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FOOD SECURITY, TECHNOLOGICAL REVOLUTION AND AFRICA'S QUEST FOR DEVELOPMENT IN THE 21ST CENTURY: EXAMINING THE NEXUS

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Abstract

Food is the most important of the three basic needs (food, shelter and clothes) for human existence and development. The process (agriculture) that brings about food is the bedrock of every nation's development. One fundamental instrument for its growth is technology. Africa has an opportunity to play a bigger role in the world economy, but first, it must tackle the obstacles of deficit in scientific knowledge as well as technological backwardness. In contemporary Africa, there still exists the challenge of food insecurity, which gives room for endemic, vulnerability of rural poverty and human capital underdevelopment. Popper's philosophy contains ideas that are capable of stimulating the needed knowledge relevant to Africa's quest for development in the 21st century. Therefore, in unison with Popper's philosophy on the above, and bearing in mind that the 21st century is an age where development is largely determined, not by natural resources any longer, but by knowledge economy and technological revolution - this paper focused on achieving food security through agricultural development, using relevant technologies in advancing agricultural output. In this paper, I also examined the problems militating against agriculture in Africa, as well as how investment in the agriculture and technology can be indispensable tool achieving food security and development. The result from review of related literatures showed that in Africa, there is a high level of food insecurity because of low attention on food production occasioned by the use of crude implements and inconsistency in government's agricultural development policies and programmes, as well as the Covid-19 crisis that is affecting global economies. Conclusively, in Africa, both the citizens and government despise agriculture. Deterioration in technology has long been identified as one of the reasons for poor

agricultural production performance and food scarcity in Africa. Workable recommendations are outlined; among others, the researchers recommend that African leaders should mechanize agriculture; also, social protection policies should be channeled to agricultural sector to protect farmers who are vulnerable to threat of life and avert risks associated with farming.

Keywords: Food security, technological revolution, agricultural production, development, Africa

Introduction

The recent literature on development in Africa emphasizes that the agricultural development still needs to play a key role for poverty reduction and food security. As compared to the situation of the Green Revolution in Asia, there are new opportunities for the agricultural development in Africa, but also new challenges. To achieve this, technological revolution policies must be designed and vigorously implemented (Anderson, Birner, Naseem & Pray, 2018; Kanu & Imatiri 2019a). One of the most distinguishing factors between the developed and developing countries is application of appropriate technology as well as its diffusion to different sectors of the economy (Ekekwe, 2010). The growth in technology transfer across the world especially in the 21st century has greatly affected various sectors of the economy across countries around the world. For example, the rise in technology has brought about growth in cross-border trade, investment, agricultural mechanization, food security and so on.

Technologies have been seen as veritable tools for economic growth and development across the countries of the world especially the developed ones (UNDP, 2008) cited in (Osabuohien, 2010). Technology is simply viewed as the techniques of doing things, while technological revolution imply improved and better ways of getting any task done. The relationship between food security, technological revolution and agriculture development, especially in Africa, cannot be overemphasized. As a roadmap to attaining development, the Millennium Development Goals (MDGs) was adopted in year 2000 and in Africa, 70% of the development target group live in rural areas and are dependent on agriculture for a living (International Food Policy Research Institute, 2004). Invariably, reducing poverty, improving nutrition and general well-being of the population would imply improving the livelihood of this majority and this hinges critically on the performance of the agriculture sector.

For a country to be food sufficient, it needs to make food available, provide easy access to food at any given time, and provide households or families with the ability to afford staple food (Reisinger, 2014; Kanu & Imatiri 2019b). Adedeyi (1989) cited in Atang and Ugo (2014) see development as a process of socio-economic and political transformation of structures in a society, in such a way that it leads to improvement in the level of living of the people including education, housing, health and nutrition and other related social services, decreasing inequality in the distribution of income, urban-rural imbalances and political and economic opportunities. This paper investigates the contribution of the agriculture sector to food security via technological revolution in Africa. The study also assesses the extent of technological evolution in Africa and suggests how technological revolution can further engender development.

Conceptualizing Food Security

Food is any substance, either solid or liquid taken into the body for nourishment and sustenance of life. Food security in its most basic form is defined as the access to food needed for a healthy life at all times. However, in a simple language, a country is food-secured when majority of its population have access to food of adequate quantity and quality, consistent with decent existence at all times (Reutlinger, 1985; Idachaba, 2004) cited in (Ojo & Adebayo, 2012). According to the Food and Agricultural Organization (2008), food security is when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary and food preferences for an active and real life. In other words, food security can be taken to mean access by all people at all times to sufficient food for an active and healthy life. Its central elements are: (a) the availability of food (b) accessibility of food, and (c) food adequacy.

Conceptualizing Technology, Biotechnology and Technological Evolution

Technology is a broad concept that deals with the usage and knowledge of tools, crafts and how it affects man's ability to control and adapt to his environment. It is quite difficult to have a generally acceptable definition of technology. Mostly, it simply refers to material objects of use to humanity, such as machines, hardware or utensils and many others (Franklin, 1989). It equally means the application of scientific knowledge in solving man's problems and improving his living condition.

Biotechnology is the kind of technological revolution that is based on biology, especially concerning agriculture, food science, and medicine. It is regarded as any technological application that uses biological systems, dead organisms, or their derivatives in making or modifying products or processes for given usage (United Nations Convention on Biological Diversity, 2002). Today, biotechnology represents a scientific advance in agriculture with far reaching potentials in increasing food production in an environmentally sustainable manner. Agricultural biotechnology includes using genetics to modify crops and plants to produce more nutritious food, cloning of livestock; tissue culture technique and genetic engineering. Apart from its potential to produce higher yields the one of biotechnology gives shorter gestation and maturity periods to crops, plants and livestock as well as will continue to use biotechnology to produce genetically modified foods.

Technological revolution, on the other hand, connotes total or radical change, as well as improvements of previous technologies to a better one. Technological revolutions have reduced barriers to communication, which have made people interact more freely within and across countries on a global space (National Science Foundation, 2002). The production frontier can be enhanced by the efficient use of modern technologies. Technological revolution involves the process of adopting innovations in order to enhance productivity. It is the ability of technology having a wider impact on the society through its application. Its adoption will enhance human activities in the society. It is disputable fact that technological revolution is a veritable for all- round development. This assertion is supported by the fact that most countries that have attained some measures of development followed the path of technological revolutions. Unfortunately, the situation in Africa has not been as desired. According to Osabuohien and Efobi (2012), the diffusion of appropriate technology is the distinguishing factor between the growth capacities of various countries. The African region is not an exception, which has been known to be amongst the slow growth regions of the world, with rising number of poor.

Technological Revolution and Development of Agricultural Sector in Africa: The Linkages

In Africa, Asia, Latin America and other third world countries, a deterioration in technology or ecology, which lower outputs from given input has long been identified as one of the reasons for poor agricultural production performance (Collier, 2008). It is equally important to note that indigenous techniques like

crop rotation and other cultural farming practices that have been used to preserve the soil structure and its fecundity do not seem to be adequate or even relevant in the present efforts to boast food production in most developing countries.

In Africa, deterioration in technology, which lower outputs from given input has long been identified as one of the reasons for poor agricultural production performance and food scarcity. A country that cannot formulate and effectively implement agricultural and food policies may find it difficult to use the citizens as catalyst for sustainable democracy and national development. More so, the very survival of the state is linked to the ability of its economy to meet the material demands of both people and government. As a fundamental factor affecting humanity globally in this century, technology has provided many opportunities. In fact, it has affected many areas of human life, as well as many sectors of the economy - one of these is agriculture.

The relevance of technological evolution in attaining improved productivity in agriculture sector in Africa cannot be underrated. In Nigeria, the government has embraced the idea of using biotechnology to boost food production as a pre-condition for food security. It established the National Biotechnology Development Agency at Abuja (Federal Capital Territory) setting aside the sum of 26 million naira (about $185,000) to be invested in the project, and specifically mandating the Institute of Agriculture Research, Ahmadu Bello University, Zaria, to apply biotechnology for the improvement of farming systems for various crops such as Sorghum, maize, cowpea, cotton and sunflower (Vanguard, February 16, 2005).

It is increasingly obvious that technological investment in agriculture has a very pivotal role to play to ensure that food is available globally, thereby serving as a major source of income which enhances households' purchasing power to buy food that has a high rate of nutritional status (Food and Agricultural Organization, 2016). In the field of agriculture, technological revolutions have helped in the production of disease resistant species of crops. The production of crops that attain early maturity as well as improved market and nutrient values has been made possible by technologies like green biotechnology. Similar improvement has been witnessed in animal husbandry where animals with higher nutrient and market values are being raised (Osabuohien, 2010).

The 21st century provides a range of new opportunities and linkages that have become available through scientific advances in a range of fields. Examples include innovations in breeding techniques (for example, precision phnotyping, genomic selection, gene editing) or the use of sensor technologies for agricultural monitoring (with applications, example in irrigation, pest control or animal and pasture monitoring (Odetola & Etumnu, 2013). One promising group of technologies that are increasingly used in developing countries is information and communication technologies (ICTs). There are many opportunities to use ICTs in the agricultural knowledge systems (for example, in research and extension services), as well as in different segments of agricultural value chains.

Innovations in Agricultural Production and Food Security: Opportunities for Africa's Development in the 21st Century

No doubt, food is life; hence, food has become an instrument of national power. One of the big opportunities for African agricultural transformation is that it can take advantage of many technological and institutional innovations that have been developed during the past decades. The World Development Report 2008 (World Bank 2008) as well as other sources, such as the World Bank's Agricultural Innovation Systems Sourcebook (World Bank, 2016), provide ample evidence of such innovations that can facilitate the agricultural transformation in Africa. They include new low-cost land certification schemes that can help to provide security of access and support land rentals; technological innovations, such as drought- and flood-resistant varieties, new types of financial services, and new value chain approaches that bring smallholder farmers into contract farming with agro-industry (Odetola & Etumnu, 2013).

In Africa, agriculture is despised. Able-bodied young men and women do not have interest in agriculture. Both the educated and the non-educated roam the nooks and crannies of the cities in the urban areas looking for non-existent white-collar jobs. However, agriculture fosters economic growth through its potential to stabilize domestic food production and thereby enhance food security. Periodic food crises undermine both political and economic stability, thereby reducing the level and efficiency of investment (Alesina and Perotti 1993; Barro and Sala-i-Martin 1995) cited in (Daio, Resnick, Hazell and Thurlow, 2006). While food imports may temporarily alleviate such crises, they are not a viable solution for ensuring long-term food security, especially given the possibility of encountering foreign exchange constraints.

Technological revolution and adequate investment in agriculture has the capacity of improving technical knowledge among African farmers, with a view to achieving food security. In fact, adopting innovation in agricultural sector is deemed essential for increasing agricultural output; reduce the vulnerability of rural poverty and consequently, food security. Food security and growth in agricultural output depend on technological usages, which enhance the productive capacity of the agricultural sector. This will reduce problems of food shortage and scarcity, as well as starvation and hunger in the African continent.

Challenges of the 21st Century for African Agriculture and Food Security

Despite the significance of agriculture to Africa's development strive, a number of problems stare it in the face. African agriculture in the 21st century faces several risks and challenges that, if not addressed, could constrain growth and development. The first challenge of the African agricultural development is caused by the diversity of agro-ecologies and cropping systems, which seriously limits the possibilities to benefit from spill-overs from public and private research and development investments from other regions (World Bank, 2008). However, expenditure on research and development, measured as percentage of agricultural gross domestic product, has remained rather low in Africa and the agricultural research systems have remained fragmented and mostly rather small (Beintema & Stads, 2014).

The second challenge is the relatively low level of market and institutional development in Africa. Supportive market and social institutions underpinned the Green Revolution of the Asian continent. In Mexico, for example, land rights regulation and institutions were restructured before farmers could profitably adopt hybrid maize (Byerlee, de Janvry & Sadoulet, 2009). Kim and Ncube (2014) argue that a key difference between the growth experience of East Asia and Sub-Sahara Africa (SSA) has been the lack of private ownership of land in SSA resulting in a vicious cycle of low investment, low productivity and low incomes. Asia had functional input and credit markets and output markets that Africa lacks, hindering African agricultural development Africa's lack of institutional development that enables private sector activity has been cited as the underlying cause of African. In response to this challenge, the African Union adopted the Comprehensive Africa Agriculture Development Programme (CAADP) in Maputo, Mozambique in 2003. One of the key policies called for member states to increase public agricultural investment to 10% of national budgets per year and for a 6% increase in agricultural productivity per year.

A third challenge for African agricultural development is climate change. As compared to temperate zones, tropical agriculture is more negatively affected by climate change, which exacerbates the already existing challenges of increasing agricultural productivity. For instance, drought reduces agricultural output, which decreases the rate of available food, and so the meal frequency decreases because the balance of nutrients is insufficient and this leads to malnutrition in children and even adults. (Agwu et al, 2011) cited in (Egbule & Dikenwosi, 2020). Few years ago, the increase in water level has resulted to flooding in some coastal areas of Nigeria. Also, increase in rainfall washed away bridges, houses, destroys properties and settlements as was witnessed in some states like Sokoto, Kebbi, Jigawa, Lagos, Ogun and Bayelsa in 2010 and Benin, Delta, Calabar, and Lagos in 2011.

A fourth challenge, which already existed in the 20th century but became better recognized in the 21st, is the need for environmental protection and sustainable natural resource management. The Green Revolution in Asia has had a range of negative environmental consequences, such as pollution by overuse of pesticides and inorganic fertilizer, depletion of aquifers and loss of biodiversity. This concern, which has been widely acknowledged in the literature, has led to calls for a "doubly green" (Conway, 1997) or "ever-green" revolution (Swaminathan, 2005). The African agricultural transformation not only has to avoid these problems caused through agricultural intensification, there is also a need to address the problems of natural resource degradation that have been caused during the past decades in the prevailing extensive farming systems, such as fertility depletion due to lack of fertilizer use. What makes tackling these problems even more challenging is the lack of any consensus on the strategies that will be most suitable to tackle agro-environmental problems. As the controversies surrounding the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD, 2009) have shown, the global community is deeply divided regarding the question as to the role of modern industrial inputs vis-à-vis agro-ecological and organic approaches in future agricultural development (Scoones, 2009).

Another major challenge that African agricultural development or transformation has to cope with is globalization. Managing an agricultural transformation under the conditions of an open market economy brings its own challenges, since African governments have fewer possibilities to protect the

sector at least initially ("infant industry") than was the case during the Asian Green Revolution. Moreover, the African agricultural transformation is confronted with highly volatile agricultural prices and with rapidly changing demands of increasingly globalized value chains (de Janvry and Sadoulet, 2010). According Daio, Resnick, Hazell and Thurlow (2006), while the recent "bypass" argument is new in the sense that globalization and trade liberalization provide more export opportunities and make food even cheaper on the international market, the difficulties created by earlier attempts to "bypass" agriculture remain. Most African countries possess a small and inefficient industrial base with an unimpressive growth performance. Turning this performance around in an open trade environment is a daunting task. Not only are fledgling industries expected to compete with the world's best in export markets, but also trade liberalization is a two-edged sword that also opens domestic markets to imports that can decimate whole swaths of industry before they have a chance to adjust and compete. The approach contrasts sharply with the proven and successful approach of many Asian countries that first nurtured their industries through growth in protected domestic markets and subsidized exports before requiring them to face the full force of international competition.

Lack of political will to support agricultural transformation and large-scale investment in agriculture is another major constraint in Africa. Political will is a challenging concept. Hammergren (1998) cited in Post et al (2010) characterized it as "the slipperiest concept in the policy lexicon," calling it "the sine qua non of policy success, which is never defined except by its absence." There have been various efforts to define political will since then. Post et al (2010) defined political will as "the extent of committed support among key decision-makers for a particular policy solution to a particular problem." According to Brinkerhoff (2010) focused on the political will to combat corruption. His concept of political will is here adapted to the will to transform agriculture.

Finally, there are still unwarranted public fears to contend with in the safety of genetically modified foods, stemming from scare-stories, reinforced by superstition and crash ignorance, of the danger in the consumption of genetically modified foods. The incontrovertible fact is that without the help of agricultural biotechnology, success in food security will continue to elude Nigeria. Other factors that are militating against agricultural production and food availability in Africa include poor infrastructure and ineffective policies, weak institutional framework, inadequate credit faculties, as well as the bottleneck associated with

assessing the available once, inadequate infrastructural facilities, especially accessible roads and so on.

Consequences of Food Insecurity in Africa

In most parts of Africa, agriculture still regarded as a vocation for the illiterates in the rural areas who have nothing better to do. The big farmers – politicians, retired generals and businesspersons – engage largely in crops or animals cultivation that are not common staples. They have pineapple plantations, ostrich and other exotic farms that add nothing to our quest for food security – mainly for export. The lack of mechanized farming is certainly something to worry about. In contemporary Africa, there still exists the challenge of food insecurity, which gives room for endemic, vulnerability of rural poverty and human capital underdevelopment. In view of the foregoing, the attainment of food security is imperative in any country. This is why all developed and developing countries make considerable efforts to increase their food production capacity. The United Nations (UN) Secretary General, Ban Kimoon, laid out these sobering statistics as he kicked off a three-day summit on world food security in Rome. "Today, more than one billion people are hungry", he told the assembly leaders. Six million children die of hunger every year, 17,000 every day. Dan Kimoon added that in 2050, the world will need to feed two million more mouths – 9.1 billion in all (Nigerian Compass, November 18, 2009). But hunger, defined here as a situation in which there is an inadequate quantity of available food; and malnutrition which is indicative of intake of unbalanced diets, have been ravaging most developing countries, severely menacing poor families (Macnamara, 1973) in (Ojo & Adebayo, 2012). Both have also had debilitating effects in the productive capacity of the citizens, impacting negatively on the overall economic development of many countries.

The twin problem of hunger and malnutrition is closely linked with poverty. While hunger may be occasioned mostly by lack of jobs, or hyper – inflation that causes reduced purchasing power among others, which may be eliminated or reduced with sound management of the national economy, malnutrition is caused by poor diet and has a very long-term devastating effect as people in many poor countries. Medical and anthropometric evidence has shown, for instance, a very close link between malnutrition and infant mortality, poor growth in children as well as reduced adults' immune system to fight some diseases. To be sure, malnutrition saps the working strength of an economy, cripples the mind and body of children and consequently deprives the society of

its greatest potential that is, its future productive human resources (Salvative & Dowlins, 1977) cited in (Ojo & Adebayo, 2012). In contrast, countries that are food-secure do not have this dreadful situation to contend with (Davies, 2009) cited in (Ojo & Adebayo, 2012).

Africa which reversed from being a key exporter of agricultural commodities into being a net importer, has the highest percentage of undernourished people and has shown less progress on reducing the prevalence of undernourishment in the last 30 years. Chronic food insecurity now affects some 28% of the population that is nearly 200 million people who are suffering from malnutrition. Famines are the most visible and extreme manifestation of acute food insecurity.

Meanwhile, Nigeria is one of the food-deficit countries in Sub-Saharan Africa, although it is arguably better in terms of production than the others are. It has also not suffered any major catastrophe that could precipitate scourges of famine, mass hunger and therefore food crisis. This does not in any way prevent public policy makers from being conscious of avoiding the debilitating impact of food shortages in neighbouring countries that has however made food security become a first order priority of the present African governments. The greatest recommendation of this paper to avoid recapitulation is that public policy makers must as a matter of urgency see food as component of welfarism and as such develop sufficient political will towards agricultural development..

Conclusion

The study appraised the indispensability of technological revolution in achieving development in Africa. Finding from the study shows that Africa has not experienced much technological revolution, which could be traceable to low investment in education and research. It was also established that there is a significant positive relationship between technological revolution, food security and development. Application of appropriate technology has been noted as one of the distinguishing factors in growth disparities across countries. Thus, this study investigates the place of food security through modern/mechanized agriculture by the instrumentality of technological revolution towards development in Africa. In fact, if Africa must contribute to the global knowledge economy and move on the path of economic progress, the issue of technological revolutions through adequate investment on functional and quality education, among others, needs to be addressed with all serious efforts. Finally, I suggest

that other scholars should examine some major agricultural policies and programmes in Africa – their prospects, challenges and the way forward.

Recommendations

This sub-section enumerated the way forward for African agricultural sector. The following measures will improve and ensure increase in agricultural productivity and food availability in Africa:

- African governments should provide more funding for agricultural universities to carry out researches on all areas of agricultural production - this will lead to more exports and improvement in the competitiveness of Africa agriculture production in international markets;
- Also, governments should revive relevant past agricultural policies and programmes, most importantly social protection policies should be channeled to agricultural sector to protect farmers who are vulnerable to threat of life (for instance, herdsmen-farmers conflict in Nigeria) and avert risks associated with farming;
- African governments should also make adequate provision of finance and credit facilities (with little or no interest) to farmers (including women) and also come up with a stable policy for loan disbursement strategy;
- Governments should mechanize agriculture, supply high yielding seedlings, subsidize the prices of agro-chemical and fertilizer for farmers, provide adequate irrigation scheme and also encourage farmers to adopt modern production technology, as well as the provision of extension services;
- Ensuring food availability via modern storage facilities could stem the rate in food insecurity. In fact, instituting an effective system of food preservation can address hunger and stabilize food prices for both farmers and consumers thereby suppressing hunger and reversing the trend of food insecurity.
- Increased agricultural productivity and food availability can be achieved in Africa through the promotion of functional and skill-oriented education system and investment. This is germane if Africa desires to contribute to the global economy.
- Supports can be provided by governments' relevant agencies, foundations, Non Governmental Organisation (NGOs) and well-meaning individuals, which can be in the form of giving free seeds and fertilizer distribution to low or middle-income farmers in post shocks (post-disaster and post-

drought) conditions in a way of recovering quick form shocks and of restarting agricultural production and food security.

- Overcoming the challenges of agricultural productivity and food availability in Africa requires particularly strong efforts to invest in research and development and to exploit economies of scale in research and development by collaborating within the region;
- Political will to support agricultural transformation and large-scale investment in agriculture is imperative and indispensable in Africa.

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