Harnessing Nigeria's Huge Agricultural Potentials for Food Security: A Roadmap

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Abstract
This paper charts a roadmap for harnessing Nigeria's agricultural potentials for food security, given resource endowments and challenges posed by the dominant smallholder farming system. The literature review notes that 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 for an active and healthy life. Agricultural potentials can be evaluated through available resources, entrepreneurial capabilities and production linkages that determine a country's productive capacity to foster growth and development The overview of resources endowments shows that Nigeria, with a landmass estimated at about 910.8 square kilometers possesses abundant natural resources including labor, arable land, water bodies and rivers, forests and wildlife, livestock, minerals, gas, and petroleum. This provides a huge agricultural potential and indeed agriculture currently accounts for about 23% of total GDP. This study identifies three-fold problems which bedeviled Nigeria's agricultural sector viz.: low productivity, lack of adequate finance (credit), and the dominance of weak markets for farm products. Available data shows that land, a key determinant of agricultural potential, remains under-exploited for crop, animal, and forestry production. Among the exploitation challenges are poor farmer's access to land, finance and credit; low labor and land productivity in the face of farming system dualism; weak base for research and development, weak markets, poor infrastructure and low industrialization. Given the need to transform the relatively unproductive dominant smallholder farming system, it is imperative to promote yield improvement techniques that build on the strength of the countries factor endowments. In the light of this, the most pragmatic path is to adopt a holistic integrated research and extension services approach that serves to escalate rather than supplant indigenous capabilities to foster the desired agrarian transformation and growth. This study concludes that in addition to getting incentives right for agriculture, the provision of low-cost finance, tied to extensive farming techniques such as small irrigation pumps, hand motorized farming implements, improved seeds accompanied by integrated extension services may be more rewarding and complimentary as capabilities escalator rather than a

wholesale adoption of foreign technologies as has been the case. Beyond primary production, there is the need to increase the domestic resource content of Nigeria's agro-allied industries to replace the competing imports, while conscious effort should be devoted to adding value to our primary exports commodities. We also need to strengthen agricultural marketing, which would require some basic infrastructure and access to both the relatively unorganized and organized markets.

Keywords: Agricultural Output, Food Security

JEL Classifications: Q10, Q18

Introduction

The need to pursue national food self-sufficiency is usually a desirable goal of every nation. No nation wants to be dependent on imports for augmenting domestic food supplies, given its adverse implications for balance of payments accounts, but also for the political economy considerations. Food supplies are easy tools for trade wars and a nation caught in it suffers serious food price inflation in addition to fundamental economic shocks.

The need to chart a road map for food security in Nigeria is very apt in this era of post-covid19. This is because the global covid-19 crisis exposed all nations to various levels of national vulnerabilities. There have been unimaginable health challenges as a result of the pandemic which resulted in economic lockdown and very deep recession. Countries that managed to cope are those with heavy stock of strategic food reserves. In the light of this development, it is imperative for national public policy to seriously take stock of resource endowments for coping with such adverse developments. There is also the need to discuss the way forward particularly now when we face an uncertain and unstable future with an increased perceptions of risks. The objective of this paper is to chart a roadmap for harnessing Nigeria's agricultural potentials for food security in the light of national prevailing circumstances. The rest of the paper reviews related literatures on agriculture, food Security and national economy especially the concepts and measurements in part 2 while part 3 reviews the concepts and measurement of productive capacities. Part 4 presents an overview of Nigeria's agricultural potentials and evaluates erstwhile harnessing/exploitations strategies. The last part discusses the constrains/challenges to harnessing national agricultural

potentials, identify productivity drivers and policies to develop productive capacities for National Food Security in the new decade

Literatures Review

There exists a rich literature on the concept of food security, and national economic development. However, the FAO provides this well-accepted definition of a state of food security: "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 2005 & 2009). This definition identifies the four components of food security as: First, the physical availability of food from the supply side perspective, which refers to the inflow and presence of safe and nutritious food at a given time and in a given place (e.g. at a local market or in a country). This often looks at the subject from the perspective of relative scarcity of food supplies. Secondly, is relative access to food which concerns itself with whether or not an individual or household is able to gain access to (and therefore eat) available food. It addresses the ability to purchase or exchange goods for foods, as well as foods that are given and other social mechanisms that affect access (e.g. unequal distribution of food among the members of a household).

Thirdly, is the utilization of food which addresses the body's ability to make the most out of the nutrients in food that is consumed. This definition notes that this concept of food utilization can be affected by factors such as: poor storage, spoilage, cooking practices, food safety, and diseases (such as worms, or HIV/Aids) that might affect sufficient consumption and digestion of food. The recent covid19 pandemic is a classic case of the inability of affected persons to benefit from food utilization {FAO, IFAD, UNICEF, WFP and WHO (2019)}. The forth perspective of food security relates to the concept of food stability. This cuts across and affects all the other components. Indeed, this definition notes that food may be available and accessible to people who are able to utilize it effectively, but this state of affairs needs to be enduring and so stable over time, rather than being a temporary state that is subject to fluctuations. Related to this is the concept of malnutrition. According to a recent report (FAO, IFAD, UNICEF, WFP & WHO. 2021) malnutrition undermines a person's ability to lead a healthy life and occurs when a person is not able to obtain the right variety of nutrients in the right amounts from their diet. It is an umbrella term that includes over nutrition (an excess of food energy), undernutrition (a lack of food energy and macronutrients such as protein), and micronutrient deficiencies (insufficient micronutrients such as iron, vitamin A or iodine).

Related to the above concepts is the need to understand how to evaluate potentials that can be harnessed by a nation. In particular, UNCTAD (2020) notes that agricultural and national resources potentials can be evaluated through available productive capacities. This is defined as "the productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop". (UNCTAD 2020, p.27). According to this literature, its basic elements are: productive resources, entrepreneurial capabilities and production linkages, each one understood as comprising the components indicated. This literature defined productive resources as factors of production, including different types of productive resources and capital. They include financial capital and physical capital, comprising both machinery and equipment (typically operating at the firm / farm level) and infrastructure particularly lacking in LDCs and which tend to hamper the development of other components of productive capacities. Natural resources, in contrast, are one of the few areas where LDCs tend to perform better than other countries, whether developing or developed.

Entrepreneurial capabilities are the "skills, knowledge and information which enterprises have, firstly to mobilize productive resources in order to transform inputs into outputs which can competitively meet present and future demand, and, secondly, to invest, to innovate, to upgrade products and their quality, and even to create markets" (UNCTAD, 2020a). A related concept is technological capabilities, which comprise the skills required for investment, production and establishing linkages at the firm / farm level. This is often needed to determine the appropriate technology and scale of investment projects, as well as the efficiency with which productive units operate. Nationally, these capabilities are not just the aggregation of individual farm/firm's capabilities, but also the complex interaction of individual units with the macroeconomic environment (Lall, 1992). Production linkages include flows among productive units (firms/farms) of goods and services, knowledge, technology and information, and productive resources (including human resources) exchanges among productive units of different sizes (micro, small and medium-sized enterprises, MSMEs, and large ones), ownership (domestic/foreign, public/private), and operating in different sectors.

Productive Capacities and Food Security Nexus

The UNCTAD Least Developed Countries Report 2020 which focused on "Productive capacities for the new decade" provides us with new literature for understanding the nexus between productive capacities and economic growth for

food security. This literature argues that sustained economic growth and national food security can only be made possible through harnessing (expansion, development and full utilization) of the national productive capacities. Hence, the nexus between national/international development and productive capacities operates, first, within firms/farms sectors as the profit-investment nexus fosters capital deepening and productivity gains. Second, it also takes place across sectors through the acquisition of productive capabilities which in itself is contingent on the existing pattern of production This body of literature asserts that this paves the way for the emergence of new products and higher value-added activities. The process of productive capacity development hinges on a mutually reinforcing dynamic relationship between the supply- and demand-side of the economy. The consensus is that it is a win-win situation if the expansion of aggregate demand creates the scope for denser inter sectoral linkages. This in itself could foster factor reallocation and pecuniary externalities, which collectively sustain the financial viability of investments, including in "social overhead capital" (UNCTAD 2020).

Measuring Productive Capacities

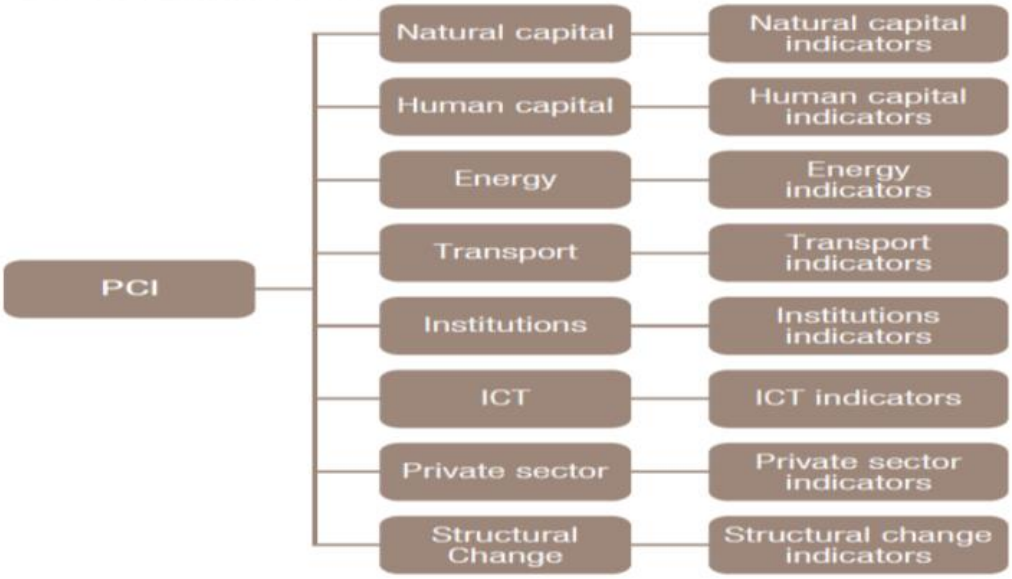
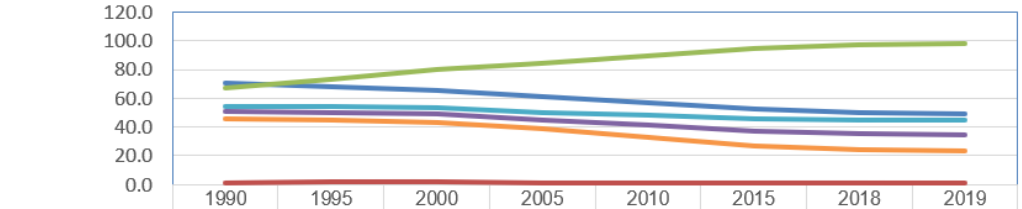


Figure 1: The PCI Thematic Structure
Source: *UNCTAD*

The economic and sectoral potential of a nation can be benchmarked using the proposed UNCTAD PCI (UNCTAD 2020). The Productive Capacities Index (PCI) is a composite of an initial list of 46 indicators extracted from various statistical data base. It is calculated as a geometric average of eight domains or components, namely: natural capital, human capital, energy, transport, ICT, institutions, structural change and the private sector. The categories are selected based on their relevance to conceptual and analytical framework for building productive capacities. The review of PCI is done to show that a holistic approach to evaluating economic potential is available. However, for the purpose of this paper, the analysis is carried out using mainly descriptive statistics.

A Survey of Nigeria's Agricultural and Natural Resource Endowments

Nigeria is blessed with the abundance of natural resources that can be exploited and harnessed for agriculture both for economic growth and rapid transformation of the rural economy. This section looks at the rich human and natural resources, climatic and edaphic conditions and enabling environment for agriculture.



	1990	1995	2000	2005	2010	2015	2018	2019
RP%TP	70.3	67.8	65.2	60.9	56.5	52.2	49.7	48.8
RPgr(%)	1.4	1.7	1.7	1.2	1.1	1.0	0.9	0.9
RP(mil)	67.0	73.2	79.7	84.6	89.6	94.5	97.3	98.2
EmpAg%TE	50.7	50.2	48.8	45.0	41.4	36.9	35.5	35.0
AgEm_M%	54.6	54.7	53.8	50.2	48.3	45.4	44.8	44.5
AgEm_F%	46.1	44.9	42.9	38.8	33.2	26.5	24.2	23.6

Figure 2: Trend in rural Population and Agriculture Labour Force in Nigeria, 1990-2019

Available demographic data show that Nigeria's total population rose steadily from about 95.3 million in 1990 to about 201 million in 2019. However, the rural population which stood at about 67 million representing 70.3% of total in 1990 suffered slow growth rates caused by rural urban migration to 98.2m in 2019 accounting for 48.8% of the total (see Fig. 2). The agricultural sector, which accounted for about 50.7% of total labor force in 1990 suffered stagnation and declined to approximately 35% in 2019 (World Bank, 2020). There has been rising abandonment of rural farms, especially in the north and middle belt reputed as the food basket of the nation due to a myriad of internecine crisis.

Table 1: Agricultural and Total GDP at 2010 Constant Prices (N'Trillion)

	Agr Tot	Crops	Live-stock	For-estry	Fishing	Total GDP	Crops Gr(%)	TotGD-GGr(%)	Crops%-TGDP	Agric-%Tot
2001	5.02	4.22	0.57	0.09	0.14	25.27	3.8	6.7	16.7	19.9
2002	7.82	6.98	0.60	0.09	0.15	28.96	65.3	14.6	24.1	27.0
2003	8.36	7.49	0.62	0.09	0.16	31.71	7.4	9.5	23.6	26.4
2004	8.89	7.96	0.66	0.10	0.17	35.02	6.2	10.4	22.7	25.4
2005	9.52	8.52	0.71	0.10	0.18	37.47	7.1	7.0	22.7	25.4
2006	10.22	9.16	0.76	0.11	0.20	40.00	7.5	6.8	22.9	25.6
2007	10.96	9.83	0.81	0.11	0.21	42.92	7.2	7.3	22.9	25.5
2008	11.65	10.44	0.86	0.12	0.22	46.01	6.2	7.2	22.7	25.3
2009	12.33	11.05	0.92	0.13	0.24	49.86	5.8	8.4	22.2	24.7
2010	13.05	11.68	0.98	0.14	0.25	54.61	5.8	9.5	21.4	23.9
2011	13.43	12.02	1.00	0.14	0.27	57.51	2.9	5.3	20.9	23.4
2012	14.33	12.92	0.97	0.15	0.29	59.93	7.5	4.2	21.6	23.9
2013	14.75	13.25	1.03	0.15	0.32	63.22	2.5	5.5	21.0	23.3
2014	15.38	13.79	1.09	0.16	0.34	67.15	4.1	6.2	20.5	22.9
2015	15.95	14.27	1.15	0.17	0.36	69.02	3.5	2.8	20.7	23.1
2016	16.61	14.89	1.19	0.17	0.36	67.93	4.3	-1.6	21.9	24.4
2017	17.18	15.44	1.20	0.18	0.36	68.49	3.6	0.8	22.5	25.1
2018	17.54	15.79	1.21	0.18	0.37	69.80	2.3	1.9	22.6	25.1

Source: CBN Statistical Bulletin 2020

Despite this trend, agriculture especially crops production remained a major contributor to GDP in Nigeria. Table 1 shows the agricultural sector accounted for an average of 24.5% of total GDP in 2001-2018. Crop production accounted for 21.9% comprising mainly cereals and tubers while livestock, fishery and forestry production accounted for the balance. There exist immense potentials for crops and livestock production if efforts are made to adopt good farming practices, such as use of improved seeds variety and the adoption of small-scale irrigations for crops production supported by deliberate effort to resolve the perennial conflict between livestock free grazers and farmers.

Agricultural Raw Materials Export/Import Trade

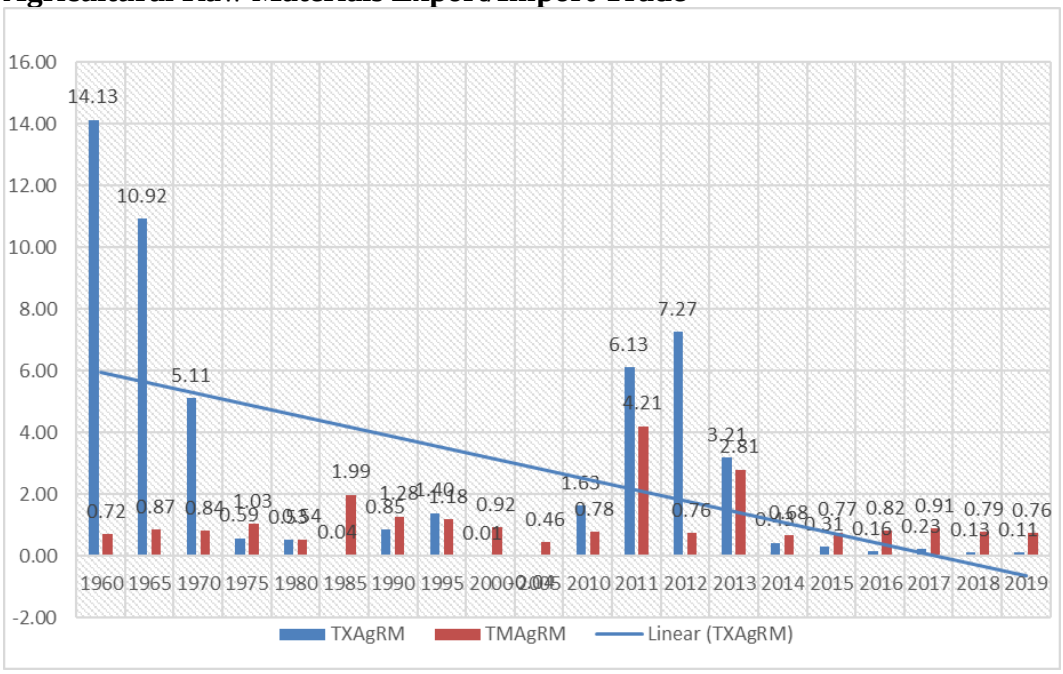
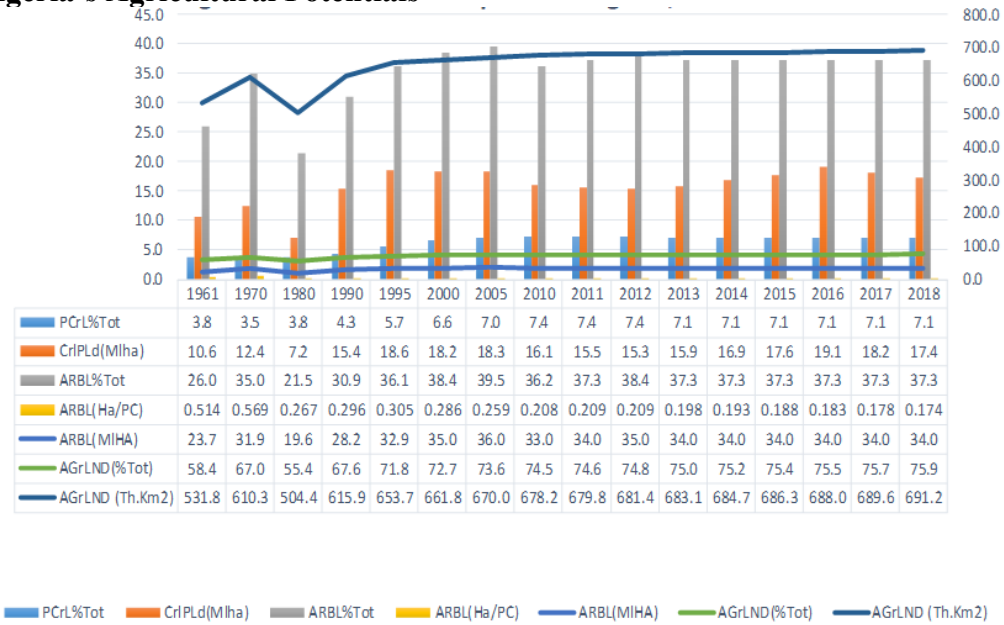


Figure 3: Share of Agricultural Raw Materials in Nigeria's Merchandise Exports and Imports, 1960-2020 (%)

Prior to the advent of crude oil, agricultural products especially cocoa, groundnut, cotton and oil palm produce were the major items on Nigeria's exports basket accounting for about 14.3% and 10.9% in 1960 and 1965, destined mainly as raw materials for agro allied manufacturing firms in Europe. Very little agricultural raw materials import was evident during this period. However, following Nigeria's oil fortune in the 1970s, there was a deliberate neglect of agriculture in favor of food imports. Consequently, the country that was reputed as a net exporter of agricultural products, became a net importer. Figure 3 shows that total trade in agricultural raw materials represented by the linear trend line declined rapidly from about 6% of total trade in 1960 to less than 1% in 2019. The agricultural raw materials trade gap became precarious with exports which declined rapidly, while imports of agricultural commodities such as wheat, barley, corn and soybeans, meant for the brewing, confectionary/flour and livestock feeds industry became a key feature of our import trade. Immense opportunities currently exist for domestic agro allied manufactures to embark on backward integration to develop local substitutes for these products. This has become inevitable given the rise in balance of payment challenges, and the need to

conserve foreign exchange reserves in the face of speculative attacks on the domestic foreign exchange markets.

Nigeria's Agricultural Potentials



	1961	1970	1980	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
PCrL%Tot	3.8	3.5	3.8	4.3	5.7	6.6	7.0	7.4	7.4	7.4	7.1	7.1	7.1	7.1	7.1	7.1
CrlPLd(Mlha)	10.6	12.4	7.2	15.4	18.6	18.2	18.3	16.1	15.5	15.3	15.9	16.9	17.6	19.1	18.2	17.4
ARBL%Tot	26.0	35.0	21.5	30.9	36.1	38.4	39.5	36.2	37.3	38.4	37.3	37.3	37.3	37.3	37.3	37.3
ARBL(Ha/PC)	0.514	0.569	0.267	0.296	0.305	0.286	0.259	0.208	0.209	0.209	0.198	0.193	0.188	0.183	0.178	0.174
ARBL(MlHA)	23.7	31.9	19.6	28.2	32.9	35.0	36.0	33.0	34.0	35.0	34.0	34.0	34.0	34.0	34.0	34.0
AGrLND(%Tot)	58.4	67.0	55.4	67.6	71.8	72.7	73.6	74.5	74.6	74.8	75.0	75.2	75.4	75.5	75.7	75.9
AGrLND (Th.Km2)	531.8	610.3	504.4	615.9	653.7	661.8	670.0	678.2	679.8	681.4	683.1	684.7	686.3	688.0	689.6	691.2

Figure 4: Available Arable Cropland in Nigeria, 1961-2019

The agricultural potential of any nation is dependent on natural resources endowments and the adopted exploitation strategies. An overview of resources endowments shows that Nigeria possesses significant natural and agricultural resources including agricultural land, water bodies and rivers, forests and wildlife, livestock, minerals, gas and petroleum. Nigeria's total landmass estimated at about 910.8 square kilometers provides a huge agricultural land potential. Figure 4 shows that agricultural land (AGrLND) estimated at 691.2 thousand km^2 grew slowly since 1995 accounting for 71.8% of total land area to about 75.9% in 2018. The arable land cultivated stood at less than 40% and ranged from as low as 7.2 million hectares representing 21.5% of available arable cropland in Nigeria in 1985 to as high as 39.5% in 2005. These figures suggest that there exists immense potential to bring more arable land under cultivation which could lead to more than doubling the current national output of arable crops production in the foreseeable future. This outcome is subject to adopted land tenure and farming system. Available data shows the dominance of smallholder farm holdings.

Figure 4 shows that average arable land holding per capita has declined steadily since 1960 following rapid rural population growth to less than 1ha per farmer.

Related to the arable land potentials is Nigeria's agro climatic conditions, which lends itself to agriculture. The land is traversed by some of Africa's major rivers, including the Niger River and River Benue that empties into the ocean at the Niger Delta Basin. Topographically, the land is generally undulating, vast and expansive plains, dotted with hills, mountains, and river valleys. The middle belt and the northern part of Nigerian land is well-suited for agricultural mechanization and cultivation. The soil is rich in plant minerals, particularly the alluvial deposits of the Niger and its tributaries as well as the banks of other rivers, with immense potentials to support crop, animal and forestry production. It is worthy to note that the climate in Nigeria is dominated by two seasons, namely, dry and wet seasons. While the rainy season which lasts between April to October is characterized by heavy rainfall with an August break, the dry, commonly referred to as the harmattan is a season that occurs between the end of November and the middle of March. It is characterized by dry and dusty winds with very scanty rain if any.

The rainfall pattern dictates the crop production practices. Precipitation is highest around the southern coast (Bight of Biafra) where the rain reaches 3,000 mm per year. However, rainfall then decreases as one goes from the coast to the north of Nigeria where often less than 50 mm rainfall is recorded. This scanty precipitation leads to drought and stressful livelihoods for human and livestock populations in these parts of the country. Between the wet feet of the coastal areas to the dry stretches of the Sahel to the north, one passes through the sub humid zones which support various crops, particularly roots and tubers and grains like maize and sorghum.

The vegetation cover of Nigeria follows the rainfall pattern from the south to the north. There is the coastal swamp, followed by the mangrove zone with aerial or floating trees. The coast has coconut trees and oil palm trees. Then there is the forest zone with big and lumber trees like obeche, iroko, mahogany with lianas and tick undergrowth for which the tall trees provide a shade cover. The soil is rich as it receives organic matter from falling leaves and decaying branches and other matter. However, the zone is difficult to work on for farming activities and is not amenable to easy mechanization unlike the guinea and Sudan savannah areas to the north of the forest and deciduous forest areas. As will be shown later,

the wide range of ecosystems of Nigeria constitutes a productive base for a wide range of crops, livestock and, indeed, wildlife. The farms are generally small family farms (about one to two ha), rely on low level technology and crude farming methods, with family labour as the main input into the family-owned operations. There are also some large, highly mechanized farms in the country with average farms size of about 50 ha each, located mainly in the savannah regions. The farms are often owned by corporate interests and are linked to other industries as suppliers of raw materials. This is particularly so for grains, tubers and tree crops, mainly citrus fruits.

An analysis of the agricultural potentials of the three major agro-ecological zones show that, despite the diversity of their production system some complementarities exist in terms of products: The coastal area that is wetter favors the production of roots, tubers, plantains, rice and corn and additionally the production of cash crops such as timber, palm oil, pineapple, rubber, coconuts, cocoa, coffee, kola plantations. It is also an area where real agro-industrial units prosper. The central semi-humid area is characterized by a wide variety of productions: yams, cassava, maize, rice, sorghum, millet, beans, legumes, and mango plantations, citrus, cocoa, coffee, rubber, cashew, and natural species such as shea nuts and cotton crops. The dry zone corresponding roughly to the sub Sahelian zone lends itself to the production of mostly cereal crops (sorghum, millet, cowpea, rice, peanuts...) and some irrigated crops (rice, wheat, onion, tomato ...), is also the main rearing tank of the country. It is on record that Nigeria is the leading food basket for most crops due mainly to; its diverse ecosystems, surface, and subsurface water resources, about 2.3 million hectares of irrigable land and another 8 million hectares of lowland that can be brought under cultivation during the dry season (UNECA 2012).

The livestock resource of the country is made up of cattle, sheep, goats, donkeys, horses, pigs, and indigenous and exotic poultry. Majority of the livestock, particularly the ruminants, is found in the semi-arid and sub-humid zones where grasses abound for grazing in the range. The two zones hold nearly 90 per cent of the cattle herd and most of the sheep and goats as well. There exists great potential for livestock production as well as agro-industrial processing. At the moment, most of the livestock are sold live as meat animals in local and international boarder markets existing in many parts of the country. Both fodder crops and livestock sector productivity suffers from structural constraints such as scarcity of capital, shortage of quality feed and widespread prevalence of disease. These can be addressed through the establishment of grazing reserves, local

production of animal feeds, propagation of improved animal husbandry, access to veterinary and animal diseases controls services and also through technical assistance to small producers.

Nigeria's fish resources come from the vast inland fresh waters of several rivers and lakes, the brackish waters of the creeks and lagoons and the marine waters of the Atlantic Ocean to the limits of its Exclusive Economic Zone (EEZ). While the output potential of the various ecosystems is considerable, it has neither been estimated nor has it been sustainably exploited. Processing facilities for fish are inadequate and considerable losses are borne by the fisher folks. Offshore marine fishing suffers from encroachment by foreign vessels while pirates who now operate in the high seas are posing serious danger to local marine fishermen. A new development in recent years is the massive investment in aquaculture production systems. The challenge of the various ventures is the lack of good and unadulterated fish meal. But if well organized and expanded, this is a growth pole for fish protein production for the nation and potential for export. Fish is important part of the diet in Nigeria and expansion in production would address food challenges.

Forests contribute to economic development and food security through support to agricultural systems, maintaining environmental integrity and through providing opportunities for income and employment. Rural communities depend on forests for wood fuel and other non-wood forest products. Timber is Nigeria's main forest resource and accounts for a significant part of forestry production. There are also a number of forest reserves in the high forest zone with well managed and graduated harvesting practices. New growth and replanting is also gaining ground and may re-establish sustainable production of timber across the nation. There are some 100,000 or more square kilometers of Savannah forest reserves in which usable but scattered quantities of timber are available. In addition, there are large areas of forest lands outside the reserves which are not under strict control but which supply almost half of the total volume of timber produced in Nigeria. Logging activities here support the sawmilling activities which are wide spread, while intensive logging, remains in the lowland rainforest zone. The progression of the Sahara Desert southwards is also being contained by tree planting and other soil conservation activities.

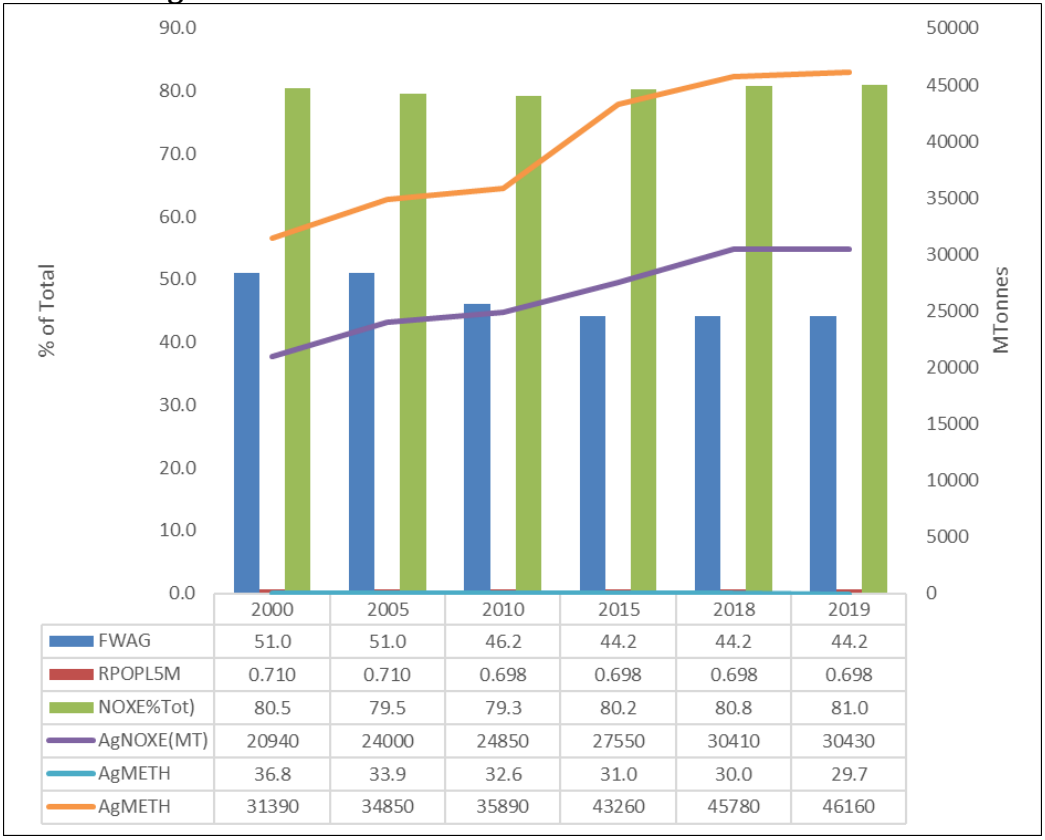
Wildlife resources and production is intricately linked to the nation's ecological zones. The class of wildlife inhabiting the mangrove and freshwater zone includes

crocodiles, sharks, hippos, crabs and an array of amphibians. Large varieties of birds, climbing animals (monkeys, apes, etc.), elephants, catlike carnivores, herbivores and a host of reptiles are located in the rainforest areas. The Sudan-Sahelian zones are the habitat for principal ungulates and hoofed animals, carnivores, wild dogs, ground-nesting birds, ostrich and others. Of course, there are other varieties of wildlife such as snails, caterpillars and silkworms found in many communities throughout the country. While most of these resources are being exploited through traditional means in the name of 'Bush Meat', their value is more in tourism propensities which they have and which have not been exploited at all as countries in eastern and southern Africa have done.

An Assessment of agricultural potentials erstwhile exploitation strategy

The analysis so far shows that land, the fundamental factor influencing agricultural potential, remains under-exploited for crop, animal and forestry production in Nigeria. In order to harness these resources to its full potential, it behooves public policy to balance the pursuit of agricultural growth stimulating objectives with sustainability concerns. It is imperative, therefore, to evaluate erstwhile harnessing strategies especially the pervasive farming systems and the relative efficiency and sustainability of propagated research, technology and extension service for fostering agrarian growth and food security. This calls for the critic of the dominant farming systems, benchmarked against standard global agricultural and environmental conditions criteria, given factor endowments and production characteristics of the nation. This criterion requires that all agricultural land i including that which is no longer used for production purposes, is maintained in good agricultural and environmental conditions. It is obligatory for farmers to implement farming measures aimed at the mitigation of and adaptation to climate change; the maintenance of permanent grassland; the protection of the soil against erosion; the maintenance of soil fertility through care for soil organic matter and soil structure; the protection of water against pollution by plant nutrients and pesticides; the protection of biodiversity; and the retention of landscape features.

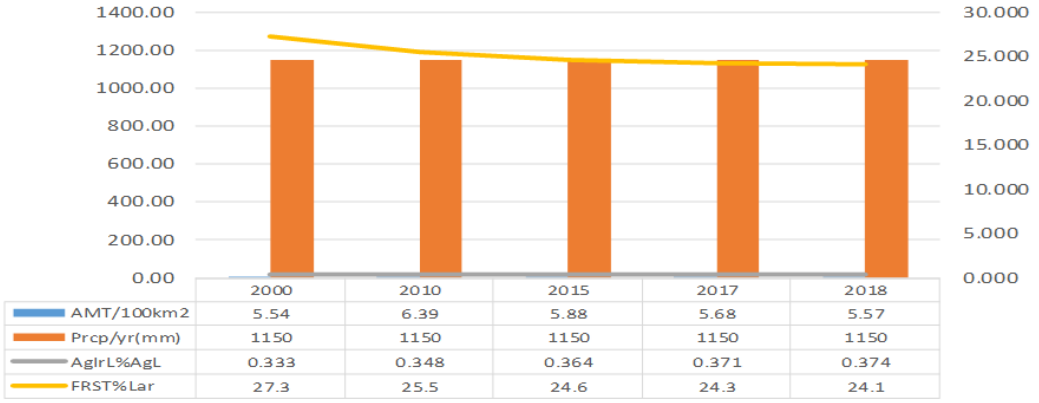
Trends in Agricultural and Environmental Conditions



	2000	2005	2010	2015	2018	2019
FWAG	51.0	51.0	46.2	44.2	44.2	44.2
RPOPL5M	0.710	0.710	0.698	0.698	0.698	0.698
NOXE%Tot)	80.5	79.5	79.3	80.2	80.8	81.0
AgNOXE(MT)	20940	24000	24850	27550	30410	30430
AgMETH	36.8	33.9	32.6	31.0	30.0	29.7
AgMETH	31390	34850	35890	43260	45780	46160

Figure 5: Agric Environmental Indicators in Nigeria, 2000-2019

There has been a progressive decay in Nigeria's agricultural and environmental conditions arising mainly from both adverse human exploitations' activities and natural causes. Figure 5 shows that the annual freshwater withdrawals for agriculture (FWAG) as a percentage of total freshwater withdrawal has declined from 51% in 2000 to 44.2% in 2019. Rural population living in areas where elevation is below 5 meters (% of total population) is approximately 0.7%. Erosion of rural farmlands have been reported in areas along riverbanks especially the tributaries of the rivers Niger and Benue and their estuaries via the Niger delta. Available data also show that agricultural nitrous oxide emissions (% of total) is around 80%. It rose from about 20,940 (thousand metric tons of CO2 equivalent) in 2000 to 30,430 in 2019. Also agricultural methane emissions (% of total) declined from36,8% in 2000 to 29.7% in 2019.



	2000	2010	2015	2017	2018
AMT/100km2	5.54	6.39	5.88	5.68	5.57
Prcp/yr(mm)	1150	1150	1150	1150	1150
AgIrL%AgL	0.333	0.348	0.364	0.371	0.374
FRST%Lar	27.3	25.5	24.6	24.3	24.1

Figure 6: Other Agricultural/Environmental Conditions and Farm Machinery, Tractors per square km, 2001-2018

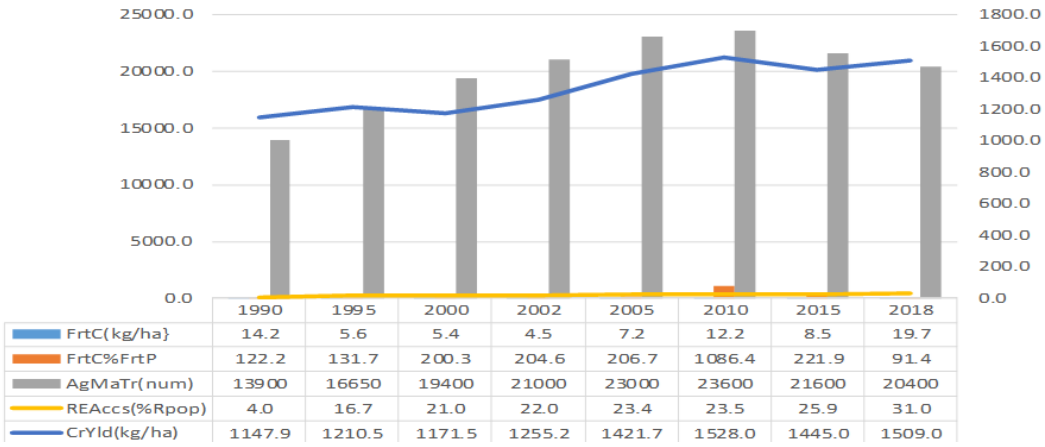
Figure 6 shows that on the aggregate the level of mechanization of agricultural activities in Nigeria going by available tractors in the country. This is estimated at about 6 tractors per 100 sq. km of arable land. Agriculture also seems to be dependent on seasonal rainfall. Average precipitation is 1150mm in depth (mm per year) while agricultural irrigated land is very low at < 0.4% of total agricultural land area. The experiments with the establishment of huge sprinkler irrigation works via the River Basin Authorities have not recorded any significant success. There has also been progressive deforestation of rural farmlands for fuel and shelter. Consequently, forest area declined from 27.3% in 2000 to about 24.1% of land area in 2018.

Relative efficiency and sustainability of propagated agricultural systems and technologies

Nigeria's agrarian structure is basically a mixed system of subsistence and modern farming, with the existence of a wide gap between both production systems. The Nigeria's National Bureau of Statistics (NBS &World Bank 2016) estimates show that subsistence farming accounts for about 90 per cent of agricultural output, while the modem farming sector accounts for the rest. In general, the subsistence farming is characterized by (i) production for subsistence; (ii) the abundance of land and the practice of shifting cultivation; and (iii) a land tenure system which grants rights of access to each family (both nuclear and extended). The system results in land fragmentation, whereby the farm family can plant only very small areas at a time, using traditional tools and crude implements such as hoes and cutlasses and relying mainly on human labour. Production is highly labour

intensive and the demand for labour can be very high at peak periods, particularly during weeding and harvesting. The productivity of the subsistence farming system is low and depends largely on labour availability and the vagaries of weather.

The NBS et al (2016) agricultural household post-harvest survey of crop farming and livestock rearing is quite revealing. This report shows that the average household farm size was 1.3 hectares. Nationally, while only about 5 percent of the farms are owned through outright purchase, family inheritance accounts for about 70 percent of small holder farms. In general, the rate of application of modern inputs such as fertilizer, herbicides, and pesticides were estimated at approximately 47 percent, 30 percent, and 21 percent of plots, respectively. Other forms of agricultural inputs utilized were purchased seeds and animal traction, while the dominant livestock husbandry kept indicates that goat is the most common animal owned among livestock owning households across all regions (67.3%). Overall, male-headed households own more animals than female-headed households. The majority of livestock owning households reported slaughtering (29%) or selling (28.5%) livestock.



	1990	1995	2000	2002	2005	2010	2015	2018
FrtC(kg/ha}	14.2	5.6	5.4	4.5	7.2	12.2	8.5	19.7
FrtC%FrtP	122.2	131.7	200.3	204.6	206.7	1086.4	221.9	91.4
AgMaTr(num)	13900	16650	19400	21000	23000	23600	21600	20400
REAccs(%Rpop)	4.0	16.7	21.0	22.0	23.4	23.5	25.9	31.0
CrYld(kg/ha)	1147.9	1210.5	1171.5	1255.2	1421.7	1528.0	1445.0	1509.0

Figure 7: Farm inputs Consumption and Access in Nigeria, 1990-2018

Efforts to transform the subsistence farm sector have focused on the adoption of new technologies and the emphasis is on propagating the use of modem farm inputs such as tractors, ploughs, sprinkler irrigation, improved high yielding varieties, fertilizers, agrochemicals and pesticides, most of which are imported.

Production is highly capital intensive and labour displacing, so that only a very few farmers can engage in modem farming. Figure 7 presents farm inputs consumption and access from 1990 to 2018. It shows that fertilizer consumption in Nigeria is among the lowest in Africa estimated at less than 20 kg/ha. It suffered a decline from about 14.2 kg/ha in 1990 to as low as 4.5 kg/ha in 2002. Domestic consumption of fertilizer depended on imports which ranged from 91.4 per cent of domestic production in 2018. Indeed, for a long period of time, fertilizer consumption depended solely on imports. Figure 7 shows that while consumption was augmented with about122.2 percent imports in 1990, it rose dramatically to account for 1086.4% of domestic fertilizer production in 2010. There was also a decline in the number of agricultural machineries in use by the farm sector over time. The stock of tractors with farm implements in use suffered attrition overtime without replacement. Access to electricity by rural farming households has remained low and suboptimal ranging from 21 per cent of rural population in 2010 to 31 per cent in 2018. Cereal yield (CrYkd(kg/ha) estimated at 1509kg/ha in 2018 is below African average of about 4500 kg/ha.

The current reality of today is that the modern farming sector is in malaise, fostered mainly by the maintenance or exaggeration of socially "incorrect" signals and incentives, inherent in the adopted structural transformation strategies. Some of the wrong incentive signals include bias in the protection and promotion of modem farms, as against the traditional systems, through investment in the propagation of modern technologies, provision of generous Incentives for their adoption, regulations, etc. For instance, a wide range of internal and external pricing policies was used to foster and protect large-scale farming for a long time in Nigeria. This included subsidies and special tax concessions to modern sector investors, overvalued exchange rates and foreign exchange allocations designed to lower the cost of Importing capital and intermediate goods, subsidized interest rates and credit rationing, together with a whole array of bureaucratic formal institutional and licensing arrangements (Balogun 2016). Interestingly, however, the traditional system has exhibited some vibrancy and ability to sustain itself year in, year out. The vibrancy of the traditional system despite attempts to "supplant" it is rooted in the historical traditions and current realities of today. The strengths of the traditional farming system lie in the constructive use of indigenous values, cultures and institutions in very many ways for subsistence over a long period of time. For instance, the informal credit system which draws on customary values and patterns of social organizations have remained successful, while many indigenous cultivation practices, such as bush fallow, alley and mixed farming have some technical merits.

Agricultural Potentials Exploitation Challenges

The agricultural potential exploitation challenges confronting Nigeria are myriad. These include problems relating to the farmer's access to land, finance and credit; low labour and land productivity; weak base for research and development as well as extension services, weak markets, poor infrastructure and low industrialization. Limited access to land, finance and credit by dominant small-holder farmers because of the high levels of risk and uncertainty such as: the lack of collateral; the informal nature of most of the farming units which makes access to formal finance and credit difficult, even from development banks. This often has adverse implications on their ability to use modern technology and ultimately on productivity of the farms. This is particularly evident in the agro-processing sector, where the majority of the businesses are informal small and medium enterprises (SMEs) and tend to be undercapitalized. These farmers often lack tangible assets that can be tendered as collateral to procure working capital. This problem is accentuated by the lack of appropriate farm management skills, especially poor record keeping and very weak commercial and financial skills and thus are unable to attract any form of private or public finance outside the family circles.

Land productivity in Africa is estimated at 42% and 50% of that in Asia and Latin America respectively (UNECA, 2009). Labour productivity was only 57% and 58% compared to Latin America and Asia respectively and estimated at about 2tones/ha. Low productivity is often attributed to the limited availability of inputs such as agrochemicals, seed, animal feed and fertilizer. The current weak institutional base for the supply of these inputs remained the greatest challenge to farming in Nigeria. In particular, the erstwhile fertilizer procurement and distribution schemes of the federal and state governments which enjoyed considerable subsidies were jettisoned as it turned out to be a drain on public funds with the primary benefits accruing to unintended beneficiaries especially rent-seeking marketers. The country's supplies of fertilizer derived from domestic production sources which suffered setbacks may have bounced back with the commencement of production by the privatized fertilizer plant.

The greatest challenge to harnessing the immense agricultural potentials for growth is the weak base for research and extension service in Nigeria today. There appear to be an inherent conflict in the adopted development strategy which resulted in the emergence of structural dualism – an economic system characterized by the existence of a wide gap in the relative productivity of the

traditional vis-a-vis modern farming systems. Three main problems are often cited as its underlying cause: i) the posture of policy, which believes that traditional systems (which represents "underdevelopment") must be supplanted by modern ones (which represent "progress") in order to foster growth and development – a position that is not supported by the realities of today. Although modern techniques (when available and affordable) are preferred to the traditional methods, the concern, however, is with the slow pace of internalization of this process of change that is alien to the country's social and economic context. It is therefore not surprising that the traditional farming systems are still as vibrant as ever today and coexisting side by side with the modern farming systems; ii) Related to this is the failure of adopted strategies to extend erstwhile incentives to the traditional farming systems, as they have been to the modern ones. This is reflected by the total neglect and failure of policy to recognize their strengths, while exaggerating their weakness, which constitutes a serious impediment to their transformation process. And iii) is the scarcity of intermediate technologies capable of bridging the gap in the dualistic character of agricultural production systems in Nigeria. While modernization inputs and services are all for a few medium to large farms, there is absolutely nothing for the small holders - a reflection of the defects of adopted modernization strategies which only made provision for a sharp switch from traditional methods to capital intensive modern ones. For instance, when farmers modernize, they switch from an inexpensive hoe to a very expensive tractor, as well as having to change their crop husbandry methods and management. There is no middle course and/or transitional state, thereby putting the farmer in a state of dilemma.

This is a reflection of the current weak enabling environment, epitomized by the apparent lack of a predictable and honest administration of the regulatory framework, to assure law and order, and provide reliable and efficient socio-economic infrastructure and information service - all preconditions for the efficiency of productive enterprises, whether private or state-owned. In a recent report by OECD (2018), it notes that infrastructure is mainly a governance challenge, such that while high-quality public infrastructure supports growth, improves well-being and generates jobs; poor state of infrastructure is associated with economic stagnation, poverty and unemployment. This report highlights several governance challenges that all countries face all through the infrastructure policy cycle. These include lack of strategic vision of appropriate integrated infrastructure model, vulnerability to corruption and mismanagement, political dynamics that undermine sound decision making when processes for identifying priority projects and choosing delivery modes are not sufficiently formalized.

There are also challenges relating to poor stakeholders' consultation, poor coordination across tiers of government, uncertainty with regards to revenue flows and sources.

Sub-Sahara Africa ranks lowest in terms of use of technology such as mechanization, agro-chemicals and irrigated land for crop production (UNECA, 2009). For example, irrigated land is only 3.6% of total cropland in Africa compared to a world average 18.4%. As noted earlier, presently, less than 5 per cent of irrigation capacity is utilized in Nigeria. Three important technologies that assisted many advanced countries to enhance the relative productivity of agriculture are: genetically modifies organism (GMO) techniques, cloning and drones (OECD 2019). Both GMOs and cloning are biological technologies that are in use in advanced countries to enhance yields. The agricultural drone is a multifunctional unmanned aerial vehicle mostly used for optimization of yield, monitoring of crop development level, irrigation capacity and efficiency level, combating diseases and pests and plant feeding in agricultural operations. As a global trend, major producers and exporters of agricultural products made huge investments on drones mechanized farming especially in Europe, Asia and North America. The application of drones for mechanized farming is popular in European nations like the United Kingdom, Germany, France, Italy, and Spain. In the African continent, drone technology is gradually gaining presence. Though not yet popular, the technology has been introduced through the use of awareness projects and training for farmers in countries like Cameroon, Ghana, Zambia, South Africa, Kenya, Morocco and a few others. Drone technology is most efficient in a capital abundant and labor scarce economies that lends itself to large scale mechanization which may not be cost effective in economies dominated by small farm holdings. Closely related to drones is an agricultural robot that is deployed for agricultural purposes. The main area of application of robots in agriculture today is at the harvesting stage. Emerging applications of robots or drones in agriculture include weed control cloud seeding, planting seeds, harvesting, environmental monitoring and soil analysis.

Agricultural Marketing Challenges

Within the context of national food security discussions, efficient operation of agricultural markets holds the key to agrarian progress. This entails putting in place an efficient system/process for marketing of farm produce which comprise of staple food (grains, tubers, vegetable and fruits), tree crops, horticultural and semi-processed products at both domestic and international markets. An efficient

system depends on the trade incentives which informs farmers decisions to produce a saleable farm product for both private benefits and national social welfare objectives.

The private benefits emanate from market opportunities offered by global demand and the ease of access to markets for the particular agricultural products, which is heavily dependent on the economic efficiency of the current technical approach to pre- and post-harvest marketing operations. These operations consist of all the activities involved in the movement of goods and raw materials from the field to the final consumer. It includes handling of product at the farm, initial processing, grading and packing in order to maintain and enhance quality and avoid wastage. Unfortunately, the present system of marketing of agricultural goods in Nigeria is bedeviled by inefficiencies of immense magnitude that only a holistic approach to tackling the trilemma of agricultural production (farming), agricultural finance (credit), and agricultural marketing (sale of farm products) can provide the desired optimal solution. The problem is accentuated by the diverse nature of farm produce which cover not only the products arising out of cultivation, but also products arising from dairy farming, poultry farming, fruit cultivation, vegetable farming, fish and forestry products etc. In this wider sense, milk and milk products, eggs, fruits, vegetables, honey are also agricultural goods.

The social welfare objective considerations include pursuits of interventionist trade policies intended to favor agriculture tended over time to penalize agricultural trade. The Nigerian experience showed that erstwhile agricultural produce marketing especially exports handled by the abolished marketing boards failed woefully to guarantee prices while it imposed implicit taxes on farm produce. The fertilizer and other farm inputs subsidies benefitted most the importers who earned the rents while it was out of the reach of the farmers, intended beneficiaries. The promotion of private sector export schemes governed by packing credits (mainly letters of credit) and subject to compliance with trade and foreign exchange restrictions have also faced immense challenges. These schemes failed woefully which informed the trade liberalizations embarked on since the mid-1980s, designed to free the commodity, financial and forex markets. Among the institutional reforms embarked upon is the establishment of the Nigeria Commodity Exchange (NCX) - an organized market for sellers and buyers of agricultural commodities and solid minerals. Aside from dealing in spot and futures, the NCX introduced electronic Commodity Receipt for cocoa, sesame, cashew, paddy rice, maize, sorghum, ginger, soya bean and groundnut since 2014. The efficiency of the NCX market has been hampered by inadequate

post-harvest handling facilities such as silos, packaging and poor transportation system for farm produce evacuation to domestic and international markets. This also reflects the weaknesses in adopted import substitution industrialization strategies that promoted agro-allied industries that depended solely on imported agricultural commodities, with the hope that they may increase the local content over time. Also export led strategies were ignored with undue reliance on participation in relevant international commodity agreements/cartels guided by WTO rules of engagement. There is a global threat to food security as a result of apparent agricultural trade wars that has limited access of African countries to the much-needed grains for augmenting domestic food supplies.

Towards a Viable Roadmap for Harnessing Nigeria's Agricultural Potentials

In the light of challenges identified, there is the need to adopt a holistic approach to tackling the three-fold problems which bedeviled Nigeria's agriculture viz.: low productivity of agricultural sector, lack of adequate agricultural finance (credit), and the dominance of weak markets for the sale of farm products at both local and international markets.

The Feasible Roadmap to Overcome the Stagnating Agrarian Growth

With regards to overcoming low productivity, there is the need to get both macroeconomic and sector-specific incentives right for agriculture especially for the dominant smallholder farms and firms. This is imperative to correct the defects of erstwhile farming system modernization approach in Nigeria which not only provided very favorable structure of incentives to a few modern farms but biased against the smallholder farm/firms sector that accounts for over 90 per cent of the sectors output. More worrisome is the apparent mutually exclusive coexistence of both systems with very little prospect that modernization will have spillover effects on smallholder farming system. This is further compounded by a missing middle as adopted policies so far made no provision for escalating relatively rudimentary smallholder farming system to the technologically advanced modern system. Several literatures maintained that given the wide disparity between the two methods, a pragmatic but more viable strategy will be to promote those technical change that builds on the strengths of the smallholder farming ones (given its characteristics, factor endowments and enabling environment) rather than attempts to supplant it. This calls for the promotion of indigenous capabilities escalator that can serve as a bridge to transform and spur the desired growth rather than a wholesale adoption of foreign technologies as has

been the case in several less developed and developing countries (Johnson, 2019; OECD, 2019).

Cirera and Maloney (2017) propose a capabilities escalator which depicts the sequential nature in the process of technological capabilities acquisition. They note the truism that smallholder farms/firms do not naturally move by themselves up the escalator, despite proven high returns. Instead, they needed to be exposed via the propagation of an appropriate integrated research and extension services to very accommodating intermediate productivity improvement technologies that should not displace but improves smallholder farms/firms productivity. The centerpiece of this approach should not be sole propagation of large scale mechanization which may be difficult to access, but intermediate equipment such as hand-motorized mowers, sprayers, small scale irrigation, solar driven rural electrification and processing equipment. Several analysts (Palmer et al., 2017, 2018; Lall, 1992) argue that, over the medium-to-long term, economic growth arises from the interplay of capabilities which define the best that can be achieved and incentives that guide the use of the capabilities to stimulate their expansion, renewal, or disappearance. These literature further note that the potential to leapfrog development in developing countries through adoption of imported modern fourth generation farming technologies (driven by ICTs) ought to be qualified as it tended to widen global inequality. This is often biased against LDCs that lacks the capacity to assimilate new technologies to the benefit of DCs large scale producers that now dominate global food and agricultural trade.

Consequently, there is therefore an urgent need to refocus the current national agricultural research and extension services towards upgrading the dominant smallholder farming system to the desired "missing middle". This calls for systemic review to address the problems of institutional weakness especially the defects in the modernization and technological propagation strategies which failed to meet the needs of an integrated farming system approach. Three key areas requiring attention are: institutional restructuring, fostering public private partnership in research and development and the provision of rural infrastructure that supports farming enterprises.

There is the need to review the current didactic approach of most of the research and extension service agencies to incorporate a holistic farming systems perspective into their work plan. The current situation whereby single-function agencies staffed by professionals with a narrow, didactic approach (Akanji & Balogun 1998) seemed inadequate to address the numerous basic needs (food,

shelter, education, health and finance) of stallholder farming household. It is expedient, in this era of financial resource constraints, to chart a new direction in institutionalization, which may include a major restructuring to advocate holistic methods. This calls for radical changes to established institutions which for both practical and political reasons, are extremely resistant to changes that involve shifts in power and responsibilities. Unfortunately, the defunct World Bank assisted ADPs were relatively successful as multi-sectorial and multi-disciplinary research and extension service institutions suffered setbacks because it was perceived to be a duplication of the functions of some existing line ministries and agencies that are well accommodated within the annual fiscal budgets. A less radical approach may be to create a coordinating cell or unit, drawing on resources from line institutions and ministries. This has its drawbacks, as it can sometimes amount to the creation of another irrelevant, under-funded service at the periphery of the institutional mainstream.

PPP in R&D is imperative and inevitable given the extent of financial distress of both national and subnational fiscal authorities – especially Ministries, Departments and Agencies responsible for agriculture and food security. Some activities where PPP can yield quick gains are fertilizer production, improved seeds/seedling productions, animal feeds and husbandry methods, integrated farming/processing of staple food crops, grains, fish and livestock. The objective will be to foster the right PPP synergy towards developing the desired intermediate technologies.

The provision of finance for rural infrastructure that supports farming enterprises. This is required for the dominant smallholder farms to access productivity improvement technologies. The role of development finance is very important in achieving this goal. The current CBN anchor borrowers programme in moving the farm sector towards achieving this goal is very commendable. In particular, tied loans to yield improvement techniques which results in incremental output, and guaranteed markets for produce has tended to ensure loans redemption. Additionally, major grains and staple food processors that benefitted from the schemes are contributing to the improved domestic food supplies while Nigeria's food import bill is falling.

Concluding Remarks

Given the dominance of smallholder farms/firms in Nigeria, and the need to transform their relatively unproductive farming systems, there is the need to

promote yield improvement techniques that builds on the strength of the countries factor endowments. The envisaged strategies should aim to provide the missing middle that is consistent with our enabling environment. In the light of these conclusions, let us think out of the box with regard to what policy directions we should take to get incentives right (Balogun 2016) as part of our roadmap to harnessing immense agricultural potentials. Thus, low cost finance, tied to extensive farming techniques such as small irrigation pumps, hand motorized farming implements accompanied by integrated extension services may be more rewarding and complimentary. Beyond primary production, there is the need to increase the domestic resource content of Nigeria's agro-allied industries. A conscious effort should be devoted to indigenous foods production to replace the competing imports while conscious effort should be devoted to add value to our primary exports commodities. We also need to strengthen agricultural marketing which would require s some basic infrastructure such as transport, products assembly centers for standardization and grading, basic trading communication system, effective method of storage and warehousing, access to innovation, credit and access to both the relatively unorganized and organized markets.

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