

CHEMISTRY EDUCATION: A PANACEA FOR FOOD SECURITY AND NATIONAL DEVELOPMENT

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Abstract

Chemistry education plays a great role in food security, national development and its sustenance. Nigeria is faced with food crisis as a result of internal problems of insecurity (the recent farmer-herder clashes, activities of Boko haram, Islamic State of West African Province, (ISWAP) as well as other terror groups in the country and the lack of political will by the present administration to tackle the problems, gender inequality, educational decadence, dwindling human resource base, poor health facilities, outbreak of Covid-19, political conflicts, poor youth orientation, bad governance and, dwindling national economy, climate change among others. The challenges of food security demands effective application of Chemistry Education to change the orientation and mind-set of Nigerians towards applying the scientific knowledge and skills acquired to agricultural production, utilization and other agricultural businesses. The situation calls for a real exploit of the scientific knowledge via crop improvement; smarter use of agro chemicals like fertilizers, pesticides, fungicides and effective management of agricultural inputs to ensure increased productivity and food security. This paper focuses on Chemistry education, food security and insecurity in Nigeria as well as harnessing the knowledge and skills acquired through Chemistry education for enhancing food security, national development and sustenance. The paper opined that Chemistry education holds the key to food security, national development, and its sustenance. Therefore, it is recommended that all stakeholders in food production are to ensure and allow Chemistry education to take and play its pivotal role towards enhancing food production and security for national development and sustenance.

Keywords: *Science, Chemistry Education, Technology, Food Security and National Development.*

INTRODUCTION

We live in an age of globalization, science and technological advancement. Everyone has recognized the importance of science and technology for national development. Throughout the world, education is considered to be a very important tool for attaining national goals. Education provides learners with skills needed for survival. It is therefore important to utilize the value of Science education, especially Chemistry education for attaining food security and national development. Agricultural production ought to be the responsibility of every citizen including youths in the Secondary Schools and this can be achieved only if the youths are effectively and meaningfully empowered with scientific knowledge, skills and attitude derivable from Chemistry

Education. An important goal of Chemistry education is to foster human enterprise through experimentation, observation, application and carefully designed resource management systems. Hence, Nigeria requires as a matter of urgency, an effective application of Chemistry Education to change the orientation and focus of citizens especially the youths towards enhancing agricultural production for food security, sustenance and national development.

Chemistry education is the acquisition of knowledge and skills relating to the structure, composition, and properties of matter as its transformation when subjected to different conditions for a functional living (Horby, 2010). In recognition of the importance of Chemistry education to global development and improvement in the welfare of mankind, the mission of the International Union of Pure and Applied Chemistry (IUPAC) as captured in the declaration "Advancing Worldwide Chemistry" is to advance the worldwide aspects of the chemical sciences and to contribute to the application of Chemistry in the service of mankind." IUPAC has been utilizing its global perspective to contribute towards the enhancement of education in Chemistry and to advance the public understanding of Chemistry and the scientific method" for everyday life applications (Otaha, 2013; Fisher, et al, 2021).

Chemistry education plays a central role in global sustainable economic development and food security. It plays the major roles in agriculture (fertilizers and insecticides, herbicides, fungicides, rodenticides), clothing (textile fibers), housing (cement, concrete, steel, and bricks), Medicine/Pharmacy (drugs and pharmaceuticals), Transportation (fuel, alloy materials), space science, military, schools, (laboratory chemicals and equipment etc.), engineering, industry and tourism (Horby, 2010; Fisher, et al, 2021). Presently, man is experiencing an era in scientific and technological development that affects his life in one way or the other. Chemistry education addresses the social objective of substance development as education is now of the primary means for empowerment, participation, cultural preservation, social mobility and equity (Mohammed, & Bello, 2013).

The impact of Chemistry on technology, which is seen as the application of scientific knowledge, skills, work, attitudes, tools and equipment in evaluation of new processes and adoption of these processes to the production of goods and services for the benefit of mankind involves the process of bringing manufacturing inventories and sculpturing, designing etc. (Fisher, 2021). Currently, science and technology, which hinges strongly on Chemistry, is the key driver of developments in the modern society. Every Chemistry concept in the syllabus exposed to learners provide an excellent opportunity for advancing scientific and chemical knowledge, attitudes, aptitude and problem solving skills towards attaining scientific, technological and economic security.

The production, processing, and use of chemicals in modern society in providing solutions to our immediate societal needs such as food security can be achieved through effective application of the knowledge and skills acquired in Chemistry education in agriculture and other related areas. Indeed, the applications of Chemistry to solving everyday life problems are demonstrated through inculcation of skills, knowledge, attitude and values for adoption of new technologies. Skills such as problem solving, innovative ability, manipulation, measuring, experimenting, reasoning, adopting of existing technology, communication, analysis and appropriate management skills are precursor for increased food production, processing, safety, and security (Okoro, 2013). Also, mental ability like creativity, understanding, application, resourcefulness, improvisation and initiative developed will serve as foundation towards applying the scientific knowledge to attaining food security through increase agricultural productivity (Okoro, 2013; Mohammed, & Bello, 2013). Furthermore, positive attitude like consciousness, appreciation, and self-confidence as well as responsible values of honesty, hard work, interest, team-spirit, patience and commitment among others would significantly play a key role in promoting sensitivity to practical application of Chemistry education to solving societal problems (Fisher, 2021). Hence, the capacity to produce, process or preserve food is directly linked to the level of scientific knowledge and technological development. Nigeria therefore needs a functional

Chemistry education that will assist in addressing the current food insecurity for national development and its sustenance.

It is on this basis that the paper looked at the link between Chemistry education and increase in agricultural production with the aim of bringing about food security in Nigeria through meaningful teaching and learning of Chemistry. In specific terms, this paper discusses Chemistry Education, agricultural production; food security; enhancing agricultural production through Chemistry Education and its implications for food security in Nigeria.

THE CONCEPTS OF CHEMISTRY EDUCATION, FOOD SECURITY, AND NATIONAL DEVELOPMENT

Chemistry is a branch of science that investigates nature systematically with a view to understudying and harnessing it to serve human needs (Okoro, 2013). Science may be regarded as the body of related courses concerned with knowledge. It consists among other component; Chemistry, Physics, Biology, Mathematics, Astronomy and Agriculture. Among these, Chemistry is considered to be the mother of science (Okoro, 2013; Fisher, 2021). Science can therefore be seen as established human knowledge, a problem solving activity, or concerned with the relation between theory and experiments.

Chemistry is defined as the study of composition, structure and properties of matter as well as its transformation when subjected to different conditions (Horby, 2010). Education is the acquisition of knowledge and skills for a functional living (Otaha, 2013). It is one of the subset of Science, Technology, and Mathematics Education (STEM) education or discipline-based education research (Horby, 2010). The aim of education is to equip the individual with the necessary knowledge and skills for positive contribution in the development of the society (Muhamed & Bello, 2013). Education is therefore, the developments of skills and training in problem solving through identification of problems, matured judgment, critical thinking as well as change in values, attitude and beliefs.

Chemistry Education or chemical education is the study of teaching and learning of Chemistry (Horby, 2010). It is the systematic process of acquiring the fundamental knowledge about the universe for a functional living (Otaha, 2013). Chemistry education plays an important role in enhancing the quality of teaching, research, and development as well as equip learners with good knowledge and skills to increase food production and services to meet human needs. Notwithstanding the negative role Chemistry education does play globally, such as pollution, chemical warfare, and drug abuse etc., the positive roles are well known. Chemistry is the central in the drive of global sustainable economic development (Muhamed & Bello, 2013). With the indispensable knowledge and skill richly acquired through chemistry education, man can shape and reshape his world for his benefit. Hence, the development of the nation is usually measured by the degree and extent of growth brought to it through the enterprise of science education and technology, the gate way to which is Chemistry education.

Food security is defined differently by different authors over the years due to global food challenges. In the World Food Conference of 2000, food security was defined in terms of food supply ensuring the availability and price stability of basic foodstuffs at the international and national level thus: "Availability at all times of adequate supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". Food security according to Food and Agricultural Organization (FAO, 2011) exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for active and healthy life. The United Nation`s Committee on World Food Security (UNCWFS) and the Food and Agricultural Organization (FAO) defined food security to mean that all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meet their food preferences and dietary needs for an active and healthy life (United Nations, 2021; FAO, 2010). On the other hand, the United State Department of Agriculture (USDA) defined food insecurity to mean "a situation of limited or uncertain availability of nutrition by adequate and safe foods or limited or uncertain

ability to acquire acceptable foods in socially acceptable ways (International Policy Research Institute, IFPRI, 2021). Food security therefore means the availability of adequate and the right kind of food as well as one's access to it. Assuring food security in Nigeria therefore depends on large-scale food production, storage, processing and distribution as well as tackling economic and social accessibility through Chemistry education.

A major thrust of teaching and learning of Chemistry education is to make an individual scientifically literate. Scientific literacy can be seen as the recognition, understanding and application of scientific principles and concepts to real life problems both at personal and societal levels. Chemistry education therefore, is the vehicle through which students can be endowed with chemical knowledge and skills as necessary capacities and potentials for technological, agricultural and economic development.

Unfortunately, food production in Nigeria is carried out by illiterate peasant farmers who lack capital, skills, energy and other viable ingredients to produce large quantity of food. An increase in Chemistry education by farmers will increase their knowledge and skills in food production, processing and preservation, hence improving food security, national development and sustenance. Moreover, Chemistry education could never be of more importance than now that advances in research and its resulting technologies have irrevocably expanded the scope and application of unique training in observation and reasoning for agricultural production (Fisher, 2021). The knowledge and skills in Chemistry is required for deep understanding of agro ecosystem function in particular, nutrient cycles and the molecular reactions within and between species (Mohamed & Bello, 2013). The unique characteristics and knowledge of Chemistry education increases understanding in areas of interactions between crops and pests, how plants obtain and use nutrients from the soil and how to increase production through the use of new agro chemicals like pesticides, herbicides, and fertilizers for increased crop yield (Fisher, 2021). Indeed, the success and confidence of using Chemistry to find solution to problems of everyday life is important. Food production and security was largely through knowledge, skills, attitudes and values gained through agricultural training (IFPRI, 2021). This goes to show the extent to which appropriate knowledge, reasoning, observations and experiments which are unique features of Chemistry education would help students to develop scientific approach to problem solving of real life challenges particularly food supply. The author opines that to achieve food security in Nigeria is a task that requires a holistic approach in terms of commitment, knowledge and skills acquisition by all categories of individuals especially the youths at all levels of education.

Otaha (2013) defined national development as a gradual and sustained growth in all sectors of a nation. Mohammed, et al, 2013 viewed national development as a gradual and steady increase or improvement in all sectors of the economy of a country. Gboyega (2023) captures national development as an idea that embodies all attempts to improve the conditions of human existence in all ramifications. It implies improvement in material and well-being of all citizens in such a way that today's consumption does not imperil the future. It also demands that poverty and inequality of access to goods and services be significantly reduced or removed. It seeks to improve personal physical security and livelihoods and expansion of life chances. Naomi (2022) views national development as improvement in societal advancement, equitable distribution of resources, provision of health care, education, housing and other essential services for improved well-being of the people in all sectors, corporate bodies and other groups in the society. It can be seen as growing or becoming industrialized (IFPRI, 2021). National development as used in this context means the gradual growth of the nation in all sectors of the economy and/or becoming more advanced. National development can be said to be the overall development or a collective socio-economic, political as well as religious advancement of a country or nation which can be achieved through collective mapped-out strategies by individual, corporate bodies and government. It can be seen as a phenomenon that embraces a whole nation. National development is therefore the ability of a country or countries to improve in all sectors of the economy for improved welfare of the people. The question is whether this could be done through the

knowledge of Chemistry education. Educational institutions everywhere are established to carry out the role of teaching, research and community services, thereby contributing meaningfully to the social, economic, cultural, political, scientific and technological development of any nation (United Nations, 2021). Chemistry education is the vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potentials for development. In addition, chemical education addresses the social objective of substance development as education is now the primary means for empowerment, participation, cultural preservation, social mobility and equity (Mohammed et al, 2013).

Chemistry is one of the naturally and well-established means through which the nation's abundant natural resources can be harnessed into useful ventures for the overall economic and socio-political wellbeing of its citizenry. It is the nucleus of science, which ultimately is the foundation upon which any nation is developed. The knowledge and skills acquired through Chemistry education can be used in the production of agricultural chemicals like herbicides, pesticides, and fertilizers for increased food production, processing, and preservation for food security, national development and sustenance.

FOOD INSECURITY IN NIGERIA

Food remains an issue, either it is too much or not enough in the continuing development of the human race. In Maslow hierarchy of needs, food is a basic survival need that must be met before other needs like security and self-actualization can be achieved. Food is defined as material, usually of plant or animal origin, which contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals, and is ingested and assimilated by an organism to produce energy, stimulate growth, and maintain life (IFPRI, 2021).

Food security is built on three pillars namely, food availability, access and use. Availability means sufficient quantities of food available on a consistent basis; food access refers to having sufficient resources to obtain appropriate foods for a balanced diet and food use (FPRI, 2021). In a simple term, food security refers to both physical and economic access to food that meets the individual home dietary requirement as well as their individual member's food preferences. Thus, household food security is attained when all members, at all times, according to their food preference have access to enough food for an active, healthy and psychologically balanced life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern. In other words, food insecurity exists when people do not have adequate access to available, accessible and utilizable food (WHO, 2019; IFPRI, 2021).

Food insecurity in this study is defined as the inability to harness both material and human resources to boost agricultural production of staple crops and animals in quantity and quality for human consumption and healthy life (WHO, 2019). Currently, Nigeria is suffering from food poverty (IFPRI, 2021). The daily experiences have shown that prices of staple foodstuff like rice, garri, yam, cocoyam, potatoes and plantain among others are sky rocketing beyond the reach of the common citizen. This high food prices have not only placed considerable pressure on poorer households to spend more on food but has narrowed down access to affordable nutritious food in quality and quantity, forcing both urban and rural dwellers to cut down on food consumption. By the situation, the country is at a sorry state of depending on imported food. Nigeria is said to be a food deficit country with domestic agriculture still under developed (FGN, 2015).

In Nigeria, agriculture has a huge untapped capacity with over 60% of arable land not yet cultivated (UN, 2021). Similarly, IFAD (2012) reported that only a half of the 71 million hectares of cultivable land and 7% of irrigable land are currently used for farming. Compounding the problem of food security are political conflicts, poor youths orientation about farming, insecurity, dwindling national economy, economic poverty, corruption, poor policy implementation and growing population, which have worsened the already poor agricultural supply in the country resulting in serious food crisis. For a country to have sustainable food security, food supplies must keep pace with increase in population and urbanization (FAO, 2017). It is therefore not surprising

that Nigeria is in the present dilemma due to an imbalance between agricultural production and population growth. Nigeria with the current annual inflation rate as reported by the National Bureau of Statistics, 2022, rose to 11.3 percent in 2016 to 28.5 percent in 2022. Nigeria is seriously threatened by shortage of food supply hence the continuous increase in prices of staple food over the years.

Food insecurity in Nigeria is attributed to decline in local production because of activities of terror groups such as Boko haram, ISWAP and other terror groups, farmer-header clashes, kidnappings, violent rebel activities, climate change, inflation, lack of technological knowhow, low agricultural inputs, inadequate storage and processing facilities, education decadence, dwindling human resource base, poor health facilities, political conflicts, poor youth orientation, bad governance, dwindling national economy, outbreak of Covid-19 and gender inequality among others which have contributed to rising food prices in the country of recent. Estimation shows that over 70 percent of the globally hungry are either girls/and or women because they are denied ample access or unable to participate in labour (Food and Agricultural Organization Statistic, FAOSTAT, 2022, Warr, 2014).

The percentage of undernourishment has been constantly on the rise in Nigeria from 2008-2022. From 2014-2016 and 2015-2017, there was a drastic rise, with an increase of almost two percent (9.6% in 2014-2016 to 11.5% in 2015-2017) and again, another two percent to 13.4% in 2016-2018 (FAOSTAT, 2022., FAO,2019). Due to the fact, that these numbers are always only a three-year average, it can be said that 2014-2022 is a significant turning point in the Nigerian food security situation.

The Green Household Survey (GHS) by the Food and Agricultural Organization (FAO) from 2010-2019 shows that the percentage of households facing food shortage in Nigeria has risen over the period under study. In one decade, the number of households experiencing food shortage has increased from barely 10% in 2010-2011 to over 31% in 2018-2019 (UN, 2021). Successively, households are struggling with getting enough food regularly.

This invariably affects the rate of quality and nutritious food intake in Nigerian households. It can be argued that the food intake requirements of majority of Nigerians have fallen far below the international standard. This is very worrisome and demands urgent intervention by all to ameliorate the pains of hunger, malnutrition and health breakdown faced especially by the low-income citizens.

ENHANCING FOOD PRODUCTION AND SECURITY IN NIGERIA THROUGH CHEMISTRY EDUCATION FOR NATIONAL DEVELOPMENT AND SUSTENANCE: THE WAY FORWARD

Naturally, Nigeria is a well-endowed nation with abundant material resources such as arable landmass, seaports and irrigable swamps that can be cultivated to provide enough agricultural products for consumption and export (Mohammed, 2013). Nigeria was once an exporter of foodstuff such as groundnut, palm oil, cocoa, rubber, hides and skin among others and could still be if there is a deliberate effort in increasing agricultural production, processing and preservation (George, et al, 2020).

The use of Science, Technology and Mathematics Education can be a key for economic meltdown through sensitization of the youths scientifically with the main focus of using modern production technologies for agricultural production for self-reliance. A report by the Pan Africa Chemistry Network (2012) on increasing Africa's Agricultural Productivity emphasized that increase in agricultural productivity needs scientific intervention and fundamental research in chemical sciences in partnership with other disciplines.

Chemistry education as a scientific tool should be used to harness natural resources to enhance living through solving visible societal problems, such as easing economic poverty, disease, food insecurity and making lives more convenient. Advances in Chemistry Education have resulted in production of new chemicals and food engineering thereby bringing endless innovations in additives and food products currently found in market stores and supermarkets all

over Nigeria. For example, advancement in Chemistry has brought about production of chemicals, pesticides, herbicides and improved seeds that are used to facilitate food production in terms of quality and quantity. In addition, in the daily food preparation, a lot of food additives, flavours, preservatives, spices, emulsifiers, food coloring and food seasoning are used to make food tasty, attractive, and nutritious and ensures preservation without losing quality. It is therefore critical that Chemistry students be exposed to appropriate knowledge of Chemistry in the areas of agrochemicals and chemical-based technologies to boost agricultural production and enhance social, environmental and economic sustainability for food security.

Chemistry Education is involved in all aspects of crops and animals production, food safety, quality control, nutrition, processing and utilization of materials including bio-energy. In basic research, Chemists study the various components and properties of proteins, fats, starches, and carbohydrates, as well as micro components such as additives and food flavors to determine how each works in food as well as their health benefits. Enhancing domestic agricultural production and supply is a necessity as it is one of the only ways to curb the high rate of food inflation, put food on the table, and promotes good health and productivity in the country. As a potential solution to food insecurity, Chemistry education should be used to enhance skills and change attitudes of students to become more curious about application of knowledge and skills acquired for increased agricultural production and other societal problems to curb food insecurity and its sustenance for national development.

Agricultural production is one of the most important responsibilities of any nation as it is directly linked with health, job productivity, security and development of the nation. In Nigeria, agricultural production has been a challenging issue over the years with each successive government evolving policies to address the persistent problem though with very little success. Nigeria domestic agricultural production output is still under-developed for a number of reasons. Among the reasons are lack of scientific and technological know-how, use of manual farm tools/methods, lack of formal (Chemistry) education, ignorance, lack of modern farm machines and techniques, lack of food storage or processing facilities, lack of agricultural inputs and chemicals such as herbicides, fertilizers, rodenticides, fungicides, insecticides etc. and global warming. These challenges to increased agricultural production have to be tackled immediately to increase agricultural production, food safety, and security for national development. Adequate agricultural production is therefore a necessity for productive life and national security and development.

Agricultural productivity emphasized that increase in agricultural productivity needs scientific intervention and fundamental research in chemical sciences in partnership with other disciplines. Chemistry education therefore exposes the individual with the appropriate knowledge and skills for increased agricultural production, processing of agricultural products, and preservation to ensure food security, safety, and sustainability for growth and national development.

In the present dwindling economy, addressing hunger through Chemistry education is inextricably linked to knowledge acquisition, understanding and manipulating crop-enhancing agricultural chemicals to ensure viable agricultural products. Chemistry applications play a critical role in enhancing agricultural production through soil and crop management, enhanced understanding of soil processes, plant nutrition, fertilizer production and application, development of improved crop varieties and methods of controlling pests and diseases. The onus, therefore, lies with the stakeholders in the identification and support of processes and linkages that promote attitude change for increased agricultural production, hence food security in the country.

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how each works in food as well as their health benefits. Enhancing domestic agricultural production and supply is a necessity as it is the only way to curb the high rate of food inflation, put food on the table, and promotes good health and productivity in the country.

Chemical education holds a key towards tackling the problems plaguing agricultural production, thus addressing food scarcity and security in the country. Advancing agricultural production has a far-reaching effect on food security, economic, national development and social life of the citizens. It is hoped that an effective application of Chemistry education would improve food productivity as well as increase capacity, skills and attitudinal change for food production and supply in quantity and quality that will ensure food security and its sustenance for national development.

It is the opinion of the authors that through Chemistry education, the importation of basic staple foodstuff like rice, maize, wheat, sorghum, millet, chicken etc. will be reduced with increased food export that will boost the nation's dwindling economy for long-term survival, food security and its sustenance for national development. Furthermore, youth's restiveness arising from lack of employment would be reduced if the youths are meaningfully engaged in agricultural production as a means of livelihood and income.

CONCLUSION

The pride of any nation is to attain an advanced level development. Science and technology of which Chemistry education is the fulcrum is relevant for attaining food security and national development in Nigeria now that the country is experiencing dwindling economy, insecurity with resultant food scarcity and inflation. For the food security in Nigeria to be realized, the teaching of Chemistry must target the students or youths who are energetic and strong with commitment and focus of involving them in agricultural production, processing of agricultural products, and preservation for food security, sustenance and national development. Chemistry education is very essential in meeting the challenges of poor scientific knowledge, poor orientation, lack of initiative and negative interest through inculcation of skills, knowledge, attitude and values for adoption of new technologies. It is therefore, imperative that the paper suggest that Chemistry Education should be used to accelerate, motivate, and provide a comprehensive knowledge base and skills towards improving productivity in agriculture through deployment of existing and new technologies for production, processing, preservation, and distribution of agricultural products for food security, its sustenance and national development.

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