Journal of Economic Studies (JES)
Department of Economics,
Nnamdi Azikiwe University, Awka,
Anambra State, Nigeria.

Web:www.nauecojournals.com *ISSN 1119-2259*

THE ROLE OF GOVERNANCE IN TECHNOLOGY TRANSFER AND THE DEVELOPMENT OF RICE VALUE CHAIN IN NIGERIA

by
Ibrahim S. KEKERE and Suleiman DAHIRU
Department of Economics, Ahmadu Bello University Zaria, Nigeria
Ibroks301@gmail.com 08038742067/Sdahiru97@yahoo.com 08067811866

Abstract
Adoption of modern technology in agriculture (especially rice farming) is crucial for improving productivity and welfare of farmers in Nigeria. Despite government intervention in the sector, productivity of local farmers has not improved compared to the growing demand. Anecdotal evidence suggest that this bias for imported rice is mostly due to the use of outdated technology in rice farming and lack of coordination among the key players in the rice value chain. These challenges underscores the need for governance in setting rules, both formal and informal rules operating in the value chain and the system of coordination, regulation and control in which value is generated along the rice value chain. Given the role of institution in shaping the dynamics of innovation intensity and technological pattern, the objective of this study is to examine the role of governance in improving rice value chain through technological transfer. This study adopted the descriptive statistics and used tables and chart to analyse its result and the lesson one can learn from the literature and cross country experience. The paper recommends that governance is needed for developing domestic technological capabilities, negotiating favourable terms for technological transfer to domesticate imported technology through local R&D effort, appropriate coordination between R&D institutions and farmers by creating the enabling environment for the former to undertake leading edge innovation in biotechnology and other inputs design, also, to ensure that research output reach the end user (farmers) at subsidized costs.

Keywords: Governance, Technology transfer, Value chain
JEL Code: G3; O10; Q12

1.0 Introduction

The adoption of modern technologies in agriculture is essential to improving productivity and welfare of poor farmers and is key to achieving poverty reduction and rural development. However, the adoption of modern technology has been disappointing, particularly in rice production in Nigeria. Studies have indicated that value chains can play an important role in technology adoption, not just by processing companies, but also by farmers, through vertical coordination and spillover effects (Dries et al., 2009; Kuijpers and Swinnen, 2016). Upgrading the quality of local rice in Nigeria, often requires investments in new technologies by farmers to improve productivity for minimum output as well as to satisfy other types of private standards to compete favorably with high quality imported rice. The debate about upgrading the quality of

our local rice in Nigeria to curtail imports of high quality rice from Asia has been strengthened by foreign exchange crisis occasioned by volatility in international oil price and the need to pay for huge import bills for staple food like rice. Like in any other African country, rice production and related activities like processing, distribution and consumption are key to unlocking economic development, food security and poverty reduction (Demont and Ndour, 2015; Tollens, 2006; Veld and Maertens, 2014).

Several policies have been implemented in the past, for instance, the Agricultural Transformation Agenda (ATA) introduced in 2012 was aimed at improving farmers' income, increase food security, generate employment and transform the country to a leading player in the food market. Subsequently, the Agricultural Promotion Policy (APP) was launched to resolve food production shortages and improving output quality. In addition to this, the Economic Recovery and Growth Plan (ERGP) prioritizes food security and aimed to achieve self-sufficiency in tomato paste, rice and wheat 2019/2020 respectively. Despite this policy interventions, the agricultural sector is still largely underdeveloped. This is due to focus is on production rather than on enhancing value addition across value chain segments, also, the Nigerian value chain is characterized by 80 per cent of small holder farmers and a few commercial processors plagued by inadequate inputs, obsolete technology and poor financing, non-coordinated and ineffective transaction, traditional market for commodities are fragmented, producers focus on short term benefits etc.(Mgbenka and Mbah, 2016). The consequences of these are high cost of transaction, low prices, low value added and weak stimulation of technology.

Value chain analysis as well as the deployment of modern technology in agriculture is widely believed to be important for improving the productivity and welfare of poor farmers in developing countries, and a key ingredient for achieving poverty reduction, food security, rural development and structural transformation (Swinnen and Kuijpers, 2017). However, the adoption of modern technology, including improved seeds and chemical fertilizer, has been disappointing, particularly in Africa (Evenson and Gollin, 2003; Sheahan and Barrett, 2014). The existing literature has tried to find explanations for this phenomenon by looking at various factors, including credit market imperfections (Feder et al., 1985), learning processes (e.g. Lambrechtet al., 2014), the quality of technological inputs (e.g. Bold et al., 2015), and profitability (e.g. Suri, 2011). Cohen and Levinthal, (1989) assert that, the positive influence that technologies produced abroad may exert on the domestic production capacity is strictly dependent on the actual absorptive capacity of the adopter country. This means that the availability of a considerable level of technological capabilities, especially in developing countries, represents a crucial factor to benefit from technology imitation and spillovers (Archibugi and Pietrobelli, 2003; Filippetti and Peyrache, 2011; Fu et al., 2011). As emphasized by Fagerberg and Verspagen (2002), technological catch-up is not all about replacing an outdated technological set up with a more modern one, but to continually transform technological, economic and institutional structures. Given the role of institution in shaping the dynamics of innovation intensity and technological pattern Barbosa and Faria, (2011), the objective of this study is to examine the role of institution in improving rice value chain through technology transfer and adoption.
Recent empirical analysis of value chain includes issues of governance (rules operating in a value chain) and coordination (formal and informal arrangements between actors) and their impacts on how actors operate in the chain (Rosales et al. 2017). The analysis of governance has the objective of examining the rules, both formal and informal, operating in the value chain and the system of coordination, regulation and control in which value is generated along a chain. The concept of governance used in this article is about the ability to exert control, set institutions and/or enforce parameters that have influence on actors

in the value chain. This include negotiating favorable terms for technology transfer on key agricultural inputs, most of which are imported. This embodies elements like codifiability of information pertaining to product design and specification, quality system, environmental standards etc.T he role of value chains in technology adoption and transfer has been largely ignored so far in the literature, despite the dramatic transformation and spread of modern agri-food value chains. Value chain organization and innovations as well as governance can have an important impact on modern technology adoption, not just by downstream companies, but also by farmers. This article adds to the small but emerging literature on the role of governance in technology transfer. To achieve this objective, the paper is structured into five sections. Section one deals with the introduction, section two is concerned with conceptual/theoretical framework while section three dwelt on the empirical literature. Section four looks at stylized fact while section five concludes the paper.

2.1 Theoretical Literature

2.1.1Governance and Technological Capability and Transfer

The concept of value chain has risen to the fore in recent times due to major changes in market conditions. For instance, on the demand side there is increasing demand for variety and quality. Also, on the supply side, firms have increasingly concentrated on their core competence in other to achieve systemic efficiency in the global market place. These two factors have meant that chain coordination – referred to as "chain governance" (Gereffi, Sturgeon, and Humphrey, 2005) – is a necessary component of value chain competitiveness. Here, Gereffi has made the widely cited distinction between chain governance executed by key buyers ("buyer-led chains") and that in which the governance role is played by a holder of core technology ("producer-driven chains"). Drawing from the literature on firm capabilities and learning pioneered by Penrose (1959), provides other reasons why firms are prepared to buy key inputs in the face of asset specificity and therefore construct relatively complex inter-firm relationships. According to Penrose, how and whether firms can capture value depends in part on the generation and retention of competencies (that is, resources) that are difficult for competitors to replicate. In practice, even the most vertically integrated firms rarely internalize all the technological and management capabilities that are required to bring a product or service to market. As such, the literature on firm capabilities and learning, argues that the learning required to effectively develop the capability to engage in certain value chain activities may be difficult, time-consuming, and effectively impossible for some firms to acquire, regardless of frequency or scale economies. This gives impetus to the issue of governance in coordinating the buying and selling of agricultural technology, ensuring effective transfer through developing capabilities to domesticate such technology for easy deployment in rice farming.

The importance of value chain governance to policy makers lies in its ability to be able to lay a simple framework for understanding the complex interactions that characterized the relationship between the sellers and buyers of foreign technology that lies at the heart of technology transfer. According to Autio and Laamanen (1995) technology transfer can be viewed as an active process, during which technology is carried across the border of two entities. Technology transfer occurs when a country acquires, imitates, or adapts technology developed elsewhere, this helps determine a country's level of agricultural productivity. According to Anderson (1989), technology transfer helps increase agricultural productivity, cut production costs, and lower consumer prices. According to Martinot, Sinton and Haddad (1997), technology transfer is a fundamental process of learning. As such the effectiveness of technology transfer depends on the degree of transferred technological knowledge and the recipient's absorptive

capacity to receive the knowledge (Fu and Zhang, 2011). According to Carud (1997) and Lundval and Borras (1997), the knowledge transferred can include know-what, know-how, know-why and know-who. The technological knowledge can flow through various conventional and unconventional mechanisms, including trade in equipment, foreign direct investment (FDI), joint ventures, licensing agreements, R&D cooperation, outward FDI, as well as international conferences, papers, and labor mobility (Able-Thomas,1996).The driving force behind technology transfer include the technology gap between transferors and transferees, life cycles of products, internalization, need and resource relationship and domestic market (Reddy and Zhao, 1990).This study focus on agricultural-based technological transfer in the context of rice production in Nigeria.

The benefits depend on how the technology is transferred, the speed of transfer, and the degree of government policy influence on technology transfers. Accordingly, technology transfer in agriculture involves new crop varieties (high yielding or disease resistant strains, often genetically engineered), manufactured inputs (fertilizers, pesticides, and other agricultural chemicals), machinery (tractors and cultivators, grain drying equipment and other postharvest technology), management techniques (computers, financial statements, and tillage practices), University research and training (biotechnologies and new crop varieties, training for scientists and farmers). A critical factor in effective technology transfer is a strong local research program that facilitates technology adaption and adoption.

Many agricultural technology systems in developing countries fail to make sufficient and relevant technologies available to farmers. This stems, in part, from poor linkages between research and technology transfer components. Attempts to improve these linkages include reorganizing research or extension units and creating special linkage units. Eponou, (1993) argues that the key constraint to effectiveness is the lack of a true system perspective with shared goals, synergy, system wide leadership, accountability and partnership with farmers. Three broad models of innovation in developing countries have been identified. They are the 'linear model', the 'chain-link' model and the 'farming systems research' approach (Eponou, 1993). The linear model, which is in operation in a large percentage of national research and transfer systems, has the following principles:

i. Research, as representative of the scientific method, considers itself to be the sole source of technology.
ii. Knowledge generation, transfer and use are sequential without any interaction or feedback loops.
iii. There is a science-practice continuum. The sequence is basic research, applied research, adaptive research, action by subject matter specialists, extension and application by farmers. The institutions of the system are organized accordingly. There is no need for synergy and there is a clear division of labor. Research generates technology. Technology transfer delivers technology to farmers. Farmers use technology.
iv. There is no collective responsibility for the outcome of joint effort, and research does not necessarily see the generation of practical technologies as the required output of its efforts.

The linear paradigm has not been successful with all types of technology, particularly those needed by resource-poor farmers and those that promote sustainability. In the 'chain-link' model of commercial innovation, perceived potential markets are captured through innovation, testing, redesign, distribution, production and marketing by an agro industrial organization (which may be public or private). Linkages take the form of feedback loops, especially between distribution and marketing on the one hand and units performing other tasks on the other hand. In this model, the systems perspective is fully recognized and is well managed by the agro industrial organization. Both farmers and research may be contractors to the organization and have explicit terms of reference.

Thirdly, is the system approach, the system perspective mean that all research and technology transfer organizations serving a given set of farmers/clients are part of a single agricultural technology system. Second, all the components share and adhere to an agreed-upon strategy which allows them to work towards a shared strategic goal or mission,
in this case to make relevant technologies available to farmers (Eponou and Rolling, 1992). The system perspective has six basic elements, which include; shared strategic goals, synergy as the mode of functioning, strong leadership for the whole, decision-making by consensus, accountability to clients and policy-makers and farmers as partners. However, implementation of this six element calls for a specific set of behaviors and attitudes from the component organizations as well as other actors in the system, in this case the government. According to Costatntini and Liberati, (2014) technology accumulated in rich countries may help poor countries achieve higher development levels more rapidly, and that well-functioning institutions may improve the capacity to transform the imported technology into domestic development opportunities.
The notion of technology transfer argued in this paper is that the recipient of technology from other clime should have the necessary capabilities to unpack the black box. The technological capabilities in this case implies the information and skills-technical, managerial and institutional- and at the heart of it all is governance. Some degree of governance is required for appropriate coordination between the R&D institution and the farmers. For instance, government can create the enabling environment for R&D institution to undertake leading edge innovation in biotechnology and other inputs design and also, ensure that the research output reach the end-user at subsidized costs (farmers).

2.2 Review of Empirical Literature

Value chain describes the full range of activities required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers and final disposal after use (Kaplinsky and Morris 2001). They do not exist in the sense of their having a tangible reality: they are simply a framework for trying to understand how the world works. It also constitutes a whole range of discrete, though interrelated, activities involved in the design, production and marketing of a product (Porter, 1985). Various chain conceptualizations mentioned in the literature include: filiere approach (Raikes, Jensen and Ponte, 2000), linkage approach (Hirschman, 1958), Porter's value chain (Porter, 1985) and the global value chain analysis (Gerefi, 1999). All of them deal with the flow of products and services along the chain, relationships between firms and co-ordination of production chains.
Technology transfer is indeed a partnership between the provider of the technology who has something to share and the receiver who will put it to good use. The two parties have roles to play if technology transfer is to be effective. Technology transfer is only said to be successful if it results in a positive change (Wallace et al. 1998). According to Schultz (1964) the critical factor in raising productivity is 'technical change' and the role of government is to promote technical change. Central in Schultz's policy prescription is for the government to invest in agricultural research. In Nigeria, despite huge investment in agriculture through the several research institution in existence, the effort is yet to translate into higher agricultural output to offset huge food imports, especially rice import. This is because the research output from these institutions consistently fail to serve the need of majority of farmers (who are mostly small scale farmers) effectively. Therefore, the purpose of technological adoption/transfer is to encourage rice farmers to participate in the global value chain through transfer and adoption of appropriate technology in rice production.
Governance issues plays a key role in a value chain. In addition, the structure of regulations, entry barriers, trade restrictions and standards can further shape and influence the environment

in which upgrading can take place. The concept of value chain includes issues of governance (rules operating in a value chain) and coordination (formal and informal arrangements between actors) and their impacts on how actors operate in the chain (Rosales et al. 2017). The analysis of governance has the objective of examining the rules, both formal and informal, operating in the value chain and the system of coordination, regulation and control in which value is generated along a chain. According to Gereffi (1994), value chains consist of three main components: input–output, geography, and governance. The governance dimension has received the most attention in value chain analysis because it brings to the foreground questions about the forces that both enable and limit what actors in the chain can do (Sturgeon, 2008). As succinctly stated by Giuliani, Pietrobelli, and Rabellotti (2005), "at any point in the chain, some degree of governance or coordination is required in order to take decisions". These decisions could include what should be done, how to do it, or how much or when something should be produced in both market and non-market contexts (Giuliani et al., 2005).

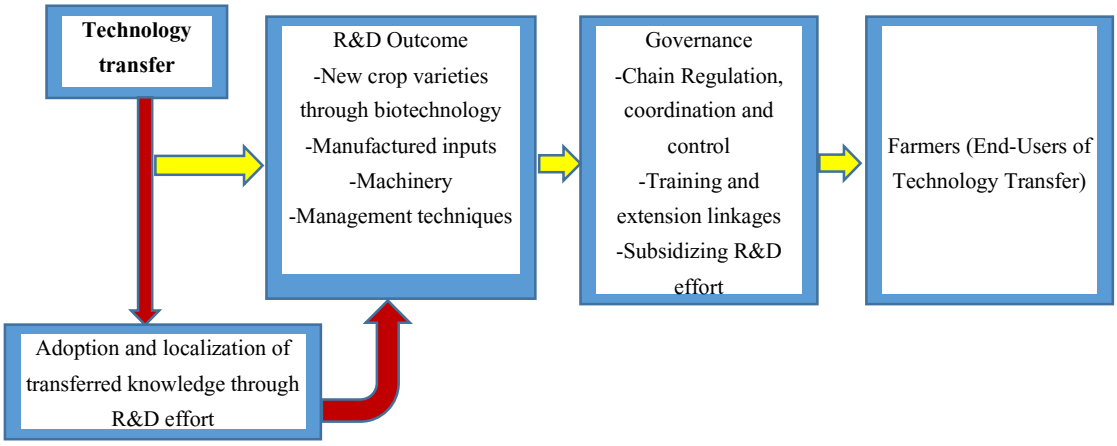

Figure 1. Innovation/Technological Transfer, Governance and End-Users (Farmers)
Source: Adapted from Gereffi, (1994)

As evident in Figure 1, governance lies at the heart of technology transfer effort/outcome and end-users, which in this case is the farmers. As noted by Amponsah (1996), the four major elements that should provide the enabling environment in influencing technology adoption, transfer and commercialization in African countries are market incentives, institutions, investment and infrastructure, which are referred to as the four I's. The key catalysts for the successful functioning of the four I's are interactions among appropriate micro- and macroeconomic policies and a well-functioning system of governance (Obi and Nwakaire, 2014). In this case, for transfer of technology to address the constraints of farmers (precisely rice farmers), government will have to be proactive in subsidizing outcomes/output of agricultural research institutes or private research organizations to farmers. For instance, agricultural inputs like hybrid rice seeds (to replace low yield seeds) and other inputs like fertilizers, pesticides etc can be made available to farmers to increase their productivity.

Most countries in the world that were able to transform their agricultural and industrial sector[1] achieved success through shifting their

[1]One of the reasons why Korea is renowned for having low project costs and rapid implementation of investments is that the government made a deliberate effort to develop investment capabilities by helping firms to locate sources of technology and negotiate favorable terms, including the participation of local engineering firms in design and construction.

technology frontier by determined effort of their respective government to reduce the cost of acquiring new technology to make it affordable to end users (farmers). For example, new rice varieties developed by the International Agricultural Research Centers (IARC'S) along with investment in irrigation facilities by the government allowed Indonesia to change from a major rice importer to an exporter, primarily at the expense of U.S. and Thai growers (Anderson, 1989). Also, the experience of Japan and the Asian Newly-Industrialized Countries (NICs) shows that growth in the domestic ability to select technologies, negotiate favorable terms for its transfer and participate in the design and setting up of the plant can greatly reduce project cost and increase the subsequent capabilities for technology adaptation and improvement (Biggs, Shah and Srivastava, 1995).

The transfer and adoption of new technology can increase output, decrease output price, and affect a country's balance of agricultural trade, as evident in Figure 2. The size of the economic effect depends on a country's share of world production and export markets, the sensitivity of supply and demand to changes in commodity prices, and the speed of technology transfer. International technology transfer raises income and fosters economic growth in the adopting country, an important issue for developing countries. Countries that can expand their export base earn much needed foreign exchange to repay foreign debts and purchase imports. Growth in developing countries, enhanced by technology transfer, raises income and increases the total demand for other goods produced in the country.

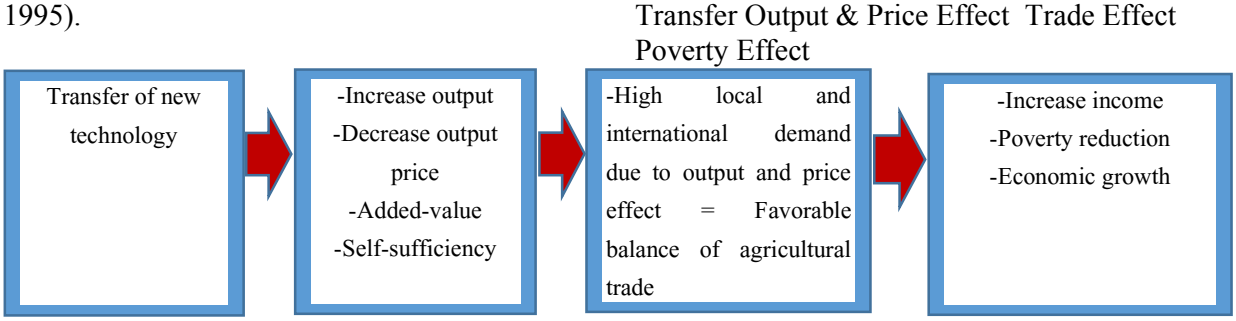

Figure 2. Technology Transfer, Trade, Growth and Poverty Nexus
Source: Author's Conception

Technology transfer through development of innovative, efficient and effective science and technology through fostering scientific principles in the production of rice could lead to self-sufficiency, added-value, increased competitiveness and export, and subsequently improved farmers' income/welfare and poverty reduction. However, existing literature on value chain and technology transfer mostly do not define the process of technology transfer but rather indicate the manner of their occurrence. Our contribution to the literature is to succinctly explain how technology transfer will strengthen the rice value chain in a manner that will benefit both farmers and consumers through value creation, which may involve different phase of codification based on the mechanism of knowledge transfer in rice farming. Deployment of modern technology and the transfer of such technology in rice farming through importation and adoption of innovative methods, design transfer which covers various intellectual property right as well as the capacity transfer which involves strengthening local R&D effort to be able to adapt new solutions to local conditions. The advantages to the Nigerian economy is three folds, first, reducing local demand for imported rice. Second, it increases our opportunity export local rice by taking advantage of the huge market for imported rice in Sub-Saharan Africa, and, lastly, it will

discourage the activities of cross-border smuggling of foreign rice.

3.0 Methodology

This study adopted the descriptive statistics and used tables and charts to analyze its results. The paper starts with a review of relevant literature on value chain, technology transfer/adoption and governance with a view to draw lesson for Nigeria. The paper adopts some numbers of indicators for the assessment of technology transfer and governance. The governance indicator used in this paper is government effectiveness (GE), control of corruption CP and regulatory quality (RQ). Government effectiveness reflect perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Control of corruption (CP), reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests, while, regulatory quality (RQ) captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development The data for our proxies of governance is obtained from World Governance Indicator (www.govindicators .org).

The estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance) and the data is obtained from World Wide Governance Indicator of the World Bank from 1996 to 2017 due to unavailability of data for earlier periods. This paper also measures technology transfer as high tech export as a percentage of manufactured export, this is in line with (Maskus 2004 and World Bank 2006) that posit that technology transfer between countries can take both market and non-market form and manufactures imports as a % of merchandise imports. Various proxies have been used in the empirical literature which strongly support the findings that the bulk of technological transfer takes place via trade, foreign direct investment as well as licensing. Country specific characteristics could play a role in determining which of these channels could guarantee technology transfer. For instance, it depends on recipient country's research capabilities and potential for imitation or reverse engineering (Maskus, 2004) as well as the governance structure in place. The data for technology transfer is obtained from World Development Indicator (WDI) and it covers the period 1996 to 2017. Rice data is obtained from World Rice Statistics (http://ricestat.irri.org:8080/wrs/) from 1980 to 2018.

4.0 Analysis of Result

Nigeria is currently witnessing rapid increase in rice consumption due to population growth, urbanization and rising purchasing power. Rice is the largest source of food calories and has become a highly strategic commodity in Africa (Seck, Toure, Coulibally, Diagne and Wopereis, 2013). Although, rice production in Nigeria has shown some marginal improvement due to deliberate government effort to increase rice production. For instance, during the last quarter of 2016, government supported major integrated rice mills under its Anchor Borrowers programme to pursue its backward integration agenda. The Anchor Borrowers programme is expected to provide funds to the large scale operators in local rice sectors. Also, within the same period government amended its forex policy to exclude rice from its imports and port clearance documentation. This implies technical import ban placed on rice as the commodity will not be issued the required document for port clearance even when its import purchase is funded through the parallel foreign exchange market.

Despite all these policies, rice import and consumption have exceeded local production in the last few years. For instance, the average annual import of rice for the period 1980-2018 (Table 1) is 1.34 million metric tons representing a growth rate of 8.38 percent per

annum, this represent 17 percent of import entering Sub-Saharan African countries. Local production of milled rice within the same period stood at 2.06 million metric tons with growth rate of 7.10 percent per annum. Similarly, there is significant growth in harvested area compared to growth in yield within the period under review.

Table 1: Averages and Growth Rate of Imports, Production, Consumption, Harvested Area and Yield for Nigeria and Sub-Saharan Africa (1980-2018)

	NIGERIA	SUB-SAHARAN AFRICA
IMPORTS	1.34	7.91
GROWTH RATE (%)	8.38	7.21
PRODUCTION	2.06	8.43
GROWTH RATE (%)	7.1	4.33
CONSUMPTION	3.37	14.77
GROWTH RATE (%)	6.81	4.67
HARVESTED AREA	1.88	7.38
GROWTH RATE (%)	105.26	2.82
YIELD	1.69	1.73
GROWTH RATE (%)	1.7	1.51

Source: World Rice Statistics (http://ricestat.irri.org:8080/wrs/)

The annual average of the area brought under rice cultivation in Nigeria was slightly greater than 1.88 million hectares over the period 1980-2018 with an annual growth rate of 105 percent. This represent 25 percent of the total area under cultivation of rice in Sub-Saharan Africa which stood at 7.38 million hectares. Although, the growth rate of yield is slightly higher than SSA average, the yield per hectare is lower than SSA average. The average yield of paddy rice in Nigeria is 1.69 tons per hectare, as against, 1.73 tons per hectare in Sub-Saharan Africa. Trend from the 4-year period average indicated that the rate of growth of cultivated area of paddy rice increased astronomically from 3.2 percent to 4.92 percent between 1980-1983 and 1984-1987 and peaked at 27 percent between 1988 and 1991 (Figure 3). The increase in the area put under rice cultivation is due to deliberate government policy to boost local production by imposing ban on the importation of rice through the inauguration of the Agricultural development Project with the aim of providing infrastructure and farm input to rural farmers. This led to the increase in harvested area from 0.75 million hectares in 1987 to 1.65 million hectares in 1989. The ban on rice import was removed in 1995 and replaced with 100% tariff on rice import. This rate was however reduced by half (50%) in the following year and increased again in 2001 to 85% (Boansi, 2013).

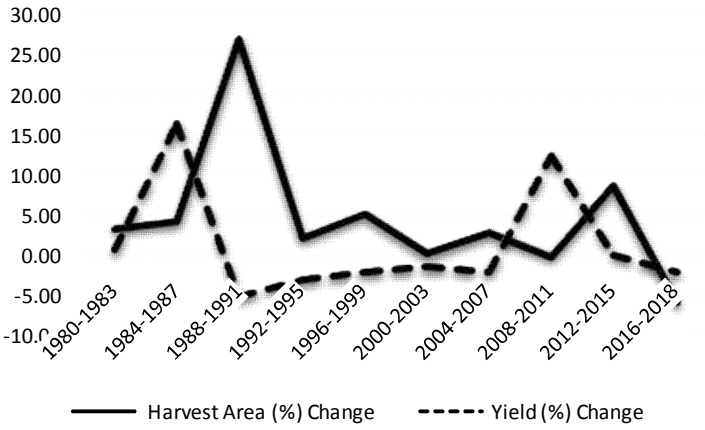

Figure 3. Period Averages of Harvested Area and Yield for Nigeria
Source: World Rice Statistics (http://ricestat.irri.org:8080/wrs/)

Correspondingly, both the growth rate of average yield and land areas under paddy cultivation fell drastically due to stiff competition from imported rice and poor variety of rice seeds planted by farmers. As evident in Figure 4, average yield rose steadily from 1.49 tonnes per hectare between 1980 and 1983 to 2.00 tonnes per hectare in 1988-199, it fell steadily thereafter and reached its lowest for the period 2000-2003 (1.39 t/ha) and later, steadily increased to an average of 1.92 (t/ha)between 2016 and 2018. On the average yield in Nigeria has not increased significantly over the study period compared to development in other countries and region. For instance, yield in Egypt grew from 5.72 tonnes per hectare from 1980-1983 to 10.85 tonnes per hectare between 2008 and 2011 (Table 2). Similarly average yield in China rose from 4.61 t/ha between 1980 and 1983 to 6.89 t/ha for the period 2016-2018.

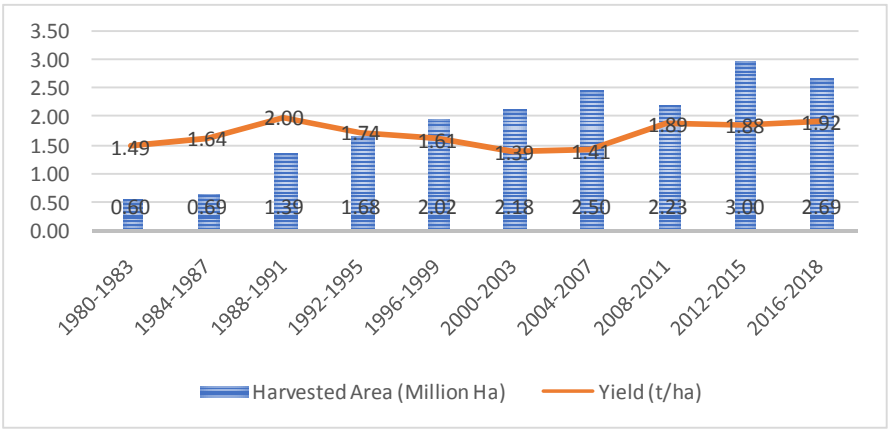

Figure 4. Period Average of Yield and Harvested Area
Source: Author's Computation from World Rice Statistics (http://ricestat.irri.org:8080/wrs/)

Table 2. Period Averages of Harvested Area (Million Ha) and Yield (T/Ha) for Some Selected Countries and Region

	Nigeria		China		Egypt		India		Thailand		Sub-Saharan Africa		World	
	Harv Area	Yield	Harv Area	Yield	Harv Area	Yield	Harv Area	Yield	Harv Area	Yield	Harv Area	Yield	Harv Area	Yield
1980-1983	0.60	1.49	33.34	4.61	0.42	5.72	40.09	2.00	9.21	1.94	4.34	1.36	152.96	2.92
1984-1987	0.69	1.64	32.41	5.35	0.42	5.77	40.47	2.22	9.57	2.03	4.84	1.43	143.10	3.24
1988-1991	1.39	2.00	32.57	5.55	0.40	6.71	42.31	2.60	9.41	2.11	5.79	1.61	145.28	3.47
1992-1995	1.68	1.74	30.84	5.88	0.55	7.82	42.15	2.78	9.02	2.28	6.11	1.58	146.83	3.64
1996-1999	2.02	1.61	31.42	6.31	0.59	8.53	44.21	2.88	9.77	2.38	6.80	1.62	149.58	3.82
2000-2003	2.18	1.39	28.37	6.17	0.61	9.63	43.35	2.93	10.12	2.61	7.14	1.61	153.62	3.89
2004-2007	2.50	1.41	28.77	6.32	0.66	9.88	43.32	3.16	10.33	2.70	8.02	1.73	150.56	4.05
2008-2011	2.23	1.89	29.70	6.60	0.62	9.68	43.58	3.35	10.85	2.83	9.10	2.04	157.19	4.26
2012-2015	3.00	1.88	30.24	6.80	0.71	9.19	43.59	3.63	10.37	2.74	10.95	2.14	162.78	4.44
2016-2018	2.69	1.92	29.95	6.89	0.73	8.17	43.46	3.78	10.69	2.87	11.88	2.18	161.16	4.52
Average	1.90	1.70	30.76	6.05	0.57	8.11	42.65	2.93	9.93	2.45	7.50	1.73	152.31	3.82

Source: Author's Computation from World Rice Statistics (http://ricestat.irri.org:8080/wrs/)

On the average yield in Nigeria is below the global and Sub-Saharan Africa, for instance, as observed from Table 2, average yield in China and Egypt are above the world average with a yield of 6.05 and 8.11 t/ha respectively. While Thailand and India are below the world average, average yield in Sub-Saharan Africa is the least among all countries in the sample except Nigeria. Globally, rice consumption has outstripped production which has resulted to a rise in the prices of rice. This situation is worrisome in Sub-Saharan Africa and Nigeria in particular. Current trend in production, consumption and import in Sub-Saharan Africa shows that growth rate of consumption and import outstrip production, for instance, food production in SSA increase marginally from an average 3.83 million tonnes between 1980 and 1983 to 16.62 million tonnes in 2016-2018 (Table 3), this significant strides in rice production is mostly driven by trend increase in production mostly in Nigeria, as it contribute over 24 percent of SSA production between 1980-2018. However, Nigeria import over 20 percent of SSA import and consume over 22 percent within the same period. At the global level, SSA barely produce 2.09 percent of world production and import 26.53 percent of world import. This huge mismatch between production and consumption has implication for food security in SSA countries. For instance, self-sufficiency defined as the ratio production to consumption averaged 63 and 59 percent for Nigeria and SSA respectively during 1980-2018. However, the rate increase and peaked at 84 and 69 percent between the period 1988-1991 for Nigeria and SSA and declined subsequently to 56 and 53 percent for the 2016-2018 for Nigeria and SSA respectively.

Table 3. Period averages and Growth Rate of Some Selected Indicators in Nigeria and Sub-Saharan Africa (SSA)

		1980-1983	1984-1987	1988-1991	1992-1995	1996-1999	2000-2003	2004-2007	2008-2011	2012-2015	2016-2018
Nigeria	Production	0.59	0.77	1.66	1.75	1.94	1.81	2.17	2.65	3.55	3.78
	% of SSA Production	15.40	17.31	28.83	29.27	28.45	25.22	24.66	22.21	23.61	22.75
	Consumption	1.27	1.17	1.97	2.20	2.64	3.26	3.92	4.74	6.00	6.72
	% of SSA Consumption	19.43	16.54	23.54	23.82	24.19	23.34	23.11	23.09	22.47	21.23
	Import	0.72	0.50	0.28	0.33	0.96	1.66	1.68	2.49	2.45	2.70
	% of SSA Import	26.13	19.08	10.38	10.55	21.31	22.59	21.16	26.07	20.54	17.55
	Self-Sufficiency Ratio	0.47	0.66	0.84	0.80	0.73	0.56	0.55	0.56	0.59	0.56
SSA	Production	3.83	4.44	5.76	5.98	6.82	7.19	8.81	11.92	15.02	16.62
	% of World Production	1.34	1.40	1.67	1.66	1.74	1.83	2.11	2.64	3.15	3.41
	Consumption	6.51	7.05	8.35	9.23	10.92	13.99	16.98	20.54	26.70	31.65
	% of World Consumption	1.36	1.52	1.92	2.24	2.72	3.71	4.75	6.25	8.86	11.49
	Import	2.76	2.64	2.71	3.16	4.50	7.33	7.95	9.54	11.93	15.38
	% of World Import	25.49	25.90	23.29	18.74	20.31	29.04	28.45	29.93	30.73	33.45
	Self-Sufficiency Ratio	0.59	0.63	0.69	0.65	0.62	0.51	0.52	0.58	0.56	0.53

Source: Author's Computation from World Rice Statistics (http://ricestat.irri.org:8080/wrs/)

Technology Transfer and Governance Index

The mechanism through which technology is transferred from one country to the other or from one businesses to another is called technology transfer which could be through trade or investment channels. The trade channels include: direct exporting, one-off transaction, licensing while investment channels co-production, sub-contracting, contract joint venture, equity joint venture, wholly owned subsidiary (Dorota, 2013). One of the stylized fact evident in the trend below (Figure 6) is that manufactured imports as a percentage of merchandize imports averaged 70.15 percent for all the periods (1996-2017). This indicates that domestic firms in Nigeria lack the capacity to codify information implicit in those imported manufactures. Countries that have been successful in terms of domestic research and development (R&D) effort to replicate foreign technology will experience a nose-dive in her manufactured import. However, the reverse trend is observed in the pattern of high tech export as a percentage of manufactured export. It peaked in 1999 with 13.9 percent and declined thereafter, the average between 1996 and 2017 is 2.09 percent, indicating dependent on high tech import. This implies that, the high import of manufactures is not taken advantage of by domestic firm.

The concept of "governance" (understood as the power to control, influence, set the modes and rules of interaction) in value chains is somewhat underrated in the implementation of upgrading strategies. The estimate of proxies of governance use in this work as indicated in figure 6 shows that the three governance parameters (control of corruption, regulatory quality and government effectiveness), the proxies use in this work are within the negative range indicating weak governance performance. Effective governance lies at the heart of successful innovation system that will guarantee transfer of technology and enhance the competitiveness of rice production.

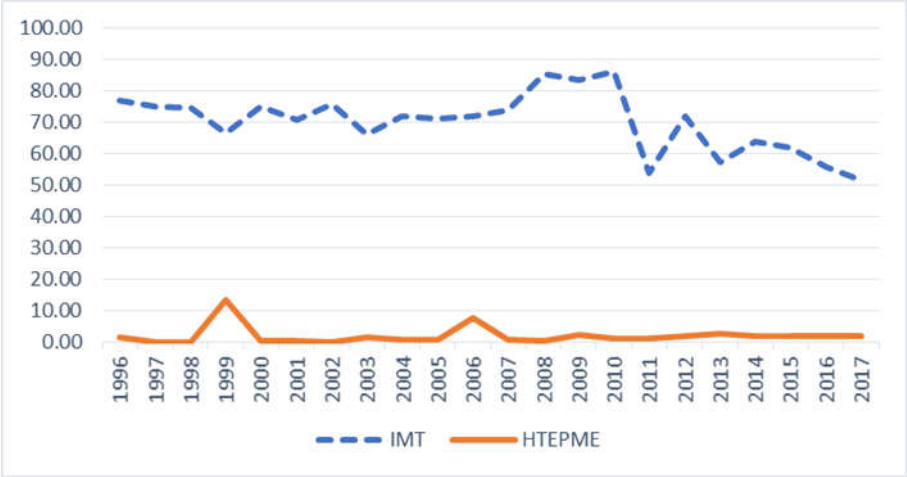

Figure 5. Manufactures Imports as a % of Merchandise Imports (*IMT*), High Tech Export as a Percentage of Manufactured Export (*HTEPME*)
Source: World Development Indicators (WDIStatistics)

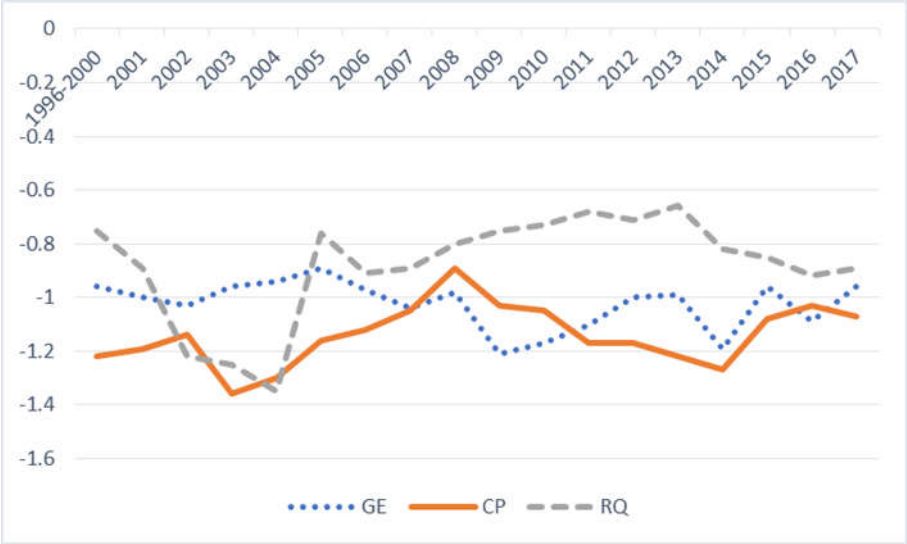

Figure 6. Government Effectiveness (GE), Control of Corruption (CP) and Regulatory Quality (RQ)
Source: World Wide Governance Indicator (wgidataset)

5. Conclusion and Recommendation

The adoption of modern technologies is crucial for improving the productivity of rice farmers in Nigeria with welfare implication on poor farmers who operate below the technology frontier. The rate of technology adoption among local farmers. Several factors have been identified in the value chain literature in Nigeria, but the role of governance has not received much attention so far. In this paper we have explained why governance may play an important role in enhancing farmers' access to and adoption of new technology. Given an imperfect technology market, research and development effort by both public and private sector research institution can be integrated backward to enhance farmers' productivity as well as ensuring food security for the country. This may further increase employment opportunities as both up- and downstream companies may have adequate supply of raw material to work up to their installed capacity,

especially the integrated millers. Policy outcomes need to target increasing access to technology, including improving the abilities of firms, agricultural R&D institutions to identify, acquire, adapt and use knowledge and technology with regards to best practice in rice farming. Underlying these outcomes are national policies that support improving domestic absorptive capacities and stimulate local innovation system to achieve successful transfer of technology. This is the reason why this paper emphasizes on the issue of governance in developing a supportive environment for technology transfer.

References

Able-Thomas, U., (1996). Models of renewable energy technology transfer to developing countries. *Renew. Energy* 9 (1), 1104–1107.

Amponsah, W.A. (1996). Creating an Enabling Environment for Agricultural Technology Transfer and Commercialization: a Comparative African Study, In: Gelaw, B., Acquah, E. and Whyte, C. (eds), Proceedings of the Workshop on Commercialization and Transfer ofAgricultural Technology in Africa, Accra, Ghana, November 4–7 1996. Technical Paper no. 57. Office of Sustainable Development, Bureau for Africa, U.S. Agency for International Development, pp. 28–37.

Autio, E and Laamanen, T (1995). Measurement and evaluation of technology transfer: review of technology transfer mechanisms and indicators, *International Journal of Technology Management*, Vol 10 (7/8)

Biggs, T., Shah, M and Srivastava, P (1995). Technological capabilities and learning in African enterprises, World Bank Technical Paper Number 288, Africa Technical Department Series.

Boansi, D (2013). Output supply and yield response of rice in Nigeria: Implication for future rice policy. http://mpra.ub.uni-muenchen.de/48080/

Boeninger (1992). Governance and Development: Issues and Constraints, *Proceeding of the World Bank Annual Conference on Development Economics 1991*. Washington DC. The World Bank, 267-287

Bold, T, Kaizzi, K. C., Svensson, J, Yanagizawa-Drott, D (2015). Low Quality, Low Returns, Low Adoption: Evidence from the Market for Fertilizer and Hybrid Seed in Uganda. HKS *Faculty Research Working Paper Series*, June.

Bold, T., K.C. Kaizzi, J. Svensson, and Yanagizawa-Drott, D (2015). Low quality, low returns, low adoption: Evidence from the market for fertilizer and hybrid seed in Uganda. Working Paper RWP15-033, Harvard Kennedy School.

Carud, R., (1997). On the distinction between know-how, know-why, and know-what. *Adv. Strat. Manag.* 14, 81–101.

Cohen, W.M., Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *Econ. J.* 99, 569–596.

Conley, T and Udry, C (2003). Learning about a New Technology: Pineapple in Ghana, Working Paper, University of Chicago and Yale University.

Costatntini, V and Liberati, P (2014). Technology transfer, institution and development, *Technology Forecasting and Social Change*, 88, pp. 26-48

Croppenstedt, A., M. Demeke, and M.M. Meschi. (2003). Technology Adoption in the Presence of Constraints: The Case of Fertilizer Demand in Ethiopia. *Review of Development Economics* 7 (1): 58–70.

Dardak, R. A and Adham, K. A (2014). Transferring agricultural technology from government research institution to private firms in Malaysia, Procedia-Social and Behavioral Science 115, pp. 346-360

Demont, M and Ndour, M. (2015) Upgrading rice value chains: Experimental evidence from 11 African markets. *Glob. Food Security*, *5*, 70–76.

Dorota, R (2013). Approaches to International Technology Transfer Measurement – An Overview, *Optimum Studia Ekonomiczne*, NR 5 (65)

Downer, A. (2000) Good Governance: Guiding Principles for implementation: In Ovat, O. O (2013). Corruption, governance and public spending in Nigeria: implications for economic development. Being a paper presented at the 54th Annual National Conference of the Nigeria Economics Society held at the Sheraton Hotels and Towers, Abuja, 17th – 19th September.

Dries, L., Germenji, E., Noev, N., Swinnen, J.F.M., (2009). Farmers, Vertical Coordination, and the Restructuring of Dairy Supply Chains in Central and Eastern Europe. World Dev. 37 (11), 1742–1758.

Eckhardt, J.T. and Shane, S.A. (2011). Industry changes in technology and complementary assets and the creation of high-growth firms. *Journal of Business Venturing* 26, 412-430

Eponou, T (1993). Integrating Agricultural Research and Technology Transfer, *Public Administration and Development*, Vol. 13, pp. 307-318

Evenson, R. E., Gollin, D, (2003). Assessing the impact of the green revolution, 1960 to 2000. *Science* 300 (5620), 758–762. http://dx.doi.org/10.1126/science.1078710

Feder, G., Just, R and Silberman, D (1981). Adoption of agricultural innovations in developing countries: A survey, World Bank Staff Working Paper No. 444

Feder, G., Just, R. E and Zilberman, D (1985). Adoption of agricultural innovations in developing countries: a survey. *Econ. Dev. Cult. Change* 33 (2), 255–298.

Feder, G., Just, R. E and Zilberman, D (1985). Adoption of agricultural innovations in developing countries: A Survey. *Economic Development and Cultural Change* 33 (6): 255–98.

Frederick, S., Staritz, C., 2012. Developments in the global apparel industry after the MFA phase out,In: Rosales, R. M et al (2017). Value chain analysis and small-scale fisheries management, *Marine Policy*, 83, pp. 11-21

Gereffi, G (1999). International Trade and Industrial Upgrading in the Apparel Commodity Chain, *Journal of International Economics*, Vol. 48, No. 1, pp. 37-70. doi:10.1016/S0022-1996(98)00075-0

Gereffi, G. (1994). The governance of global value chains. *Review of International Political Economy*, 12(1), 78–104. http://dx.doi.org/10.1080/09692290500049805.

Gereffi, G., Sturgeon, T. and Humphrey, J. (2005). The Governance of Global Value Chains, *Review of International Political Economy* 12(1): 78-104.

Giuliani, E., Pietrobelli, C., & Rabellotti, R. (2005). Upgrading in globalvalue chains: Lessons from Latin American clusters. *World Development*, 33(4), 549–573. http://dx.doi.org/10.1016/j.worlddev.2005. 01.002.

Hirschman, A (1958). The Strategy of Economic Development, Yale University Press, New Haven.

Humphrey, J., Schmitz, H., (2002). How does insertion in global value chains affect upgrading in industrial clusters? In: Rosales, R. M et al (2017). Value chain analysis and small-scale fisheries

management, *Marine Policy*, 83, pp. 11-21

Kaplinsky, R. and Morris, M. (2001). A Handbook for Value Chain Analysis. Ottawa: International Development Research Centre.

Kuijpers, R and Swinnen, J (2016).Value chain and technology transfer to agriculture in Developing and Emerging economies, *Amer. J. Agr. Econ*. 85(5): 1403–1418. doi: 10.1093/ajae/aaw069

Kuijpers, R., Swinnen, J.F.M., (2016). Value Chains and Technology Transfer in Emerging and Developing Countries. Working Paper.

Landell – Mills, P. and Serageldin. I. (1992). Governance and the External Factor *Proceedings of the World Bank Annual Conference on Development Economics 1991*. The World Bank. March, 303-320.

Lowitt, K., Hickey, G. M., Ganpat, W and Philip Leroy (2015). Linking communities of practice with value chain development in smallholder farming system, *World Development*, Vol. 74, pp. 363-373

Lundvall, B.Å., Borrás, S., (1997). The globalizing learning economy: Implications for innovation policy. Report from DG XII, Commission of the European Union, pp.34–39

Martinot, E., Sinton, J.E., Haddad, B.M., (1997). Technology, international transfer for climate change mitigation and the case of Russia and China. *Annu. Rev. Energy Environ*. 22, 357–401.

Maskus, K. E. (2004), Encouraging International Technology Transfer, UNCTAD-ICTSD.

Mgbenka, R.N., and E.N, Mbah (2016). A Review of Smallholder Farming In Nigeria: Need For Transformation, *International Journal of Agricultural Extension and Rural Development Studies*, Vol.3, No.2, pp.43-54, Available:http://www.eajournals.org/wp-content/uploads

Minten, B., Randrianarison, L. and Swinnen, J. (2009). Global retail chains and poor farmers: evidence from Madagascar: In Swinen, J (2016). Value chains, agricultural markets and food security: The state of agricultural commodity market in depth, FA0 2015-2016

Mitchell, J., Keane, J and Coles, C (2009). Trading up: How a value chain approach can benefit the rural poor, COPLA Global: Overseas Development Institute

Moser, C and Barrett, C (2003). The Complex Dynamics of Smallholder Technology Adoption: The Case of SRI in Madagascar, Working Paper, Cornell University.

Nigatu, G., Hansen, J., Childs, N and Seeley, R (2017). Sub-Saharan Africa is projected to be the leader in global rice imports, *USDA Economic Research Service*

Obi, O. F and Nwakaire, J. N (2014): Repositioning agricultural development in Africa through appropriate technology transfer, *African Journal of Science, Technology, Innovation and Development*, DOI:10.1080/20421338.2014.924258

Ovat, O. O (2013). Corruption, governance and public spending in Nigeria: implications for economic development. Being a paper presented at the 54th Annual National Conference of the Nigeria Economics Society held at the Sheraton Hotels and Towers, Abuja, 17th – 19th September 2013.

Porter, M. E (1985). Competitive Advantage: Creating and Sustaining Superior Performance, The Free Press, New York,

Raikes, R., Jensen, F. M and Ponte, S (2000). Global Commodity Chain Analysis and the French Filière Approach: Comparison and Critique, Centre for Development Research, Copenhagen (CDR) Working Paper No. 3,

Reji, E. A (2013). Value chain and small

enterprise development: Theory and practice, *American Journal of Industrial and Business Management,* 3, pp. 28-35

Rosales, R. M et al (2017). Value chain analysis and small-scale fisheries management, *Marine Policy*, 83, pp. 11-21

Schultz, T.W. (1964) Transforming Traditional Agriculture, Yale University Press, New Haven CT.

Sheahan, M and Barrett, C (2014). Understanding the agricultural input landscape in Sub-Saharan Africa: Recent plot, household and community-level evidence. *Policy Research Working Paper* 7014

Sheahan, M, Barrett, C. B., (2014). Understanding the Agricultural Input Landscape in Sub- Saharan Africa: Recent Plot, Household, and Community-Level Evidence. Policy Research Working Paper. The World Bank Group, August.

Janssen, E., Food Policy (2017), http://dx.doi.org/10.1016/j.foodpol.2017.08.005

Johnson, M., Hazell, P., & Gulati, A. (2003). The Role of Intermediate Factor Markets in Asia's Green Revolution: Lessons for Africa? *American Journal of Agricultural Economics*, 85(5), 1211–1216.

Sturgeon, T. J (2008). From commodity chains to value chains: Interdisciplinary theory building in an age of globalization, Industrial Performance Centre, MIT Working Paper Series,

Suri, T (2006). Selection and comparative advantage in technology adoption, *Economic Growth Centre Discussion Paper* No. 944

Suri, T (2011). Selection and comparative advantage in technology adoption. *Econometrica* 79 (1), 159–209. http://dx.doi.org/10.3982/ECTA7749.

Swinen, J (2016). Value chains, agricultural markets and food security: The state of agricultural commodity market in depth, FA0 2015-2016

Swinnen, J and Kuijpers, R (2017). Value chain innovations for technology transfer in developing and emerging economies: Conceptual issues, typology and policy implication, *food policy*, http://dx.doi.org/10.1016/j.foodpol.2017.07.013

Tollens, E (2006). Markets and institutions for promoting rice as a tool for food security and poverty reduction in Sub-Sahara Africa. *Afr. Crop Science Journal*, *15*, 237–242.

Velde, K.V and Maertens, M (2014). Impact of contract-farming in staple food chains: The case of rice in Benin. In Proceedings of the Agri-Food and Rural Innovations for Healthier Societies, Ljubljana, Slovenia, 26–29 August.

Wallace, C.E., Anderson, J.A. and Wilson, E.M. (1998). Transportation Technology Transfer: a Primer on the State of the Practice, Transportation Research Circular no. 488, Washington, D.C: Transportation Research Board, National Research Council.

World Bank (1989). Sub-Saharan Africa: From Crisis to Sustainable Growth: A Long-Term Perspective Study: In Ovat, O. O (2013). Corruption, governance and public spending in Nigeria: implications for economic development. Being a paper presented at the 54th Annual National Conference of the Nigeria Economics Society held at the Sheraton Hotels and Towers, Abuja, 17th – 19th September.

Xiang, T., Huang, J., Kancs, D., Rozelle, S. & Swinnen, J.(2012). Food Standards and welfare: general equilibrium effects: In Swinen, J (2016). Value chains, agricultural markets and food security: The state of agricultural commodity market in depth, FA0 2015-2016

Zhang, F and Gallagher, K. S (2016). Innovation and technology transfer through global value chains: Evidence from China's PV industry, *Energy Policy* 94, pp. 191-203