obesity and diabetes are showing particularly worrying trends not only because they are affecting large proportion of the population but also because they have begun to appear earlier in life (Thiam *et al.*, 2006). In a very recent study among children and adolescents we have shown that the prevalence of overweight, obesity and thinness (underweight) were 11.5%, 2.7% and 13.3%, respectively (Ene-Obong *et al.*, 2008). This is a dangerous trend since obesity in children is an indicator of adult obesity. It has been shown that 60% of children who are over weight have one additional risk factor for cardiovascular diseases (CVD).

A review of available data in Nigeria(Ene-Obong, 2008), the prevalence of obesity and overweight were found to range between 9.0-9.6% and 18.6-27%, respectively in the urban areas and 3.6-4.6% and 12.6-16.6%, respectively in the rural area, indicating significant urban rural differences. Obesity and overweight were more prevalent among females (6-8% and 14-27%, respectively) than in males (1-2% and 12%, respectively). Similarly, obesity and overweight were significantly $P<0.001$ more prevalent among female children (3.7% and 12.9%, respectively) than male children (1.8%-10%, respectively). Obesity and overweight appear to increase with age across all age groups. Obesity, overweight and thinness were more prevalent at age 9 years and 14 years. These periods appear to be very critical for the Nigerian child.

Infections/HIV/AIDS

The above conditions also co-exist with high rates of communicable diseases such as HIV/AIDS, malaria, tuberculosis (TB), etc. According to the Institute for Security Studies (2003), Nigeria is the third country with the highest prevalence rate of HIV/AIDS after South Africa and India. Nigeria has a great deal of political, social, and economic influence in West Africa, hence the scourge affecting about 3.9% of the work force in Nigeria goes to affect not only Nigerians but other neighbouring countries (Population Reference Bureau-PRB, 2006). The intensity and the pattern with which HIV/AIDS affect nutritional status are very much different from that in other infections and in ordinary cases of inadequate nutrient intake. For example, HIV/AIDS wasting unlike simple starvation which depletes adipose fat more, takes greater toll on muscle mass (Laura, 1998). Massive depletion in cell mass is an unwelcome situation as it increases mortality risk in HIV/AIDS irrespective of CD4 cell count (Gibert *et al.*, 1997).

Nutrition has important role to play in slowing down the progression of HIV/AIDS. It is both a preventive and therapeutic treatment for HIV infection. Piwoz and Preble (2000) reported that much research conducted in Africa have shown that nutritional status may affect the progression of HIV infection and the survival of patients. This situation is a big challenge to nutritionists in the sub-Saharan Africa region. There is an urgent need for the development of nutritionally rich food materials for the HIV/AIDS patients from locally available and cheap food sources. Work is now going on in our laboratory in this direction. It is hoped that this will go a long way in improving the nutritional status and therefore quality of lives of people living with HIV/AIDS.

Nutrition education is an important aspect of client care. In some areas, the importance of nutrition therapy in HIV disease is underestimated and overlooked. A preliminary study with HIV/AIDS patients (Unachukwu and Ene-Obong, 2006) showed that their food habits were affected by their relatively poor nutrition knowledge, availability of food, lack of financial resources and nutrition counseling. About 73% of them had never received any form of nutrition counseling. Their mean nutritional risk score to be 8.1 (high nutritional risk range is 6 or more). There was a significant positive relationship between the nutrition knowledge score of the respondents and their body mass index- BMI ($r=0.886$; $P<0.5$).

Infant Malnutrition: The national data on infant mortality and morbidity due to preventable diseases is not encouraging. Available statistics show that infant (under 1 year) mortality rate as at 2006 is 99/1000 live births, while neonatal mortality is 53. Percentage of infants with low birth weight-LBW (1999-2006) was 14% (Nigeria Health Review, 2007). This figure is significantly higher in rural communities. In a study conducted by Mozie (2000) in Izzi Local Government Area of Ebonyi, we

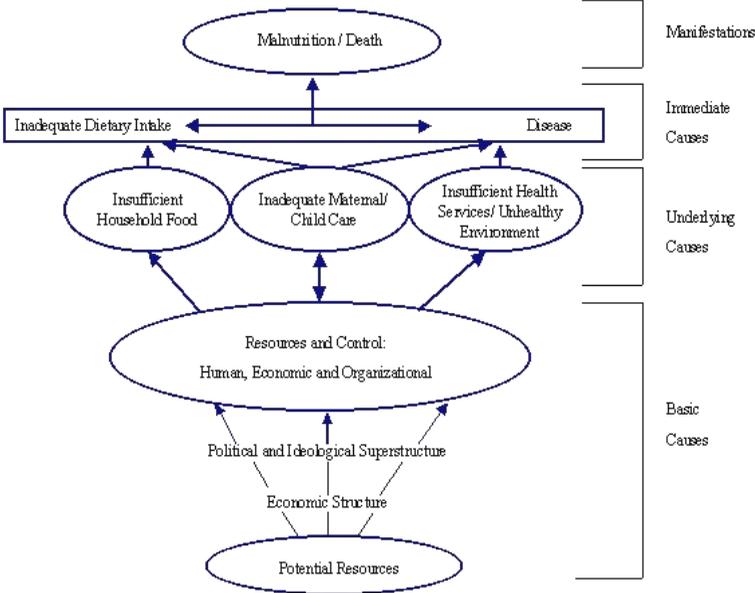
used hospital records collected for a period of 10 years and found that 50% of the women had LBW (<2.5kg) infants. Of 76 adolescent (<20 years) mother, 57(75%) had LBW infants.

Causes of Malnutrition

The science of nutrition has evolved from the medical, natural science or biological paradigm to a social, behavioral, economic, agricultural and political paradigm. This is the basis of the UNICEF conceptual framework for malnutrition, which has led to a better understanding of the causes and consequences of malnutrition and the relationship between nutrition and health (Fig 1). Using this framework it is possible to distinguish three major levels of problems and causes related to malnutrition.

Immediate causes: These are proximal factors which finally precipitate malnutrition. They are related mainly to physiological relationships and have been identified as ***inadequate food intake and diseases***, which usually interact in a mutually reinforcing manner (Fig. 2). Diseases (such as diarrhoeal, malaria, measles, acute respiratory infections and even HIV/AIDS) are characterized by anorexia, which is accompanied by reduced food intake, loss of appetite and nutrient malabsorption, all of which leads to nutrient deficiencies. Infection can cause diarrhoea or vomiting, leading to further nutrient loss. Nutrient can be lost through feces as a result of damage to the intestinal wall caused by some pathogens. It is also characterized by altered metabolism and redistribution of nutrients. The result is increased nutrient requirement, which coincides with reduced nutrient intake, reduced nutrient absorption and nutrient loss.

Fig. 1: Conceptual Framework for Malnutrition



Malnutrition, on the other hand, magnifies the effect of disease. It has long been established that malnourished individuals are more susceptible to infections. This is attributed to the impaired immune function. Infection on the other hand causes further deterioration of nutritional status. This leads to the vicious “malnutrition- infection cycle” (Fig.2).

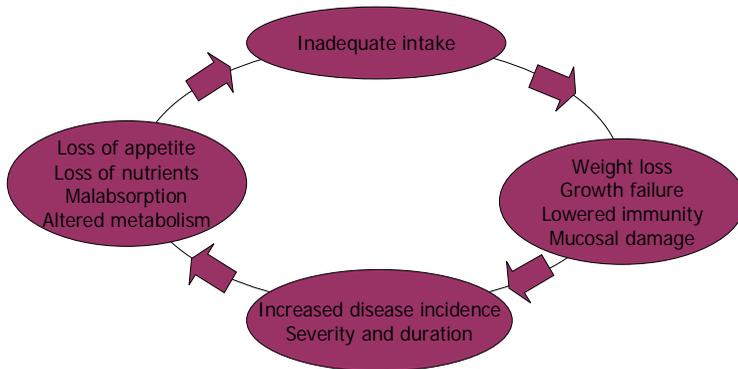


Fig 2: Poor health and infection cycle

ii) Underlying Causes: Causes of inadequate food intake and diseases are inadequacies in *food security*, *caring capacity* of the vulnerable groups and the quantity and quality of *basic/essential services* (health, education, housing, water and sanitation). The underlying reasons are related to the availability and economic and social accessibility to these services which is determined in turn by the economic, human and organizational resources.

Food security is defined as a state in which all people have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Parikh, 2000). The definition that best comprises the current understanding of food security according to Gross *et al.* (2000) states that ‘food security is achieved if adequate food (quantity, quality, safety, socio-cultural acceptability) is available and accessible for and satisfactorily utilized by all individuals at all times to achieve good nutrition for a healthy and happy life. This definition of food security

emphasizes the **stability, availability, accessibility, and utilization of food.**

Food availability is achieved when adequate food is obtainable. *Access (affordability)* is ensured when all households and all individuals within the households have sufficient resources to obtain appropriate food (through home production, purchase, bartering, food aid or loans and donation) for a nutritious diet. Economic access is also not limited to monetary access. It includes access to land, credit, and education and to health services (Parikh, 2000). *Adequate utilization* refers to the ability of the human body to ingest and metabolize food. This brings in the newer concept of *Nutrition Security*, which is more than food security in that it goes beyond food intake to emphasize the biological/physiological perspective. *Stability* means that enough food is available on a continuous basis, including when households face a stress such as crop failure, fluctuations in food prices or seasonal changes in cash income or food production (FAO, 2005)

A major factor in determining nutrition in poor households is the use of available resources, especially for providing food and maintaining of health in the face of unsanitary conditions. This applies with particular reference to children and mothers. Given certain level of household food security, healthy environment and access to services, much depends on how the individuals in the household, especially the women cope with their situation. “Care” as defined by ACC/SCN (1991) refers to the provision in the household and community, **time, attention and support** to meet the physical, mental and social needs of the growing child and other family members. At the extreme, lack of “care” is neglect.

iii) Basic causes: Basic causes are related a country’s economic situation, political climate, ideology and policies, institutions

and pattern of resource allocation combined with climatic (floods, drought, etc.), environmental problems like deforestation and low productive technology. All these lead to poor food production. Negative cultural practices and high population growth further compound the problem.

Nutrition Transition

In developing countries, nutrition transition is identified by a shift from a situation in which energy-poor plant food-based diets, physical activity and under nutrition is prevalent to one in which high consumption of energy-dense processed foods and animal products, sedentarism and high rates of obesity and nutrition-related chronic diseases are the norm (Corvalan, 2006). Many factors have been identified as driving the nutrition transition programme in the developing countries. They include globalization, technological changes in food production, processing and distribution, higher incomes, demographic shifts and urbanization (Hawkes *et al.*, 2005), adoption of western dietary pattern facilitated by advertising for the consumption of unhealthy foods and lack of physical exercise (Joiner, 2006).

As mentioned earlier, our traditional foods are at the point of extinct (Okeke *et al.*, 2008a). The younger generations do not even know them, like them, let alone consume them. As children grow their food/ dietary habits are influenced by the eating habits of their parents, what they are exposed to at home, the environment they find themselves, peer pressure, as well as other physiological needs. Our study of school children and adolescents showed that children in the urban environment (Lagos) were more exposed to fast foods and so preferred and consumed fast foods more than home prepared foods. There was a significantly ($p < 0.001$) higher prevalence of overweight and obesity among those who preferred fast food than those who preferred home prepared foods. When given an array of foods to choose from, it was observed that most of the children preferred

fried foods to boiled ones; sweetened biscuits; carbonated soft drink to soymilk; full cream milk; and among the cereals, weetabix, and whole wheat bread were the least liked (Ene-Obong *et al.*, 2008). Even among obese undergraduates, 64% preferred fried foods (fried plantains and eggs), 45% preferred bread cake, almost 60% sweetened biscuits, 36% and 40% preferred condensed and full cream milk, respectively, while 41% would choose ice-cream from among milk products (Ene-Obong and Okechukwu, 2007, In Press). We also looked at snacking habits and found that over 93% of the children and adolescents snacked. The most popular snacks were biscuits, 75%; doughnut/buns/puffs, 25%; cake, 23% (Table 11). About 67% of obese undergraduates snacked. Interestingly, about 77.5% of them love snacking because snacks taste good.

Technological advancements have led to the production of improved methods of transportation; communication; computerization, and labour- saving devices. These developments, good as they are, have also led to sedentary pursuits, e.g. television and movie watching, video and computer games, internet browsing and chats, especially among the younger population. Among adults these development have increased sedentary jobs and pastimes.

With urbanization, our environment, schools and work places have become obesogenic. Our roads, particularly in the urban areas are heavy with traffic. The lack of safe walk ways, Ways and high incidence of crime prevent people from taking walk. We now have limited play grounds for children to play at school and at home due to overcrowding. Restricted or lack of playtime in school and at home in pursuit for high academic achievement through extra study and lessons are being imposed on children by parents and teachers (Ene-Obong, 2008).

Ene-Obong *et al.* (2008) examined the activity pattern of school children and adolescents and observed behaviors patterns that indicate sedentary lifestyles. About 96% of the children and adolescents went to school from their homes. Although 53% claimed they lived within <30minutes walk to school, only about 35.8% walked to school. We found a significantly ($p<0.001$) higher prevalence of obesity and overweight among children who went to school by car/motorcycle than those who trekked to school. The out-of- school activities were more or less sedentary, namely, sleeping, watching television/video, playing computer games and a few who joined in household food preparation. There was under-reporting with regard to time spent watching television/video or playing computer games. It is clearly evident that with the advent of home videos in Nigeria, a lot of children and adult have adopted watching them as pastime. About 48% and 27% reported watching television or playing computer games, respectively for about 1-2 hours per day. Interestingly 5% and 8% of those who responded to watching television and playing computer games said they had no restrictions as to the number of hour used. The response was usually “*as long as I wanted.*” About 13% and 3.4% watched and played computer games, respectively for 3 hours or more

There is need for a more detail study on the activity patterns of Nigerian children and adolescents. However, several studies have showed the effect of these habits on body size. Crespo (2001) found that obesity in children increased the more hours they watched television. Children who use a lot of media have a lower activity level which is linked to a higher rate of obesity (Vandewater, 2004). Also a strong relationship was found between playing electronic video games and childhood obesity in school-aged Swiss children (Stettler, 2004).

Poor maternal and infant feeding practices

There is evidence of association between retarded fetal growth and NCCDs, including obesity. Poor nutrition and constrained growth in the womb and early childhood, especially if followed by accelerated weight gain later in childhood, leads to increase risk of NCCDs (and obesity) later in adulthood (Baker, 1995). This underscores the importance of good maternal nutrition before and during pregnancy and the targeting of early events in the lives of infants. Available data show that under nutrition and over nutrition exist among adolescent girls and women of child bearing age. Our studies and others have consistently shown that women, particularly in the rural areas have poor nutrient intakes (Mozie, 2000; Ene-Obong *et al.*, 2001; Maziya-Dixon *et al.*, 2004). We found heavy workload, poor education, and quality of diet to be the major causes of malnutrition among rural women. Education was found to modify the cultural barriers that discriminate against women (Ene-Obong *et al.*, 2001). Poor nutrition among pregnant women can lead to poor health and productivity and low birth weight of infant.

The importance of exclusive breastfeeding and adequate complementary food cannot be over emphasized. According to Koletzko and von Kries (2001) breastfeeding provides simple preventive strategies that exploit putative long-term imprinting mechanisms and present little risk of potentially adverse effects. There is strong evidence that breast-feeding for at least six months was associated with a risk reduction for overweight and obesity of >30% and 40%, respectively (von Kries et al., 1999). Despite the elaborate campaigns on its benefits, national data shows that the rate of exclusive breast feeding is approximately 15%, while 73% of the women introduced food/water in the first month of life. However, the rates are higher (>50%) in Baby-Friendly Hospitals. The major obstacle to exclusive breast feeding is its cultural unacceptability especially as it relates to

not giving the infant water to drink (Onuoha and Ene-Obong, 2005).

The problem of adequate complementary food is still very much with us. Fermented cereal gruel-pap (*ogi/akamu*) continues to be the preferred complementary for infants in Nigeria. This has been shown to be inadequate in term of nutrient density. It is bulky, viscose, and low in nutrients. The development of adequate complementary foods has been a subject of intensive research in our department of Home Science, Nutrition and Dietetics, starting with the Bean/ Cowpea Collaborative research Project, using locally available cereal-legume mixes. However, one basic problem with these mixes is their low level of calcium and vitamin A (Uvere *et al.*, 2002; Onuoha, 2006). However, efforts are now on to take care of these limitations by employing food-to-food fortification (Onuoha, 2006).

It is important to note that there is yet on village-based business model to promote the production of these mixes or effective Home Economic extension service to deliver essential nutrition education services to those who need them in the rural areas. The CCRSP actually tried to do this in the past by establishing a village-based mill in Ogbodu-aba but for the “Nigerian factor.”

Approaches to solving the problems of malnutrition

National Initiatives: The failure in the solution of the nutrition problem in Nigeria can be attributed to many factors. One of them is the way nutrition has been perceived in the past and even now. In the 1940s and 1950s nutritional problems (malnutrition) were viewed as largely medical. Attention was focused on vitamin deficiencies (beriberi, pellagra, survey and exophthalmia) and protein –energy deficiencies. By the 1970s, overall food energy supply became the issue. Thus various Nigerian governments initiated different agricultural programs

in order to boost food supply. There was the Farm Settlement Scheme and National Accelerated Food Production Programme inaugurated in 1972 by General Yakubu Gowon. This was followed by the Operation Feed the Nation (OFN) introduced by the Murtala/Obasanjo administration; the River Basin and Rural Development Authority established in 1976; the Green Revolution and World Bank funded Agricultural Development Project of the Shagari administration and the Directorate for Food, Road and Rural Infrastructure (DIFRRI) of the Babangida administration. Experience has shown that laudable as these programmes were; mere increase in food production could not and did not solve our nutrition problems. More recently is the International Fund for Agricultural Development/Cassava Multiplication Programme/ Fisheries Development Project of the last administration.

Prior to 1990, food and nutrition activities in Nigeria were carried out sectorally and uncoordinated, giving rise to several policies addressing food and nutrition concerns in the different development sectors. However, in 1990, the Federal Government of Nigeria (FGN) established the National Committee on Food and Nutrition (NCFN) as an institutional arrangement to coordinate and provide leadership to articulate a comprehensive policy and actions that could effectively reduce malnutrition considerably or eliminate it in Nigeria. The NCFN was initially domiciled at the Federal Ministry of Science and Technology, later relocated to the Federal Ministry of Health (FMOH) in 1993 and by 1994 further relocated to the National Planning Commission (NPC). The establishment of the NCFN led to the formulation of a National Food and Nutrition Policy in 1995. The policy was approved in 1998 and launched on 5th November, 2002. The Policy is to address the problems of Food and Nutrition across different sectors and different levels of the Nigerian society from individual to the national level.

International initiatives: Some of these developments at the national level were spearheaded by international initiatives.

- At the World Food Conference in 1974, world leaders accepted the collective responsibility of the international community to abolish hunger and malnutrition within a decade.

- In 1990, UNICEF supported the World Summit for Children with a call to reduce severe and moderate malnutrition among children less than 5 years of age by half the 1990 rate by the year 2000.

- In 1992, WHO/FAO jointly organized the International Nutrition Conference (ICN) in Rome. The aim of the conference was to keep nutrition at the forefront of development agenda. The government of 159 states, including Nigeria, adopted the World Declaration and Plan of Action for Nutrition (ie the determination to eliminate hunger and reduce all forms of malnutrition) and also endorsed the ambitious goal of the World Summit for Children.

- Again in 1996, FAO organized the World Food Summit. At this summit 186 Heads of States and government pledged their political will and commitment to a Plan of Action to reduce the number of undernourished people to half their 1996 number by the year 2015. The World Food Summit's milestone decision on the right to food led to a renewed focus on the right to adequate food. This right has been recognized in several instruments under international law as far back as 1948, with the Universal Declaration of Human Rights; the International Covenant on Economic, Social, and Cultural Rights (ICESCR) of 1966; the Convention on the Rights of the Child (CRC) of 1990; and the

Convention on the Elimination of all forms of Discrimination Against Women (CEDAW).

- Between 1992 and 1999, various United Nation Agencies emphasized the human rights paradigm. This has led to the adoption in 1999 of the right to adequate food by the United Nation High Commission for Human Right (UNHCHR)-Committee on Economic, Social and Cultural Rights (CESCR). The Right to adequate food implies: **“the availability of food in quantity and quality sufficient to satisfy the dietary needs of individuals, free from adverse substances and acceptable within a given culture.”** Every State is obliged to ensure for everyone under its jurisdiction access to the minimum essential food which is sufficient, nutritionally adequate and safe to ensure their freedom from hunger.
- In 1997 there was the establishment of the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) and their Inter Agency Working Group (IAWG). This consisted of 26 International organizations and agencies with a shared commitment to reduced food insecurity and vulnerability and its multidisciplinary causes rooted in poverty.

Finally at the Millennium Summit in September 2000, the largest gathering of world leaders in history adopted the United Nation’s Millennium Declaration , committing their nations to a global partnership to reduce poverty, improve health and promote peace, human rights, gender equity and environmental sustainability. This has led to the current Millennium Development Goals (MGDs). They include:

Goal 1: Eradicate extreme poverty and hunger

Goal 2: Achieve universal primary education

Goal 3; Promote gender equality and empower women

Goal 4: Reduce child mortality

Goal 5: Improve maternal health

Goal 6: Combat HIV/AIDS, malaria, and other diseases

Goal 7: Ensure environmental sustainability

Goal 8: Develop a global partnership for development

It is noteworthy that the first six (6) goals are directly or indirectly related to nutrition.

The question is: with these and some other initiative not mentioned, where are we now?

Most of the strategies mentioned above are geared towards ensuring food security. Whether food security will translate into improved nutrition security will depend on factors such as health, sanitation, method of food preparation, adequacy of general childcare (Kikafunda and Bambona, 2005), adequate water supply, food allocation and care of vulnerable members within the household (FAO, 2005). The condition of nutrition security combines:

- Access to nutritionally adequate and safe food;
- sufficient knowledge and skills to acquire, prepare and consume nutritionally adequate diets, including those that meet the special needs of young children;
- Access to health services and to healthy environment that ensures the effective biological utilization of the foods consumed (FAO, 1997).

It is important to mention here that the Food Fortification (e.g. vitamin A), salt iodization and the home-grown school feeding (HGSF) programmes of the government are steps in the right direction. Again the HGSF programme is dead in most States. However, there are still a lot of problems and hindrances

Hindrances to Progress: Between 1999 and 2000 the World Health Organization organized several rounds of joint WHO/FAO follow-up workshops in several regions of the world

to monitor progress so far. These follow-up workshops highlighted the impediments to progress in improving the nutritional status of populations and emphasized the need for:

- Effective inter-sectoral coordinating mechanism with clear definition of each sectors area of responsibility for action
- Community ownership and empowerment (beneficiary-driven demand) as a must for successful implementation and sustainability
- Increasing national budgetary resource for nutrition improvement and allocating resources wisely
- Intensifying advocacy at all levels, specifically aimed at decision makers, development planners and those who control resources
- Seizing opportunities to ensure that nutrition becomes an important component and an outcome indicator of relevant development programme such as those of poverty alleviation, roll-back malaria, integrated management of childhood diseases and prevention and control of HIV/AIDS.
- Representatives from civil society, academic institutions, NGOs, and private sector to be involved in the planning and implementation of nutrition improvement programmes.

In Nigeria, the need for an effective coordinating body was taken care of by the establishment of the NCFN as noted earlier. However, the three areas of performance of such agencies in three African countries (Nigeria, Mozambique and Uganda) were evaluated in a recent study by Benson (2007). These areas of performance include: cross-sectoral coordination, advocacy to sustain political commitment for public action to address the problem of malnutrition and resource mobilization.

Interestingly, only in the Nigerian Nutrition Policy is improved nutrition noted as a critical input to achieve the broad development goals of economic growth and poverty reduction, although this orientation of the Nigeria Nutrition Policy is not reflected in the master development strategy for the country, e.g. the National Economic Empowerment and Development Strategy (NEEDS). Although NEEDS included nutrition as a cross-cutting issue, the main focus of NEEDS is economic empowerment/growth. Development is both economic growth and human development. In the 1996 Human Development Report, UNDP defines the three most important human capabilities expressed by human development as follows: (1) the capability to be well nourished and healthy; (2) the capability for healthy reproduction, and (3) the capability to be educated and knowledgeable (UNDP, 1996). All these have implication for nutrition.

Apart from the difference mentioned above, similar findings include:

- In none of the three countries are nutrition activities with a national scope undertaken that involve more than one sector.
- There are no large-scale community-driven development efforts under way that have a strong focus on nutrition.
- There was a low profile of malnutrition within national development policy processes. This is because there are no politically-well-connected leaders working with the agencies in the three countries to ensure that public nutrition activities were allocated sufficient resources.
- There was no evidence that the level of resource allocated by national government to support nutrition activities has changed substantially since they were formed. Most program costs for nutrition activities of national scope are covered by international development

partners (mainly UNICEF, BASICSG in the case of Nigeria) rather than the national government.

- In all the countries the political commitment that exists to address malnutrition is insufficient to mobilize sufficient resources and to build coordinated effort across the sectors concerned that achieve much success.
- Public understanding of the burden that malnutrition imposes on society and what needs to be done to address the problem is weak in the three countries. None of the three agencies was found to be playing a central role in bridging this knowledge gap.

The summary given above captures the hindrances to proper implementation of nutrition programmes in Nigeria. In addition, there is also the low level of skills and poor understanding of the role of nutrition in national development by those who implement nutrition programmes. Even when nutritionists are deployed, they are not given positions where they can influence policy; their career structure excludes them from such management position. In this regard I want to say that some action is now on at the Federal government level to correct this anomaly

While it is true that there is need for advocacy and political commitment in order to improve nutrition in Nigeria, it must be noted that key activities contributing to the improved nutritional status of the population ultimately must take place at the level of the individual, household and community. This is because the individual belongs to the family/household, while individual households/families make up the society at large.

Consumption Patterns and Food Intake of Nigerian

Consumption patterns are closely related to the type of food commodities grown or produced in the different areas (King *et*

al., 1985). In the south (coastal strip and forest areas) the major agricultural products include starchy roots and tubers and starchy fruits (plantain and banana), cereals (maize and rice) and some legumes. In the northern part of Nigeria, cereals are the dominant staples. These provide about 80% of daily energy intakes. Protein is derived mainly from cereals, legumes and meat produced in substantial amount in this area. The nomadic population consumes some quantity of milk, being cattle rearers.

Food consumption in Nigeria has been very dynamic over the years. Some of the factors contributing to this change include cultural and agricultural practices, education, improved standards of living, and population movement/urbanization. In the traditional Nigerian society, farm families cultivated starchy roots, tubers, cereals, legumes, fruits and vegetable. These foods made up the family food basket and were occasionally supplemented by wild and domesticated animals. Legumes, cereals, wild herbs, fruits and vegetables made significant contributions to nutrient intakes of the population, especially during the hungry season as they were normally preserved and stored ready for such seasons. (Nnanyelugo *et al.*, (1985) found that cowpeas and other legumes contributed markedly to the protein, iron thiamin and niacin intake of rural population especially during the pre-harvest wet season. Wild herbs and vegetables were used not only as food but as medicine for various types of ailments. So, basically the traditional Nigerian diets were plant-based. Foods were prepared in their fresh forms and eaten immediately without preserving or keeping them for a longer time.

What do we see today? These practices are no longer maintained. During the colonial days, the cultivation of cash crops affected agriculture and eating habits. Matters were made worse with the “oil boom” and consequent urbanization. With the foreign exchange revenue accruing from oil and high value

of the naira, import of food and other products artificially became cheaper in relation to domestic production. The varied traditional foods are now old fashion and have given way to imported foods. A typical example is the importation of rice, which has reduced local production and replaced the more nutritious local rice (Ofada, adani, Abakilki rice, etc.) and other local staples.

A critical appraisal of a typical Nigerian diet, using 24 hour dietary recalls in rural and urban communities, shows that they are monotonous and are predominated by few foods (Ene-Obong *et al.*, 2001; Okeke *et al.*, 2008b). The commonest foods found regularly on our menu are rice, fufu and soup. The case for the highly refined foreign rice must be viewed more seriously as it is served in almost every function (traditional or western) and cooked in every home with or without vegetables. Bread, spaghetti and *indomine* noodles are also finding their way into our regular menu. Apart from the vegetables used in cooking our soups/sauces, vegetables are hardly consumed in their raw forms. Fruits are not eaten with meals but infrequently and merely as snacks. From most of the food consumption studies in south eastern Nigeria, we found that meat and milk made little contributions to the nutrient intake of the population. This pattern of consumption gives rise to bulky, low nutrient and low dietary fiber diets that have serious health implications as we have already discussed above.

Nutritional Quality of Nigerian Foods/diets

Nutritional quality of a food/diet is determined by the ability of the food/diet to contribute to the maintenance of biochemical functions and optimum health. It depends on the level, availability and utilization of essential nutrients. Thus a comprehensive evaluation of a food/diet begins with an analysis of its components (composition). The final stage is the

determination of the capacity of the food/diet to meet nutrient requirement of humans at various ages.

Nutrient Composition: The need for an understanding of the nutrient composition of locally available foods/diets in any community cannot be overemphasized. A major challenge facing nutritional epidemiologists is the correct measurement of dietary exposure. For nutritional epidemiological studies, they are used to estimate the adequacy of dietary intake of population groups; determine the relationship between diet and health and nutritional status. They can also be used for evaluation of nutrition education, nutrition intervention and food fortification programmes. The task of combating malnutrition needs teaching aids and ready reference materials with regard to the nutritive value of foods. Knowledge of the nutritive value of foods commonly consumed by the population will help in the understanding of the relationship between food intake and the incidence of malnutrition.

As a result of the growing need for Nigerians to know the composition of the foods they consume, in 1986, a workshop on “Food Composition Table for Nigeria” was held at the University of Ibadan. This workshop revealed that few foods have been given research attention to the detriment of others. It showed that little or no information existed on the nutrient composition of our traditional foods in the raw, prepared and processed forms. The few data that existed were scattered. It is unfortunate to state that about 22year after that workshop we do not still have a comprehensive food composition database for Nigeria as obtained elsewhere in the world. For the Nigerian Nutritional epidemiologist, this is a very serious handicap. There is however a fairly recent publication by Oguntona and Akinyele (1995) on the Nutrient Composition of Commonly Eaten foods in Nigerian- Raw, Processed and Prepared. Although a good

attempt, the publication has some limitations and a lot of gaps still exist.

In a recent documentation exercise of the Igbo traditional food systems in collaboration with the Center for Indigenous Peoples Nutrition and Environment (CINE), McGill University, Canada, Okeke *et al.* (2008a) found that of a total of 294 species and over 400 varieties of food items documented, about 217 were missing in the Food Composition Tables currently used in Nigeria. Even the ones contained in the tables contain several gaps or limited information with regard to their contents. The reason for this is the lack of inadequate funding and coordination of research in Nigeria and the consequent lack of basic research equipment/facilities.

At the beginning of my nutrition career, protein-energy malnutrition was the emphasis and there was the need to find alternate sources of cheap affordable protein foods for the population. Since the cost of animal protein was high, the tendency was to consume more of the cheaper starchy staples and fewer animal products. This practice is still prevalent today, especially among the rural population and the urban poor. This led to the interest in vegetable proteins of which cereals and legumes are the chief sources. However, legume grains contain twice the protein content of cereals and much more than the levels in root and tuber crops and so legumes are the leading candidates in this respect.

Legumes were once regarded or described as “poor man’s meat.” This term however, recognized both their high nutritional value and low cost relative to animal products. Market index studies showed that apart from corn (maize), legumes were the cheapest sources of protein for human consumption (Ene-Obong, 1984; King *et al.*, 1985). They contribute significantly to the protein, iron, thiamin and niacin intakes of pre-school

children and pregnant women (Ene-Obong, 1984; Nnanyelugo *et al.*, 1985). It is interesting to note that legumes are no longer referred to as “poor man’s meat” but rather as food for the rich, the informed and those who can afford it (Nnanyelugo *et al.*, 1991). For example, *Okpa*, is now a popular snack/meal not only in Enugu State but in almost every parts of Nigeria.

In Nigeria, various legumes are available. They include the cowpea or black-eyed beans (*Vigna unguiculata*), Pigeon pea or *fiofio/agbugbu* (*Cajanus cajan*), bambara groundnut or *okpa* (*Vigna subterranean*), African yambean or *igirigi/okpodudu/azama* (*Sphenostylis stenocarpa*), lima bean (*Phaseolus lunatus*), groundbean (*kerstingeilla geocarpa*), oil bean seed (*Pentaclethra macrophylla*), horse-eye bean (*Mucuna spp.*), African locust bean (*Parkia spp.*) and a host of others. Soybean (*Glycine max*) is not indigenous but is vigorously promoted. Of all these, the cowpea is the most widely used and researched. It constitutes more than 50% of all legumes consumed. It is consumed once a week or more by more than 75% of the respondents in both rural and urban areas (King *et al.*, 1985; Ene-Obong and Izuchukwu, 1990), regardless of family size, occupation, educational background or marital status of respondents. In Ondo State, the percentage is even higher-85% (Fasominu, 1989).

A Case for Traditional Plant Foods

My experience in the field during the Cowpea Collaborative Research Support Project (CCRSP), which started in 1981, helped me to develop interest in our indigenous legumes. I found that in the rural communities some of the indigenous legumes consumed actually contributed more to the nutrient intakes than the black-eyed pea (cowpea). The CCRSP was a donor-driven research but was very beneficial to us as individual researchers, institution and nation at large. It provided a lot of research facilities and helped to build capacity among staff and

students. My M.Sc project contributed the major baseline data for the project that lasted 10years and eventually won the ITF award in 1991. Hence for my Ph.D work I concentrated on the nutritional evaluation of underutilized/underexploited traditional plant foods with particular reference to those used as soup condiments and those eaten as pulses (legumes). By the special grace of God I had a one-year research fellowship at the National Institute of Nutrition, Rome, Italy (1987-1988) sponsored by the Third World Academy of Science (TWAS). This fellowship accorded me the opportunity to acquire tremendous analytical skills in the evaluation of foods/ diets. On coming back to Nigeria, TWAS still gave me a grant to continue my work. My studies showed that underutilized legumes actually have some important nutritional advantages over the ones that are highly consumed and publicized. I will like to make a case for our traditional plant foods using the African yambean (*Sphenostylis stenocarpa*) and traditional soup thickeners as typical examples.

As far back as 1987, the Food and Agriculture Organization of the United Nation (FAO/UN, 1987) recognized the role of minor crops in nutrition and food security. At its eighth session in March 1985, recommended that member governments with the help of FAO and bilateral and multi-lateral cooperation undertake programmes to:

1. assess through appropriate agriculture and consumption survey the importance of the locally produced traditional crops in the subsistence sector and their economic and nutritional importance in the context of national food supplies.
2. take into account the nutritional value of the minor crops and their cultural place in the community in order to prevent the decline of the most important traditional crops

3. develop appropriate agricultural policies through adequate producer prices and credit facilities to increase their production, storage and commercialization
4. develop with international research institutions appropriate genetic improvements and processing technologies to obtain from traditional crops convenient foods for the urban market corresponding to local taste and preferences so as to decrease food dependency.

In 1992, at the International Conference on Nutrition (ICN), the World Declaration and Plan of Action for Nutrition recommended the promotion of dietary diversity and use of locally available nutrient rich indigenous and traditional foods as a vital tool against food insecurity, malnutrition and disease. This has consistently being reaffirmed at various national and international meetings (WHO, 2003; FAO, 2004). The question is “how far has the Nigerian government implemented these strategies 20 years after despite all its agricultural programmes over the years? I believe we can all answer this question.

Our recent experience during a research project aimed at documenting the traditional food systems of the Igbo culture area of Nigeria showed that the nation is richly endowed with abundant food resources (Okeke *et al.*, 2008a). Unfortunately, this plant diversity is threatened and many of the foods are becoming extinct. Factors influencing this trend include urbanization; change in dietary habits, cultural changes, and over reliance on a few high yielding crops. For these traditional plant foods, little is know about their taxonomy, composition and health benefits and so are hardly considered by national and international agencies in global food and nutrition initiatives. Their dignity and use have even declined among rural people themselves.

What are these traditional plant foods? FAO (1987) defined traditional plant foods as those plants, which are accepted by a community through custom, habit and tradition as appropriate and desirable foods. They are grown for food within the farming system operating in any particular locality or gathered in wild or semi-wild conditions. These include a large variety of legumes, oilseeds, fruits and vegetables. There is no universally accepted list of such plants. Different communities can evolve their own list based on their preferences and food habit.

These resources are indispensable in reversing the “poverty micronutrient-malnutrition trap” in developing countries (Demment *et al.*, 2003). They can provide a source of income for producers and offer potential foreign exchange benefits to national economies. Their promotion is likely to benefit particularly the small farmers, women and other low income groups who are normally by-passed by the benefits of general economic development and who are worst affected by malnutrition (FAO, 1987). There is therefore need to identify these crop varieties with selective nutritional assets. Improved technology will facilitate the detection, isolation, identification of food components with specific health benefits (Combs, 1999).

Nutrient Potentials of Traditional Plant Foods

Nutrient Content: The proximate, mineral (Table 2) and amino acid composition of the African yambean and other legumes were compared (Ene-Obong and Carnovale, 1992a). Although the cowpea had higher protein and ash content than the African yambean, it is interesting to note that the African yambean had a better pattern of essential amino acid (EAA) (Table 3).

Table 1: Nutrient composition of some known and lesser know legumes in Nigeria per 100g dry matter (Ene-Obong and Carnovale, 1992)

Nutrient	African †yam- bean	Pigeon †pea	Bambara *ground- nut	Cowpea cultivars			
				<i>Akidi</i>	<i>Olalu- di</i>	Black- eyed beans (white)	Brown beans
Protein %	21.6	22.1	16.0	28.0	27.8	26.5	24.4
Ash %	3.1	3.9	3.0	4.4	3.6	4.2	4.0
Fat%	2.1	1.8	6.0	1.8	1.9	2.1	2.0
DF %	19.12	23.8	ND	24.0	21.1	11.8	11.4
Carbo- hydrate %	54.03	48.4	65.0	41.8	45.6	55.5	58.2
Iron (mg)	4.7	5.2	4.2	4.9	8.2	8.4	8.2
Zinc (mg)	2.6	3.2	ND	4.3	4.9	4.8	3.8
Calcium (mg)	46.0	110	85	72	75	87	101
Phos- phorus (mg)	288	355	ND	474	379	422	468
Sugar %	5.87	5.80	ND	6.53	5.13	6.01	6.62
Starch %	48.2	42.6	ND	35.3	40.5	49.5	51.6

***Values from: FAO (1982); † Values are averages of three cultivars of the legumes**

One of the yard sticks for evaluating the protein quality of a food is its capacity to meet the need for EAA. It has higher values in all EAA except for phenylalanine where its value was equal to that of cowpea (5.62mg/gN) but significantly lower ($p<0.05$) than that of pigeon pea (9.72 mg/gN). The African yambean compares well with soybean in EAA except for methionine and tryptophan. Despite this limitation, the African

yambean still has more sulphur-containing amino acids (SAA) than pigeon pea, cowpea and soybean.

Table 2: Comparison of the essential amino acid composition (mg/gN) of African yambean, cowpea, pigeon pea, soybean and FAO reference pattern

Essential amino acid	Soybean		African *yambean	Cowpea*	Pigeon *pea	FAO reference pattern	LSD. 05
	†	§					
Lysine	6.4	7.0	7.67 ^a	6.58 ^a	6.57 ^a	4.32	0.74
Threonine	3.9	3.2	3.9 ^a	3.68 ^b	3.49 ^b	2.88	0.22
Cysteine	1.3	0.8	1.69 ^a	1.01 ^b	1.18 ^b	2.02	0.30
Valine	4.8	4.4	5.22 ^a	4.90 ^b	4.29 ^b	4.32	0.70
Methionine	1.3	1.6	1.19 ^a	1.19 ^a	1.09 ^b	2.30	0.08
Isoleucine	4.5	3.8	4.57 ^a	4.33 ^a	3.71 ^b	4.32	0.46
Leucine	7.8	7.3	7.60 ^a	7.50 ^a	7.15 ^b	4.90	0.27
Phenylalanine	4.9	5.1	5.62 ^a	5.62 ^b	9.72 ^a	2.88	0.74
Tryptophan	1.3	1.9	1.02 ^b	1.06 ^b	1.21 ^a	1.44	0.12
Total S-amino acid (SAA)	2.6	2.4	2.88	2.2	2.27	4.32	

† Data from FAO (1982);

§ Data from Evans and Bender (1967);

LSD.05=Least significant difference

* Source : Ene-Obong and Carnovale(1992)

All legumes are limiting in SAAs (cysteine and methionine). This is the reason why nutritionists encourage the practice of combining legumes with cereals (corn, millet, sorghum, fonio/hungry rice (*acha*), wheat, oat, etc.). Cereals are rich in these SAA but limiting in the EAA lysine. Legumes on the other hand, are very rich sources of lysine. Therefore, the practice of consuming legume and cereal helps to improve the amino acid profile of our traditional diets and is highly encouraged. Typical Nigerian dishes with such combinations are rice and beans, *akara and ogi*/bread, corn and pigeon pea or other legumes (*ayaraya oka*), etc. The nutrient composition of these foods have

been analyzed and published in several journals (Nnanyelugo *et al.*, 1985; Ene-Obong, 1992; Okeke and Ene-Obong, 1995; Ene-Obong and Madukwe, 2001; Okeke *et al.*, 2008). These diets are rich sources of protein, iron and zinc.

One of the problems associated with Nigeria foods/diets is the variations in their composition. This is due to lack of standardized recipes. Culture, socioeconomic status, family characteristics/preferences are some of the factors that affect the quantity and variety of food commodities used in the cooking and consequently the nutritive value of the foods.

Protein Quality of Traditional Plant Foods: The total quantity of many nutrients in a food/diet is a poor indicator of nutrient adequacy. The adequacy depends on the amount consumed (serving portion consumed), availability and utilization of the essential nutrients. The availability and utilization can be measured more accurately using biological (*in vivo*) assays. However, some chemical methods (*in vitro*) methods have been found to correlate well with *in vivo* methods. The protein quality of the African yambean and pigeon pea were evaluated using both *in vivo* and *in vitro* techniques. The foods were processed, cooked, dried and mixed to resemble the traditional dishes prepared from them (Ene-Obong and Obizoba, 1995) The African yambean was mixed with corn or *agidi* (corn starch pudding) and both supplemented with crayfish. The pigeon pea diets were formulated to resemble *ayaraya* and *achicha*. These were supplemented with either crayfish or fermented oil bean. The results showed that for protein efficiency ratio (PER), biological value (BV) and net protein utilization (NPU), the African yambean mixtures or diets were comparable with casein (control), indicating a synergistic supplementation effect, which presumably resulted in an EAA pattern similar to that of casein diet (animal protein). Similarly, the BV of the pigeon pea diet compared well with that of casein. However, NPU is more of a

practical magnitude than BV in protein quality evaluation. This is because digestibility is an important and integral part of the nutritive value of a dietary protein source. NPU is a measure of both digestibility and BV of the amino acid mixture absorbed from food (Scrimshaw and Young, 1972). This indicates the superiority of the African yambean diets to pigeon pea.

Other parameters were used in addition to N-intake and output to evaluate these diets (e.g., liver weight, liver nitrogen, plasma albumin and plasma proteins). Plasma albumin synthesis is very sensitive to the level of protein in the diet. At lower levels of nitrogen intake, albumin synthesis in the liver decreases resulting in lower albumin concentration in the plasma (Millward and Garlick, 1972). Plasma albumin was highest for the African yambean mixed with corn although its value was statistically equal to that of casein. Without going into the technicalities, the following points from this study which can be used in standardizing traditional legume-based dishes are as follows:

- That legume-cereal blends compare favourably with casein (animal protein) with or without supplementation.
- That the African yambean blends were superior to the pigeon pea blends.
- That supplementation with crayfish is superior to that of fermented oil bean seeds.
- That legume-starchy staple (yam, cassava, cocoyam, and plantain) blends be supplemented with crayfish rather than fermented oil bean seed. It is advisable to use both.
- That African yambean, an under-exploited traditional legume is superior to most commonly consumed and promoted legumes in Nigeria.
- This work also showed that pap (*ogi/akamu*) and *agidi* (corn starch pudding) have undergone a lot of processing and are very low in nutrient. They must be supplemented

with other nutrient-dense foods whenever they are to be consumed. Hence it is recommended that pap be supplemented with soybean or other legume flours/milk/crayfish, etc.

Anti nutritional Factors in Traditional Foods: The problem of plant protein digestibility has been suggested to be the effect of an interplay of several factors such as presence of enzyme inhibitors (trypsin, chemotrypsin etc), phytate, polyphenols (e.g. tannin), and other anti nutritional factors. Again the levels of these anti nutrients in the African yambean were found to be lower compared to the other legumes studied (Ene-Obong, 1995). Trypsin inhibitor which had the greatest effect on the *in vitro* protein digestibility of the African yambean is known to be heat labile. Thus the various heat treatments applied during preparatory procedures are effective in inactivating these protein inhibitors (Ene-Obong, 1992).

Constraint to the use of African yambean: The constraints mentioned even in areas where it is grown, consumed and cherished include: low production/non-availability, hard-to-cook (HTC) phenomenon or long cooking time, low status of the crop (women being the sole producers), lack of appropriate technology and organoleptic qualities (Ene-Obong, 1992). The HTC phenomenon has been shown to be genetic and this can be taken care of by genetic selection (Ene-Obong and Okoye, 1996). These constraints can also be handled by simple domestic processing techniques. For example, simple overnight soaking (6-12 hours) can reduce the cooking time of the African yambean by more than 50 %. Also soaking was able to reduce the levels of tannin and phytate (Ene-Obong and Obizoba, 1996). However, prolonged soaking reduced the level of calcium and iron values by 19% and 35%, respectively. This is because substantial amount of these minerals, including zinc and magnesium are located in the seed coat of the legume.

Calcium is one of the nutrients that is limiting in the Nigerian diet due to the poor or non consumption of milk and milk products and vegetables. Legumes constitute one of the major sources of calcium in our diets and so efforts should be made to dehull (removal of seed coat as in the preparation of *moi moi*) them only when absolutely necessary, e.g., in production of infant complementary foods. In this case efforts must be made to replace lost calcium from other sources. Adequate calcium intake reduces the risk of developing bone disease, rickets, osteoporosis, hypertension and colon cancer.

Soup Condiments as Traditional sources of Dietary fiber

In addition to the contribution of traditional legumes to protein, mineral and B-vitamin intakes, our studies showed that they are also good sources of dietary fiber. This is commonly referred to as *roughage*. *Dietary fiber* is the term used to describe the portion of plant cells that cannot be digested by human alimentary enzymes and therefore cannot be absorbed from the small intestine. It is different and more than crude fiber (roughage) in foods. They lower blood sugar and cholesterol levels, help to form softer bulky stools and speed up transit time through the digestive system, and protect against colon and rectal cancers. Our studies showed that of all the cowpea cultivars, *akidi* and *olaludi* (which are local cowpea cultivars), all the pigeon pea cultivars and the brown cultivar of the African yambean had dietary fiber content ranging from 21.1% - 25.7%. The two popular cowpea cultivars, white and brown, had the least (11.8% - 11.4%, respectively). Other common sources include fruits, vegetables, and cereal grains.

A large number of traditional soup thickeners/condiments are used in Southeastern Nigeria. They include:

- *Afzelia africana*: Counterwood tree (English), *Akparata* (Ibo), *Kawo* (Hausa), *Apa* (Yoruba)
- *Detarium microcarpum*: Tallow tree (English), *Ofo* (Ibo), *Taura* (Hausa), *Agashidam* (Tiv).
- *Brachystegia eurycoma*: *Achi* (Ibo), *Ukung* (Efik), *Akolodo* (Yoruba), *Okwen* (Bini).
- *Mucuna urens/Sloanei*: Horse –eye bean (English), *Ukpo* (Ibo), *Apon* (Yoruba)
- *Mucuna pruriens*: Velvet bean (English), *Agbara* (Ibo)
- *Sclerotium of Pleurotus spp.*: *Osu* (Ibo).

These were also found to contain appreciable amounts of protein (11.5% - 33.6%), fat (3.2-29.1%), and small quantities of carbohydrates (2.6-10.4%) (Table 4).

Table 4: Nutrient composition; total, soluble and insoluble dietary fiber contents of Nigerian soup thickeners (% per 100g dry matter

	Dry matter	Protein	Fat	Ash	CHO	Dietary fiber	Soluble DF	Insoluble
<i>Afzelia africana</i> (<i>Akparata</i>)	86.2	20.9	29.1	3.9	8.7	37.4	24.9	12.5
<i>Brachystegia eurycoma</i> (<i>Achi</i>)	86.7	11.5	4.7	2.2	4.4	77.2	51.3	25.9
<i>Detarium microcarpum</i> (<i>Ofo</i>)	89.0	13.9	11.5	1.8	2.6	70.2	50.0	20.2
<i>Pleurotus spp.</i> (<i>Osu</i>)	81.5	13.2	3.2	1.4	10.4	71.8	0.70	71.1

<i>Mucuna urens</i> (Ukpo)	89.8	21.2	17.8	2.4	7.5	51.1	38.4	12.7
<i>Mucuna Pruriens</i> (Agbara)	93.3	33.6	3.8	3.6	38.6	20.4	ND	ND

^a Mean value for white and black varieties; CHO=carbohydrate; DF= Dietary fiber; ND= Not determined

Source: Ene-Obong and Carnovale (1992)

Table 4 shows the soluble and insoluble dietary fiber components of these food items. These were also analyzed in the form in which they are used. The dietary fiber content of the food items ranged from 18.5-77.8% dry matter. With the exception of *Pleurotus spp.*, the other thickeners had soluble dietary fiber content ranging from 66% - 75% (Ene-Obong and Carnovale, 1992b).

Table 5: Mineral composition of soup thickeners (mg/100g dry matter)

	Iron	Zinc	Calcium	Phosphorus
<i>Azzeria africana</i> (Akparata)	11.1	4.3	338	488
<i>Brachystegia eurycoma</i> (Achi)	10.5	1.9	13.7	250
<i>Detarium microcarpum</i> (Ofo)	6.9	2.5	116	360
<i>Pleurotus spp.</i> (Osu)	7.3	5.1	8.6	286
<i>Mucuna urens</i> (Ukpo)	14.2	3.3	26.5	271
<i>Mucuna Pruriens</i> (Agbara) ^a	9.2	5.3	26.8	483

^a Mean value for white and black varieties

Source: Ene-Obong and Carnovale (1992)

They are also very good sources of the minerals: iron, zinc, calcium and phosphorus (Tables 5).

The soluble dietary fiber is capable of forming a viscous mixture with water, slowing the digestion and absorption of carbohydrates, and thus having a beneficial effect on blood

glucose and insulin levels. Their ability to bind with bile acids, together with short-chain fatty acid production in the colon, help to lower blood cholesterol and other lipid levels. They may undergo varying degrees of fermentation in the colon, resulting in an increase in fecal mass and increased intestinal propulsion. On the other hand, the insoluble ones are able to retain large amounts of water, making them very effective stool-bulking agents. This also increases intestinal propulsion.

The findings of this study showed that these traditional food items may play multiple roles in health promotion and protection. Because of the high protein, fat, iron, calcium and phosphorus in addition to the dietary fiber content of *Afzelia africana* a preliminary assessment was conducted using it to produce diabetic snacks (Ene-Obong and Odoh. 2001). This was done by producing a composite of plantain flour and *A. africana* in various ratios. The effects of the snacks on post-prandial glucose level of diabetics as well as its acceptability were investigated. The snacks were highly acceptable to both diabetics and non diabetics. The mean post-prandial blood glucose response was found to be lower than that of the control although the difference was not significant.

Based on the findings of this study, Onyechi *et al.* (1998) investigated the therapeutic properties of *Afzelia africana* and *Detarium microcarpum* in human subjects. *Detarium microcarpum* was found to significantly reduce postprandial blood glucose and insulin concentration in healthy human subjects, while *Afzelia africana* increases serum blood cholesterol. This is alarming, since this thickener is still used by some sections of the Nigerian population. The authors suggested that *Afzelia africana* should be processed appropriately to remove some toxic factors before use. Work is now going on in our laboratory using simple household processing techniques to reduce this limitation and enhance its effectiveness. However, it

must be stated that these soup thickeners have great therapeutic potentials and must be fully exploited to contribute to stemming the rising tide of diet-related chronic non-communicable diseases associated with the “nutrition transition.”

Micronutrient Bioavailability

Bioavailability of trace elements from foods has always been of interest to nutritionists, food scientists and clinicians. It is more so now that micronutrient deficiencies have become a public health problem in developed and developing nations of the world, due to their social and economic impact. Without a detailed knowledge of nutrient bioavailability, it will be impossible to relate dietary intake with indices of physiological function used to assess health.

Trace element disorders are not exclusively as a result of inadequate dietary intake but by a host of interacting factors such as intake level of the nutrient and its chemical forms, promoters (ascorbic acid), inhibitors (phytate, fiber) or interaction between mineral elements, age, physiological and pathological states, etc. The question that is usually asked is whether these deficiencies are as a result of inadequate intake, inadequate absorption or excessive demand.

We determined the micronutrient (iron, zinc and copper) content of some southeastern Nigerian foods/diets and evaluated the adequacy of these foods/diets in meeting the nutritional needs of the vulnerable groups (pre-school children, pregnant and lactating women) (Madukwe and Ene-Obong, 2002). The factors affecting the bioavailability of these micronutrients were also determined (Ene-Obong and Madukwe, 2001). A diet that supplied at least 30% of the day's requirement was considered adequate, bearing in mind that the individual would get the remaining nutrients from the other two meals of the day. Results showed that the diets contained enough micro nutrients to meet

the nutritional requirement of the groups studied. This is in line with earlier studies which showed that the micronutrient contents of some of our traditional diets are able to provide more than enough of these nutrients when consumed at recommended energy levels (Sayers *et al.*, 1974; Mbofung *et al.*, 1987; Ene-Obong, 1993).

One of the major problems of Nigerian foods/diets is their high bulk, containing 50-80% moisture per 100g of edible portion. This makes it impossible, particularly for the pre-school child with small stomach capacity to consume much at a given time. Socio-economic status and household size are some of the factors that can affect the portion size of food consumed by individuals. The serving portions used in these studies may not even be attained by some individuals or household in the rural communities. For example in a study of pregnant women in Izzi Local Government Area of Ebonyi State, Mozie (2000) found that these women deliberately had lower serving portions, because they were afraid of having big babies. This will further lower the amount of nutrients they can obtain from such diets.

Although the content of the micronutrient studies were sufficient in terms of the amount, bioavailable iron and copper were grossly inadequate for all the groups. Interestingly, iron, copper and zinc directly or indirectly play significant role in the etiology of anaemia. Iron is needed to make haemoglobin, a protein in the red blood cell that carries oxygen to the brain, muscular system, immune system and other parts of the body. Copper is an essential element for a wide range of animal species. It is a component of ceruloplasmin responsible for oxidation of iron to its trivalent (Fe^{3+}) state. Only as Fe^{3+} can iron be coupled to its transport protein, transferrin. It is possible that the iron deficiency found in the Nigerian population is a combination of Fe and Cu deficiency.

Using the FAO/WHO (1988) model for estimating bioavailability, we were able to classify southeastern Nigerian diets as low-(7.5%), intermediate-(15%), and high-(22.5%) bioavailability (Ene-Obong and Madukwe, 2001). Starch-based diets were classified as low bioavailability diets, with a mean value of 9.0%; cereal and legume-based diets as intermediate, with mean values of 14.4% and 14.3%, respectively, while the soups were classified as high bioavailability, with a mean value of 21.7%. Fortunately, these soups are eaten with starch-based dishes. However, because of economic reasons, the quantity of soup consumed tends to be very small. Among the starch-based diets yam pottage and *Ukpo-ogede* had values as high as 13% and 11%, respectively compared to others that were <10%. Generally, the presence of fish/meat factor and vegetables improved the bioavailability of iron. This, once more, emphasizes the need to supplement our traditional starchy roots and tuber-based dishes with vegetables and crayfish.

On the other hand, the phytate: zinc molar ratio (PZMR) of the meals and their serving portion were < 10, indicating that the amount of phytate in the diets is not sufficient to exert any serious effect on zinc bioavailability. It is generally thought that phytic acid is the major inhibitor of Zn utilization from foods of plant origin, especially in the presence of calcium. The low PZMR of the diets could be attributed to processing e.g. fermentation. Fermentation is capable of reducing the phytic acid content of foods by 20-34% (Ene-Obong and Obizoba, 1996). Thus it is possible to deduce from this that Zn deficiency may not necessarily be attributed to phytic acid or tannin levels but may occur as a result of interactions with other dietary components, e.g. calcium and iron. These two micronutrients interfere with Zn uptake by direct competition.

Healthy Eating or Eating Right

My experiences in food consumption surveys, food quality evaluation and interactions with people made me to realize the need for nutrition education at all levels. Nutrition is one subject that affects everyone irrespective of age, sex, education, occupation, socio-economic status, physiological state, culture, religious affiliation or geographical location. It is no wonder then that everyone is a “nutritionist.” This has led to a lot of misunderstanding, misconception and nutrition quackery. This is because people lack the correct knowledge or basic information on which to base their practices. At this junction, I want to appreciate and thank God for the Full Gospel Businessmen’s Fellowship International (FGBMFI), Calabar Main Chapter who (saw the need of taking care of the soul as well as the body-the temple of the Spirit of God), invited me to give a talk on “Eating Right.” By the special grace of the Almighty God that talk metamorphosed into a text title: **EATING RIGHT: A NUTRITION GUIDE** (Ene-Obong, 2001).

The main objective of the book is to provide validated, correct nutrition information that would enable people make informed choices within budgetary and cultural constraints and contribute to the maintenance of personal health, well-being and productivity. The book is intended for a wide range of audience and I am aware that the content has continued to be blessed as many as have read and used it. It is my intention (by His grace) to continue to update this book in order to include new developments in the field of nutrition. I will not go into the details of the book but cannot end this lecture without discussing the issue of what constitutes healthy eating or eating right at least for the benefit of those who have not seen or read the book.

Balanced Diet or Adequate Diet?: When we talk of healthy eating or eating right, one is literally referring to a consumption pattern that will lead to good health and well-being. This is

popularly known as eating a “*balanced diet*.” Basically the foods we eat contain six vital nutrients (carbohydrates, proteins, fats, minerals, vitamins and water) that are essential for growth, repair and maintenance of the body. Requirements for these nutrients have been set for different ages, sexes and physiological groups. Balanced diet was therefore previously used by the professionals to describe the meal that contained all these nutrients in their right proportions. Thus, nutrient intake must balance requirement in order to avoid deficiency disease symptoms, for example, rickets (calcium deficiency), anemia (iron deficiency), night blindness (vitamin A deficiency), etc. The balanced diet has so far helped and is still being used for some nutrients (iron, calcium) to reduce the prevalence of deficiency diseases.

As mentioned earlier, we are in a “nutrition transition” and the co-existence of under nutrition and over nutrition referred to as the “double burden of diseases” and new wave of developments in food and nutrition sciences has led to a new paradigm; a shift from known nutrients to speaking about “food components”; a move from the focus on nutrient deficiency and requirement to encompass the prevention and alleviation of diet-related non-communicable diseases. This has resulted in the use of such terminologies as *rational diet*, *prudent diet*, *healthy diet or healthful diet and adequate diet*. Thus, the use of the term balanced diet is now regarded in the nutrition community as obsolete. The term *adequate diet* is now preferred and used to describe the meals we consume.

Advancement in nutrition science and phytochemistry has shown that apart from the six major classes of nutrients in foods, there are other substances that are beneficial in the maintenance of good health. These include dietary fiber, phytochemicals, antioxidants, essential fatty acids, oligosaccharides, enzymes and micro-organisms. Foods containing one or more of these

substances are referred to as *functional foods*. They promote health and provide additional benefits beyond that of meeting basic nutritional needs. They are said to promote intestinal health, protect against cardiovascular problems and other cancers, reduce cholesterol levels, lower blood pressure and improve the immune response.

An adequate diet is therefore that which is balanced in nutrients but also contains sufficient amounts of other dietary components that are necessary for good health. It emphasizes *nutritional balance as well as functional diversity*. It addresses the health outcomes of the nutrition transition by paying attention to the *energy density* of the diet, *glycemic control*, and *oxidative stresses*. These features are not given priority by the use of the term balanced diet. Let us briefly examine what these food components are and where we can find them.

Dietary fiber: This is the portion of plant cells that cannot be digested by human alimentary enzymes and therefore cannot be absorbed from the small intestine. It is different and more than crude fiber (roughage) in foods. They lower blood sugar and cholesterol levels, help to form softer bulky stools and speed up transit time through the digestive system, and protect against colon and rectal cancers.

We can obtain dietary fiber from;

- Whole grain cereals (whole wheat, corn, millet, guinea corn, *acha* or hungry rice)
- Legumes (black-eyed beans, pigeon pea, bambara groundnuts (*Okpa*), African yambean, soybeans or any other indigenous legume found in particular localities or areas.
- Fruits and vegetables- There are many varieties of vegetables in Nigeria. Examples include the green spinach, fluted pumpkin leaves, *ewedu*, *okazi*. Select

these fruits and vegetables depending on what is available in your own locality.

- Some traditional soup thickeners as mentioned above

Phytochemicals: These are chemicals found in plant that are not necessarily nutrients but provide significant health benefits. They have also been shown to reduce risk of certain diseases like cancers and heart diseases. Examples of phytochemicals include saponnins, phenols, carotenoids, monoterpenes, flavonoids, indoles, fructo-oligosaccharides and a host of others. Again such chemicals are found in foods such as legumes, fruits (oranges and other citrus fruits, bananas, mango, etc.) and vegetables (cucumber, carrot, cauliflower, broccoli, onions, chili peppers, eggplants, etc.), green/black tea, mushrooms and garlic.

Antioxidants: Free radicals (reactive oxygen species) are produced during normal biological reactions in the body. Their production cannot be stopped but they must be removed in order to prevent their damaging effects. Thus antioxidants are substances which help to counteract the actions of free radicals in the body. They do this by simply controlling the free radicals or transforming them to less damaging compounds or repairing the damage cell itself. Free radicals have been implicated in the etiology of the following diseases: arthritis and rheumatic disorders, cancers, eye diseases, coronary heart diseases, cataract formation and weakening of the immune system.

Typical antioxidants include: vitamins C and E, beta-carotene, niacin (B₁), riboflavin (B₂) and minerals (zinc, selenium, copper and iron). The major sources are fruits and vegetables, cereals and legumes, and red palm oil (for beta-carotene, alpha-tocopherols and tocotrienols).

Essential Fatty Acids: There are some fatty acids that must be consumed in order to maintain health. These are called essential

fatty acids. They are essential because the body cannot produce them in sufficient quantities. They include alpha-linolenic acid (Omega-3), linoleic acid (Omega-6) and oleic acid (Omega-9). Alpha-linolenic acid and linoleic acids are precursors of eicosanoids. These are potent regulators of body functions such as blood pressure, labour, blood clotting, immune response, inflammation and secretion of the stomach. Blood clots are part of the heart attack process. However, eicosanoids formed from Omega-6 have been found to have the potential to increase blood pressure, inflammation, platelet aggregation, allergic reactions and cell proliferation, while those produced by Omega-3 fatty acids have opposing effects. Thus, the balance between Omega-6 and Omega-3 fatty acids may be of paramount importance (Bagga *et al.*, 2002; Chajes and Bougnoux, 2003).

Sources of omega-3 fatty acids include: salmon, trout, herring, tuna, sardines, mackerel, walnuts, pumpkin seeds and soybeans. Regular consumption (about twice weekly) of alpha-linolenic acid (omega-3) has been suggested in order to obtain adequate amount of omega-3. Studies have shown that those who eat fish about twice a week (240g) run lower risk for heart attack than those who rarely eat fish. Omega-3 fatty acid has a favourable effect on heart rhythm (Wardlaw and Kessel, 2002). Recently, there has been concern about the presence of dioxins and polychlorinated biphenyls (PCBs) in oily fish. However, according to Buttriss (2004), it has been suggested that their presence is far outweighed by their nutritional benefits, such that high risk groups (e.g., pregnant women) can benefit from one or two servings a week and other groups can safely consume more (up to 4 servings per week for men, boys, and women past childbearing age). A portion or serving in this case is considered to be about 140g.

Omega-6 dietary sources include meat, butter, egg yolks, whole milk, corn oil, safflower oil, sunflower oil, and cotton seed oil. **Dietary sources of omega-9** (a monounsaturated fat) are: extra-virgin olive oil, almonds, avocado pea, canola oil and nuts.

Probiotics and Prebiotics: Probiotics are single or mixed culture of live microorganisms which beneficially improve the properties of the indigenous micro flora. *Lactobacillus* and *Bifidobacteria* are typical examples. **These are available in yogurts and fermented food products.** Prebiotics are said to be non digestible food ingredients that beneficially affect the host by stimulating the growth and/or activity of one or a limited number of bacteria species already present in colon and thus attempt to improve host health (Gibson and Roberfroid, 1995). Such indigestible products can be obtained from fruits, vegetables and legumes.

How do we plan an adequate diet?

Having known the components in the various foods we consume, the next question would be: how does one select and combine these foods to make up an adequate diet? What quantity of the various types of food can one eat or how often can one consume these foods? The fact that some foods were not mentioned above does not mean that they are not good or healthful. No food is essentially bad. Even the foods we regard as “junk” still have their place in human nutrition. What makes the food we eat healthful or unhealthful is the way we select and combine them, the way we process, prepare, preserve, and cook them, the quantity we eat and the frequency of consumption. There are practical guides that are employed in this process, but I shall briefly discuss four of them:

- The Food Guide Pyramid
- Dietary Guidelines for various age groups
- Recommended Nutrient Intakes (RNIs)

□ Serving Portions

The Food Guide Pyramid

This is a systematic way of classifying foods. Foods can be classified according to their functions, nutrient content, types or a combination of all three. The American “Basic Four” has always been used in nutrition practice for planning meals. The Basic Four was made up of: the milk group; meat group; vegetable and fruit group; and the bread and cereal group. The United States Dietary Guideline for the year 2000 recommended the use of the Food Group Pyramid made up of five groups. It includes:

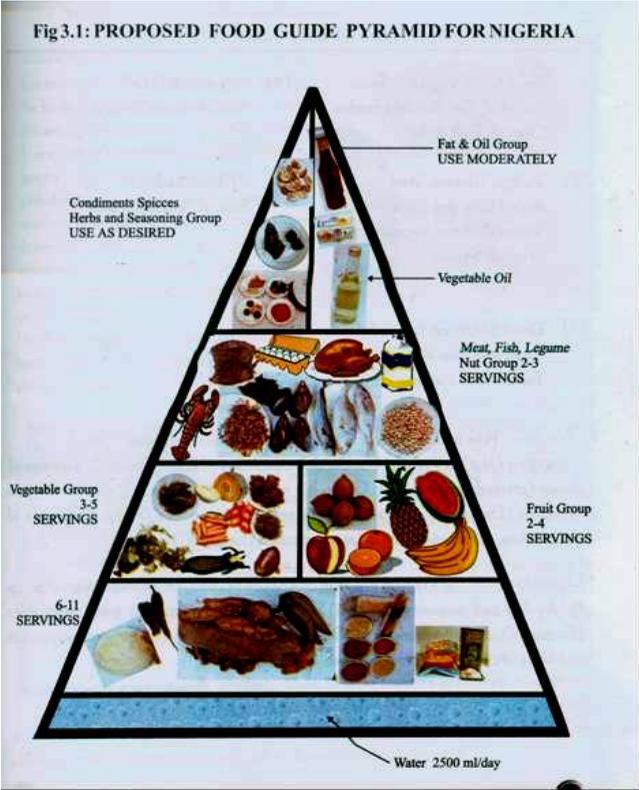
1. Grain group
2. Fruit group
3. Vegetable group
4. Meat Group
5. Milk or Dairy group

This food grouping is not quite applicable to our Nigerian situation. Experience in the field shows that milk and its products are not major part of our food system, particularly in the rural areas. Foods in this group lack dietary fiber and vitamin C. Although items in the meat group are available, they are beyond the reach of the common man. The starchy staples are completely absent. In order to adapt the food pyramid to suit our culture, available food resources and improve our eating habit, I attempted a modification of the American Food Pyramid as shown (Fig. 3). This is made up of seven groups.

The pyramid is to show the serving portions. Serving portions are more towards the base, while they decrease as one moves toward the apex of the pyramid. At the base of the pyramid are the starchy roots and tubers and cereal grains and their products, with 6-11 serving portions/day. This is in line with the high-carbohydrate-low fat diet recommendation. The products can be home produced or commercially produced food items. If they

are commercially products, it is advisable to buy whole meal, enriched or fortified products. The major function of this group is to provide energy. However, cereals can provide some amount of proteins, minerals and vitamins if not over processed.

Above the root, tuber and cereal group are two groups: the fruit group and the vegetable group. They are separated to ensure adequate consumption. These two groups desire special emphasis. They are the major sources of mineral, vitamin and anti-oxidants. Studies have shown that those who ate fresh fruits daily had a 24% lower rate of death



from heart disease, 32% lower rate of death from stroke and 21% lower rate of death from all causes than those who eat fresh fruits on a less than daily basis (Key *et al.*, 1997). Most of the food consumption studies showed that most people do not consume fruits. Even when they are eaten, they are not eaten with meals. The vitamin C in fruits and vegetables helps to absorb non-heme iron in our diets.

The next is the meat group. The major function of this group is to provide protein. They are also good sources of B-vitamins, iron, calcium, Zn, etc. All edible meat and meat alternatives, legumes and seeds are included in the group. Two to three servings of the meat group is recommended.

At the apex are food items that should be used in moderation. This includes the various types of cooking oils, butter, margarine, and other fatty foods. The second group at the apex contains spices, herbs, seasonings and other condiments used in the preparation of traditional soups/sauces and dishes. These are normally used in small quantities or according to taste.

Dietary Reference Values

These are derived from measurements or calculation of nutrient requirements based on specified life stage group and by gender if applicable. The values obtained are standards against which measured intakes can be compared. They are intended to apply to healthy subjects. The value for each nutrient is set to be adequate for 97-98% of all individuals in a life stage group, given a specified definition of adequacy. They are expressed as single absolute values and not in relation to weight or height. These values vary among countries. At the moment there are no specific tables of reference nutrient intake for Nigeria. In the absence of such, the FAO/WHO expert recommendations are followed.

Food-Based Dietary Guidelines

The Federal Ministry of Health in collaboration with the World Health Organization (FMOH/WHO, 1999) developed some dietary guidelines for various age groups aimed at ensuring that all segment of the Nigerian population consume adequate amount of food/nutrients to prevent protein-energy malnutrition, micronutrient deficiencies and diet-related non-communicable diseases. The advantages of these guidelines are as follows:

- They are food-based and so are easier to understand
- They help the consumer think in terms of foods rather than nutrients
- They address multiple nutrient deficiencies at the same time
- Since foods have social, cultural, ethnic and family values and meanings they can be adapted to different culture and dietary traditions and locally feasible strategies
- They are preventive, cost-effective and sustainable
- They also address and support the crucial role of breastfeeding and the special diet and care needs of infants and children.

These guidelines are contained in the book “Eating Right”

Serving Portions

The serving portion can be used as a standard for nutritional adequacy of a diet. Although it is less precise, it is more related to how people eat. It does not represent a fixed quantity of energy or amount of a given nutrient but a certain quantity of food, which can be obtained using household measures (e.g. kitchen spoon, cups, glasses, etc.). Unfortunately, we are yet to determine standard portion sizes for our traditional foods/diets. This is a vital tool in dietetics practice and a major challenge to the Nigerian Dietetics Association.

A Redefinition of Diet Quality

Malnutrition cannot be reduced by mere intake of food but by the consumption of high quality diet. In nutritional science, the adequacy of a food/diet was and is still based by some on the ability of the food to have a balance of the six key nutrients. In defining the quality of diet, functions that address the health outcomes of the nutrition transition, particularly through attention to energy density, glycemic control, and oxidative stress must be addressed. Uauy and Solomons (2006) have shown that dietary quality has at least five basic elements:

- Safety from microbiological pathogen and their toxic by-products
- Adequate (avoiding both deficit and excesses) density in micronutrients and health promoting bioactive compounds
- Freedom from nutrient excess or substance that are noxious to health activity
- Cultural acceptability and harmony with the local culinary traditions of a population.
- Existing basis within local cultivation, husbandry practices that are environmentally safe and sustainable.

For this lecture, it will not be possible to discuss every aspect of dietary quality mentioned above. However, it is important to note that all of the above conditions must be met to ensure good health. Health is only possible where resources are available to meet human needs and where the living and working environment is protected from life-threatening and health-threatening pollutions, pathogens and physical hazards (WHO, 1992). I shall concentrate on what constitutes a high quality diet from a purely nutritional point of view.

There are four major aspects of a high-quality, healthy diet. They include: **variety, adequacy, moderation, and overall balance**, covering nutrition concerns of both developed and developing countries (Kim *et al.*, 2000)

Variety: This can be evaluated in two ways: overall variety and variety within group. Overall variety means inclusion of at least one serving per day from each of the food groups. Variety within group involves choosing different foods from within a particular group. For example, within the meat group, ones protein intake should not come from only one source. A diet that has variety within a similar food group as well as an overall variety is believed to be superior to a diet with a monotonous source.

Adequacy: This criterion evaluates the intake of dietary elements that must be supplied sufficiently to guarantee a healthy diet, as well as a precaution against under nutrition. These foods/nutrients are fruits, vegetables, complex carbohydrates, protein, iron, calcium and vitamin C. Based on my experience in the field these are the foods/nutrients that are limiting in our diets and goes to support the earlier data given for Nigeria. The 8 components and the criteria for assessing them (Kim *et al.*, 2000) are as follows:

Components	Creteria
Vegetables group	≥ 3-5 serving/day
Fruit group	≥ 2-4 serving/day
Grains	6-11 serving/day
Fiber	20-30g/day
Protein	10% of energy/day
Iron	100% of RDA
Calcium	100% RDA
Vitamin C	100% of RDA

Requirements for iron, calcium and vitamin C vary with age and sex. The number of servings for vegetables, fruits, grains and fiber depend on the energy intake (e.g. 1700kcal, 2200kcal and 2700kcal).

Moderation: Moderation evaluates the intake of foods and nutrients that are related to chronic non-communicable diseases and may need restriction. Such items include fat, salt, cholesterol and sugar. This does not imply avoidance, since certain levels of these are necessary for body function.

Total fat	≤ 20% of total energy
Saturated fat	≤ 7% of total energy
Cholesterol	≤ 300mg/day
Sodium	<2400mg or 2.4g/day
Empty calorie foods	≤ 3% of total energy/day

Overall balance: This is the overall balance of the diet in terms of proportionality in energy from the different sources (protein, fat and carbohydrates) and fatty acids (saturated-SFA, monounsaturated-MUFA and polyunsaturated fatty acids-PUFA). Excessive intake of saturated fatty acids is a risk factor for several chronic diseases, while intakes of MUFA and PUFA have been found to be protective of these conditions (Weisburger, 2000). The ratios are as follows:

Carbohydrate: protein: 55-65: 10-15: 15-25
fat ratio
Fatty acid ratio PUFA:SFA= 1-1.5 and MUFA: SFA= 1-1.5
(PUFA:MUFA:SFA)

These criteria formed the basis for the construction of the Diet Quality Index-International (DQI-I), which is a useful tool for global dietary assessment (Kim *et al.*, 2000). It is a global tool for monitoring healthfulness of diet and for exploring aspects of diet quality related to nutrition transition. Table 6 shows the

range of population dietary intake goals recommended by World Health Organization (2003).

Table 6: Range of population Dietary Intake Goals

Dietary Factors	Goals
Total fat	15-30% energy
Saturated fatty acids	<10% energy
Polyunsaturated fatty acids (PUFA)	6-10% energy
n-6 Polyunsaturated fatty acids (PUFAs)	5-8% energy
n-3 Polyunsaturated fatty acids (PUFAs)	1-2% energy
Trans fatty acids	<1% energy
Monounsaturated fatty acids	By difference ^a
Total carbohydrate ^b	55-75% energy
Free sugar ^c	<10% energy
Protein	10-15%
Cholesterol	<300mg/day
Sodium chloride (salt)	<5g/day
Fruits and vegetables	>=400g/day
Total dietary fibre	From foods
Non-starch polysaccharides (NSP)	

^a This means “total fat – (saturated fatty acids + polyunsaturated fatty acids + trans fatty acids)”; ^b The percentage of total energy available after taking into account that consumed as protein and fat hence the wide range; ^c The term “free sugar” refers to all monosaccharide and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey syrups and fruit juices.

Source: WHO (2003)

Thus, a healthy high quality diet leading to optimum health should contain sufficient energy and nutrient, but also limit the amount of saturated fat, trans fat, cholesterol, sodium, added sugar and include many servings of fruits and vegetables and whole grain products (Hawkes *et al.*, 2005).

Having examined the consumption patterns of the Nigerian population, the various recommendations for adequate nutrition, we can observe obvious discrepancies between the current diets

and what is recommended. If we are to conduct self-study of our food habits, most of us will not score high. The truth is that there are many factors that affect what people eat. These include: personal taste, knowledge of nutrition, food skills, habits, food price, product advertising and agricultural policy. According to Kennedy *et al.* (1999), some of these factors are the responsibility of the individual but many of the forces that shape food consumption are beyond the consumer's direct control. Thus, it cannot be assumed that nutritional problems can be addressed solely by encouraging individuals to improve their diets, but also requires that sufficient quantities of healthy foods are available in the market (McNamara *et al.*, 1999).

The situation mentioned above has great implications for the Agricultural production and policy. Traditional agriculture measures success in terms of food production. The adequacy of food supply is often defined in terms of energy alone and food supply data is used to assess nutritional adequacy. This method tends to overstate the actual amount of food available. Our present knowledge of the relationship between diet and health suggests the need for a paradigm shift. Welch and Graham (1999) argued that while the production paradigm helped world agriculture to provide adequate calorie and while the sustainability paradigm addressed many of agriculture's environmental problems, there is a need to view agriculture as a producers of balanced nutrition. This requires going beyond just increasing yield, but ensuring that human food and nutrition needs are linked to systems of food production and acquisition. It will also require linking outcomes with improvement in consumer accessibility and nutrient content and bioavailability (Combs, 1999).

These can be achieved specifically through breeding and biotechnology. High-yielding varieties with enhanced capacity to take up and retain trace elements from the soil can be produced. This is said to have been done in the case of high-

yielding varieties of rice containing twice the iron and zinc content of varieties currently in the field. Also, using molecular biology and plant breeding it will be possible to produce low-anti nutrient plant foods.

There is need to revitalize our traditional food systems in order to expand the food base and diversify our diets. This will require the combination of indigenous knowledge and the advancements in science and technology to select, and produce these foods. There are many more taxonomic, agronomic, processing, nutritional and marketing challenges that will require research and development action plan in order to achieve this objective.

A case for Nutrition Education

The Holy Bible declares that people perish for lack of knowledge. In this regard I am referring to the lack of nutrition knowledge. Nutrition effected directly and defines the health of all. This is the reason why the knowledge of nutrition should be a must for everyone. Besides, there are other reasons why nutrition education is imperative. The traditional food environment and procedures for communicating food-related information are being overwhelmed by urbanization, commercialism, and other factors. Folk wisdom, misconceptions about foods need to be supplemented and replaced with scientific information. Consumers are bombarded every day with all sorts of nutrition information. In most cases, they are unable to understand and interpret the information given and so end up being confused. Part of the reason is that the consumers are not equipped by prior education to effectively interpret and use product information.

Based on the above, I wish to state that nutrition education or nutrition as subject should be made compulsory for every body at some point in the school system from nursery, through primary, to the secondary school. This is the period when foundations are laid. The present system whereby only few

female students offer it as an SSCE subject needs to be discouraged; after all females as well as males can influence family food consumption positively or negatively. This will be enhanced by other nutrition activities e.g. school feeding and gardening programmes. Even in the tertiary institutions nutrition education should take its proper place in the General Studies programme. I believe that this will help promote the development of conceptual framework (principles, generalizations and application of principles) that provides the basis for interpreting the meaning of product information to make consumer decisions. I must say that this was the basis for writing the book on “Eating Right.” It is not a recipe book but a book to help individuals understand the basic principles of nutrition. A good knowledge of these principles will enable individuals adjust to changing food supplies; discriminate among differing kinds of dietary advice; seek out and be receptive to further knowledge and finally make informed choices that will maintain health, well-being and productivity.

Mr. Vice-Chancellor, I want to sincerely thank you for this wonderful opportunity given to me to deliver this lecture. I also want to publicly and sincerely thank you for righting one of the wrongs done to me in this University. I have forgiven all concerned. I am saying this because this is the only opportunity I have to appreciate you. In the final analysis, I learnt that God was actually working for my own good to allow it happen. He wanted me to serve at a time that I could bring out the best He has bestowed on me. The issue is that I have always been misrepresented and misunderstood, but it really does not matter. If Jesus was misunderstood, who am I not to be? I am happy that I gave my best to this University anytime I was given the opportunity. However, I have learnt so much in this place and I thank God for having led me thus far. I want to also joint many to congratulate you for what God has used your administration to do in the University of Nigeria, Nsukka. Having been here for

the past 30 years, I know that the difference is clear. Congratulations Sir! I however have one appeal to make and that is; that some good landscaping be done for all the new structures to add value to them and further beautify our environment.

Permit me Sir, to appreciate my teachers- Prof. Agusiobu (though late, he was a father and a teacher); Prof. Okorie, my undergraduate supervisor; Late Prof. D.O. Nnanyelugo, my M.Sc Supervisor and Prof. I.C. Obizoba, my Ph.D Supervisor. Prof. P.O. Ngoddy initially was a co-supervisor for my Ph.D. I want to appreciate him for his critique of my work which actually gave me some good direction. I will not forget Mrs. Veronica Onuoha, and Dr (Mrs.) Emelie for their inspiration and many others too numerous to mention. You will bear with me that they taught me well. I also want to thank some of my research associates and colleagues - Prof. E.Chinwe. Okeke, Prof. (Mrs.) Ada Uwaegbute, Dr Chris Iroegbu and Dr. A.E. Onwurah. I have enjoyed and learned much working with all of you. I cannot easily forget Prof. Obidoa. He allowed me to use his laboratory to do my work when I came back from Italy. On behalf of all those who benefited from your laboratory I say thank you and God bless. My friends, colleagues and students in the Department, thank you for your love and cooperation. I will like to specially thank some of my friends: Mrs. Uduak Okon, Dr Uche Amazigo, Prof. (Mrs.) Obioma Nworgu, Mrs. Chinyere Nwabueze, and Dr. (Mrs.) Nne-Ola Onuoha. I thank God for having these virtuous women as friends. Nne-Ola, I want to thank you and Rev Christian Jireh for the spiritual role you played in my life. You have been wrongly accused on many occasions. How I wish people know you as God does. Never mind; continue the good work because God will surely reward you for the lives God has used you to touch.

I will like to appreciate my siblings for their love and encouragement. I sincerely want to appreciate Uche Jerry Eze, our wonderful son-in-law and our in-laws, Dr and Mrs. Akanwa, for their prayers, love and support. You are a blessing to us as a family. I will like to specially thank the Prof. Obi Njoku, Chairman Senate Ceremonial Committee and all the members of the Committee for their love and support. God bless you all.

Finally, I want to acknowledge the following groups for their support of my research activities and experiences:

- The Bean Cowpea Collaborative Research Support Project (University of Georgia/ University of Nigeria, Nsukka)
- The Third World Academy of Sciences (TWAS) for Research and Training in Italian Laboratories
- The Applied Diarrhoea Disease Research (ADDR) Project of the Harvard Institute for International Development (HIID)
- NEST /Ford Foundation
- Senate Research Grant 83/84, University of Nigeria, Nsukka
- WHO/African Programme for Onchocerciasis Control (APOC)
- Center for Indigenous People's Nutrition and Environment (CINE), McGill University, Canada

Mr. Vice-Chancellor, distinguished Professors and members of Senate, my colleagues, students and friends, well wishers, Lions and Lionesses, ladies and gentlemen thank you for your patience and God bless you.

References

Administrative Committee on Coordination, Sub- Committee on Nutrition (ACC/SCN, 1991) Some Options for improving nutrition in the 1990s. Supplement to SCN News No. 7: (Mid 1991)

Baker DF (1995): Feta origin of coronary heart disease. *BMJ* 311(6998): 171-174

Bagga D, Anders KH, Wang HJ, Glaspy JA (2002): Long-chain n-3-to-n-6 polyunsaturated fatty acid ratio in breast adipose tissue from women with and without breast cancer; *42(2)*: 180-185

Benson T (2007): Cross-sectoral coordination failure: How significant a constraint in national efforts to tackle malnutrition in Africa? *Food and Nutrition Bulletin*; 28(2, Supplement):S323-s330

Brundtland GH (1999): Nutrition, Health and Human Right. In: *Adequate Food: A Human Right*. ACC/SCN United Nations System's on Nutrition. No. 18 (July): 19-21.

Buttriss J (2004): Oily fish: still on the menu! *British Nutrition Foundation; Nutrition Bulletin*, 29: 287-288

Chajes V, Bougnoux P, (2003): Omega-6/omega-3 polyunsaturated fatty acid ratio and cancer. *World Rev Nutr Diet*: 92:133-151

Combs, GF (1999) Opportunities for food system based approaches to improving health; Opening presentation, 9th Gatlinburg symposium on plants, nutrition and health. October 10th, 1999

Corvalan C (2006) Latin America: avoiding the nutrition transition “trap”. 10th Dr Abraham Horwitz Lecture; UN/SCN: Tackling the double burden of malnutrition: A global Agenda 32: 38-48

Crespo CJ, Snut E, Troiano RP, Bartlett SJ, Macera CA, Andersen RE (2001) Television watching, energy intake and obesity in US children. Archives of paediatric and Adolescent Medicine, 155: 360-365

Demment MW, Young MM, Sensenig RI (2003) providing micronutrients through food based solutions: a key to human and national development. J. Nutr. 11(Suppl. 2) 33: 3879S-3885S

Ene-Obong (1984): Market index, consumption patterns and utilization of cowpea/legumes to the nutrient intakes of selected communities around Nsukka. M.Sc Thesis: Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka.

Ene-Obong (1992): Nutritional evaluation, consumption patterns and processing of the African yambean (*Sphenostylis stenocarpa*) Ph.D Thesis: Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka

Ene-Obong (1993): Adolescents living in boarding houses in Nsukka, Enugu State, Nigeria 11: Quality of school meals and snacks and their contribution to nutrient intakes. Ecol. Fd. Nutr. 30: 179-193

Ene-Obong (1995): Content of anti nutrients an in vitro protein digestibility of the African yambean, pigeon pea, and cowpea. Plant Fd. Hum. Nutr.; 48:225-233

Ene-Obong (2001): Eating right: A Nutrition Guide. The University of Calabar Press, Calabar

Ene-Obong (2008): Epidemiology of Obesity in Nigeria. A paper presented at the Nestle Nutrition Institute Africa (NNIA) Cluster Scientific Meeting for Nigeria held at Protea Hotel, Enugu on the 22nd May, 2008. Theme: The Double Burden of Childhood Malnutrition and Obesity in Emerging Nations (Nigerian Experience)

Ene-Obong HN and Carnovale E. (1992a): A comparison of the proximate, mineral and amino acid composition of some known and lesser known legumes in Nigeria. *Food Chem.* 43: 169-175

Ene-Obong EE and Okoye FI (1993): Effect of seed coat on water permeability in the african yambean, *Sphenostylis stenocarpa*. *Nigerian Journal of Botany*; 6:43-51

Ene-Obong H.N and Carnovale E. (1992b): Nigerian soup condiments: Traditional processing and potential as dietary fiber sources. *Food Chem.* 43: 29-34

Ene-Obong HN and Obizoba IC (1995): Protein quality of some Nigerian traditional diets based on the african yambean (*Sphenostylis stenocarpa*) and pigeon pea (*Cajanus cajan*) *Plant Fd Hum. Nutr.* 48: 297-309

Ene-Obong HN and Obizoba IC (1996): Effect of domestic processing on the cooking time, nutrients, anti nutrients and in vitro proetin digestibility of the African yambean (*Sphenostylis stenocarpa*) *Plant Fd. Hum. Nutr.* 49:43-52

Ene-Obong HN and Izuchukwu (1999): C.C. (1991): Household consumption pattern, processing and utilization of soyabean (*Glycine max*) in Urban Nsukka. *Nig. J. Nutr. Sc.* 12(2): 48-52.

Ene-Obong, HN and Madukwe, E.U (2001): Bioavailability of trace elements in south eastern Nigerian meals and the effect of dietary components. Nig. J. Nutr. Sci. 22 (1 and 2): 4-12.

Ene-Obong, HN, Enugu GI and Uwaegbute AC (2001): Determinants of Health and nutritional Status of Rural Nigerian Women. J. Health Popul. Nutr. 19(4): 320-330.

Ene-Obong, HN and Udoh IF (2001): A preliminary assessment of the acceptability and effect of snacks based on *Azelia africana* and plantain (*Musa paradisiaca*) composites on post-prandial glucose level of diabetics. Plant Product Res. J; 6:1-10.

Ene-Obong HN., Odoh I.F., Ikwuagwu O.E. (2003) Plasma vitamin A & C status of in-school adolescents and associated factors in Enugu State, Nigeria. J. Health Popul. Nutr. 21(1): 18-25.

Ene-Obong HN and Okechukwu, IY (2008) Prevalence and determinants of obesity infemale undergraduate students living in halls of residence in the University of Nigeria, Nsukka Campus (In Press)

Ene-Obong HN, Ejekwu A, Onuoha NO, Ibeanu V (2008) Prevalence of obesity, overweight and thinness among school children and adolescents from southern Nigeria. (In Press)

FAO (1987): Promoting underexploited food plants in Africa: A brief for policy makers. FAO/UN, Rome

FAO/WHO (1988): Requirements of vitamin A, iron, folate and vitamin B₁₂, Food and Agriculture Organization, Rome. P.45-50

FAO (1997): *Agriculture, food and Nutrition for Africa. A resource book for teachers of agriculture*. Rome, Food and Nutrition Division

FAO (1998): Guidelines for national FIVIMS. Background and principles: Interagency Working Group. Rome (available at <http://www.fao.org/docrep/003/x8346E/x8346e01.htm>)

FAO/WHO (2004): Promoting fruit and vegetable consumption around the world. Fruits and vegetables for health: Report of Joint FAO/WHO Workshop, 1-3 September, Kobe, Japan.

FAO (2005) *Protecting and Promoting Good Nutrition in Crisis and Recovery: Resource Guide*. Food and Agriculture Organization of the United Nations, Rome.

Fasominu AM (1989): Consumption pattern and utilization of available legumes among the people of Ondo LGA, Nigeria. 1st Degree Thesis: Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka.

Gross R, Schoeneberger H, Pfeiffer H, and Preuss HJ (2000) Four dimensions of food and nutrition security: Definitions and concepts. ACC/SCN: Nutrition and Agriculture, 20(July): 20-25

Hawkes C, Eckhardt C, Ruel M, and Minot N (2005) Diet quality, poverty and food policy: A new research agenda for obesity prevention in developing countries. UN/SCN 29: 20- 22

Institute for Security Studies Profile; Economic Community of West African States (ECOWAS). [Ww.iss.co.za/AF/RegOrg/unity to union/ecowas.prof.htm/](http://www.iss.co.za/AF/RegOrg/unity%20to%20union/ecowas.prof.htm/)

Joiner K (2006) 10th ECOWAS Nutrition Forum on Nutrition and Diet Related Chronic health problem, Geneva

Kennedy E, Blaylock J, and Kuhn B (1999): On the road to better nutrition, p.1-4. *In* E. Frazao (ed.) America's eating habits: Changes and consequences (AIB-722). USDA Economic Research Service, Washington, DC., 473pp.

Key, JA *et al.*: In Medical Update (1997): Vitamin Information Centre; Vitamin: New Developments No. 28, July

Kikafunda, J. and Bambona, A. (2005) Food Security does not Automatically Guarantee Nutrition Security: A Case Study of Bushsenyi District, Western Uganda. African Crop Science Conference Proceedings 7: 687-689

Kim SW, Haines SMA, Popkin BM (2003): The diet quality index-international (DQI-I) provides an effective tool for cross-national comparison of diet quality as illustrated by China and United State. *J. Nutr.* 133: 3476-3484

King J, Nnanyelugo DO, **Ene-Obong HN** and Ngoddy PO (1984): Market index and dietary patterns of low income households with special reference to cowpea (*Vigna unguiculata*) Nig. *J. Nutr. Sc.* 5(1): 53- 58.

King J, Nnanyelugo DO, **Ene-Obong HN** and Ngoddy PO (1985): Household consumption profile of cowpea (*Vigna unguiculata*) among low-income families in Nigeria. *Ecol. Fd. Nutr.* 16: 209-221.

Koletzko B, and von Kries R (2001) Is early feeding related to later obesity risk? *Annales Nestle*, 50(2): 69-76

Kracht U and Schulz M (1999) Food security and nutrition: A global challenge Lit-Verlag; Germany

Laura MK (1998): Nutritional assessment and management of HIV Disease patients. *AIDS Read* 8(3): 121-130

Madukwe, EU and **Ene-Obong HN** (2002): Adequacy of micronutrient content of south eastern Nigerian meals in meeting the nutritional needs of vulnerable groups. *Agro-Science: Journal of Tropical Agriculture, Food, Environment and Extension*, 3(2): 37-44

Maziya-Dixon B, Akinyele IO, Oguntona EB, Nokeo S, Sanusi RA, and Harris E (2004) Nigeria Food Consumption and Nutrition Survey 2001-2003 (Summary). International Institute for Tropical Agriculture (IITA); Ibadan, Nigeria. Pp 67

Mbofung CMF and Atinmo T (1987): Trace element nutrition of Nigerians. *Wld Rev. Nutr. Diet* 51: 105-139 (Karger, Baseh)

Millward DJ and Garlick PJ(1972): The pattern of protein turnover in the whole animal and the effect of dietary variation. *Proc. Nutr. Soc.* 31: 257

Mozie A (2000): Food habits and nutrient intakes of pregnant women and their effect on birth weight of infants in Izzi Local Government Area, Ebonyi State, Nigeria. M.Sc project report; Department of Home Science, Nutrition and Dietetics, University of Nigeira, Nsukka.

Murray CJ, Lopez AD (1994) Global and regional cause of death pattern. *Bulletin World Health Organization* 77:447-480.

Nnanyelugo DO, King J, **Ene-Obong HN** and Ngoddy PO (1985): Seasonal variations and contribution of cowpea (*Vigna unguiculata*) and other legumes to nutrient intake in Anambra State, Nigeria. *Ecol. Fd. Nutr.* 17: 271-287.

Nnanyelugo DO, Ngoddy PO, Uwaegbute AC, **Ene-Obong HN**, and Ngwu EK (1991): Assessment of cowpea project impact using rapid rural appraisal (RRA) technique. Paper

presented at the 24th annual conference of the Nutrition Society of Nigeria. 5th-9th November, 1991. River State University of Science and Technology, Port Harcourt, Nigeria.

Obaid TA (2004) Health and link to nutrition: Maternal health is key. UN/SCN: Nutrition and the Millennium Development Goals 28(July): 15-18

Oguntona EB and Akinyele IO (1995): Nutrient composition of commonly eaten foods in Nigeria-Raw, Processed and Prepared. Food Basket Foundation Publication Series Pp131

NDHS (2004): Nigerian Demographic and Health Survey. National Planning Commission (NPC): Nigeria and ORC Macro. <http://www.who.int/infobase/reviewer.aspx>?

Okeke, EC and **Ene-Obong HN** (1995): Nutrient composition of conventional foods as eaten in Northern Anambra State, Nigeria. J. Nutri. In Recipe and Menu Dev. 1(3): 27-34.

Okeke EC, **Ene-Obong HN**, Uzuegbunam AO, Ozioko AO, and Kuhnlein H (2008a): Igbo Traditional Food Systems: Documentation, Uses and Research Needs. Pakistan Journal of Nutrition 7(2): 365-376

Okeke EC, **Ene-Obong HN**, Uzuegbunam AO, Ozioko AO, Umeh SI and Kuhnlein H (2008b): Nutrient composition of foods and their contribution to energy and nutrient intakes of children and women in rural households in Igbo culture area. Pakistan Journal of Nutrition 7(5) xxx-xxxx

Onuoha NO (2006): Production and evaluation of a low-cost micronutrient-rich complementary food. Ph.D Thesis, Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka.

Onuoha N.O. and **Ene-Obong H.N.** (2005) Exclusive Breastfeeding: Mothers' experience, attitude and effect on child's health in Nsukka Urban, Nigeria. *Nig. J. Nutr. Sci.* 26(1):34-42

Onyechi UA, Judd PA, Ellis PR (1998): African plant foods rich in non-starch polysaccharides reduce postprandial blood glucose and insulin concentration in healthy human subjects, *British Journal of Nutrition*, 80(5): 419-428

Parikh KS (2000). World food system: Resilient for the rich, stubborn for the starving. *UN/SCN: Nutrition and Agriculture*, 20(July): 17-20

Population Reference Beareau (PRB, 2006): World Population Datasheet. <http://www.prb.org/Datafinder.aspx>

Piwoz EG and Preble EA (2000): HIV/AIDS and Nutrition – A review of the literature and recommendation for nutritional care and support in sub-Saharan Africa. Academy for Education Development: Washington D.C.

Sayer MH, Lynch SR, Charlyon RW, Bothwell TH, Walker RB and Mayer F (1974): Iron absorption from rice meals cooked with fortified salt containing ferrous sulphate and ascorbic acid. *Brit. J. Nutr.* 31: 367-375

Schmidhuber J and Shetty P (2005) Nutrition transition obesity and non-communicable diseases: Drivers, outlook and concerns. *UN/SCN* 29:13-19

Scrimshaw NS and Young VR (1972): Clinical methods for the evaluation of protein quality. In; Protein and amino acid function. (Ed.) Bigwood EJ, VOL. 2: 363-380. Pergamon Press, New York.

Shetty P (2002) Food and Nutrition: The global Challenge. In: Introduction to Human Nutrition MJ Gibney, HH Vorster, and FJ Kok (eds.). The Nutrition Society Textbook Series: Blackwell Science Ltd., p.342.

Stettler, Nicolas, Signer, Theo and Suter Paolo (2004) Electronic games and environmental factors associated with childhood obesity in Switzerland. *Obesity Res.* 12:896-903

Thiam I, Sambe K, Lavanga D, (2006) Diet related chronic disease in the West African region. Standing Committee on Nutrition (SCN) News 23: 6-10

Uauy R and Solomons NW (2006) The role of the international community: Forging a common agenda in tackling the double burden of malnutrition. *UN/SCN* 32:24-37

Unachukwu and Ene-Obong (2006): The nutritional knowledge, food habits and anthropometric status of HIV/AIDS patients attending a hospital in Lagos. A paper presented at the Annual General Conference of the Nutrition Society of Nigeria

UNDP (1996): *Human Development Report*. New York: Oxford University Press

Uvere PO, **Ene-Obong HN**, Eze, N. (2002): Production of complementary food from maize and bambara groundnuts processed by fermentation and malting. *Plant Product Res. Journal* 7(1): 20-31

Vandewater ER, Shim M, and Caplovitz AG (2004) Linking obesity and activity level with children's television and video game use. *Journal of Adolescence*, 27: 71-85

Viscser TLS and Seidell (2001): The public health impact of obesity. *Ann Rev. Pub. Health*, 22: 355-375

Von Kries R, koletzko B, Sauerwald T (2000) Breastfeeding and obesity: cross sectional study. *BMJ* 319:147-150

Vorster HH and Hautvast Jo (2002): In: *Introduction to Human Nutrition*. Gibney MJ, Vorsteer HH and Kok FJ (eds.); on behalf of The Nutrition Society; Blackwell Science Ltd.,

Wardlaw GM, Kessel MW (2002) *Perspective in Nutrition*. 5th edition: McGraw-Hill Companies. p.482.

Welch RM AND Graham RD (1999): A new paradigm for world agriculture: Meeting human needs. *Field Crops Research* 60: 1-10

Weisburger JH (2000): Prevention of cancer and other chronic diseases worldwide based on sound mechanism. *Biofactors* 12: 73-81

WHO (2000) *Obesity: preventing and managing the global epidemic*. Report of a WHO Consultation on obesity, Technical Report Series, No. 894

WHO (2002a) *The World Health Report 2002: Reducing risk, promoting healthy life*, World Health Organization, Geneva

WHO (2003) *Diet, nutrition and the prevention of chronic disease*. Report of the Joint FAO/WHO Expert Consultation: WHO Technical Report Series, No.919. Geneva

WHO (2005): *Preventing chronic diseases: A vital investment*, WHO, Geneva.

WHO (2006) Nutrition for health and development: challenges.
<http://www.who.int/nutrition/challenges>. Department of
nutrition for health and development: World Health
Organization, Geneva
