

SCIENCE, TECHNOLOGY AND INNOVATION FOR NATIONAL FOOD SECURITY



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Abstract

Food security has been defined in various ways by the various organizations from time to time. The concept of food security is to ensure that all people, at all times get access to the basic food for their active and healthy life. Food security is characterized by availability, access, utilization and stability of food. Many underdeveloped and developing countries including India and most African countries such as Somalia, Kenya, Nigeria to mention but a few are currently facing the challenge of food security. The main thrust of this paper is science, technology and innovations for food security in Nigeria. The paper also looked at the concept of food security, the global food challenges and food challenges in Nigeria. It was observed that the remote cause of food insecurity in developing countries is the inability of people to gain access to food due to widespread poverty and unemployment, which also inhibits purchasing power and prevents assured access to food supplies. Other causes of concern which leads to food insecurity are the rise in prices of staple food such as rice, beans, garri, wheat and maize which are almost beyond reach of average Nigerian populace, climate change, and government policies. The paper outlined how science, technology and innovation can to curtail the challenges of food security. Conclusions were drawn and recommendation were also made amongst which are (1) government should support research and development in agriculture. (2) Government should adopt policies which are geared towards reduction of unemployment in Nigeria.

Keywords: Science, Technology, Innovation and Food security

The issue of food security has been on the front burner for long and statements about several countries in Africa that are food insecure. We have been confronted with horrific photographs of starving children in countries lying on the horn of Africa, countries such as Somalia, Ethiopia, some parts of Kenya, among others. These

frightening photographs depict an avoidable disaster. Africa's agricultural system is backward, and worsened by high global food prices.

In Nigeria, food accounts for a large, and increasing, share of family budgets for poor and urban families. If prices of staple foods soar, poor people bear the brunt. The Food and Agricultural Organisation (2012), an agency of the United Nations (UN), once raised alarm that Nigeria, Morocco and Bangladesh from time to time face imminent food crisis. The report stated that the world food situation was in dire straits. As clothing and shelter serves as the basic necessities of life, food remains the most vital because its central to human existence. It is a known fact that the ruthless expedition for food has shaped human history, provoking wars, driving migration and underpinning the growth of nations. The recent escalation of food prices call for sober reflection. Globally, food crisis is worsening. This vital issue has taken the centre-stage among world leaders, thereby increasing the concern for the world's ability to feed its 6.5 billion people, to avert world-wide unrest and political instability as reported in most countries (FAO, 2012).

Consequently, various international organizations and individual countries embarked on aggressive food security crusades to remedy the situation in order to make food affordable to all.

The Food Security assessment in 2005 proves that 750 million people were food insecure in 70 low-income countries. Asia and Commonwealth of Independent States experienced a 30% drop in the number of hungry people. Latin American and Caribbean countries has varied slightly over time, in food security, but there has been a discernible trend across the region as a wholly. Despite the strong growth in food production, Sub-Saharan Africa is the only region where hunger has risen in the last decade. The challenge today is that high food prices will cause increase in food security and also widespread food crisis in many developing countries. Poor people in developing countries spend between 50-80% of their income on food meet consumers need. Any increase in food prices will reduce food consumption and increase hunger. In Nigeria the prices of rice, corn and wheat record high roof-tops recently (FAO, 2016).

This global food crisis has been attributed to a number of factors including climate change, population growth, increased demand for bio-fuels, failure to improve crop yield, high oil prices, leading to increased input loss for producers and traders. The structural problems like under-investment in agriculture and dominance in supply chain of food and agricultural policies sky rocket prices of food. Rapid urban growth for instance, is raising concerns about food supply. Will there ever be a time when one will not have to worry about where his or her next meal is coming? This challenge and the use of science, technology and innovation for food security among others constitute the main thrust of this paper.

Concept of Food Security

Food insecurity is closely linked to hunger and malnutrition, whilst malnutrition is the most serious consequence of food insecurity. The nature and extent of hunger and food insecurity in Nigeria are of public health concern. Available data showed that total average household expenditure on food for the period between 2009 and 2010 was about 65% (NBS, 2012). Nigeria was ranked 38th out of 76 on the 2014 Global Hunger Index (IFPRI, 2014), whilst another report indicated that the absolute number of food-insecure people was 17 million in 2012, and projected to rise to 43 million by 2022 if the situation is not addressed. The lack of food is the most critical dimension of poverty and is one of the MDGs indicators.

The food distribution system in Nigeria remains largely inefficient due to factors such as crop seasonality, inadequate storage technology and facilities, inadequate transport and distribution systems, as well as market information. All of these result in considerable spatial and seasonal variation in food production and availability and are responsible for the considerable variations in food prices across the country. The problem is aggravated by lack of adequate storage facilities and basic preservation techniques at the house hold level (NFNN, 2016).

According to the 1996 World food Summit, food security is the people's right to define their own policies and strategies for the sustainable production, distribution and consumption of food that guarantees the right to food for the entire population on the basis of small and medium sized production, respecting their own cultures and the diversity of peasant, fishing and indigenous forms of agricultural production, marketing and management of rural areas, in which women play a fundamental role. Food security is also seen as a state of affairs where all people at all times have access to safe and nutritious food to maintain a healthy and active life (Gurkarm, 2005 in Eme & Onyishi (2014).

Adegbola, Bamishaiye, & Daura (2011) added that food is not only a basic need; it also provides the physiological foundation upon which other considerations and human activities are structured. He noted that for us in Nigeria, food security is both a national objective and a challenge. Food security is not simply having sufficient and adequate quantities of our various staple foodstuffs but it also entails access to the entire citizenry to these food items at affordable prices.

Food security can also be defined as a condition where all people, at all times, 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 (World Food Summit, 2003). Indicators of food insecurity in a given region include numbers of hungry or malnourished people, of underweight children and of people suffering from micronutrient deficiency. The importance of food to individuals and households cannot be overemphasized.

Food security according to Siamwalla & Valdes (2004) in Eme, & Onyishi, (2014) is the ability of the countries, regions or households to meet target levels of food consumption on a yearly basis. In a similarly vein, the Committee on World Food Security posited that food security connotes physical and economic access to adequate food for all household members, without undue risk of losing the access. The Food and Agricultural Organization (FAO) also defined food security as a state of affairs where all people at all times have access to safe and nutritious food to maintain a healthy and productive life. This implies: availability, accessibility, and proper utilization. Food security means ensuring that sufficient food is available; maintaining sufficient supplies through domestic production at relatively stable levels; allowing access to food for those in need of it; and ensuring biological utilization of food. This implies adequate storage against spoilage, disease and ensures that nutrient balance. In addition, the World Bank (2007) looked at food security as access by all people at all times to enough food for an active, healthy life. Food security is thus people oriented and it implies a situation in which all households have both physical and economic access to adequate food for all members and households are not at risk of losing such. Food security has three aspects; food availability, food access and food adequacy (Nwaniki, 2007 in Otto & Ukpere, (2012)

Food availability has to do with the supply of food, that is to say food should be sufficient in quantity and quality and also should be in variety. If food security is to be attained, appropriate adaptation measures to climate change need to be taken within the global agricultural environment. The right to sufficient food is enshrined in the universal declaration of human rights and in subsequent international law. It is unfortunate to note that only 22 countries have embedded this right in their constitutions. Food security has to do with the absence of threats of hunger or malnutrition people face in their lives. In a broad sense, it entails safety from basic physiological needs. The lack of safety will be manifested in chronic hunger or starvation and malnutrition. It can either be chronic or transitory. Chronic food insecurity is a perpetual inadequate diet resulting from the lack of resources to produce or acquire food. Transitory food insecurity on the other hand, is temporary decline in household's access to enough food. It results from instability in food production and prices, or in household incomes. Both conditions are prevalent in sub-Saharan Africa and some parts of Asia. It is informative to also note that food security measures are in tandem with the UN MDGs of reducing population of hungry people by half in 2015.

All the above definitions have stressed that food security is of supreme importance in improving the nutritional status of many millions of people who suffer from persistent hunger and under nutrition and many others who are at the risk of facing the same situation. They have also touched some important components of the concept of food security.

From the above perspectives, it can be implied that food crisis can occur when at a point it is no longer possible for people to have access to food or even have the capacity

to purchase it. Currently, the situation seems to be the case in Nigeria and elsewhere in Africa. The crisis has arisen, as shall be seen, due to poor implementation of agricultural policies and programs, a situation that has resulted into food insufficiency both in quantity and quality due to prolonged years of neglect or insensitivity on the part of the institutions responsible for encouraging food production.

The Global Challenge of Food Security

Food security is usually framed in four dimensions: food availability, access to food, food utilization, and food stability. These dimensions build the overall framework of the definition established by the Food and Agriculture Organization of the United Nations (FAO): Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life (FAO, 2016).

According to FAO (2015) about 795 million people, or every ninth person, are undernourished, including 4.90 million children under the age of five. The vast majority of them (780 million people) live in the developing regions, notably in Africa and Asia. Depending on the region considered, the share of undernourished people differs considerably, ranging from less than 5 per cent to more than 35 per cent. In particular, sub-Saharan Africa shows high values, with almost 25 per cent of the population undernourished. While the hunger rate – the share of undernourished in the total population – has fallen in the region, the number of undernourished people has increased by 44 million since 1990 due to population growth. In absolute terms, the number of people exposed to food insecurity is highest in South Asia, with 281 million undernourished people. Across all countries, people living in rural areas are the most exposed to food insecurity, owing to limited access to food and financial resources.

Sustainable Development Goal 2 aims to end hunger and ensure access to sufficient, safe and nutritious food by all people all year round. Overall, most of the Sustainable Development Goal targets are related to the overarching issue of achieving food security on a global scale. Poverty and climate change exacerbate the global challenge of food insecurity. Other factors are directly implicated in the achievement of food security, including increasing population and urbanization, changing consumption patterns, conflicts and particular topographical features in certain geographies. Innovative capabilities are critical not only for ensuring nutritious food at all times but also for harnessing agriculture and the broader food system as a driver of economic and sustainable development.

Challenges of Food Security in Nigeria

Attaining food security in its entirety poses a huge challenge in a country like Nigeria, as a result of a wide spectrum of problems. More than 90 per cent of agricultural production in Nigeria is rain-fed with about 79 million hectares of arable land, of which 32 million hectares are cultivated (Nwajiuba, 2012, cited in FAO, 2012).

Both crop and livestock production remains below potentials. Despite a seven percent growth rate in agricultural production (2000 to 2008), the growing population is dependent on imported staple food (e.g rice) exemplified by increase in food import bill.

First and foremost, the primary cause of food insecurity in developing countries is the inability of people to gain access to food due to widespread poverty and unemployment, which also inhibits purchasing power and prevents assured access to food supplies. Secondly, global food prices have risen dramatically in the last few years and are forecast to rise further or become more volatile (IAASTD, 2009, Nelson et al, 2011, cited in, FAO, 2011).

Food price volatility has exerted considerable pressure on global food security, and many Nigerians depend on market for their food supply and vulnerable to high food prices. Related to high food prices is a high cost of input which limit yield and production levels that many time lead to sub-optimal input utilization. For instance, fertilizer consumption in Nigeria is one of the lowest in sub-Sahara Africa at 7lg per hectare (Abu, 2012, cited in, FAO, 2012).

Thirdly, the inherent characteristics of climate that manifest themselves as changes of climate over a period time affect food security significantly in unpredictable ways as a result of their detrimental effect on pests, crops diseases, crop production, animal husbandry, and humans. Changing climatic conditions affect both the physical and the economic availability of certain preferred food items. Their impacts on income-earning opportunities can affect: the ability to buy food, the availability of certain food products, and price. Changes in the demand for seasonal agricultural labour, consequent upon changes in production practices, will in turn affect income generating capacity. Fourth, farmers in Nigeria also have limited access to credit, and less than 10 per cent of irrigable land is being irrigated. Fifth, the global economy is knowledge-driven and food system efficiency is dependent heavily and directly on agricultural technological innovations and innovations in relevant sectors. Nigeria's adult literacy level is 54.5 per cent (NBS, 2009).

Finally, the apparent inconsistency in government's targeted policy intervention and implementation strategies further compounds the problem of food security. For instance, weaknesses and threats to Agricultural development in Nigeria include: (a) Poor access to credit, technical inputs, machines and farm implements (i.e. fertilizers, seeds, pesticides, tractor, plow, harvesters etc) by farmers (b) Degradation of agricultural natural resources especially soil and water bodies. (c) Poor infrastructure (i.e. rural roads, water supply, storage facilities and market infrastructure) (d) Bad and inconsistent government policy (e) Poor budget allocation to agricultural sector (f) Poor and inadequate irrigation facilities (g) Uncontrolled grazing and livestock migration in some areas and (h) Poaching and settlement within protected areas and bush fires. At the production stage, certain factors affect the quantities and types of food produced. There

should be concerted effort geared both from private and public sector in making efforts towards national food security in Nigeria.

Science, Technology and Innovation for Food Security

Science, technology and innovations have tended to impact positively in a number of ways on sustainable food production in Africa. Essiet (2014) rightly noted that tracking the challenges of malnutrition and food security and improving production to create jobs require rethinking of how food is produced, distributed and consumed.

Rademacher (2015) has argued that food crises in the sub-Saharan Africa was perceived to emanate from inadequate supply of food, hence a strategy of making food available for donor countries was adopted. That is, “the problem was not lack of food but an inability on the part of both local and international actor to distribute food it is most needed in timely and cost effective manor”. Climate change and economic crises were identified as influencing food production on the continent. Therefore, Rademacher (2015) suggested that there was a need to look beyond the food supply box with a view to discerning alternative solutions. There is no gainsaying the fact that, the problem of achieving sustainable food production in Africa is partially hinged on her mode of production. Most of Africa still largely adopt the traditional and primitively self-sustaining agricultural production. The adopting of modern or contemporary scientific and technological innovations by farmers which are essentially small-scale which are very insignificant when compared to the number of farmers and size of the land involved. Yet, the productive capacity of most African farmers is not largely achieve sustainable food production.

Science, technology and innovations have largely offered the likely solution to this problem. Acquiring and adopting the needed and relevant innovations to Africa poses a number of questions.

A number of technologies can play vital roles in addressing concerns related to the four dimensions of food security (see table below). New and existing technologies to combat biotic and abiotic stresses, raise crop and livestock productivity, improve soil fertility and make water available and can potentially increase the amount of food produced. Storage, refrigeration, transport and agro-processing innovations can address the dimension of food accessibility. Science principles can be used to produce high-nutrient staple crops which can help to combat malnutrition, improving food utilization and use. Finally, Science, technology and society can be used to adopt methods for climate change mitigation and adaptation – including precision agriculture, index-based insurance and early warning systems which can help to address food instability. The challenges of food security and suggestions and examples of innovations that can be applied to tackle the food challenges in order to achieve national food security are outlined in the table below;

Food security	Challenge	Examples of science, technology and innovation
Food availability	Biotic stresses	Disease- or pest-resistant crops Pest-resistant eggplant Rust-resistant wheat varieties Pesticides Herbicides Tilling machines Spatial repellent for on-farm pests Improved agronomic practices (for example, push-pull mechanisms)
	Abiotic stresses	Salt-tolerant crops (for example, quinoa, potato) Climate-resistant crops
	Improving crop productivity (in general) ^a	Conventional breeding Tissue culture and micro propagation Marker-assisted breeding Advanced genetic engineering Low-cost diagnostic toolkits for extension workers
	Improving livestock agriculture (in general)	High-nutrient, low-cost animal fodder Liquid nitrogen and low-cost alternatives for animal semen preservation Low-cost diagnostic toolkits for livestock veterinarians Tissue engineering for laboratory-grown animal products Low-cost veterinary pharmaceuticals (ideally thermostable)
	Lack of water availability	Water storage technologies (subsurface water technologies, aquifers, ponds, tanks, low-cost plastic water tanks, natural wetlands, reservoirs) Canal irrigation Micro-irrigation technologies, drip irrigation, bubbler irrigation, microsprinkler irrigation Water lifting (hand-powered mechanical pumps, treadle pumps, solar-power irrigation pumps, hydrogen-powered pumps, electric and fossil fuel pumps) Fungal seed and plant treatment for water-related stress Stabilized silicic acid for drought tolerance Irrigation scheduling systems and decision-support systems Planting technology for increased water efficiency Water pads (water-buffering technology) Rainwater harvesting mechanisms Water desalination technologies Wastewater reuse Conservation agriculture Portable sensors for groundwater detection

Soil		Synthetic and organic fertilizers Biogas digesters Slurry separation systems Zero or conservation tillage Soil microorganisms Natural nitrogen fixation Point-of-use kits for evaluating soil nutrient content
Need for precise integration, scheduling of inputs for increased yield		Imaging and associated analytics Drones Internet of things Big data Farm management software and applications
environments	Farming in urban	Indoor farming Vertical farming Aquaponics Low-cost greenhouses
intensive operations	Power and control-	Tractors Robotic technologies Animal-drawn implements
Food security	Challenge	Examples of science, technology and innovation
		Low-cost solar dryers Vacuum or hermetic sealing
	Need for harvest and agro-processing equipment	Crop threshers (motorized and bicycle-powered) Agro-processing technologies (crop, meat, dairy products, fish)
Food utilization and use	Lack of nutritious foods, especially staple crops	High-nutrient staple crops Vitamin A-enriched cassava, maize, orange-fleshed sweet potatoes Iron and zinc-fortified rice, beans, wheat and pearl millet quality protein maize
	Lack of information on healthy diets	Dissemination of nutrition information (for example, health mobile applications)
	Inability to predict when and how to farm	Weather-forecasting technologies Infrared sensors for detecting crop stress Hyperspectral imaging, based on drones and satellites
Food stability	Lack of financial mechanisms to ensure income	Index-based insurance (crops and livestock)

Source: UNCTAD

Conclusion

Food is not like other commodities, it is an indispensable and an important factor in nation's quest for economic growth and development. Being an inevitable commodity all efforts must be geared towards ensuring its adequate supply for sustainable economic development and human survival. In Nigeria, most of the food needed is produced by peasant farmers who are scattered all over the rural areas and not multinational companies who produce on large scale for export and profit. For the dream of food security to be realized agricultural policies must target these peasant farmers and their rural environments.

Recommendations

Based on the foregoing, the following recommendations were proffered:

1. The government; federal, state and local government should increase national support for research and development in agriculture and thus make adequate provision for infrastructure, electricity, road, extension services, marketing, organizational and social innovations to improve food security.
2. The government; federal, state and local government should create coherent policy frameworks that encourage inter ministerial coordination for food security, provide an enabling framework for agricultural innovation and establish appropriate regulatory frameworks
3. In order to reap the full value of science and technology vis-à-vis the achievement of food security, Nigeria must lay a solid foundation for its science and technology by investing more on education, research and development (R&D), as well as initiate public policies aimed at sharing adaptive and practical innovations and breakthroughs in science, technology and sustainability of food in Nigeria.
4. Nigeria political leader must exhibit transparent and coherent will to formulate and implement comprehensive policy on sustainable food production. For instance, the strategy of extrusion technology should be principally adopted to boost food production on the continent.
5. Government should make policies geared towards reduction of unemployment and promote productivity in Nigeria.

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