

Reinvigoration Of Bioscience Research In Nigeria For Enhancement Of Food Security and Nutritional Wellbeing

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Abstract

Hunger and undernourishment are prevalent problems in sub-Saharan Africa including Nigeria. Nutrition is a critical part of health and development as it is related to improved infant, child, and maternal health, safer pregnancy and childbirth, stronger immune systems, lower risks of non-communicable diseases, and longevity. Food security is achieved when everyone, at all times, has physical, social, and economic access to enough, safe, and nourishing food to suit their dietary needs and preferences for an active and healthy life. Basic as well as applied research in Biosciences contributes to food production by improving the use of plants, livestock, fish, and microorganisms. It has played an essential role in the provision of affordable, safe, and sustainable food, in promoting lifelong health and well-being, and in the development of bio-based technologies to support clean and sustainable industries. Although the bioscience research conducted in our universities and research institutes in Nigeria contributes to the food security and nutritional well-being of the populace, there is a need for new or renewed strength. Challenges often include inadequate/poor funding, corruption, lack of replication studies, lack of adequate and accurate science communication, and poor career prospects and remuneration for Bioscientists. However, the focus should be on bioscience for sustainable agriculture, crop and farmed animal health, waste reduction, biofortification of foods, and development of food peculiar to our environment to discourage food importation. Public investment in addition to new and imaginative public-private collaboration can make the biological science revolution beneficial to Nigeria.

Key words: Reinvigoration, Bioscience, Research, Enhancement, Food-Security, Nutritional-Wellbeing

1.Introduction

Bioscience is a collective term for any science that deals with living organisms. Biosciences include botany (Plant Science), Zoology (Animal Biology), Genetics, Microbiology, Biochemistry, Human Biology, and Bioinformatics. Bioscience is at the core of research and innovation that is curing diseases, providing safe and ample food and water, and developing new sources of fuel. Research is about solving problems, obtaining new facts, or adding information to elucidate a problem. It is about inquisitiveness and the ability to look at problems from different perspectives. Reinvigoration implies giving new or renewed strength or energy to something. Hunger and undernourishment are prevalent problems in the world, especially in sub-Saharan Africa and Nigeria is not left out. According to the Food and Agricultural Organization (FAO) globally one (1) in eight (8) persons is chronically undernourished including one (1) in three (3) persons in sub-Saharan Africa and one (1) in four (4) persons in Asia. Also, every seven seconds a child under the age of 10 years dies directly or indirectly from hunger in the world; others suffer from micronutrient deficiencies resulting in various deformities including mental

and physical stunting of growth. These unfortunate events take place in a world that, according to estimates, could generate more than enough food to feed everyone, provided it was properly stored, processed, and distributed (WHO, 2020).

A vital component of well-being and growth is nutrition. Better nutrition is related to improved infant, child, and maternal health and stronger immune systems, safer pregnancy and childbirth, lower risks of non-communicable diseases (such as diabetes and cardiovascular disease), and longevity. Malnutrition in every form, presents a significant threat to human health. Today, the world faces a double burden of malnutrition that includes undernutrition and overweight, especially in low and middle-income countries. There are multiple forms of malnutrition including undernutrition (wasting and stunting), inadequate vitamins or minerals, overweight, obesity, and resulting in diet-related non-communicable diseases. The worldwide burden of malnutrition has substantial and long-lasting effects on people and their families, communities, and nations in terms of development, economy, social issues, and health (WHO, 2021).

Food security 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 an active and healthy life (Yngve *et al.*, 2010). Food insecurity is often rooted in poverty which decreases the ability of countries to develop their agricultural markets, economies, and access to quality and nutritious food which is fundamental to human existence (Agbugba *et al.*, 2022). Since the concept of food security originated in the mid-1970s during the time of global food crises, the focus has transmogrified from ensuring food availability and price stability to policy issues and dramatic reductions in poverty and levels of malnutrition. Therefore, to efficiently define food security as a term, five different components are essential namely food availability, access to food, food utilization, food stability, and malnutrition (Bankefa *et al.*, 2021).

1.2 The Link Between Biosciences Research, Food Security and Nutritional Wellbeing

Biosciences contribute to the shape of future food production through basic as well as applied research in the production of and use of plants, livestock, and fish. Biological science is the whole gamut of the study of all living organisms and how they relate to the environment. Bioscience research has an essential role in the provision of affordable, safe, and sustainable food, in promoting lifelong health and well-being, and in the development of bio-based technologies to support clean and sustainable industries. Research into plant and crop science aims to understand the fundamental processes underpinning plant growth, development, and stress tolerance, and to translate this knowledge to enhance crop yields and food security. For example, research in Plant Sciences has led to engineering synthetic symbioses between plants and bacteria to deliver nitrogen to crops and this can improve rice production amongst other crops. The knowledge of plastid biology, plant metabolism, and oxygen and nutrient sensing mechanisms can be used to increase plant yield and tolerance to biotic and abiotic stress; the molecular mechanisms underpinning plant disease and immunity; pest management; pollinator nutrition and physiology, and agrochemical resistance.

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A better understanding of epidemiology and pathogen biology, the dynamics of virus-host interactions, immune responses of the host against infectious agents, and the development of novel and effective vaccines will improve animal welfare and control of livestock diseases. This will lead to increased meat production and availability. By inhibiting the growth of unwanted toxin-producing microbes that are naturally present in food and by creating antimicrobial compounds to kill unfavorable putrefactive microorganisms, biotechnology can enhance the edibility, consistency, and shelf life of food. The fermentation process raises the dietary value of the food along with the biosynthesis of vitamins, necessary amino acids, food flavoring, additives, preservatives, and proteins by improving the protein and fiber digestibility (Ghosal, 2018). To comprehend how foods affect the human body, nutritionists draw on concepts from molecular biology, biochemistry, and genetics. The study of nutrition also examines how dietary decisions can be used to lower illness risk, what occurs when a person consumes too much or too little of a nutrient, and how allergies operate.

Food safety- a term describing the handling, preparation, and storage of food in ways that prevent foodborne illnesses is a global problem. Globally 1 out of 10 people contract foodborne illnesses (FBIs) (Udoh, 2020). Bioscience research is key to reducing foodborne illnesses to the barest minimum. Food safety and nutrition are inextricably linked: to achieve optimal human health and well-being, people must be both well-nourished and free from foodborne disease. Despite these linkages, the connections between food safety and nutrition have been largely lacking from existing frameworks for food systems, which tend to treat food safety superficially, as only one sub-component, not integrated throughout (Nordhagen *et al.*, 2022). Sub-Saharan Africa with its fertile lands and labor is not able to produce food to match population growth. The production sector is unable to meet the needs of the growing population as a result of its inability to solve the problem of food safety; less attention is paid to food contamination and foodborne illnesses (Cudjoe *et al.*, 2022). Moreover, if the ‘ ‘ zero hunger’ ’ goal envisaged by World Food Program is to be actualized by 2030, then it is crucial to pool efforts toward the provision of suggestive approach(es) for mitigating global hunger and under-nutrition while averting the “ evils days” of food scarcity, starvation, foodborne illnesses, wastage, malnutrition, and death. On this note, microorganisms have revolutionized from the era of only being known as food spoilers and disease-causing agents to useful resources with the capability to improve food supply, food safety, and food production through bio-preservation, bio-based production, and bio-fertilization among others. Therefore, the exploration of microbes in redeeming the “ evils” associated with food insecurity is necessary and cannot be overemphasized. To this end, the optimization of different microbial processes as food security-enhancing agents (Bankefa *et al.*, 2021).

Food safety is majorly a term used in describing the handling, preparation, and storage of food in ways that prevent foodborne illness. It also describes various factors that are ensured in maintaining good health and preventing potential risks. Different parameters are involved in food safety which includes; food origin, food labeling, food hygiene, food additives, biotechnology

implementation and guidelines, and government policy. Food may be presented as a vehicle to a pathogen upon which infection can be transmitted, hence, making the food insecure. Food safety is very important since illnesses arising from it are of public health concern. Food safety is an integral part of food and nutritional security because the presence of any of the food safety hazards, such as microbial pathogens, parasites, adulterants, naturally occurring toxins, antibiotic drug residues, pesticide residues, and heavy metals could lead to food losses which might result in insufficient supply of foods to meet the population demand and may also pose threat to health upon consumption (Jaffe *et al.* 2019), thereby leading to food insecurity. It is important to emphasize that amidst the food safety hazards, pathogenic microorganisms, particularly bacteria remain the major culprits responsible for the deterioration of global food safety, causing different kinds of foodborne diseases (FBDs) in humans upon consumption of contaminated foods and food products. However, in general, approximately 600 million people become ill worldwide each year due to food safety issues, with diarrheal diseases being the major manifestations, which affect about 550 million people worldwide with 230, 000 death cases every year (WHO 2020), and hence, suggests the need for reviewing the overall processes associated with food safety.

1.3 Status of Biosciences Research in Nigeria

In developed nations, opportunities for researchers and other investigators to undertake innovative research are plentiful. This has resulted in the researchers acquiring the enhanced ability to collaborate within institutions and with others around the world (Holbrook and Sanberg, 2013). In these technologically advanced nations, consistent advances in science and technology have allowed such interactions to blossom rapidly.

Nigeria is a diverse multi-ethnic nation with a problematic political structure that often prioritizes less important needs of a nation like remuneration of the political class to research. Although research is undertaken by government-owned Research Institutes, Universities, Polytechnics, and Colleges of Agriculture; the establishment and operation of these public institutions often reflect the socioeconomic and political diversity of the country. Nigeria is the most populous country in Africa and consequently, the largest number of students enrolled in the higher education sector (Akudolu and Adeyemo, 2018). However, it is important to emphasize that most students that enroll in the biosciences are among those who have first attempted to get into medical school meaning that most bioscientists and bioscience students did not ab initio aspire to a career in biosciences. This scenario sends a message on the nature of bioscience research in the country because if it's not yet an area very young people are aspiring to get into; it therefore means that it is not fully thriving and may not be contributing efficiently to National development. However, many Nigerian universities have faculties or colleges of biosciences or biological sciences which houses courses like Animal and Environmental Biology, Biochemistry,

Biological Sciences, Biotechnology, Botany, Microbiology, Plant Science, and Zoology. These faculties engage in both undergraduate and postgraduate research. Many related research institutes have either departments or units for Biotechnology and product development,

molecular biology, plant breeding, food science, seed technology, fermentation technology, waste biology, etc.

Productivity in research is a quintessential indicator of efficiency in any production system. Ironically, research productivity is measured as the number of publications per researcher in institutions such as Universities or Research Institutes. Recent investigations of the research productivity among six selected West African Countries revealed that there had been a significant increase in scientific publications in Nigeria compared to other countries under consideration (Odeyemi *et al.*, 2019). However, do these high numbers of publications correspond to the rate of citations, impact on communities, advancement in medical and veterinary care (Garba and Sai' du, 2020), food security and nutritional well-being, or even improvement in life as is the case in other climes? The impression that publication output equates to research productivity is an erroneous one. Assessment of impact generated as a result of research varies depending on whether it is an academic impact" which is the intellectual contribution within the academic circle, " external socioeconomic impact , or both (Penfield *et al.*, 2013). Research should produce a positive impact on the scientific, technological, and socioeconomic development of the country. The present bioscience researches conducted in our universities and research institutes, are we sure they are contributing meaningfully to the food security and nutritional well-being of Nigerians?

1.4 Challenges of Biosciences Research in Nigeria

Research in all areas faces numerous and varied challenges. The biosciences are not immune to these challenges. Nigerians are industrious, innovative, inquisitive, and rich in patience and perseverance. These are attributes of good researchers. In other words, Nigerians make excellent researchers and have been proven to do so globally (Garba, B and Saidu, B 2020). However, the challenges of Biosciences research in Nigeria include inadequate/poor funding, corruption, lack of replication studies, lack of adequate and accurate science communication, and poor career prospects and remuneration for Bioscientists.

- i. Inadequate funding: All research requires financial support and the struggle to find and maintain funding has long been the central obstacle most scientists face in their careers, Bioscientists are not left out in this problem. Funding is usually not adequate and in the Nigerian case almost nonexistent making the bioscientists live a life of struggle and always making an extra effort, improvising to get something done. Poor funding affects the nature and scope of study, level, and availability of sufficient data for policy formulation and implementation. Poor funding comes with a myriad of other problems including the poor motivation of the Bioscientist, the stressful nature of academic life, and poor remuneration in addition to the problem of research accessibility. A large chunk of research in Nigerian Universities and other institutions of higher learning is conducted during postgraduate studies which to a large extent are personally financed by the postgraduate students themselves with occasional support from some tutors (Desmennu and Owoaje, 2018). It is very challenging for an individual to finance any meaningful research up to the point of conclus.

- ii. Corruption: In rare cases where funding is available, the funds are not free from the plague of corruption that has bedeviled our country making life for researchers brutish and philistine. Allocation of funds is often based on nepotism rather than being objective on the need of society at the material time. The scientists may not carry out replication studies and data may be falsified (Loannidis, 2005) to validate a known trend that was not observed during the studies rather than create an opportunity to refute earlier assertions with well laid out scientific procedures.
- iii. Lack of adequate and accurate science communication: Bioscience research must be made understandable to the public thereby removing existing disorientation in society and build confidence for the future. Bioscientists must be open, understandable, and accessible to the masses. Science must not continue to hide in laboratories, research fields, and farms, behind office doors and university auditoriums. BioScience issues need to be communicated to everyone in a language they will understand. Venture capitalists who are not scientists will definitely foot drag to invest in what they do not understand or fully comprehend.

1.5 Bioscience Research for Enhancement of Food Security and Nutritional Wellbeing in Nigeria

Bioscience research can be utilized to enhance food security and nutritional well-being in Nigeria in the following thematic areas bioscience for sustainable agriculture, crop and farmed animal health, waste reduction, biofortification of foods, focus on the development of food peculiar to our environment thereby discouraging importation of foods laden with chemical preservatives. Molecular biology and biotechnology remain a powerful tools to achieve food security via an increase in productivity, low production costs, conserve biodiversity, make efficient use of inputs for a suitable environment, and increase the stability of production by managing biotic and abiotic stress. Interdisciplinary, multiscale system modeling approaches can help in the sustenance of agroecosystems. Bioscience research can help develop novel strategies to predict, detect and manage threats to plant and animal health thereby solving the challenges of resistance and improving the welfare of farm animals.

The integration of novel crop and nutritional research will enhance food safety (Nordhagen et al., 2022) especially if the fundamental knowledge of microbiology is applied to minimize pathogens and toxins in the food system. This will ensure pre- and post-harvest pest and pathogen management in addition to the development of appropriate technologies for preservation taking cognizance of our environment and leveraging technology for cost reduction strategies. The proper understanding and control of fundamental biological processes involved in crop physiology, maturation, and post-harvest spoilage will help reduce waste in the food system (Atanda, *et al.*, 2011; Sekaran, *et al.*, 2021). Understanding genomics and identification of the genetic diversity that is needed to develop the next generation of improved crops and farm animals will definitely enhance food security and nutritional well-being. Biosciences integrated

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with novel engineering and technology solutions will help develop precision agriculture and smart technologies including digital and predictive tools to improve decision-making in agriculture.

Biofortification” or “ biological fortification” refers to nutritionally enhanced food crops with increased bioavailability to the human population that is developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic practices. Biofortification is the process of enriching the nutritional quality of food crops by the use of conventional plant breeding and modern biotechnological techniques. The objectives are to improve protein content and quality, oil content and quality, vitamin content, and micronutrient and mineral content. Biofortification of essential micronutrients into crop plants can be achieved through three main approaches, namely transgenic, conventional, and agronomic, involving the use of biotechnology, crop breeding, and fertilization strategies, respectively (Shahzad *et al.*, 2021).

Reducing postharvest losses, especially in developing countries, could be a sustainable solution to increase food availability, reduce pressure on natural resources and eliminate hunger. Cereal grains are the basis of staple food in most of the developing nations, and account for the maximum postharvest losses on a calorific basis among all agricultural commodities. As much as 50%– and 60% of cereal grains can be lost during the storage stage due only to the lack of technical inefficiency. The use of scientific storage methods can reduce these losses to as low as 1%– to 2% (Kumar and Kalita, 2017).

Recommendations

Public investment will be needed, and new and imaginative public-private collaboration can make the biological science (gene) revolution beneficial to developing countries including Nigeria. This is crucial for the well-being of today's hungry people and future generations. There is a need for reorientation and a change of approach. For instance, it is good that we send bio scientists abroad for training and skill acquisition, however, it is more important to empower already trained Bioscientists with grants and provide an enabling environment to initiate research, train others and go beyond preliminary studies to the development of protocols that will improve food production, enhance food safety and nutritional wellbeing of the people.

There is a need for concerted efforts for inter and intra-disciplinary research.

Bioscientists can help improve crops using sophisticated genetic engineering or selective breeding to develop a wide range of staple crop varieties for different situations and purposes. Improved crops can have more farmer-preferred traits like higher yields or desired coloration. Other improved crop varieties have a greater adaptability to a changing climatic, biological, or physical environment. In addition, Bioscientists can produce biofortified crops that address hunger and micronutrient deficiencies, particularly in children and women. These crops can also have a longer shelf life, need less time to grow, or have better disease and pest resistance making them highly valuable to farmers.

Bioscientists can study soil biological processes, beneficial organisms and their mechanisms, management strategies, and soil input products to ensure effective nutrient use. Scientists can develop best-fit integrated soil fertility management practices, including matching improved germplasm and technologies specific to farm niches.

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