

## Improving Agricultural Productivity through Increased Local Biodiversity Exploitation and Food Composition Database Management

Victor N Enujiugha\*

Department of Food Science and Technology, Federal University of Technology, Nigeria

\*Corresponding author: Victor N Enujiugha, Department of Food Science and Technology, Federal University of Technology, Akure, Nigeria, Tel: 8034261870; E-mail: venujiugha@yahoo.com

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### Abstract

It has become evidently clear to the global community that even in countries boasting adequate food and nutrition security there is rural hunger. Smallholder farming families who represent one-third of the global population have a crucial role to play in the utilization of all available local bio-resources to boost food production and increase livelihoods and consumer choices. If local biodiversity and traditional bio-resources are adequately tapped and effectively utilized, there will be, as a consequence, great improvements in agricultural productivity. Farmers are usually more motivated when they know that the agricultural produce from their farms would be in demand. Compiling/collating data on the nutrients and bioactive compounds composition of the diverse local biodiversity is expected to ginger greater productivity, especially if the components are necessary for enhanced nutrition and health. In this paper the potentials of local biodiversity are highlighted and the avenues for their wider exploitation and commercialization are discussed with a view to improving food security. The findings here have greatly underscored the need for effective collaboration between all stakeholders and increased advocacy and enlightenment of local farmers to the rich natural endowments of their immediate ecosystems.

**Keywords:** Biodiversity exploitation; Agricultural productivity; Food composition; Interventions

### Introduction

Malnutrition has been viewed as the outcome of various processes in society whose causes may be immediate, underlying, or basic. The immediate causes are grouped into those related to food intake and those related to diseases. Basic causes are related to various more structural and environmental constraints related to social, political, economic, demographic, ecological and organizational factors. Underlying causes at household and family levels include inadequate access to food, health services, water and sanitation as well as inappropriate maternal and child caring practices. Devereux describes smallholder agriculture in Africa (both crops and livestock) as one of the most precarious livelihood systems in the world [1]. Unfortunately this particular system relies heavily on women's input. Women and children are particularly at risk, as they have special nutritional needs and are among the most vulnerable, given their low social status in many countries [2,3]. Moreover, whereas women and children are usually the last to benefit from increased household income, they are usually the first to make sacrifices when the financial situation deteriorates. Malnourished women and children live in families who do not have the ability, and/or the knowledge and skills to provide the foods they need. This is often due to the fact that poor families do not have the resources to produce or they lack sufficient income to purchase sufficient amounts of the right kinds of food, a situation that may be made worse by a combination of poor feeding practices and high levels of illness and disease. An analysis of the nutrition needs of the African child as related to growth, development and productivity has shown that agricultural productivity cannot be separated from sustainable diets [4]. Since children's nutrition is crucial for their physical and cognitive development and for their productivity and

earnings as adults, the health and economic consequences of insufficient food and poor diets are lifelong— for the individuals as well as for society [5].

The impacts of the food price crisis, followed by the financial and economic crisis, on increased hunger and undernutrition have challenged the achievement of the first Millennium Development Goal (MDG1, Eradicate Extreme Poverty and Hunger), and are likely to have repercussions on other MDGs, especially on maternal health and child mortality (MDGs 4 and 5). It must be emphasized that adequate food is a human right, a right of every individual in every country. A rights-based approach to agricultural productivity views governments' promotion of food security as an obligation, hence not as a form of benevolence. It insists on the accountability of duty-bearers to rights-holders. Improved public understanding of human rights in general and the right to food in particular helps individuals and communities to participate in making decisions that affect their food security situation. Activities intended to increase food production, such as incentives to private investment and rural job creation, are combined with specific measures to empower individuals and communities, including vulnerable populations. One major rewarding activity is the persistent and incremental exploitation of the various local biodiversity towards solving the prevailing food and nutrition security challenges, as well as increasing the household livelihoods and economic status.

In developing countries where the supply of animal protein is inadequate to meet the protein needs of the rapidly growing population, contemporary research efforts are geared towards harnessing the nutrient potentials of some of the lesser-known legumes and oilseeds. Some of these seeds have relatively high protein contents and can be used to increase the protein intake of people through development of new products and fortification of various starchy staples [6]. Nigeria is known to be rich in different plant and animal resources which could be exploited for the general wellbeing and

empowerment of the different people groups. Terms such as 'underutilized', 'under-exploited', 'less-common', 'lesser-known' and 'unconventional' are frequently used to describe the low distribution or circumstantially limited use of these food resources [7]. It is therefore important to note that to truly raise agricultural productivity, the need to increase the exploitation of local biodiversity is greatly underpinned in current research efforts focused on raising household livelihoods. Such local biodiversity would especially include the wild uncultivated species, the non-wood forest products, and those species that are currently consumed at subsistence level in the rural communities. According to Toledo and Burlingame, the integration of biodiversity into food security and anti-hunger policies is likely to generate more socio-economic benefits – including supporting poverty alleviation efforts – than in any other sector [8]. More than 80% of populations suffering from hunger in developing countries depend on agriculture as a major source of income; and it is evidently clear that sustainable reductions in poverty, food insecurity and undernutrition cannot be obtained without special attention being paid to the development of the agriculture sector.

### Key Points in Improving Agricultural Productivity

Availability of funds has always been a key point in improving agricultural productivity in Africa. Devereux rightly noted that rural livelihoods in Africa are dominated by subsistence oriented rain-fed agriculture, but national food deficits are frequent and smallholder families face chronically low food production due to protracted public and private underinvestment in agriculture, compounded by repeated harvest shocks due mainly to erratic weather [1]. It is now obvious that the interventions of respective governments through scaled-up financing of rural farmers is a key component towards achieving any meaningful productivity in agriculture in the third world [8,9]. If farmers are assured of adequate markets for their produce, there is always the tendency to put in more efforts to both improvements in farm practice and increases in resource inputs in agriculture. This is particularly important in Africa where wild forest seeds and leaves play critical roles in sustainable diets and household livelihoods. For example, Roger et al. noted that although wild food products play a fundamental role in the diet of North Cameroonians rural population, several restrictions and laws related to collection and use of some species from biodiversity by local population have been promulgated by Cameroonian government, thus making their nutritional contribution in local population's diets to be restricted [10]. However, in the last decade, the concept of 'traditional foods' or 'local foods' has taken center-stage in dictating consumer choices [11].

At present, foods are no longer judged only in terms of taste and immediate nutritional needs, but also in terms of their ability to improve the health and well-being of consumers. In a recent study assaying the prebiotic potentials of fruits and vegetables, Malinowska et al. reported that foods are also judged in terms of their ability to improve the health and well-being of consumers [12]. According to these researchers, the consumption of natural sources of non-digestible oligosaccharides, such as fruits and vegetables, has advantages for its lower price in comparison to industrialized products. Drought-resistant food crops with nutraceutical properties and better storage quality are gradually gaining relevance [13]. Many under-utilized legumes and oilseeds with high anti-oxidant properties, for example, are being increasingly incorporated into local diets [14]. However, while the current focus on exploiting the availability and medicinal values of local vegetables, fruits and nuts has impacted heavily on diet

preferences among rural dwellers (which comprise more than 80% of the population), the prevalent unpredictable weather conditions affect seasonal crops and dictate availability of local biodiversity.

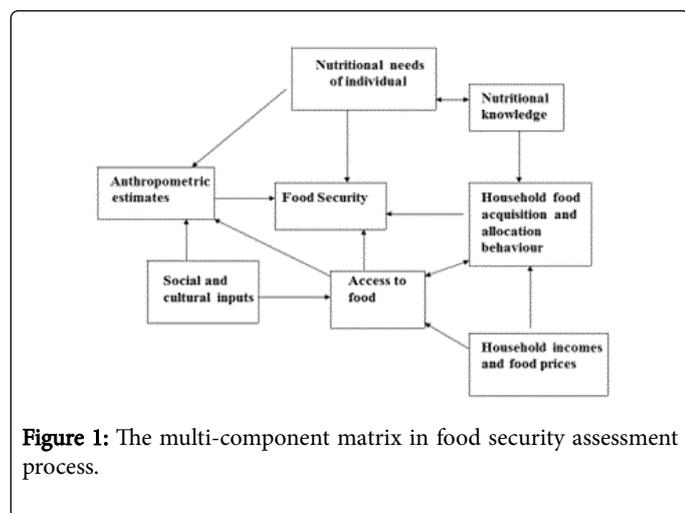
Gender education and empowerment are critical factors in improving the agricultural resource base in Africa. In a recent study, Okunlola and Enujiugha examined women's involvement in the processing and preservation of fruit and vegetables and observed that women are mainly responsible for all household tasks [14]. They also have the major responsibility for post-harvest activities such as processing, handling and preservation and other important strategies for increasing food availability in general and for counteracting seasonal variations. When women are effectively organized into cooperatives and given necessary education regarding farming practices, with attendant financial empowerment, it is expected that agricultural productivity would receive a boost and household livelihoods would shoot up [3]. For Africa to be food secure, there is an urgent need for respective governments to provide maximum support for rural women who are directly involved in subsistence agriculture through upgrading current agricultural practices and making available modern implements for needed efficiency.

Compiling comprehensive nutrient data on our local foods will surely go a long way to harnessing their hidden potentials. When people know the high nutrient values of what they are consuming, it spurs increased exploitation [7]. There are many wild and uncultivated, but nutritionally relevant, local fruit trees and seed crops that are currently endangered by increased urbanization and western ideologies [15]. Fortunately, the new trend in food composition data collection and dissemination has helped to enlighten the diverse populace on the potentials of many neglected seeds and nuts.

### The Nigerian Biodiversity Potentials

The Nigerian agro-ecological landscape encompasses plant and animal resources, as well as microorganisms that include many mushrooms and edible algae. Most of the potential food inputs are still at the wild unexplored stage and yet to be fully tapped or utilized [6]. Nigeria's biodiversity is grossly under-researched and under documented; hence its contribution to scientific knowledge and sustainable national development falls short of its inherent potentials. It has been observed that most of the domestic, commercial and industrial activities carried out in the country impacts heavily on the biodiversity resources. A majority of rural dwellers in many parts of Nigeria derive a high percentage of their income from wild bio-resources. Accordingly, biodiversity forms a solid base for rural livelihoods and economy. Unprocessed wild resources are collected mainly by men and youths while the majority of women are involved in the processing of these wild resources to add value for distribution and marketing. Biodiversity therefore forms an integral link between poverty reduction, provision of employment, and sustainable livelihood. That is why access to food is tied to food security (Figure 1) which in turn is influenced by agricultural productivity through increased biodiversity and other essential natural resources exploitation. In Nigeria, about 70% of the population derive their means of livelihood from agriculture, and the economy is characterized by a large rural based traditional sector [14]. Furthermore, most of the rural poor derive their livelihood from wild species of biodiversity. The diversity of culture has considerable impact on biodiversity utilization and the level of protection. Natural and man-made threats including resource over-exploitation, together with direct and indirect consequences of socio-economic development,

have contributed to the erosion of biodiversity in the country (CBD, 2001).



The country is endowed with a variety of plant and animal species. There are about 7,895 plant species identified in 338 families and 2,215 genera (Table 1). There are 22,000 vertebrates and invertebrates species. These species include about 20,000 insects, about 1,000 birds, about 1,000 fishes, 247 mammals and 123 reptiles. Of these animals about 0.14% is threatened while 0.22% is endangered. About 1,489 species of microorganisms have also been identified (Table 1). All of these animal and plant species occur in different numbers within the country's vegetation that ranges from the mangrove along the coast in the south to the Sahel in the north. Most of the biodiversity sustain the rural economy.

Groups of plants	Families	Genera	Species
Algae	67	281	1335
Lichens	-	14	17
Fungi (Mushrooms)	26	60	134
Mosses	-	13	16
Liverworts	-	16	6
Pteridophytes	27	64	165
Gymnosperms	2	3	5
Chlamyosperms	2	2	6
Monocotyledons	42	376	1575
Dicotyledons	172	1396	4636
Total	338	2215	7895

**Table 1:** Inventory of Plant Species in the Nigerian Ecological Landscape.

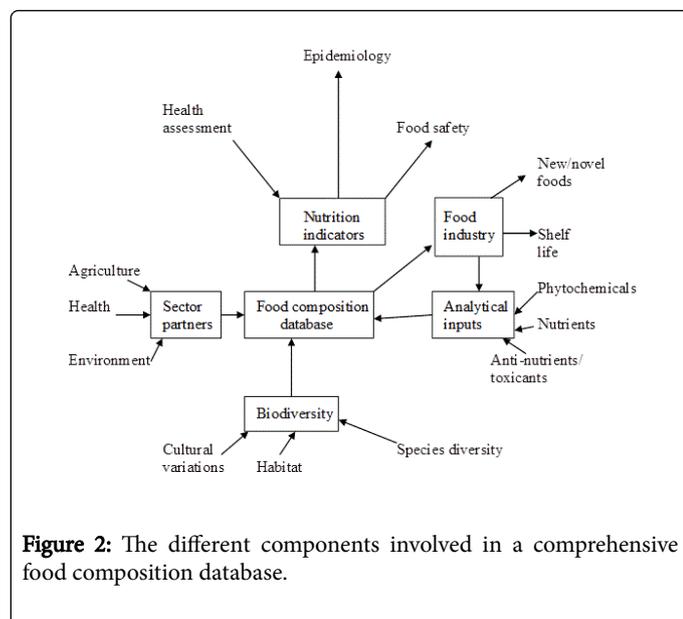
Non-timber forest products (NTFPs) are used for food, medicines, oil, resin, tannin, household equipment, fuelwood, and furniture and building materials. The subsistence rural dwellers have continued to exploit these products for income generation. The use of only improved varieties of crops and the complete neglect of local varieties and the land races lead to loss of biodiversity. For instance, *Dioscorea*

*dumetorum*, *Dioscorea bulbifera*, *Trichosanthis* species (Snake tomato), and *Digitaria exilis* (Hungry rice - 'acha') are no longer in popular cultivation. The Nigerian agro-ecological landscape is replete with diverse oilseeds which include groundnut, soya bean, palm kernel, cotton seed, locust bean, melon, conophor nut, castor bean, African oil bean, sesame seed, dika nut, mesquite seed and other such seeds. Some of these seeds are, at present, not well known, and thus may be grossly underutilized relative to their potential. Some of them exist as wild forest seeds and nuts and have been found to be highly nutritious [6]. Conophor nut, for instance, has been found to contain the sn-3 fatty acid, linolenic acid as high as 70% of total fatty acids in the oil, making it better than rapeseed oil in terms of oil quality.

### Avenues for Increasing Biodiversity Exploitation

A major key to improving agricultural productivity via increased biodiversity exploitation is the establishment of a food composition database, to capture the nutrient potentials of all fauna and flora of importance. The essential component of a food composition database is the coverage of wide range of food sources, exposing their nutrient potentials and the part they play in the formulation of different recipes. According to Rosenberg, hunger and nutrition are currently defined in terms of not only how many tons of food are available, but also by the need for nutritional quality in the human diet [16]. Without a good and functional food composition database system, the exploitation of traditional foods and the utilization of natural biodiversity would be incomplete. An understanding of the components of locally available breeds/varieties, their usefulness in recipe formulation, and their nutrient potentials helps to dictate the need to increase or decrease their cultivation. There is an on-going partnership between the Nigerian Food Composition Group and Nestle (Nigeria) to produce a functional and widely accessible food composition table for the country. If nutrient analysis and data dissemination of the various food species and intra-species diversity are systematically undertaken, national information systems for food and agriculture will be strengthened and can be used to form the basis for priority setting and national policy making.

The availability of relevant, reliable and up-to-date data on the nutrient composition of foods consumed by the people of Nigeria is critical in the field of nutrition and the food sciences. This has far-reaching policy and decision-making implications for several arms of government, industry, research centers and individuals. Beneficial areas include health assessment, the formulation of appropriate institutional and therapeutic diets, nutrition education, food and nutrition training, epidemiological research on relationships between diet and disease, plant breeding, nutrition labeling, food regulations, consumer protection, agricultural goods and products, as well as applications in trade, research, development, and assistance. Figure 2 outlines the different components involved in a comprehensive food composition database. Knowledge of the nutrient composition of foods is an essential tool for nutritionists, dietitians, food scientists, food industries, health workers and decision makers. Most quantitative studies of human nutrition require detailed information on food composition and such information is indispensable in the dietary treatment and management of diseases. In the food industry, nutrient composition of various foods provides a better understanding of the role that different foods play in the diet of consumers, thereby opening up avenues for new product development. Also, in the agricultural industry, the continuous development of new plant varieties by breeders requires up to date and comprehensive information on foods.



A food composition database would play the following roles in the achievement of food security: (i) encouraging the utilization of local biodiversity which provides consumers with wider choice of food recipes and helps to improve the nutrient profiles of diets; (ii) linking household livelihoods with nutrition by encouraging actual nutrient intakes via sound nutritional knowledge; and (iii) providing data on phytochemicals and other bioactive components, thereby helping in food safety assessments. It helps in harnessing local biodiversity, especially those underutilized food sources with high nutrient potentials and mobilization of sector partners (ministries of Agriculture, Health and Environment) for participation in funding and steering group activities. The recent fruitful partnership between Bioversity International, Food and Agriculture Organization of the United Nations (FAO) and the West African Health Organization (WAHO) has yielded the much publicized Food Composition Tables for West Africa with the attendant metadata domiciled in the FAO/INFOODS web site [17]. These tables have been able to highlight the nutrient potentials of hitherto unknown wild forest seeds as a step towards their wider exploitation and commercialization. An in-country food composition table would be expected to be more detailed in terms under-utilized and wild species. However, as climate changes, the value of biodiversity for food and agriculture will obviously be altered. Climate change will both threaten the survival of individual species and affect the way different elements of biodiversity interact in food and agricultural ecosystems. While the current focus on exploiting the availability and medicinal values of local vegetables, fruits and nuts has impacted heavily on diet preferences among rural dwellers (which comprise more than 80% of the population), the prevalent unpredictable weather conditions affect seasonal crops and dictate availability of local biodiversity [18]. Climate change affects food production which will ultimately affect biodiversity and sustainability of local diets.

A very important and significant avenue for increasing biodiversity exploitation lies with the intensity of extension work (a process of involving trained field supervisors to interact with farmers on new trends) among the rural folks. The major challenges in extension work include becoming truly responsive to local conditions and concerns; fostering greater local self-reliance through individual capacity

building and local institutional development; addressing financial insecurity and low educational levels of extension staff; and the specific interests of engaging indigenous knowledge, farmer inventiveness and farmer-to-farmer communication. The major effort in agricultural development should be the transformation from subsistence farming to commercial farming [9,19,20]. Farmers are encouraged to go beyond feeding their households and making meager incomes to contributing to food security in the country, thus generating household income for additional food purchase on the one hand and facilitating access of local consumers to nutritious foods on the other, thereby raising the household livelihoods. The food and agriculture sector has a major role to play in providing appropriate information to consumers and in particular to poor households so that they can make the best use of locally available foods and cover their nutritional requirements, particularly of small children and women.

## Conclusion

The highly essential step of increasing local biodiversity exploitation as a way to improving the food security and agricultural productivity of individuals and households has been examined in this discourse. The establishment of virile food composition database and the empowerment of indigenous extension workers are seen as key elements in implementing the shift from subsistence farming to commercial farming. Ultimately, there would be a paradigm shift from feeding individual households to feeding the nation. This is important in meeting the millennium developments goals, especially that of eradicating poverty.

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