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Innovation and Creativity in Agriculture for sustainable Development

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Abstract: To cope with today's markets and economy pressure, innovations and creativity becomes very important in agriculture. The fact that agriculture is a major source of employment and backbone to many industries in terms of raw materials supply, heightens the critical role of innovation, creativity and resourcefulness. More critical is the present state of food supply in which Nigeria has transited from food exporter to net food importer. No thanks to the prevailing political economy and non–supportive policies. Farmers would languish in poverty, rural development would suffer set back and the resultant effect on the economy and citizenry is better imagined without innovation and creativity. Thus, the chapter elucidated the need for innovation and creativity, trending innovation and creativity among practicing farmers in Nigeria and other burning issues of agricultural innovation system.
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1. Introduction

The challenges of today's world are bringing many pressures to bear on agriculture; population growth, the impact of climate change, the need to reduce greenhouse gas emissions in agriculture, rapid development of the emerging economies and growing instability associated with land, water, energy shortages and banditry or terrorist attacks. This scenario heightens the critical role of innovation to make agriculture more competitive and sustainable. Innovation, in general terms, is a process by which something new is implemented in a given context; it is socially appropriate and provides benefits for the parties involved. The World Bank in 2006 identified six changes in the context for agricultural development that heighten the need to examine how innovation occurs in the agricultural sector namely:

- Markets, not production, increasingly drive agricultural development;
- The production, trade, and consumption environment for agriculture and agricultural products is growing more dynamic and evolving in unpredictable ways;
- Knowledge, information, and technology increasingly are generated, diffused, and applied through the private sector;
- Exponential growth in information and communications technology has transformed;
- the ability to take advantage of knowledge developed in other places or for other purposes;
- The knowledge structure of the agricultural sector in many countries is changing markedly; and. Agricultural development increasingly takes place in a globalized setting.

Innovation is a major instrument in social and economic development; especially, eco-friendly innovation stimulates not only production but an efficient use of natural resources as well. As a result of changing economic, political, and ecological conditions in the world, innovations now enable higher value in unprocessed raw material within a chain; processing, packaging, storage, delivery, and distribution of food after production and food safety. Consequently, use of technology in agriculture accelerates growth and development with effective production through the processes. The ultimate impact of innovation and creativity can be achieved in decreasing poverty through rural development. The development of agricultural food industry and integrated supply chains with globalization, technological and corporate advancements and environmental effects have all widened the scope of agriculture. Additionally, global financial crises in recent years have revealed a weakness in the implementation and sustainability of current growth models and agricultural policies. New structural solutions are therefore required. Aside from these issues, modern growth theory considers technological change as the engine of economic development. It is often pointed out that the use of technology will

contribute significantly to rural development and a decline in poverty. Developments in science, technology, and engineering are main instruments to help reach these goals and to bring about the changes stated above.

Developments stated above have impacted many countries in the world including Nigeria. The use of technology in world economies is a determining factor in competition and affects the agricultural industry as well. Therefore, technology not only produces major results in growth and employment in agriculture but especially in rural development and lowering poverty. Additionally, sustainable and eco-friendly agricultural production which can be achieved through creativity and innovation has major questions awaiting answers. Hence the need to explore the trends in agricultural creativity and innovations. Aside the introduction, the rest of this chapter is structured as follows: Section two dwelled on the concept of innovation and agricultural innovation system. Section three elucidate the need for innovation in Nigerian agriculture, Section four enumerate the trending innovation and creativity in agriculture/farming while the paper ends with conclusion and recommendations.

2. The Concepts of Innovation and Agricultural Innovation System.

Innovation according to IICA (2013) can be classified using several different methods. Some apply in certain specific contexts, such as those frequently mentioned in our agricultural milieu:

Institutional innovation. These innovations, for our purposes, entail a change of policies, standards, regulations, processes, agreements, models, ways of organizing, institutional practices or relationships with other organizations, so as to create a more dynamic environment that encourages improvements in the performance of an institution or system to make it more interactive and competitive.

Technological innovation. This is the application of new ideas, scientific knowhow or technological practices to develop, produce and market new or improved goods or services, reorganize or improve production processes or substantially improve a service. Technological innovations are generally associated with changes in goods or productive processes; but technological innovations may also be applied to marketing processes or forms of organization by either producers or institutions.

Social innovation. This is the development or substantial improvement of strategies, concepts, ideas, organizations, goods or services, to bring positive changes in the way of meeting or responding to social needs or serving social purposes. Social innovations are constructed jointly by several different stakeholders for the well-being of individuals and communities; they may generate employment, consumption, participation or introduce some other change to improve the quality of life for individuals and that can be duplicated in other settings.

Other classification systems are more general and can be used more widely, such as the following categories based on the OECD (2005) definition:

***Product innovation*:** changes or additions to goods produced or services delivered.

***Process innovation*:** changes to the way goods are produced or services are delivered.

***Marketing innovation*:** changes in the method or conditions for marketing the good, or changes in the placement or target of the good or service.

***Organizational innovation*:** changes in an organization's structure, activities or services, in its processes or methods, or in its relationship with other stakeholders (such as partnerships).

Innovations can also be classified according to who implements them:

***Entrepreneurial*:** These innovations may be implemented equally by small-scale producers or by large companies. Such innovators may introduce changes in products, processes, marketing or organization to bring about economic, social or environmental improvements.

***Organizational or institutional*:** These changes are implemented by various kinds of organizations, institutions or associations, whether public, private, academic or non-governmental. They could also be introduced by national innovation systems. Again, these innovations may relate to products, processes, marketing or organizations and may seek different types of objectives. (IICA 2013; OECD 2011).

The concept of innovation systems can be understood also in a broad sense and may include a wide variety of sectors, including research, extension and other functions that promote or implement innovation. This systemic approach, unlike the traditional linear model, posits interactive, holistic flows of knowledge among the different participants. An innovation system consists of a wide array of public and private organizations, firms and individuals that demand and supply knowledge (coded - tacit) and technical, commercial and financial competencies. It also includes the rules and mechanisms by which these different stakeholders interact and relate with one another in social, political, economic and institutional settings (World Bank 2006). Investment in agricultural science and technology, generally in the form of research and extension services, has proved to be highly valuable for improving crop yields and lessening poverty in developing countries. Nevertheless, such investments should reflect all the parties' diverse needs for knowledge (World Bank 2006).

It is currently understood that the performance of innovation systems depends on the interaction among the different people and institutions responsible for generating and disseminating knowledge and technology (OECD 2002), stakeholder learning processes and the creation of an innovation-friendly environment. There is broad consensus that innovation is critically important for meeting the challenges that confront the human race, including the need to improve competitiveness, sustainability and equality in agriculture. Agriculture also needs to produce more food for a growing population, using a limited amount of farmland, while at the same time reducing its greenhouse gas emissions to avoid worsening climate change. This suggests that agricultural production needs to use knowledge more intensively, which means it must innovate.

3. The Need for Innovation in Nigerian Agriculture

In Nigeria, as in most developing countries, the main occupation of the people is agriculture and about 65% of the population is engaged in it. However, before the oil boom, a much more percentage of the population engaged in agriculture. In the 1960s, before it turned to oil, Nigeria was one of the most promising agricultural producers in the world. Between 1962 and 1968, export crops were the country's main foreign exchange earner. The country was number one globally in palm oil exports, well ahead of Malaysia and Indonesia, and exported 47 percent of all groundnuts, putting it ahead of the US and Argentina. Crops remain the dominant agricultural activity in Nigeria. The crop subsector contributes about 85 percent to the agriculture GDP, whereas livestock contributes about 10 percent, fisheries about 4 percent, and forestry about 1 percent. Of the crops subsector, roots (in particular, cassava and yam) dominate in tonnage, though cereals (maize, sorghum, rice, and millet) are becoming important for the domestic demand for food. The roots group accounts for 9 percent of GDP, whereas cereals account for 8 percent. The Nigerian agricultural environment is highly fertile, and it is rich in bio-diversity. The lands across the country can grow and support almost all the crops that exist around the world. However, despite the natural endowment the country has, food production is deteriorating. Again, her status as an agricultural powerhouse has declined, and steeply. It is noted that while Nigeria once provided 18 percent of the global production of cocoa, second in the world in the 1960s, that figure is now down to 8 percent. And while the country produces 65 percent of tomatoes in West Africa, it is now the largest importer of tomato paste. Again, while Nigeria is regarded as the largest producer of cassava, output per hectare remains one of the lowest in the world principally due to poor technological development. Today, Nigeria has transitioned from being a self-sufficient country in food to being a net importer, spending $11bn on imports of rice, fish and sugar. Nigeria imports over 1.3 Trillion Naira in wheat, rice, sugar and fish every year. The consequence of the deteriorating Nigeria's agricultural sector and as observed by Uguru, Hemen and Atuba (2016) includes the following:

a. Nigeria's food imports are growing at an unsustainable rate of 11% per annum.

b. Relying on the import of expensive food on global markets fuels domestic inflation.

c. Excessive imports putting high pressure on the Naira and hurting the economy.

d. Nigeria is importing what it can produce in abundance.

e. Import dependency is hurting Nigerian farmers, displacing local production and creating rising unemployment.

f. Import dependency is neither acceptable, nor sustainable fiscally, economically or politically.

Furthermore, the World Bank recently predicted an up to 30 percent drop in the country's crop output due to erratic rainfall and higher temperatures. The agricultural innovation systems approach emphasizes a stronger link of knowledge systems (research, extension, education) with markets and other actors in the supply chains, as well as with those in the broader policy environment. Strong agricultural research and development (R & D) is crucial for improving agricultural productivity and efficiency, which in turn both lead to agricultural development, food security, and poverty reduction. Furthermore, this agricultural innovation system changes how research is done, with a shift in focus from research outputs and productivity to the use and adoption of technologies being generated by research, as well as to how those technologies are helping to solve the problems of farmers and to alleviate the constraints of supply chain actors. However, several studies have shown that in many developing countries, in particular in sub-Saharan Africa, there is persistent underinvestment in Research and Development and weak research capacity, both of which continue to undermine agricultural productivity and growth in these countries. Again, in a survey conducted on the research institutes in Nigeria, it was revealed that the status of research performance presented so far indicates an overall weak innovation capacity of Nigeria's researchers and research organizations. At the individual researcher's level, about 40 percent of individual researchers do not have any knowledge regarding the adoption or impact of new varieties or breeds that they produced, and 20 percent do not have information on the adoption or use of new

management practices or technologies that they developed. Furthermore, the survey revealed that 86 percent of the research institutes do not have an intellectual property rights (IPR) strategy. The foregoing has revealed how great and urgent the Nigeria's agricultural sector needs innovation.

4. Trending Innovations and creativity in Agriculture/Farming

The innovation process comes about largely within "innovation systems" made up of organizations and private and public stakeholders interconnected in different ways and possessing the technical, commercial and financial competencies and inputs necessary for innovation. The lesson that have been learnt over the years is that engaging end-users such as smallholder farmers and the poorest, in identifying the problems and elaborating the solutions with them, is essential and must take place at each stage of the process that make up the system. It is also clear that while innovation in agriculture can improve the quality of life of people, they are often not adopted by smallholder farmers and the poorest, who have to overcome different types of barriers (institutional, financial, economic or cultural).

Across the globe, agricultural innovations spanning the different agricultural gamut; from urban farms, aquaponics, to food hubs, have been developed. Innovative agriculture is ensuring that new models of farming and agricultural production are evolving and bringing fresh approaches to the ways food is grown and distributed. These methods provide avenues for farmers to keep up with emerging trends and meet the demands of modern living, guaranteeing sustainably produced food.

The following paragraph on Innovations in farming/ Agriculture will shed more light on a few innovative agriculture or farming that are trending globally.

Urban agriculture/farming:

Urban agriculture or urban farming is a simple system of agriculture (plants and animals inclusive) that allows individuals utilise urban communities (cities) for the purpose of agricultural production, as opposed to the conventional methods of farming only in rural areas. This type of farming is gaining popularity in more modern societies due to urban population growth. For most developing regions in Africa where more recorded cases of rural-urban migration are becoming rampant, urban agriculture provides one of the vital solutions to some of the issues and concerns around food production and distribution.

One unique advantage of urban agriculture is the ability to integrate urban economic lifestyles with the ecological systems in these communities. The allure of rural-urban migration is the inherent possibilities of better opportunities in urban communities. However, the reality is that the inability of enough business and economic organisations to provide the required opportunities to migrants has resulted in the rise of social vices and unemployment rates.

A good way to take advantage of the situation is to integrate urban agriculture with the urban ecosystem by first indoctrinating urban residents as human resources for urban farming. In the same vein, urban waste resources can be deployed in urban farming to further strengthen the drive for a circular economy (reuse, reduce, recycle) in urban communities and also provide environmental friendly solutions to urban agriculture like the conversion of organic waste for composting and urban waste water for irrigation. In doing this, more economies and societies are taking a step closer to achieving Goal 11 of the Sustainable Development Goals (SDGs), by building sustainable cities and communities.

Urban agriculture is also a strategic method for ensuring that food supply and distribution to urban communities provide ample compensation for rural production and imports. In many ways, introducing this method of farming in more urban communities will guarantee that poverty alleviation and social inclusion for the underprivileged urban class becomes more feasible.

Aquaponics

Aquaponics is best described as recirculating system of plants, nutrients and fish; an integration of aquaculture (fish farming) and hydroponics (growing plants without soil) in one singular system. That is, wastes produced by farmed fish or other aquatic creatures are used to supply nutrients for hydroponically grown plants. This system utilises various natural and organic elements within the plants and fish in a symbiotic growth pattern. Factors like climate change, deforestation and high fossil fuel consumption will have little or no effect on the utilisation of this system. Aquaponics is regarded as a sustainable food system that offers food security solutions and gives room for:

- The ability to grow local and nutrient-rich agricultural products all year round;
- An eco-friendly and energy efficient system;
- Use of limited space for its establishment;
- Affordable and inclusive solution to farming;
- Sustainable locally sourced fresh sea food.

In the Caribbean island of Barbados, the world's most densely populated country, Bangladesh, Palestine, Malaysia, as well as some cities in the United States, aquaponics is being practiced and perfected on different levels. Online communities of aquaponics farmers are also gathering from across the world to share experiences and promote the development of aquaponics.

In coastal cities like Lagos, the aquaponics system of farming can be explored in order to curb overfishing in the oceans and preserve the coastal ecosystems. On another level, aquaponics can support poultry and cattle farming by providing nutrient supplements. It can also be used for building a sustainable animal husbandry system.

Food hubs

Food hubs are mainly thriving in developed economies like China, Russia, Bulgaria, United States, Romania, United Kingdom, Germany, Australia, France, etc. According to the United States Department of Agriculture (USDA), food hubs are "a centrally located facility with business management structure facilitating the aggregation, storage, processing, distribution, and/or marketing of locally/regionally produced food gaps." Food hubs exist to fill the gaps in the food systems infrastructure, addressing pressing concerns like transportation, product storage and product processing.

The food hub system can provide an established process for various farmers with unique agricultural products to distribute their supplies in a controlled market. It will provide these products their own platform for marketing and distribution eliminating the risk of waste that has previously been the case with some of these products like soybean, sorghum, maize, etc.

Chicken tractors

Chicken tractors – these are lightweight structures that are moveable and can be dragged across pastures, offering the birds a chance to free-range while still providing the shelter and protection of a poultry. Many new farmers are utilizing chicken tractors because the method not only gives the chickens fresh forage in the form of grasses, weeds, and insects which broadens their diet and lowers their feed needs, but at the same time delivers soil propagation for the pasture through the pecking, scratching, and fertilization services the chicken provides. This method is being practiced in India and the Caribbean.

Rotational grazing

Rotational grazing – this is the process of moving livestock strategically from one paddock to another, allowing the vegetation in previously grazed pastures to regenerate. Using lightweight electric fencing, more and more farmers are opting to rotate their livestock to encourage even grazing patterns throughout a paddock, discouraging weed competition, and then allowing for resting periods between rotations to maintain the health of their pasture's forage. It is common practice among herdsmen in Nigeria today.

Season extension – anything that allows the crop to be grown beyond its typical cultivation season. This can include row covers, hoop-houses, cold-frames, mulches, and raised beds. These season extension methods (particularly cold-frames) have been utilized in Europe for ages, and were recently popularized by Eliot Coleman in his book, Four-Season Harvest. Innovative farmers are pairing tools like hoop-houses with cold-loving crops like brassicas and greens to offer their communities fresh produce later and earlier in the season.

Vertical gardening

Vertical gardening is a great method for urban gardeners who are working with a smaller space, vertical growing of crops allows vegetable to grow upwards, therefore leaving space in your garden for other crops. There are a number of benefits to vertical gardening, from easier pest control and harvesting, to reduced waste of produce that might have otherwise been hidden in the foliage of low-growing plants. Crops like tomatoes, peas, cucumbers, beans, gourds and melons all do well trellised.

Agritourism

Agritourism – a form of niche tourism that is considered a growing industry in many parts of the world, agritourism involves bringing visitors to the farm for some kind of agriculturally-related activity. The activities that fall under this category are wide-ranging, but a few of them include farm stays, corn mazes, pick-your-own operations, and any number of farming or homesteading workshops.

Community Supported Agriculture (CSA) (programmes) or Crowd Farming/Funding many new farmers are offering CSAs–otherwise known as Community Supported Agriculture–because they afford the farmer an influx of funds at a time of year when it is so desperately needed. Through these programs, individuals pledge to support the farm, subscribing prior to the growing season for a share of the anticipated harvest. Once harvesting begins the subscribers receive weekly shares of vegetables and fruit

A multi-stakeholder approach to agricultural innovation

Amongst the various innovations in agricultural systems currently being practiced across regions, a stand out is the multi-dimensional nature of modern agricultural practices. There exists an inadvertent cross cutting of different interests and disciplines; for example the potentials of adopting waste management systems in urban farming. Going by this, different sectors like health, waste management, transportation, marketing, processing, community development, parks and nature, marine agencies, urban and regional planning agencies etc. can all partner with agencies and ministries of agriculture to form policies and develop comprehensive strategic action plans for sustained growth within the various sectors.

5. Conclusion and Recommendation

Innovation is a driver of economic growth and well-being in any nation. It is a dynamic, holistic process that generally occurs inside the Agricultural Innovation Systems (AISs). If the work of diverse participants is strengthened – research, agricultural extension and other forms of support for innovation – the Agricultural Innovation Systems can become more efficient and competitive. This can happen if all stakeholders can develop and strengthen their own capabilities, and if relationships among them are bolstered. The pursuit of innovation for agriculture should revolves around a comprehensive, broad-based approach whose cornerstone is innovation work and whose efforts are directed toward promoting a welcoming environment that includes public policies and an institutional framework to reward and support innovative, entrepreneurial work, strengthen the AISs and promote promising technologies with the potential to have an impact on the Nation and the high priority value chains. The tools for achieving this will depend on the context or reality being addressed; this means there are no recipes for promoting a culture of innovation, but that solutions may arise from many different sources, stakeholders or types of innovations.

Innovation and the processes that facilitate it do not emerge from nothing; innovation arises in a particular socioeconomic context and is shaped by the presence (or absence) of favorable conditions in which it can thrive (IICA 2013). Based on foregoing, the following recommendations are proposed.

The government should play a fundamental role, supplying the economic, social and institutional conditions that foster innovation, and should do this through effective policies for:

• Providing innovators with resources (finances, services and knowledge) by building a suitable support system.

• Removing obstacles in regulatory frameworks, including legal, trade, and governance and investment barriers.

• Strengthening the country's human resources through a sound educational system that includes all levels of schooling (from primary through higher education) and vocational training, and that counteracts the brain drain.

• Promoting research and access to up-to-date information by means of an effective research policy that encourages greater investment in research and development, meeting the country's needs, seizing opportunities and creating effective linkages among all the creators and users of knowledge, especially the small holders.

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