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The Impact of Agricultural Public Expenditure on Agricultural Productivity in Nigeria

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Work in Progress Paper Submitted for Presentation at AERC Virtual Biannual Workshop Slated for 8-11 June 2020.

Abstract

This study analysed the impact of agricultural public expenditure on agricultural productivity in Nigeria. The relevant time series data for the study were obtained from secondary sources. The data ranged from 1981 to 2014.We used Co-integration and Error Correction model and system of equations approach to model agricultural productivity and government expenditure. The heterogeneous impacts of components of government spending on agricultural productivity were also estimated. The study revealed that although, recurrent and total agricultural public expenditure does not impact on agricultural productivity, agricultural public capital expenditure has positive impact on agricultural productivity which materializes with lag. The study also implied that agricultural public capital expenditure can complement agricultural private investment. The study showed a budget discrimination against agricultural public capital expenditure in Nigeria. Finally, the study demonstrated that agricultural public spending on irrigation did not only have highest Benefit Cost Ratio of 4.74 (compared with 0.74 for input subsidy), but it also induced more agricultural private investment than spending on R&D, rural development and subsidy programmes. In conclusion, we recommend that agricultural budget execution rate should be improved through quick passage and timely implementation of the budgets. Agricultural public expenditure should be realigned to favour investments in irrigation, R&D and rural development which currently attracted lower budgetary allocations in Nigerian agricultural budgets.

Keywords: Impact, Public, Agricultural, Expenditure, Productivity, Nigeria

1.0 Introduction

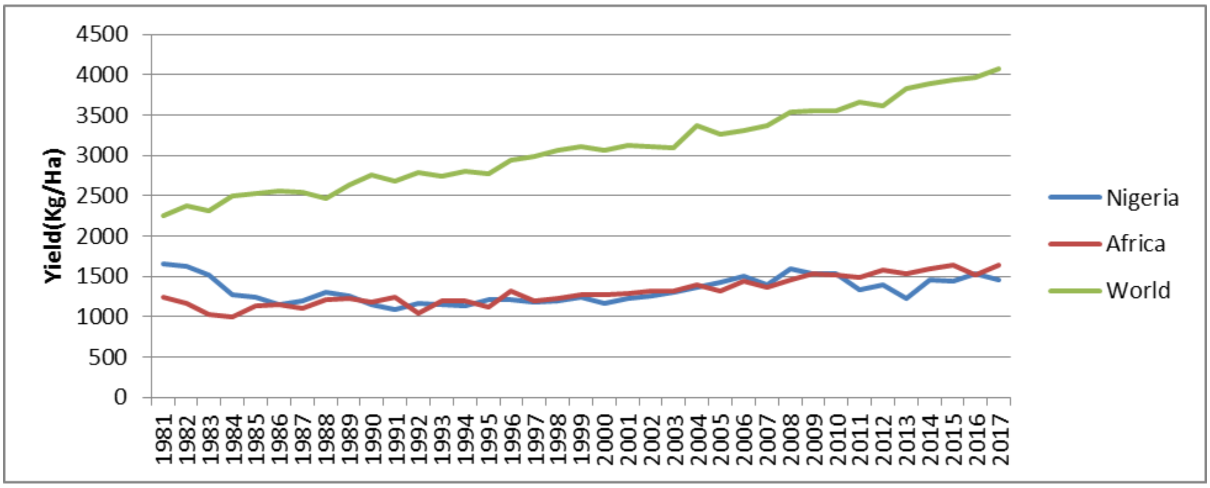
1.1 Background Information

Agriculture in the past was the biggest sector in Nigeria, and still accounts for more than 25 percent of Gross Domestic Product (CBN, 2018). The sector employed about 60% of the labour force (Olomola *et al*., 2014). At least 60% of those employed in the agricultural sector are women (Action Aid, 2015). The food crop sub-sector contributed about 76% of the share of the agricultural sector's contribution to GDP; livestock contributed 10% with remainder made up by forestry and fisheries sub-sectors (CBN, 2018). In the period before the 1970s, agriculture provided the needed food for the population as well as serving as a major foreign exchange earner for the country. It was a major source of raw materials for the agro-allied industries and a potent source of the much-needed foreign exchange (Alabi *et al*., 2016). The agricultural sector in periods immediately after independence performed creditably the roles highlighted above to such an extent that the regional developments and growths witnessed during the period were linked directly to agricultural development (Eluhaiwe, 2010). Development economists have in fact attributed the present economic problem in Nigeria to the poor performance of the agricultural sector (Olomola *et al*., 2015).

The inherent problems in agricultural sector in Nigeria compromise agricultural productivity. This is evident in Figure 1 as it shows that the cereal yield in 2017 which stood at 1462kg per hectare was lower than its yield in 1981 which stood at 1656kg/hectare. The figure also reveals that the cereal yield in Nigeria is much lower than that of the Africa's cereal average yield of 1643g/hectare in 2017. The figure indicates further that while the average cereal yield is generally increasing in Africa (from 1241kg/ha in 1981 to 1643kg/ha in 2017) and in the World (from 2247kg/ha in 1981 to 4074kg/ha in 2017), it is declining in Nigeria (from 1656kg/ha in 1981 to 1462kg/ha in 2017). Appendix 1 corroborates the situation of waning agricultural productivity in Nigeria as it reveals that yam and cassava yield declined by 20% and 22% respectively , while their yields increased by 131% and 125% respectively under the same time frame in Ghana. The appendix also shows that while rice yield declined in Nigeria by 2%, it increased by 71%, 144% and 109% in Ghana, Benin and Ivory Coast respectively. Productivity is a key issue in the agricultural sector in Nigeria due to its importance as a strategy for agricultural performance and its impact on economic and social development. Table 1 presents the growth rates of yield of major crops in Nigeria. The table revealed that roots and tubers, cereal, coarse grains, fruits and vegetable yields grew at the rates of -0.25%, 0.35%, and 0.30%, 0.59% and 0.03% respectively. The overall growth rate of 0.08% estimated as the average growth rate yield of all the major crops in Nigeria in Table 1 suggests that the yield of the major crops stagnated between 1981 and 2017 in Nigeria. The estimated crop production and yield growth rates of 4.10% and 0.08% respectively are lower than 6.5% growth rate in the annual demand for food in Nigeria (Action Aid, 2015). This may be one of the reasons for increase in the rate of food insecurity in Nigeria. Available recent evidence shows the proportion of Nigerian who are food insecure in Nigeria had increased from 9 million in 2008 to 23 million in

2018 (FAOSTAT, 2019)[1]. The consequence of declined crop yields is also reflected in waning contribution of agriculture to Gross Domestic Product (GDP) in Nigeria. For instance, when GDP data available from CBN (2018) were analysed, agriculture contribution to GDP in Nigeria declined from 27% in 2001 to 23% in 2014. The crop sub sector's contribution to GDP declined from 24% in 2001 to 21% in 2014.

Figure 1: The Average Cereal Yield in Nigeria, Africa and the World



Source: Computed from FAOSTAT (2019)

Table 1: The Production and Yield Trends of Major Crops in Nigeria (1981 to 2017)

Crops	%Contribution to Total Crop Production	Mean Output (Tonnes)	Mean Yield (Kg/ha)	Production Growth Rate (%)	Yield Growth Rate (%)
Roots and Tubers	49	46.46	9052	5.63	-0.25
Cereal	17	16.06	1329	2.59	0.35
Coarse Grains	14	13.55	1266	2.13	0.30
Fruits	07	7.05	5525	2.32	0.59
Vegetables	07	6.45	5187	4.76	0.03
Others	06	-	-	-	-
Mean	-			4.10	0.08

Source: Computed from FAOSTAT (2019)

Lower productivity, underutilized agricultural land, and lost opportunities for value addition has increased poverty and food insecurity in Nigeria (AfDB, 2016). Most farmers lack access to financial services to allow them to scale up their businesses, buy equipment, purchase agro-chemical and improve their living standards. Farmers are often cash-constrained, hindering their ability to make improvements, upgrades or uptake new farming technologies. Many factors are implicated for poor agricultural productivity in Nigeria. The decline in agricultural spending was considered to be a major contributing factor to the cause of low and slow growth in agriculture (Islam, 2011; Alabi, 2014). Kalibata (2010) is of the opinion that improved public expenditure in agriculture will help to provide the farmers with improved

[1] With regard to the prevalent natural resources, there is no reason why Nigeria should be a net importer of large quantities of food. However, Nigeria's total food and agricultural imports are growing and it is estimated at more than $10 billion in 2015 (USDA, 2016).

inputs, including seeds as well as agrochemicals. A well-managed public spending in agriculture can be used to provide rural infrastructure such as road that will link them to markets. The public financial resources will enable the farmers to access agribusiness credit and storage facilities to reduce their estimated 50% percent post-harvest losses (Oguntade, 2014). These are important to boost agricultural productivity, which can accelerate economic growth, raise income and improve standard of living[2].

In mobilizing local resources for agricultural growth and poverty reduction, the African leaders came up with the idea of the Comprehensive African Agricultural Development Programme (CAADP) in 2003. The overall objective of CAADP was to reduce food insecurity, malnutrition and reduce poverty through agricultural-led development agenda and programmes. To achieve this noble goal, the governments targeted a 6% annual agricultural growth rate (NEPAD, 2014). The AU member countries also pledged to increase their proportion of public expenditure on agriculture up to 10% during the Maputo Declaration of 2003. This is because African leaders believed that agricultural spending is one of the direct, valuable and important tools for enabling sustainable economic growth in African countries (Somma, 2008; ECA, 2009; Bahta *et al*., 2014; Jambo, 2017). The African Union (AU) also reaffirmed their commitments to the CAADP through the Abuja Declaration of 2006 and the Malabo Declaration of 2013 (Hill, 2012; OECD, 2014). Based on Abuja Declaration, the AU countries reaffirmed their intention to increase agricultural productivity through expansion of agro-chemical fertilizer and improved seed use in Africa. The first target of the Abuja Declaration was to raise the fertilizer use up to 50kgs of nutrients/hectare from 13kgs/ hectare (Wanzala, 2011). The aims of Malabo Declaration include increasing both public and private investment in agriculture, increasing agricultural productivity levels by 50% and reducing post-harvest losses by 50% so as to end hunger and halving poverty by 2025 and reduce food insecurity in Africa (NEPAD, 2014; Lorka, 2014).

As from 2007 and 2009, Rwanda had increased its investment in agriculture by 30%, and in Sierra Leone, agriculture has gone from 2% of the budget to 10% in 2010 (NewAfrican, 2014). According to ONE (2014), Burkina Faso averaged 17% of public spending on agriculture from 2003 and 2010; this step had created 235,000 agricultural jobs within the period. This has also led to the doubling of cotton growing households in Burkina Faso. In the same vein, Ethiopia also spent 15% of her budget on agriculture and the poverty declined by 49% within the same period. This led to increase in the number of agricultural extension service by 100%. Generally, countries that adopted CAADP since its inception in 2003, by increasing their agriculture government expenditure toward 10% experienced an annual increase in their agricultural productivity of around 6% to 7% (Badiane, *et al.*, 2016). On the contrary, those countries that did not implement the CAADP goals had farm productivity growth of less than 3% (Badiane, *et al.*, 2016).

1.2 The Problem Statement

Some studies have analysed the trend and composition of public agricultural expenditure in Nigeria (World Bank, 2007; Mogues *et al.*, 2012a; Mogue *et al.*, 2008; Olomola *et al.*, 2015). Mogues *et al.* (2008) demonstrated that public spending on agriculture in Nigeria is exceedingly low compared with other African countries and with other sectors such as education, water, health, etc. Olomola *et al* (2015) also affirmed that the agricultural public expenditure in Nigeria stood at 2% of total federal expenditure in 2012. The studies indicated that Nigeria also falls far behind in agricultural expenditure by international standards, even when accounting for the relationship between agricultural expenditures and

[2]Dorosh and Haggblade (2003) and IFPRI (2006) found that investment in agriculture generally favours poor population more than similar investments in other sectors or sub-sectors in Sub Sahara Africa (SSA).

national income. Moreover, they demonstrated on analysing the components of agricultural public spending that it concentrated on a few areas. Two out of 179 programmes accounted for 77% of federal capital spending, of which 38% went to input subsidy alone (Mogues *et al.*, 2008; Olomola *et al.*, 2015). This reflects a remarkable concentration of public resources over a narrow number of activities which may limit the impact of public agricultural expenditure on agricultural productivity as critical productivity enhancing expenditures were not given top priorities (Mogues *et al*, 2008a). Other studies on the impact of agricultural public expenditure related public expenditure with economic growth and agricultural output (Ewubare and Eyitope (2015); Ayunku and Etale (2015); Ihugba *et al* (2013); Itodo, *et al* (2012); Iganiga and Unemhilin (2011) and Lawal (2011). All these studies recognised the importance of government spending on agriculture sector in enhancing its growth. However, they used single equation estimation approaches which may be inferior to system of equation approach because public investments affect productivity through multiple channels (Fan *et al*, 2000, 2004,). Therefore, policy implications from single equation studies may be misleading since changes in public investments are not linked one-to-one with changes in outcomes (Benin *et al.*, 2009; Herrera, 2007).

Although public spending on agriculture is crucial for agricultural growth and productivity, many have questioned the effectiveness and consequences of such expenditure. According to OECD (2014), regardless of the important goals achieved by public expenditure on agriculture, there are various distortions associated with the policy. In spite of that, the agricultural development in Nigeria still rely on government finance due to the presence of externalities, high risk and inadequacies in agricultural institutions (rural agricultural credit, input supply, etc) which discouraged investment in agriculture from private sources (FAO, 2013; Selvaraj, 1993). However, the economists have shown that public sector finance alone is not enough to finance agricultural sector (Jambo, 2017; Benin, 2017). According to FAO (2013), there is no doubt that more public resources are needed for agriculture, however, there is a need for new investment strategies and studies that recognises complementary roles of Foreign Direct Investment (FDI), Official Development Assistance (ODA) and remittances in agricultural public expenditure discourse.

The development economists have also revealed that the impacts of public expenditure on agricultural productivity may differ by types of expenditures (Mogues *et al*., 2012b). Just as the effect of different functional investments in agriculture may vary in magnitude, agricultural public spending might also differ by the products being targeted (Mogues *et al*., 2012a). Therefore, studies that recommend increasing agricultural spending without paying close attention to heterogeneous impacts of different types of agricultural investments may not bring about the best policy outcomes if implemented.

1.3 Research Questions

Based on the above observations, various questions continue to dominate recent debates and discussions regarding government spending on agriculture. Some of the questions are: What is the agricultural budget performance situation in Nigeria? Has the agricultural public expenditure increased in Nigeria to meet up with Maputo Declaration of 2003? Has the increase led to increase in agricultural productivity? Does the component of agriculture public expenditure (rural development, irrigation, research development and subsidy) affect agricultural productivity differently? This study aims to provide answers to these questions and make recommendations based on the empirical findings. The answers to these questions will guide the policy makers on how to prioritize and allocate public funds to achieve the best outcomes in agricultural sector in Nigeria. It will also throw limelight on which component of spending contributes more to agricultural growth and productivity in Nigeria. The study will also help the policy makers on alignment and harnessing other sources of funding for agriculture in Nigeria.

1.4 Objectives of the Study

The broad objective of the study is the analysis of the impact of agricultural public expenditure on agricultural productivity in Nigeria. Specifically;

(i) The study examined the nature, trend and structure of public agricultural expenditure in Nigeria.

(ii) It determined the impact of agricultural public expenditure on agricultural productivity.

(iii) It also estimated economic returns to the different components of agricultural public expenditure in Nigeria.

2.0 Theoretical Framework and Literature Review

2.1 Theoretical Framework

This study is based on endogenous growth model. Endogenous growth model employs a diverse body of theoretical and empirical work that emerged in the 1980s (Romer, 1994). It distinguishes itself from neoclassical growth by emphasizing that economic growth is an endogenous outcome of an economic system, not the result of forces that operate from outside the system. For this reason, the theoretical work does not invoke exogenous technological change to explain why per capita income per capita has increased since the industrial revolution. The theory tries to uncover the private and public sector choices that cause the rate of growth of the residual to vary across nations. As in neoclassical growth theory, the focus in endogenous growth is on the behaviour of the economy as a whole.

If the output takes the simple Cobb-Douglas Production form as

$$Y = A(t)K^{1-\beta}L^{\beta}. \qquad (1)$$

while, Y denotes net national product, K denotes the stock of capital, L denotes the stock of labour, and A denotes the level of technology. The notation indicating that *A* is a function of time signals the standard assumption in neoclassical or exogenous growth models: the technology increases for reasons that are outside the system[3]. The failure of the above expression to explain different growth rates among the countries made Romer to propose a model in which *A* was determined locally by knowledge spillovers (Romer, 1987a). As a possible explanation of the slow rate of convergence, Barro and Sala-i-Martin (1992) also proposed an alternative to the neoclassical model that is somewhat less radical than the spillover model in Romer (1987a). As in the endogenous growth models, they suggested that the level of the technology A(t) can be different in different states or countries[4]. They took the initial distribution of differences in A(t) as given by history and suggested that knowledge about *A* diffuses slowly from high A to low A regions. This would mean that across the states, there is underlying variation in A(t) that causes variation in both k and y(from equation (1), y = Y/L which denotes output per worker and k = K/L denotes capital per worker).

This is in line with Romer and Lucas (1990) that highlighted that growth is driven by technological change (A(t)) or Total Factor Productivity that arises from purposive investment decisions. The distinguishing feature of the technology as an input is that it is neither a conventional good nor a public good; it is a no rival, partially excludable good (Guandong

[3] The key parameter is the exponent β on labour in the Cobb-Douglas expression for output. Under the neoclassical assumption that the economy is characterized by perfect competition, β is equal to the share of total income that is paid as compensation to labour, a number that can be calculated directly from the national income accounts.

[4] The assumption that the level of technology can be different in different regions is particularly attractive in the context of an analysis of the state data, because it removes the prediction of the closed-economy, identical-technology neoclassical model that the marginal productivity of capital can be many times larger in poorer regions than in rich regions (Romer, 1994).

and Muturi, 2016). According to Udoh (2011), Lipsey (2001) and Barro (1990, 1991), the impact of government expenditure on output growth possibly operates through the total factor productivity (*A*). This is spirit behind the adoption of the CAADP together with other declarations such as the Maputo Declaration of 2003, Abuja Declaration of 2006 and Malabo Declaration of 2013. This suggests that African governments still believe they have a huge part to play in stimulating growth in agricultural sector (IFPRI, 2013). Many African states re-established their position in providing agricultural support programmes, after the inception of CAADP, with belief that increasing expenditure to agricultural sector can enhance agricultural productivity and promote economic growth and development.

2.2 Empirical Literature on the Impact of Public Expenditure on Agriculture

The provision of public goods and services hinges on market failure, including imperfect markets and information asymmetry for agricultural technology adoption, scale up, uptake and advancement (Benin *et al.*, 2012). Government spending is also justified on social grounds for income distribution and poverty reduction. Some of the empirical studies on developing countries that address the importance of public financial resources to agriculture include Fan *et al* (2000); Fan and Zhang (2004); Fan *et al* (2008; 2004;2005); World Bank (2007a); Benin *et al* (2012) and Allen *et al* (2012). Various studies on the importance of public expenditure in stimulating economy and agricultural sector have also been conducted in Nigeria and they are discussed briefly below.

Mogues *et al* (2008) demonstrated in their descriptive study on agriculture public spending in Nigeria that public spending on agriculture is exceedingly low. They indicated that less than 2 percent of total federal expenditure was on agriculture, which was far lower than spending in other key sectors such as education, health, and water. They revealed that the spending on agriculture contrasts dramatically with the sector's importance in the Nigerian economy and the policy emphasis on diversifying away from oil, and falls well below the 10 percent goal set by African leaders in the 2003 Maputo Declaration. Since their study was only exploratory one, they suggested the need for an applied research to address critical knowledge gaps in agricultural public expenditure in Nigeria.

Iganiga and Unemhilin (2011) studied the effect of federal government agricultural expenditure and other determinants of agricultural production on the value of agricultural output in Nigeria. A Cobb Douglas growth model was specified that included commercial credits to agriculture, consumer price index, annual average rainfall, population growth rate, food importation and GDP growth rate. Co-integration and Error Correction methodology were employed to draw out both long-run and short-run dynamic impacts of these variables on the value of agricultural output. Their results showed that federal government capital expenditure was found to be positively related to agricultural output. However, the study failed to account for the endogeneity of agricultural public spending, because it undermined the notion of programme placement effects in their analyses.

Udoh (2011) explored the relationship between public expenditure, private investment and growth in the agricultural sector in Nigeria. Making use of data from 1970 to 2008, their growth model incorporated variables such as agricultural output, labor force participation rate, gross fixed capital formation and total foreign direct investment. The VECM model used in his study indicated a positive relationship between public expenditure and output in the short run. This study did not consider the impacts of other components of agricultural expenditure on agricultural sector in Nigeria.

Using time series data, Lawal (2011) attempted to verify the amount of federal government expenditure on agriculture in the thirty-year period (1979 – 2007). Using trend analysis and a simple linear regression, the study showed that agricultural spending does not follow a regular pattern and that the contribution of the agricultural sector to the GDP is in direct relationship with government funding to the sector. The simple linear equation approach he used may not be able to handle the complex relationship between government expenditure and agricultural productivity.

Itodo, *et al* (2012) examined the impact of government expenditure on agriculture and agricultural output in Nigeria from 1975-2010, using Cob-Douglas production function and the ordinary least square (OLS) econometric technique, they estimated a multiple regression of agricultural output against some variables. The results revealed a positive but insignificant relationship between government expenditure and agricultural sector and agricultural output within the scope of their research. This finding may be biased because the OLS methodology they employed may be consistent and unbiased but less efficient compared with Generalized Least Squares approach employed in Seemingly Unrelated Regression (SUR) model (Cameron and Trivedi, 2010); Cameron and Trivedi, 2009)

Ihugba *et al* (2013) empirically analyzed the relationship between Nigeria government expenditure on the agricultural sector and its contribution to economic growth, using time series data from 1980 to 2011. They employed the Engle-Granger two step modelling (EGM) procedure to co-integration based on unrestricted Error Correction Model and Pair wise Granger Causality tests. From the analysis, their findings indicated that agricultural contribution to Gross Domestic Product and total government expenditure on agriculture are cointegrated. Therefore, they concluded that any reduction in government expenditure on agriculture would have a negative repercussion on economic growth in Nigeria. The relationship between government expenditure and GDP may occur through many links. Therefore, single equation model as specified in this study may not be able to capture the various links (Greene, 2012). This may also cast doubt on the estimated results from this study.

Olomola *et al* (2014) using Public Expenditure Approach to investigate agricultural spending in Nigeria observed that budgetary allocation in Nigeria to agriculture compared with other key sectors is low despite the sector's role in the fight against poverty, hunger, and unemployment and in the pursuit of economic development. Their findings on the benefit incidence of public spending on fertilizer subsidy suggest that the target population of the programme has not benefited as intended. They recommended the need for impact analysis of relevant components of agricultural public expenditure in Nigeria, especially on those components that take greater proportion of the expenditure.

Ewubare and Eyitope (2015) examined the effects of government spending on the agricultural sector in Nigeria. The ordinary least square (OLS) of multiple regressions, the Johansen co-integration techniques, and the error correction model were used for the analysis. They implied that government expenditure has positive impact on agricultural sector in Nigeria. Based on the above findings, they recommended for an increase funding of the agricultural sector in Nigeria. The fact that agriculture public spending may be an outcome rather than the cause of agricultural productivity was not tested in the study and that may bias their estimate upward or backward.

Ayunku and Etale (2015) investigated the effect of agriculture spending on economic growth in Nigeria from 1977 to 2010 with particular focus on sectorial expenditure analysis. The study employed Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests, as well as Johansen Cointegration and followed by Error Correction Model (ECM) tests. Their empirical results indicated that Real GDP was particularly influenced by changes in Agriculture Expenditure (AGR), Inflation Rate (INF), Interest Rate (INT) and Exchange Rate (EXR), these variables as they stand contribute or promote economic growth in Nigeria. Accordingly, they recommended amongst others things that government should increase spending on agriculture. However, in their study they failed to account for the fact that the impact of agricultural public expenditure may not be instantaneous (it may materialize with lag) and this may cast doubt on the estimates derived from the study.

Generally, most of the studies on public agriculture expenditure in Nigeria did not account for the endogeneity in public spending decision making which could lead to wrong conclusion emanating from their estimates of the effects of public spending. They also failed to account for time lag for the effect of public expenditure to materialize. Their findings may be biased because public spending decision at any time may depend on previous spending decisions and spending outcomes (Benin *et al*., 2009). They all used single equation estimation approaches which may be inferior to system of equations approach because public investments affect productivity through multiple channels (Fan *et al.*, 2000, 2004,). Therefore, policy implications from single equation studies may be misleading since changes in public investments are not linked one-to-one with changes in outcomes (Benin *et al*., 2009; Herrera, 2007). More importantly, none of the past studies in Nigeria examined the differential impacts of different components of agricultural spending in Nigeria.

2.3 The Composition of Public Agricultural Expenditure in Nigeria

The knowledge about the composition of agricultural public spending provides further understanding into its distribution in relation to priorities, importance, level and balance (World Bank, 2011). The agricultural public expenditures in Nigeria are mainly classified as capital (development) and recurrent. The recurrent expenditures are further classified as wage and nonwage/personnel and overhead costs. It has been revealed that high proportion of capital spending in Nigeria is devoted to crops related activities, and an extremely small proportion is directed toward livestock- and fisheries-related activities (Mogue *et al*, 2008a). On average nearly 97 percent of capital spending went to support the crops subsector, and only 3 percent of capital spending went to support the livestock and fisheries subsectors combined (Mogue *et al*, 2008a).

When the public agricultural capital expenditures in Nigeria were analysed by projects and by activities within projects based on the available data, two items dominated spending activities as shown in Figure 2. Ranked in order of size, the two dominant activities included Project coordinating unit (PCU) and Fertilizer market stabilization (subsidy).

Project coordinating unit (PCU) averaged 39 percent of total capital spending in agriculture. PCU coordinates the National Special Program for Food Security (NSPFS)[5]. PCU also coordinate the National Strategic Food Reserve (NSFR)[6], involving in the construction of silos for grain storage for purpose of food security. The disbursement of funds for Agricultural Development Project (ADP), which is the agricultural extension arm of the state ministry of agriculture are usually handled through the federal PCU.

Fertilizer market stabilization (subsidy) averaged 38 percent of total capital spending in agriculture. Figure 2 further shows that rural development, which involves in the construction of feeder roads that link farmers to the market, received average of 8%. Research and Development spending averaged 3%, while irrigation spending was accorded 1%

[5] The National Special Program for Food Security (NSPFS) is an initiative of the Federal Government of Nigeria that is being implemented in collaboration with the Food and Agriculture Organization (FAO) of the United Nations. The purpose of NSPFS is to contribute to sustainable improvement in national food security, through rapid increases in productivity and food production on an economically and environmentally sustainable basis. However, detailed financial information about the NSPFS is not publicly available, making it difficult to assess its expenditure profile.

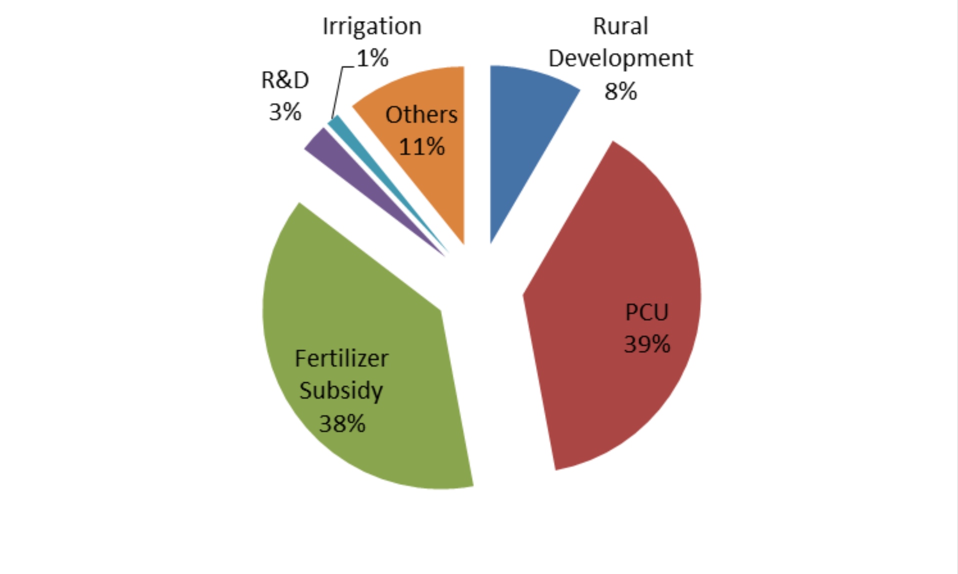
[6] NSFR aims to purchase and put into storage 5 percent of the food grains produced in the country. The resulting stocks will be available to provide relief following disasters. The grain purchases and sales are to be managed so as to help stabilize food prices during periods of surplus or deficit.

of the spending. This pattern of spending, where 71% of capital agricultural expenditure is spent on two out of 179 sub-programmes of Federal Ministry of Agriculture and Rural Development indicates a remarkable concentration of resources over a small number of activities (Mogue *et al*, 2008a).

It is evident that critical functional components of agricultural spending in Nigeria were not given due priorities as indicated in Figure 2. The structure of expenditure where research and development, irrigation, agricultural extension and education and rural development were not given top priorities, may limit the impacts of the spending on the performance of agriculture sector (IMF, 2014). IFDC (2013) revealed that fertilizer usage can help in eliminating the farming obstacles such as soil nutrient depletion. Fertilizer subsidies programmes may encourage farmers to take up a productive technology that they otherwise would have avoided as too risky (Mogues *et al*, 2008a). However, the opportunity cost associated with fertilizer subsidies has made them a less preferable way of spending on the sector. It also has tendency to crowd out private investments in fertilizer distribution if it is not properly implemented and undertaken. Fan *et al* (2007) had indicated that subsidy programmes have crowded out more productive government spending in agricultural R&D, rural roads, and education in India. Moreover, many studies have suggested that expenditure on research and development has proved to be more beneficial in the long run than input subsidy programmes (Seck *et al*., 2013; Stads and Beintema, 2015, Asare and Essegbey, 2016). Other studies have argued that the greatest contribution to economic growth and poverty reduction comes from investments in infrastructure such as irrigation and roads development (Gemmell *et al*, 2012). Kristikova *et al* (2016); Fan and Rao, 2003). Bientema and Ayoola (2004) recognized that spending on agricultural research and development can bring high returns to agriculture. According to Fan and Saurkar (2006), spending on agricultural research is the most crucial type of expenditure to increase agricultural productivity. Agricultural research and development brings new improved technologies to agriculture, which benefits the poor and smallholder farmers (Alene and Coulibally, 2009).

Political economy factors and institutional contexts can play an important role in determining the composition of agricultural government expenditure in developing countries (Mogue *et al*, 2008a). For example, policymakers will prefer spending through subsidies and price supports, mainly because the programmes have immediate short-term visible results (IFPRI, 2013a). According to Jayne and Rashid (2013), these input subsidy and price support programmes are likely to remain, because for the politicians, the programmes provide tangible and feasible evidence of government support. Therefore, it is imperative to analyse the impact of the subsidy expenditure and other components of agricultural spending in order to bring out their relative contribution to agricultural productivity in Nigeria. The results from the empirical analyses of differential impacts of different components of public agricultural expenditure can then be compared with how the government has been prioritizing the agricultural expenditures over the past years. This can shed some light on the past misallocation of funds at the same time indicating how government should allocate the agricultural budget in the future for better agricultural performance.

Figure 2: Composition of Public Agriculture Capital Expenditure in Nigeria



Source: Computed from Mogues *et al* (2008a) and Olomola *et al* (2014)

3.0 Research Methodology

3.1 Conceptual Framework

This study is based on agriculture production function framework that takes government expenditure as contributing to a stock of public capital in rural areas, and this stock contributes to agricultural productivity. The general notion is that public capital, private and foreign capitals are complementary in the production process, so an increase in the capital stocks raises the productivity of factors in production (Anderson *et al.*, 2006; Benin,*et al.*, 2009; Kakwani and Son, 2006)[7]. As illustrated in Figure 3, ODI and Remittances constitute foreign capital stock, while private capital is the investment the farmers made on their farms using their available capital resources. FAO (2013) has shown that the private investment farmers made on the farms is one of the major investments made on the farms. Since majority of the capital comes from the farmers themselves and related domestic agribusiness partners (Rudloff 2012; FAO 2012a), agricultural private investment is necessary for purchasing of agricultural inputs that are necessary for agricultural production. The Public investment is the expenditure that comes from the government side in forms of spending on Research and Development (R&D), agricultural education, extension, irrigation and rural infrastructural development. The capital stocks can be used to raise agricultural productivity directly or indirectly or both. Agricultural public expenditure can be used to set up agricultural credit institutions such as Agricultural Credit Guarantee Scheme Fund (ACGSF) in Nigeria. The Scheme was established for government to provide guarantee on loans granted by banks to farmers for agricultural production and agro-allied processing (Nwosu *et al.*, 2010; Adetiloye, 2012). The credit institution can contribute to the rural capital stock or it can assist the farmers in getting loans for the purchase of necessary inputs for the farms. Spending on Research and Development (R&D), agricultural education, irrigation and water supply, extension, and rural infrastructure will enhance agricultural productivity indirectly through development of high yielding seeds, irrigation system, improved accessibility to agricultural input and output markets. Subsidy programmes can increase input use and can lead to improved technology adoption. Remittances contribute directly to input purchases at the household and farm

[7] Crowding-out of private capital investments, with contrasting effects on productivity is also possible. This derives from the relative efficiency of public versus private expenditure in many developing economies where public sector agencies compete directly with the private sector in the provision of private goods and services (Ashipala and Haimbodi, 2003; Mbaku and Kimenyi,1997).

levels. Remittances can foster longer-term development through investment in education, land and agricultural input purchase (Iheke, 2016; Vasco, 2011). In the case of Nigeria, international remittances can play a greater role in agricultural productivity, taking into consideration that the annual international remittance to Nigeria in 2018 stood at 24.3 billion USD which was 6.1% of Nigeria GDP (KNOMAD, 2019). Iheke (2016) has shown that remittances have not only grown strongly in a positive direction, but these inflows have also exhibited a much more stability than FDI and ODA in Nigeria. However, it should be noted that large part of remittances are used for immediate consumption, health and education. Only a small proportion, around 10-12 percent, is invested in agriculture (FAO, 2013).

ODA may raise agricultural productivity directly or indirectly by relaxing capital constraint which is a key bottleneck to higher agricultural productivity in Nigeria (Verter, 2017). The ODA may come in form of agricultural policy support instruments, agricultural input supply or direct agricultural project intervention that may improve agricultural productivity in the country.

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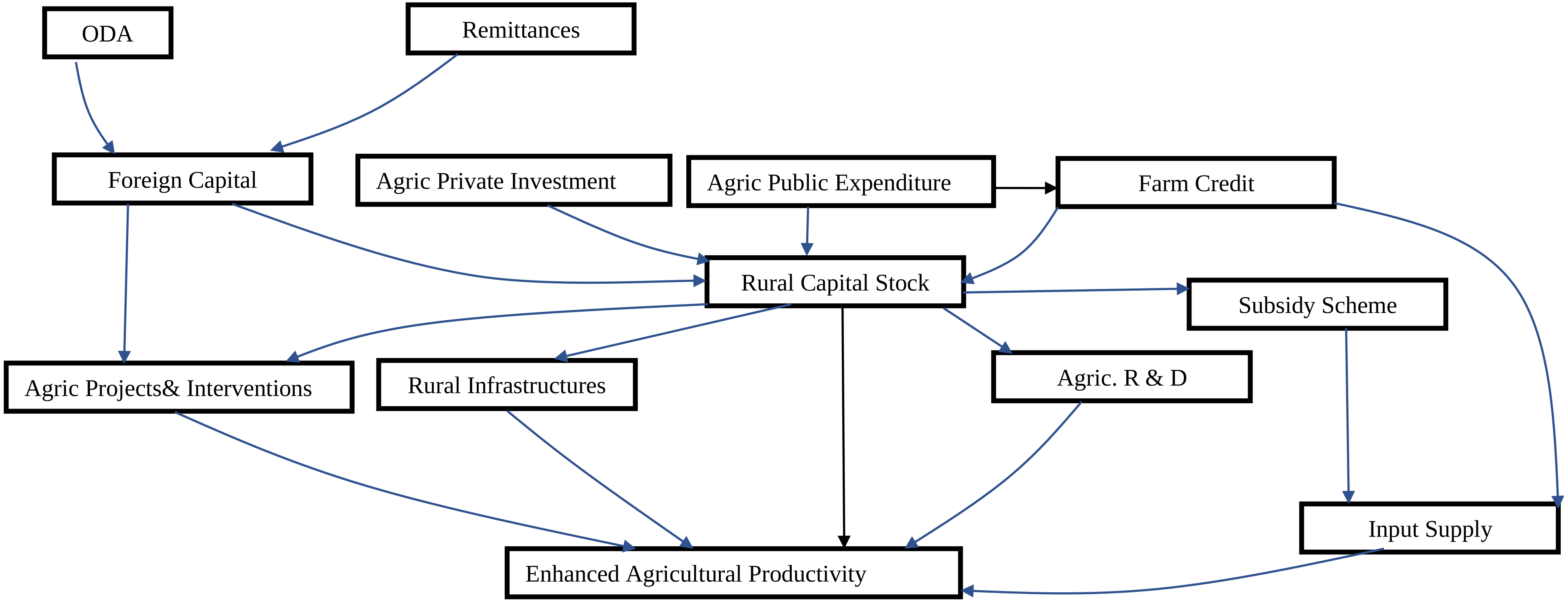
Figure 2: The Conceptual Framework of Links among Public, Private Investment and Agricultural Productivity



Source: Adapted from Wieck *et al* (2014)

3.2 Model Specification

Our analysis utilized the aggregate production framework proposed by Fosu and Magnus (2006), Constant and Yaoxing (2010) and Udoh (2011). The aggregate production framework is an extension of the conventional production function, which emphasizes labour and capital as the main factors of production, to examine the impacts of other variables such as public expenditure, foreign capitals (ODA, Remittances) and so on. The general form of the function linking aggregate output in period t with inputs or factors of production is specified as:

$$Y_t = A_t K_t^{\alpha 1} L_t^{\alpha 2} \quad (2)$$

Where Y_t denotes the aggregate production of the agricultural sector at time t, and A_t, K_t, and L_t also denote the Total Factor Productivity (TFP), the capital stock and the stock of labour at time t, respectively. According to Udoh (2011), Lipsey (2001) and Barro (1990, 1991), the impact of government expenditure on output growth possibly operates through the total factor productivity (A). Hence, Udoh (2011) assumed that TFP is a function of agricultural public expenditure (AGPE) and other exogenous factors (C). While K represents the farmers' private investment, we modeled L as the ratio of farmers' population to total population in Nigeria. We included Non-agricultural Public expenditure (NAGPE) as also a determinant of TFP through its effect on human capital development[8]. We added ODA and international remittances to the TFP model because ODA and remittances have been proved to tackle the savings and trade balance (foreign exchange) constraints to agricultural production and growth because they can bridge the gaps of limited domestic capital in developing countries, such as Nigeria (Verter, 2017). Besides contributing to household livelihoods and consumption, remittances (REMIT)[9] can foster longer-term development through investment in education, land and agricultural input purchase (Iheke, 2016)[10].

Thus, the Total Factor Productivity can be modelled as:

$$A_t = f\,(AGPE_t, NAGPE_t, REMIT_t, ODA_t, C) \quad (3)$$

Equation (3) can be written explicitly as

$$A_t = AGPE_t^{\alpha 3}\, NAGPE_t^{\alpha 4}\, REMIT_t^{\alpha 5}\, ODA_t^{\alpha 6}\, C_t \quad (4)$$

Combining equations 2 and 4 will yield equation 5 below

$$Y_t = C_t\, K_t^{\alpha 1} L_t^{\alpha 2} AGPE_t^{\alpha 3}\, NAGPE^{\alpha 4}{}_t\, REMIT^{\alpha 5}{}_t\, ODA^{\alpha 6}{}_t \quad (5)$$

Linearizing equation (5) and adding the error term (ε_t), we obtain estimable econometric model as follows:

$$LogY_t = c + \alpha_1 LogK_t + \alpha_2 LogL_t + \alpha_3 LogAGPE_t + \alpha_4 LogNAGPE_t + \alpha_5 LogREMIT_t + \alpha_6 LogODA_t + \varepsilon_t \quad (6)$$

One of the goals of CAADP is to enhance both public and private investment in agriculture (NEPAD, 2014; Lorka, 2014). By increasing the productivity of factors of production, public capital investments can crowd-in or crowd-out private investment (Benin,*et al*, 2009; Kakwani and Son 2006), therefore we specify another equation that relates farmers' private investment(AGPS) with AGPE and other factors that can influence private investment. These can include Non-agricultural Public expenditure (NAGPE), unemployment (UNEM), Comprehensive African Agricultural Development Programme indicator (CAADP) and Electricity consumption (ELEC). For example, NAGPE spending on the transport sector can have other investment multiplier effects where it improves access to education, health, and other production

[8]By including public investments in other sectors (NAGPE), we shall capture possible interaction effect between spending on the non-agricultural sectors and spending on the agricultural sector.

[9]Based on Massey *et al* (1987), FAO (2013) and Debski (2018) we assumed that 10% of total remittance is spent on agricultural activities in Nigeria.

[10]Vasco (2011) has shown that the households having one or more migrant abroad spent more on fertilizer than households that have no migrant abroad.

support services (Benin *et al*, 2009). This may induce and encourage private investment. UNEMPL is included because unemployment may be a constraint to agricultural private investment because of its negative effect on income and savings. Investment and electricity consumption can positively cointegrate (Asuamah, 2018). It has been proved that power shortages have led to the collapse of many firms and businesses in developing countries (Ubani, 2013). Kumi (2017) established strong link between electricity consumption and private investment in developing countries. CAADP is a dummy variable that can capture the effect of Maputo declaration of 2003 on agricultural private investment. It is scored 0 before 2003 and 0 otherwise. While C_t represents other exogenous variables that can influence private investment ($AGPS_t$), private investment can be related to other variables interest as expressed in equation (7) as:

$AGPS_t = AGPE_t^{\beta 1}\ NAGPE_t^{\beta 2}\ UNEM_t^{\beta 3} ELECT_t^{\beta 4} CAAD^{\beta 5} C_t$ (7)

Linearizing equation (7) and including error term (υ_t), we can obtain agriculture private investment model as:

$AGPS_t = b_o + \beta_1 LogAGPE_t + \beta_2 LogNAGPE_t + \beta_3 LogUNEM_t + \beta_4 LogELECT_t + \beta_5 CAADP + \upsilon_t$ (8)

Since public spending decision may be endogenous, in order to test for this endogeneity, we specify another equation to explain the relationship between level of government spending and agricultural productivity. The relationship between agricultural public expenditure (AGPE) and agricultural productivity is modeled as a function of past agricultural productivity ($Y_{(t-1),}$), non-agriculture public expenditure (NAGPE), AGPS, Mechanisation(MECH) and government type (GOV) as stated in equation (9). Lagged value of agricultural productivity $Y_{(t-1),}$ is included to reflect the placement effect of agricultural spending. This is because agricultural expenditure may be responding to impressive performance of past agricultural productivity. NAGPE is also included in equation (9) to capture possible interaction effect between spending on the non-agricultural sectors and spending on the agricultural sector. Possible crowd in or out of private investment (AGPS) by AGPE justifies its inclusion in equation 9. Of course, inclusion of GOV as a dummy variable will enable us to capture the effect of government type on agricultural public expenditure. This is because the data from Nigeria public expenditure shows that democratic government favours increased expenditure on agriculture than military government which may want to increase defence expenditure at the expense of other public expenditures (CBN, 2018). The democratic government is scored 1 and 0 otherwise. Mechanisation measured as number of tractor ownership per 100km^2 has been proved to be positively correlated with government expenditure (Kadhim, 2018; UNIDO, 2008), this justifies its inclusion in equation 9.

$AGPE = C_t Y^{\eta 1}_{(t-1)}\ NAGPE^{\eta 2}_t\ AGPS^{\eta 3}_t\ MECH^{\eta 4}_t\ GOV^{\eta 5}$ (9)

Linearizing equation (9) and including error term (ϑ_t), we can obtain AGPE model as:

$AGPE = a_0 + \eta_1 LogY_{(t-1)} + \eta_2 LogNAGPE_t + \eta_3 LogAGPS_t + \eta_4 logMECH_t + \eta_5 GOV + \vartheta_t$ (10)

3.3 Data Collection and Sources

The data for this study are secondary data from Nigeria[11]. The time series data used ranges from 1981 to 2014. Y is the value of Agriculture GDP per farmer as previously stated. AGPS as the agricultural private investment is a proxy for Gross Fixed Capital Formation (GFCF) in agriculture[12]. The Y, AGPE, NAGPE were obtained from Central Bank of Nigeria (CBN) Statistical Bulletin. Components of agricultural public expenditure such as expenditure on subsidy,

[11] Nigeria occupies a land area of 923,768 square kilometres, and the vegetation ranges from mangrove forest on the coast to desert in the far North. Nigeria consists of 36 states and a Federal Capital Territory (FCT). Each state is further divided into Local Government Areas (LGAs). There are presently 774 LGAs in the country. The total population of Nigeria stood at 166.2 million in 2012 has risen to 196 million in 2018 (World Bank, 2019).

[12] GFCF in agriculture measures land improvements, machinery and equipment purchases, infrastructure constructions as well as crop and livestock fixed assets and inventory.

irrigation, research and rural development were obtained from Mogues *et al* (2008a); Olomola *et al* (2015); World Bank (2007b) and Mogues *et al* (2012). Data on remittances were collected from the knowledge partnership on migration and development website (KNOMAD, 2019). AGPS, ODA were extracted from FAOSTAT website (FAOSTAT, 2019). The number of tractors per $100km^2$ (proxy for mechanisation), unemployment, and electricity consumption were obtained from World Development Indicators (WDI, 2019). The depreciated value of gross fixed capital formation used each year was constructed using the following capital formation approach:

$$\text{Value of GFCF} = GFCF_{year} \times \delta \tag{11}$$

where $GFCF_{year}$ is the Gross Fixed Capital Formation for year under consideration, δ is the depreciation rate. δ was obtained from the Pen World Table 9.1 (Knoema, 2019). The summary of the relevant variables and the units of measurement are presented in Appendix2. All monetary values were deflated using appropriate constant prices to exclude the influence of inflation and other temporary monetary and fiscal trends. The α_s, β_s and η_s are vectors of parameters estimated from the respective equations.

Since we are using secondary data in the study, we performed Augmented Dickey – Fuller test (ADF) (Kwaitkowski *et al*., 1992) test to check for unit roots. The non-stationary variables were then differenced. The differencing technique will de-trend the data and transform the series to stationary. A series is denoted by I(0) if it has no unit root before the process of differencing is applied. If the series is found to be stationary after differencing, then it is denoted by I(1) meaning integrated of order 1 (Wooldridge, 2013; Jambo, 2017).

3.4 Model Estimation Procedure

In achieving objective 1, we estimated the growth rate (trend) of agricultural public expenditure following the procedure of Barrett (2001). The growth rates of public agricultural capital and recurrent expenditure were estimated separately using equation 12 as:

$$\text{Log (AGPE)} = \alpha_o + \psi_1 \text{(Year)} + \lambda_{pt} \tag{12}$$

Where Log is the logarithm, Year is the period under consideration, where 1981 stands for 1 and 1982 stands for 2 and 2014 stands for 34. AGPE is the agricultural public expenditure, the error term is λ_{pt}, ψ_1 is the estimated AGPE growth rate when expressed in percentage. ψ_1 was estimated for recurrent and capital expenditure to check if there are differences in the growth rates of the two components of AGPE in Nigeria. We also determine the AGPE budget execution rate by calculating the ratio of public agricultural budget estimate to its expenditure[13]. We estimated the Agriculture Orientation Index (AOI) as we related AGPE share in government total spending (%Share of AGPE) to the share of agriculture GDP in the total country's GDP (%Share of AgGDP) presented in equation 13 (Mink, 2016)..

$$\text{AOI} = \frac{\%Share\ \ of\ AGPE}{\%Share\ of\ AgGDP} \tag{13}$$

In achieving specific objective 2, we first estimated the long and short run dynamic relationship between government expenditure and agricultural productivity using cointegration and error correction approaches. Cointegration analysis can be used with non-stationary data to avoid spurious regressions (McKay *et al*., 1999). When combined with error correction model (ECM), it offers a means of obtaining consistent yet distinct estimates of both long run and short run elasticities. The first step in cointegration analysis is to test the order of integration of the variables. A series is said to

[13] The difference in the actual government agriculture expenditure and its budget was tested using T-test.

be integrated if it accumulates some past effects, so that following any disturbance the series will rarely return to any particular ‘mean’ value, hence is non-stationary (Greene, 2012). The order of integration is given by the number of times a series needs to be differenced so as to make it stationary. If series are integrated of the same order, a linear relationship between these variables can be estimated, and cointegration can be tested by examining the order of integration of this linear relationship.

Formally, variables are said to be cointegrated (*m,n*) if they are integrated of the same order, *n* , and if a linear combination exists between them with an order of integration *m-n*, which is strictly lower than that of either of the variables. In practice, economists look for the existence of stationary cointegrated relationships, since only these can be used to describe long-run stable equilibrium relationship. Indeed, if there is a linear combination between the variables, which is stationary 1(0), then any deviation from the regressed relationship is temporary. Although the variables may drift apart in the short run, an equilibrium or stationary relationship is guaranteed to hold between them in the long run. Typically, economists look for variables that are cointegrated (I,1). When variables are cointegrated (1,1), there is a general and systematic tendency for the series to return to their equilibrium value; short run discrepancies may be constantly occurring, but they cannot grow indefinitely. This means that the dynamics of adjustment is intrinsically embodied in the theory of cointegration, and in a more general way than encapsulated in the partial adjustment hypothesis. The Granger representation theorem states that if a set of variables are cointegrated (1,1), implying that the residual of the co-integrating regression is of order (1,0), then there exists an Error Correction Mechanism (ECM) describing that relationship (McKay *et al.*, 1999). This theorem is a vital result as it implies that cointegration and ECMs can be used as a unified empirical and theoretical framework for the analysis of both short- and long-run relationship. The ECM specification is based on the idea that adjustments are made so as to get closer to the long-run equilibrium relationship. Therefore, the link between cointegration series and ECMs is intuitive: error correction behaviour induces cointegrated stationary relationship and vice versa. The Granger theorem can be presented formally.

If two variables X and Y are 1(1) and if there is a linear combination

$$Z_t = \mathrm{Y}_t - \beta X_t \tag{14}$$

Which is 1(0), then X and Y are said to be cointegrated (1,1) and there exists an ECM describing the relationship. Assuring that X ‘causes’ Y,

Then the ECM can be written as:

$$\Delta \mathrm{Y}_t = \alpha \Delta X_t - \lambda(\mathrm{Y}_{t-1} - \beta_{x_{t-1}}) + V_t \tag{15}$$

The estimated residuals from the co-integrating regression, Z_t, represent the divergence from equilibrium or the ‘equilibrium errors’ that are going to influence changes in Y in the following period. The coefficient β measures the long run elasticity of X with respect to Y and is estimated from equation (14); α measures the short-run effect on Y of changes in X; λ measures the extent to which changes in Y can be attributed to ECM. If $Z_t > 0,$ that is, if Y_t is above its equilibrium value, then Y decreases in the following period $(\Delta Y_t + 1 < 0)$ and errors at time t are corrected by the proportion λ. The advantage of using ECMs is twofold. First, spurious regression problems are by-passed as ΔX, ΔY, and Z are all 1(0). Second, ECMs offer a means to incorporate the levels of the variables X and Y alongside their differences. This means that ECMs convey information on both short and long run dynamics (McKay *et al.*, 1999; Udoh, 2011). Nickell (1985) demonstrates that the ECM specification represents forward looking behaviour, such that the solution of a dynamic optimization problem can be represented by an ECM.

We used lagged value of Agricultural Public Expenditure as its instrument in order to account for possible endogeneity of Agricultural Public Expenditure. Some past studies have also used lagged values of the expenditure as instruments (Benin, 2012; Alene and Coulibaly, 2009; Thirtle *et a.l*, 2003). Using lagged value of Agricultural Public Expenditure may introduce serial correlation into the model. We went further to test for first-order serial correlation using first-order serial correlation using Durbin's alternative test for autocorrelation (Durbin, 1970) and higher-order serial correlation using the Breusch-Godfrey Lagrange multiplier (LM) test for autocorrelation (Breusch, 1978; Godfrey, 1978).

Since the links between Agricultural Public Expenditure and other determinants of agricultural productivity may operate though different channels, we also estimated system of equations linking Agricultural Public Expenditure and other determinants of agricultural productivity using seemingly unrelated regression (SUR) method (Zellner 1962; Zellner and Huang, 1962; Benin, 2012). The SUR estimation is performed in stata using the SUREG command. This command requires specification of dependent and independent variables for each of the equations in the systems of equation. SUREG uses the asymptotically efficient, feasible, Generalized Least Squares (GLS) algorithm described in Greene (2012). GLS estimators are appropriate when one or more of the assumptions of homoskedasticity and non-correlation of regression errors fails (Cameron and Trivedi, 2009). In SUR, the GLS is extended to a system of linear equations with errors that are correlated across equations for a given individual but are uncorrelated across individuals. Then cross equation correlation of the errors are then exploited to improve estimator efficiency. SUR consists of *m* linear regression equations for *N* individuals. The j*th* equation for individual *i* is $y_{ij} = X'_{ij}\beta + U_{ij}$. With all the observations stacked, the model for the j*th* equation can be written as

$$y_j = X'_{ij}\beta_j + U_j. \qquad (16)$$

Then the *m* equations can be stacked to give SUR model as:

$$\begin{pmatrix} y_1 \\ y_2 \\ \mathrm{M} \\ y_m \end{pmatrix} = \begin{pmatrix} x_1 & 0\mathrm{L} & 0 \\ 0 & x_2 & \mathrm{M} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} \\ 0 & 0 & x_m \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_1 \\ \mathrm{M} \\ \beta_m \end{pmatrix} + \begin{pmatrix} \mu_1 \\ \mu_2 \\ \mathrm{M} \\ \mu_m \end{pmatrix} \qquad (17)$$

This has a compact representation as $y_j = X\beta + U$ (18)

The error terms are assumed to have zero mean and to be independent across individuals and homoscedastic. The case is that for a given individual, the errors are correlated across equations, and since the equations are linked only by their disturbances, hence the name seemingly unrelated regression (SUR) model (Greene, 2012). OLS applied to each equation yield a consistent estimator of β, but optimal estimator for this model is GLS estimator (Zellner, 1962). In using SUR, we tested for cross-equation independence of the error terms by using the Breusch-Pagan test (Breusch and Pagan, 1980). The Breusch and Pagan (1980) χ^2 statistic – A Lagrange multiplier statistic is given by

$$\lambda = T \sum_{m-1}^{m} \sum_{n-1}^{m-1} R_{mn}^2 \qquad (19)$$

where R_{mn} is the correlation between the residuals of the *m* equations and *T* is the number of observations. It is distributed as χ^2 with *m*(*m*-1)/2 degree of freedom.

In achieving specific objective 3, we separated Agricultural Public Capital Expenditure (AGPCE) into its components as government spending on agricultural R&D (RD), irrigation (IRR), rural development (RUR) and input subsidy programmes (SUB). We estimated the impact of RD, IRR, RUR and SUB using SUR model separately. From estimated equations of RD, IRR, RUR and SUB we were able to determine the marginal effect of different components of agricultural public capital expenditure (AGPCE) on agricultural productivity by totally differentiating the system of equations with respect to the particular component of AGPCE (Benin, 2015). This effect can be expressed in terms of elasticity, where the elasticity of agricultural productivity with respect to each component of AGPCE (∈AGPCE) can be obtained as:

$$\in AGPCE \equiv \frac{d(Yt)}{d(AGPCEt)} = \frac{\partial(Yt)}{\partial(AGPCEt)} + \frac{\partial(Yt)}{\partial(AGPSt)} + \frac{\partial(AGPSt)}{\partial(AGPCEt)} \qquad (20)$$

The first term on the right hand side of equation (20) captures the direct effect of the component of AGPCE, while the second and third terms together capture the indirect effect. The second term is the vector of production function estimates with respect to farm investments. The third term measures the crowding-in (or crowding-out) effects of public investments in agriculture on private farm investments. The marginal returns to public investments (i.e. the Benefit-Cost Ratio or *BCR*) can be calculated by multiplying equation (20) with the respective ratio of agricultural output per farmer to the different of components AGPCE (Benin, 2015, Goyal and Nash, 2017). Therefore:

$$\text{BCR of the component of AGPCE} = \in AGPCE \text{ x } \frac{Yt}{AGPCEt} \qquad (21)$$

Based on equation (21), Benefit Cost Ratios of government spending on agricultural R&D, irrigation, rural development and input subsidy programmes were estimated separately.

4.0 Preliminary Results and Discussion

4.1 Structure and Trend of Public Agricultural Expenditure in Nigeria

The mean budget execution rate is estimated at 77.10% and it is presented in Table 2. This suggests that about 23% of the agricultural budgets were not implemented in Nigeria. The T-ratio value of 3.1945 which is significant at 1% level implies that agricultural public expenditure is significantly lower than its budget over the period under consideration. The discrepancy in budget implementation of about 23% estimated in this study is higher than 10% discrepancy allowed in Public Expenditure and Financial Accountability (PEFA) best practice standard for budget execution (World Bank, 2011). Mogues *et al* (2008a) reported that capital budget suffered lower execution rate in Nigeria compared with recurrent budget execution rate. They reported that the recurrent budget execution rate was 104% compared with that of capital budget execution rate of 62%, with overall budget execution rate of 79% between 2000 and 2005 (Mogues *et al*, 2008a). Olomola *et al* (2015) have indicated that weak executive capacity leads to delays in budget approval at all stages of the budget cycle and this tend to hinder budget performance at the national level of government. They also reported that late completion of proposals, untimely legislative review, and late presidential approval due to disagreements with the legislature are some of the factors that delay implementation of the budgets in Nigeria. Such delays in budget approval have made it difficult for budget to meet due process requirements in budget implementation. Table 2 showed further that the coefficient of variation of budget and expenditure are 0.94 and 1.12 respectively[14]. This implies that there is more unpredictability (inconsistency) in expenditure than budget estimates. The budget execution rate also ranges from as low as 17% in 2002 to as high as 100% in 2018 as revealed in the raw data. The unpredictability of

[14] It is the ratio of Standard deviation of the variable to its mean. It is standard measure of variation in the variable.

the budget execution can limit its impact on agricultural productivity. Mink (2016) has also reported low budget implementation rates in Africa. He recommended that improving agriculture budget performance rates is essential for demonstrating that the sector can make good use of additional public resources, and for persuading ministries of finance that their budgets must be increased and improved. He also emphasised the need to improve the predictability and consistency of budget releases from ministries of finance.

Table 2: Budget Execution Rates of Agricultural Public Expenditure

Period	Mean Budget (Nominal Billion Naira)	Mean Expenditure (Nominal Billion Naira)	Budget Execution Rate (%)
1999-2003	10.2551	6.5101	68.14
2004-2008	21.1524	20.3385	92.84
2009-2013	32.2750	25.8573	83.28
2014-2018	47.9941	36.5783	64.15
Grand Mean	27.9191	22.3211	77.10
Standard Deviation	26.24063	24.8813	25.09
Minimum	3.8343	2.0801	16.50
Maximum	98.9613	98.6757	100.00
Coefficient of Variation	0.94	1.12	-
T-Ratio		3.1946***	-

Source: Computed by the Author from Data from Ministry of Finance, Abuja *** Significant at 1%

Averagely, capital expenditure shared 55% of agriculture expenditure between 1981 and 2014 as revealed in Table 3. However, there were a lot of fluctuations in the share of capital expenditure. The share of the capital expenditure ranged between 5% and 89%, and consistently fell below recommended 60% for effective agricultural performance (Olomola *et al.*, 2015). The table also showed that recurrent expenditure growth (9.14%) faster than capital expenditure (4.08%). The estimated share of agricultural public expenditure in total government expenditure in Nigeria is 1.52% as presented in Table 3, which is far lower than 4% being the average for Sub-Sahara Africa and also lower than 10% recommended in the Maputo Declaration (Benin, 2015). The table showed that it ranged from 0.65% to 6.58% between 1981 and 2014. The mean Agriculture Orientation Index (AOI) is estimated at 7.05%, this ranged from 3.32% to 31.41%. This suggests that only about 7% of what agriculture contributed to the economy was spent on the sector during the period under consideration. Goyal and Nash (2017) have revealed that most African countries spend much smaller proportions of the public budget on agriculture than the sector's contribution to the economy (GDP). Lower government budgetary commitment to agriculture in Nigeria has also been reported by Mogues *et al* (2008a) and Olomola *et al* (2015).

Table 3: Structure and Trend of Agricultural Public Expenditure in Nigeria

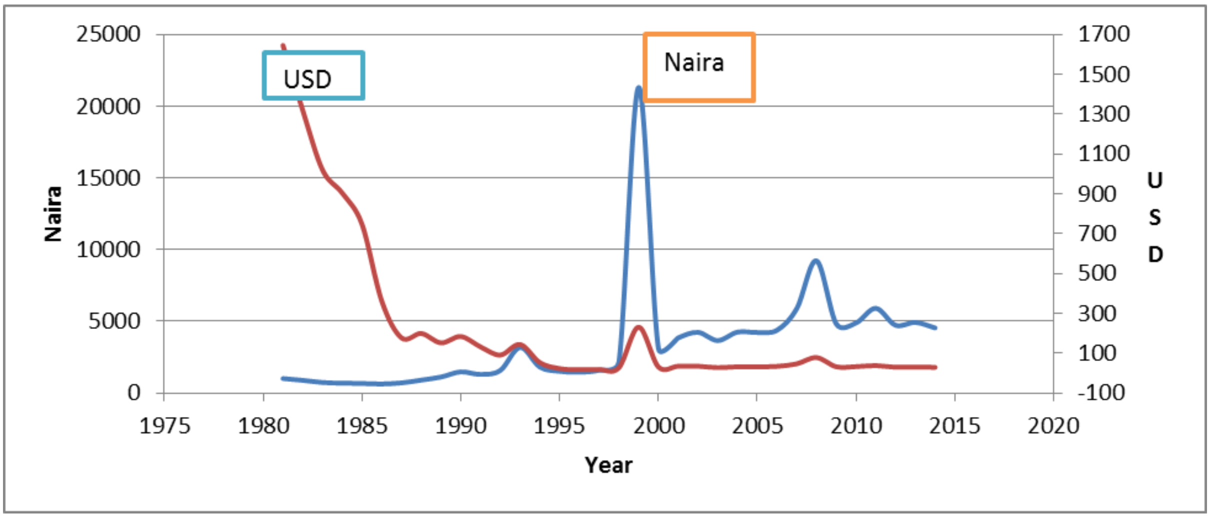
Structure of Expenditure	Mean	Minimum	Maximum
Share of Capital In Public Agriculture Expenditure (%)	54.87	4.93	89.23
Growth Rate of Capital Public Agriculture Expenditure (%)	4.08	-	-

Growth Rate of Recurrent Public Agriculture Expenditure (%)	9.14	-	-
Share of Total Agriculture Expenditure in Government Expenditure (%)	1.52	0.65	6.58
Share of Agriculture GDP in Total GDP (%)	21.11	15.50	27.00
Agriculture Orientation Index (%)	7.05	3.32	31.41

Source: Computed by the Authors

Figure 3 presents agricultural public spending per farmer in Nigeria on the basis of the local currency (Naira) and US Dollar (USD). The spending per farmer has increased from 1016 Naira in 1981 to 4541 Naira in 2014(The mean spending per farmer is 3454 naira). In US dollar term, the spending per farmer has declined from more than 1500USD in 1981 to less than 100USD per farmer in 2014(The mean spending per famer is 235 USD). When we considered this on the basis of rural population, the spending per rural population declined from 354 USD in 1981 to 4 USD in 2014. The mean spending per rural population is 47 USD which is higher than spending per capita agricultural public expenditure in Sub-Saharan Africa estimated to be USD28 in 1980/89 and USD19 in 2000/12 (Goyal and Nash, 2017).

Figure 3: Agricultural Public Expenditure per Farmer in Naira and USD



Source: Computed by the Authors

4.2 The Long and Short Run Impacts of Public Agricultural Expenditure in Nigeria

Augmented Dickey-Fuller test for unit root showed that all the variables of interest were stationary after they were differenced. This means that all the variables are integrated of the same order (1,1). This implies that the residual of the co-integrating regression is of order (1, 0), then there exists an Error Correction Mechanism (ECM) describing the relationship (McKay *et al*., 1999; Greene, 2012). Augmented Dickey-Fuller test is reported in Appendix 3. Johansen tests for cointegration of the Agricultural Productivity models as presented in Appendix 4 showed that there are at least 6, 3 and 4 cointegration variables in Agricultural Public Capital Expenditure, Agricultural Public Recurrent Expenditure and Agricultural Public Total Expenditure models respectively[15]. This indicates that there is a long run relationships among the variables specified in the models. Durbin's alternative test for autocorrelation and higher-order serial correlation using the Breusch-Godfrey Lagrange multiplier (LM) tests are both reported in Appendix 5. Durbin's alternative test for autocorrelation in Appendix 5 reveals that serial correlation is absence when the model is estimated with Agricultural

[15]Specifically, the Trace Statistics indicates that there are at least 6, 3 and 4 cointegration variables in Capital Agricultural Public Expenditure, Recurrent Agricultural Public Expenditure and Total Agricultural Public Expenditure models respectively.

Public Expenditure lagged 1 year. Likewise, Breusch-Godfrey LM test for autocorrelation also indicates the absence of serial correlation in the model.

The estimated long and short run relationships in the Capital Agricultural Public Expenditure, Recurrent Agricultural Public Expenditure and Total Agricultural Public Expenditure models indicate that recurrent and total agricultural public expenditure do not exhibit long nor short run relationships with agricultural productivity as demonstrated in Appendix 6 for Agricultural Public Recurrent Expenditure model and Appendix 7 for Agricultural Public Total Expenditure model. The non-significance of recurrent expenditure in agricultural production and productivity equation has also been established in other literatures (Mogues et al, 2008a: Benin *et al*, 2009; Benin, 2015). The literature also showed that not all public spending is productive, as the evidence found by Devarajan, *et al* (1996) and Benin *et al* (2012), regarding spending on salaries and other recurrent items.

Table 4 present the long and short run relationship between Agricultural Public Capital Expenditure and agricultural productivity in Nigeria. The error correction mechanism (ECM) estimated under the short run model in Table 4 is -0.813 and it is significant at 1%, which confirms that there is cointegration among the variables specified in the model in Table 4. The ECM in the model of -0.813 indicates that there is 81.30% chance that the short run disturbance in the model will resort to long run relationship among the variables. Table 4 also reports F value of 785.75 and 10.07 for long run and short run models respectively, and they are significant at 1%. This suggests that variables as specified in the long run and short run models have joint significance in explaining variation in agriculture productivity in Nigeria. The adjusted R Squared of 0.993 and 0.672 in the long run and short run models respectively implies that the specified variables in the long run and short run models can explain 99.3% and 67.3% in the long and short run models respectively. All variables that are significant in the long run model are also in the long run, except ODA which is not significant in the short run but becomes significant at the long run. This may be due to the fact that most of ODA projects are long termed and their impacts become pronounced with time.

Table 4 demonstrates that the regression coefficients of lagged public capital expenditure is 0.199 in the short run model and increased to 0.210 in the long run model. This suggests that the impact of the capital expenditure did not only materialize with lag but also impact increases with time. This also implies that if the past government capital expenditure increased by 100%, agricultural productivity will increase by 19.9% and 21% in the short and long respectively. The estimated elasticity of 0.199 and 0.210 also falls within the range of 0.10–0.30 as the average for Africa (Goyal and Nash, 2017; Benin, 2015).

The regression coefficients of private investment are 0.084 and 0.111 for short run and long run models respectively as indicated in Table 4. This implies that if private investment increased by 100%, agricultural productivity will increase by 8.4% and 11.1% in the short and long run respectively. The estimated regression coefficients of private investment of 0.084 and 0.111 are close to 0.12 estimated impact of private farm investment on the value of household total agricultural output per capita in Ghana (Benin *et a.l*, 2009). The positive and significant relationship between private investment and agricultural productivity is a reflection of complementarity of agricultural public expenditure and agricultural private investment.

The regression coefficient of ODA in the long run model is 0.023 which is significant at 1%. This implies that if ODA increased by 100%, agricultural productivity will increase by 2.3%. Although the impact of ODA may be low considering the fact that the value of estimated regression coefficient value of 0.023, but this value is higher than 0.018

estimated as the regression coefficient value of REMIT which is not significant even at 10% confidence level. Alabi (2014) has reported positive impact of ODA and emphasised that bilateral foreign agricultural aid influences agricultural productivity more than multilateral foreign agricultural aid.

The regression coefficients of labour (farmer/population ratio) are -4.298 and -1.806 in the long and short run respectively. The negative sign of regression coefficient of labour is an indication of declined agricultural labour productivity in Nigeria. Other scholars have also reported low and declining labour productivity in Africa. FAO (2001) revealed that labour productivity fell by an average of one percent per year in Sub-Sahara Africa (SSA) agriculture, while it increased by 1.9 percent and 2.5 percent per year, respectively, in South Asia and Latin America[16].

Table 4: Long and Short Run Impacts of Agricultural Public Capital Expenditure on Agricultural Productivity

Long Run			**Short Run**		
	F(6, 26)	785.75		F(7, 24)	10.07
	Prob > F	0.000***		Prob > F	0.000
	Adj R^2	0.993		Adj R^2	0.672
Agric GDP Per Farmer	Coefficient	P>|t|	ΔAgric GDP Per Farmer	Coefficient	P>|t|
Capital Agric Expenditure$_{(t-1)}$	0.210***	0.000	ΔCapital Agric Expenditure$_{(t-1)}$	0.199***	0.002
Private Investment	0.111***	0.000	ΔPrivate Investment	0.084***	0.001
NAGPE	0.009	0.850	ΔNAGPE	0.031	0.545
ODA	0.023***	0.009	ΔODA	0.006	0.488
REMIT	-0.018	0.170	ΔREMIT	-0.016	0.205
Labour	-1.806***	0.000	ΔLabour	-4.298***	0.041
Constant	7.355***	0.000	Constant	-0.061	0.247
			ECM	-0.813***	0.000

Source: Computed by the Authors *, ** and *** Significant at 10%, 5% and 1% respectively, Δ = differencing factor

4.3 The Impacts of Public Agricultural Expenditure on Agricultural Productivity and Agricultural Private Investment in Nigeria

To further authenticate the relationship between agricultural productivity and AGPE and to establish links among agricultural public expenditure, agricultural productivity and agricultural private investment we estimated SUR and tested for cross-equation independence of the error terms. Agricultural Public Capital Expenditure (AGPCE), Agricultural Public Recurrent Expenditure (AGPRE) and Agricultural Public Total Expenditure (AGPTE) models results are presented in in Table 5. The Breusch-Pagan test result is reported under Table 5. Table 5 shows that the estimated Breusch-Pagan test of independence Chi^2 are 7.788, 10.995 and 16.242, for Agricultural Public Capital Expenditure (AGPCE), Agricultural Public Recurrent Expenditure (AGPRE) and Agricultural Public Total Expenditure (AGPTE) models

[16] The low level of engineering technology inputs in agriculture has also been cited as one of the main constraints hindering the modernization of agriculture and food production systems in Nigeria (World Bank, 2011). It reduces the timeliness of farm operations and limits the efficacy of essential operations such as cultivation and weeding, thereby reducing crop yields. UNECA (2009) reports that Sub-Saharan Africa has 13 tractors/100km^2 of arable land compared with the world average of 200 tractors/100km^2, while Nigeria has 7 tractors/100km^2. Uguru (2012) indicates that 7% of African agricultural practices are using irrigation system; in Nigeria, only 0.8% of arable land is under irrigation compared to 28.0% in Thailand. The use of improved crop varieties and agrochemicals such as fertilizer is not yet adequate in Nigeria (Ozor and Urama, 2013). Such low levels of mechanization compromise productivity

respectively. They are all significant at 1%. This implies that there is cross dependence among the error terms in the Agricultural productivity, private investment and agricultural expenditure equations estimated in Table 5. This also establishes links among agricultural productivity, private investment and agricultural public expenditure equations. The upper part of Table 5 indicates that the three equations in all the models (AGPCE AGPRE and AGPTE) are well fitted and that the estimated coefficients in each of them are jointly significant at 1%.

Table 5 showed that in agricultural public total expenditure (AGPTE,) and agricultural public recurrent expenditure (AGPRE) models, public expenditure is not a significant determinant of agricultural productivity. This confirms non-significance of recurrent and total agricultural public expenditure as reported in Appendix 6 and 7. While the coefficient of AGPTE is 0.029 and that of AGPRE is 0.003, but they are not significant even at 10% significance level. This suggests that total agricultural public expenditure and agricultural public recurrent expenditure do not have significant impact on agricultural productivity in Nigeria. Mogues (2011) has also indicated that the estimated impact of agriculture public spending in Nigeria was not statistically significant. Fan *et al* (2008) has reported a negative impact of non-research agricultural public spending. The non-significance of agricultural public recurrent expenditure may be due to the fact that much of the spending is on salaries, wages and other recurrent items, which may be less productive. Public spending may be unproductive or even reduce the productivity of other spending because; government sometimes spend on things that are not public goods (Goyal and Nash, 2017). Empirical evidence has proved that government spending on public goods has typically been much more productive than public spending on private goods (López and Galinato, 2007).

Table 5 shows that the major significant determinants of agricultural productivity are Agricultural Public Capital Expenditure (AGPCE), agricultural private investment, ODA and labour. The coefficient of lagged AGPCE is 0.154. This is however lower than 0.199 and 0.210 estimated as the regression coefficients as the short and long run regression coefficients of agricultural capital public expenditure in Table 4. The difference may due to the fact that SUR approach takes into consideration the effect of other links that may affect the impact of agricultural capital public expenditure on agricultural productivity. SUR as Generalized Least Squares (GLS) estimation approach is more efficient than Ordinary Least Squares (OLS), leading to smaller standard errors, narrower confidence intervals and larger t-statistics (Cameron and Trivedi, 2009). The estimated regression coefficient of 0.154 demonstrates that if lagged AGPCE increased by 100%, agricultural productivity will increase by 15.4%. The coefficient of 0.154 compares favourably with the estimated elasticity of 0.17 in Alene and Coulibaly (2009) but is lower than 0.36 in Thirtle *et al* (2003). In their studies they used simultaneous equation systems in their estimations. Our finding confirms the notion that the effect of public agricultural expenditure materialize with lags since the lagged AGPCE is significant in our estimation. Our estimated elasticity of 0.154 also falls within the range of 0.1–0.3 as the average for Africa (Goyal and Nash, 2017; Benin, 2015).

The regression coefficient of agricultural private investment is 0.133 and has a significant positive relationship with agricultural productivity. This is close to 0.12 estimated impact of private farm investment on the value of household total agricultural output per capita (Benin *et a.l*, 2009). The fact that agricultural private investment has significant and positive relationship with agricultural productivity also emphasises the importance of private investment in agricultural productivity in Nigeria. The significant and positive relationship that ODA has on agricultural productivity elaborates the importance of ODA in improving agricultural productivity in Nigeria. Verter (2017) has shown that ODA may raise agricultural productivity directly or indirectly by overcoming capital constraint which is a major bottleneck to higher agricultural production and productivity in Nigeria.

The regression coefficient of labour is -1.810. The negative sign of regression coefficient of labour is an indication of declined agriculture labour productivity in Nigeria. Other scholars have also reported low and declining labour productivity in Africa. FAO (2001) revealed that labour productivity fell by an average of one percent per year in Sub-Sahara Africa (SSA) agriculture, while it increased in South Asia and Latin America. McCullough (2017) revealed that the workers in SSA countries are 3.4 times as productive outside of agriculture as in it. This finding is consistent with those of Gollin *et al* (2014). The low level of agricultural mechanisation may be implicated for declined labour productivity in Nigeria[17]. Declining labour productivity may account for migration from rural to urban areas or total emigration. It may also be implicated for diversification to off-farm and non-farm activities.

Although Iheke (2016) and Vasco (2011) have indicated that remittances can foster longer-term development through investment in agricultural input purchase but experience has shown that that large part of remittances were used for immediate consumption (FAO, 2013). The findings in the literature suggest that the loss of family labour to migration has a negative effect on agricultural production, at least in the short run (FAO, 2001a). All these findings may explain the negative and non-significance of the regression coefficient estimated for remittance in Table 5. Our raw data also reveals a negative correlation coefficient of -0.9461 between remittance and labour supply (farmer-population ratio).

Table 5 showed further that in the private investment equation, Agricultural Public Capital Expenditure (AGPCE), unemployment and electricity consumption are the significant determinants of agricultural private investment. AGPCE regression coefficient is 0.614 and it is significant at 1%. The positive and significant of AGPCE regression coefficient implies that AGPCE can complement agricultural private investment rather than crowd out agricultural private investment. The complementarity of private and public capital investment in the production process to raise the productivity factors in production has been confirmed by other scholars (Anderson *et al*., 2006; Benin,*et al*., 2009; Kakwani and Son, 2006).

The regression coefficient of unemployment -0.777 and it is significant at 10%. This indicates that a negative relationship exists between agricultural private investment and unemployment. The negative relationship established *a priori* expectation of unemployment being a constraint to agricultural private investment because of its negative effect on income generation and savings.

The regression coefficient of electricity consumption was 3.051. This implied that if electricity consumption doubles (electricity consumption is predicated on its supply and generation) agricultural productivity will increase by 305%. Literatures have documented strong link between electricity consumption and private investment in developing countries (Asuamah, 2018; Ubani, 2013; Kumi, 2017). Arjun and Alan (1975) also reported that reliable supply of energy is one of many important requirements for significant growth in Africa's agricultural productivity. This is because for the farmers in most African countries, accessibility to fuels or electricity for farm operations or crop processing is limited and expensive. Lu (2017) has also reported positive and significant impact of electricity generation on the growth of GDP. He presented a long-run equilibrium relationship and a bi-directional Granger causality between electricity and economic

[17] UNECA (2009) reports that Sub-Saharan Africa has 13 tractors/100km^2 of arable land compared with the world average of 200 tractors/100km^2, while Nigeria has 7 tractors/100km^2. Uguru (2012) indicates that 7% of African agricultural practices are using irrigation system; in Nigeria, only 0.8% of arable land is under irrigation compared to 28.0% in Thailand. The use of improved crop varieties and agrochemicals such as fertilizer is not yet adequate in Nigeria (Ozor and Urama, 2013). Such low levels of mechanization compromise productivity.

growth in his study. His result indicated that a 1% increase in electricity consumption boosts the real GDP by 1.72%. The real GDP growth induced by electricity consumption may be transmitted through the growth in investment in the country.

Although the CAADP regression coefficient of 0.084 was positive but had no significant relationship with agricultural private investment. This suggests that agriculture private investment had not increased significantly after the Maputo Declaration of 2003 based on CAADP. This suggests that advocacy for agricultural productivity improvement and priority of agricultural expenditure that goes with CAADP has not increased private investment interest in agricultural production in Nigeria. Since we have established the fact that agricultural private investment increases agricultural productivity, hence, if the Maputo Declaration of 2003 had increased private investment, we can submit that Maputo Declaration of 2003 can increase agricultural productivity through the channel of agricultural private investment.

In the agricultural public expenditure equation in Table 5, all the variables specified in the equation were significant at 1% significant level. The table demonstrated that past agricultural productivity regression coefficient is -0.339. This indicated that past agricultural productivity had negative but significant relationship with AGPCE. This removes the notion of reverse causality between agricultural public expenditure and agricultural productivity. The direction of causality is from agricultural public expenditure to agricultural productivity as indicated previously under the discussion of agricultural productivity equation. This also confirms the exogeneity of lagged agricultural public expenditure in agricultural productivity equation (Benin, 2015). The negative relationship between lagged agricultural productivity and agricultural public expenditure suggests that agricultural products that are highly productive in Nigeria attract little or no government spending in Nigeria(the higher the productivity, the lower the government spending). This may be the case for crop like yam that is highly productive(Sanginga (2015) but little is invested from the side of government in improving its yield, compared to major global "commodity" crops like maize, wheat and rice (IITA, 2012)[18].

NAGPE regression coefficient is 0.199 in the AGPCE model. This suggests that if NAGPE increased by 100% agricultural public capital expenditure will increase by 19.9%. It is worth to note that NAGPE regression coefficient in the AGPRE and AGPTE models are 2.562 and 1.225 respectively. This illustrates the fact that if NAGPE increased by 100%, agricultural public, capital, recurrent and total expenditure will increase by about, 20%, 256% and 123% respectively. This demonstrates budget discrimination against agricultural public capital expenditure compared with agricultural public recurrent expenditure, agricultural public total expenditure and non-agricultural sector expenditure in Nigeria (Benin *et al.*, 2009). While the regression coefficient of agricultural private investment in the AGPCE model is 1.180, the same value in the AGPRE and AGPTE models are -0.343 and -0.298 respectively. This implies that private investment can 'crowd in' only agricultural public capital expenditure but not agricultural public recurrent or total agricultural public expenditure.

Mechanisation regression coefficient is 1.421 which is significant at 1%. This reveals that mechanisation induces public capital agricultural expenditure. Mechanisation regression coefficient in the AGPRE model is 1.579 but it is not significant even at 10%. This establishes the fact that agricultural mechanisation is a capital intensive item in the agricultural budgets in Nigeria. The cost implication of mechanisation may account for the low level of its adoption in

[18] Sanginga (2015) has demonstrated that cassava and yam are versatile staples to address food and nutrition security and that they produce more food per unit area of land, compared to many other crops. He indicated that cassava and yam are also capable in efficiently converting natural resources into a more usable product, caloric energy which is the highest of all major arable crops; almost double that of wheat and rice (IITA, 2012).

Nigeria. The low level of engineering technology inputs in agriculture had also been cited as one of the main constraints hindering the modernization of agriculture and food production systems in Nigeria (World Bank, 2011). Mechanisation reduces the timeliness of farm operations and improves the efficacy of essential operations such as cultivation and weeding, thereby reducing crop yields loss.

Government type regression coefficient is 0.556 which is significant at 1%. This indicated that agricultural public capital expenditure was about 56% more during the democratic government than during military government. Figure 3 confirms that the peak periods of agricultural public expenditure per farmer in Nigeria coincided with period of democratic government. Most of the time Nigeria witnessed 100% budget execution also coincided with period of democratic government as indicated in Table 2. This may be the reason for the positive and significant relationship between government type and agricultural public capital expenditure. It is also evident in Table 5 that government type regression coefficient is not significant in AGPRE and AGPE models. This is an indication that democratic government favoured agricultural public capital expenditure in the budget planning.

Table 5: SUR Result for Agricultural Public Expenditure in Nigeria

	Capital Expenditure			Recurrent Expenditure			Total Expenditure		
Equations	"R-sq"	Chi^2	P	"R-sq"	Chi^2	P	"R-sq"	Chi^2	P
Agric GDP per farmer	0.9938	5630***	0.000	0.9905	3746***	0.000	0.9903	3807***	0.000
Private Investment	0.8716	240 ***	0.000	0.8538	209***	0.000	0.8475	203***	0.000
Agric Expenditure Per Farmer	0.9599	772***	0.000	0.8732	224***	0.000	0.8670	214***	0.000

	Capital Expenditure		Recurrent Expenditure		Total Expenditure	
Agric GDP Per Farmer	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**
Public Expenditure per Capita$_{(t-1)}$	0.154***	0.000	0.003	0.820	0.029	0.127
Private Investment	0.133***	0.000	0.156***	0.000	0.163***	0.000
NAGPE	0.005	0.914	-0.041	0.422	-0.038	0.445
ODA	0.025**	0.000	0.038***	0.000	0.0337***	0.000
REMIT	-0.016**	0.122	0.002	0.874	-0.007	0.460
Labour	-1.810***	0.000	-1.774***	0.000	-1.830***	0.000
Constant	7.594***	0.000	8.908***	0.000	8.599***	0.000
Private Investment	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**
Public Expenditure per Farmer$_{(t-1)}$	0.614***	0.017	0.156*	0.075	0.205*	0.078
NAGPE	-0.041	0.831	-0.312	0.274	-0.168	0.478
Unemployment	-0.777*	0.086	-1.099***	0.018	-1.059**	0.023
CAADP	0.084	0.794	0.352	0.200	0.310	0.271
Electricity Consumption	3.051***	0.000	3.641***	0.000	3.566***	0.000
Constant	-11.484***	0.000	-7.530**	0.053	-9.752***	0.000

Agric Expenditure Per Farmer	Coefficient	P>|Z|	Coefficient	P>|Z|	Coefficient	P>|Z|
Agric GDP Per Farmer	-0.339***	0.012	-0.123	0.810	-0.007	0.984
NAGPE	0.199***	0.013	2.562***	0.000	1.225***	0.000
Private Investment	1.180***	0.000	-0.343*	0.064	-0.298***	0.015
Mechanisation	1.421***	0.000	1.579	0.202	2.153***	0.008
Government Type	0.556***	0.000	-0.143	0.680	0.116	0.604
Constant	-4.214***	0.014	-32.196***	0.000	-14.623***	0.000
Breusch-Pagan test of independence: Chi^2	7.788**	0.051	10.995***	0.012	16.242***	0.001

Source: Computed by the Authors ***, ** and * = Significant at 1%, Significant at 5% and * Significant at 10% respectively

4.4 The Returns to the Components of Agricultural Public Capital Expenditure in Nigeria

The Johansen tests for cointegration in the components of agricultural public capital expenditure models are presented in Appendix 8, while Appendix 9 reports the results of serial correlations test. Appendix 9 shows that serial correlations are absent in all the models estimated. Appendix 8 reveals that there are at least 6 cointegration variables in all the component of agricultural public capital expenditure models. Based on this information we went ahead to estimate SUR for each of the component and the results are presented in Table 6. Table 6 illustrates the relationship between different components of agricultural public capital expenditure (AGPCE) and agricultural productivity. The results of the test of cross-equation independence of the error terms are reported in the last row of the table. Table 6 showed that the estimated Breusch-Pagan test of independence Chi^2 is significant at 1% for each of the component of the expenditure. This indicates that there is cross dependence among the error terms in the subsidy, irrigation, R&D and rural development expenditure models estimated in Table 6. This also evidence of links among agricultural productivity, private investment and agricultural public expenditure component equations. The upper part of Table 6 indicated that the equations in all the models (subsidy, irrigation, R&D and rural development models) are well fitted and that the estimated coefficients in each of them are jointly significant at 1%.

Examination of Table 6 demonstrates that subsidy, irrigation, R&D and rural development models exhibit the same characteristics as agricultural public capital expenditure model (AGPCE) as presented in Table 5. However, the regression coefficients of subsidy, irrigation, R&D and rural development in Table 6 are 0.1530, 0.1531, 0.1546 and 0.1544 respectively. This is an indication that that if lagged subsidy, irrigation, R&D and rural development expenditures increased by 100%, agricultural productivity will increase by 15.30%, 15.31%, 15.46% and 15.44% respectively. This showed that increase in R&D expenditure will have greatest influence (15.46%) on agricultural productivity, while increase in subsidy expenditure will have the least effect (15.30%) on agricultural productivity. Table 6 shows further that all the components of AGPCE coefficients have positive and significant relationships with agricultural private investment. This reveals that all the components of AGPCE can ‘crowd in’ agricultural private investment rather than ‘crowd out’ agriculture private investment. However, irrigation expenditure has the highest regression coefficient in the private investment equation (0.6152%). This means that irrigation expenditure can induce more private investment than any of the components of agricultural public capital expenditure under consideration. Public investment in dams and canals for irrigation has been shown to increase private investment in irrigation systems on the farm, as indicated in the study by Fan *et al* (2000). According to Rosegrant, *et al* (2009), Sub-Saharan Africa has significant unexploited potential to develop both large- and small-scale irrigation, but economic returns depends on keeping costs down. Although there is significant potential for rehabilitating existing irrigated areas in Africa, Rosegrant *et al (*2009) opined that the expertise, knowledge, and capacity to manage irrigation investments are low (Rosegrant *et al.,* 2009).

The final decision on the economic returns to different components of agricultural public expenditure will not only take into consideration the regression coefficient of the components in agricultural productivity equation but also its indirect influence on the private investment. The amount of each the expenditure component spent to generate unit of productivity will also be considered.

Table 6: SUR Results of Different Components of AGPCE in Nigeria

	Subsidy		**Irrigation**		**R&D**		**Rural Dev.**	
Equations	"R-sq"	Chi^2	"R-sq"	Chi^2	"R-sq"	Chi^2	"R-sq"	Chi^2
Agric GDP per farmer	0.9938	5629***	0.9938	5637***	0.9938	5653***	0.9939	5656***
Private Investment	0.8714	240***	0.8715	240***	0.8717	240***	0.8716	240***
Agric Expenditure Per Farmer	0.9594	762***	0.9594	762***	0.9597	768***	0.9596	766***

	Subsidy		Irrigation		R &D		Rural Dev.	
Agric GDP Per Farmer	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	P>|Z|
Agric Expenditure per Farmer($_{t-1}$)	0.1530***	0.000	0.1531***	0.000	0.1546***	0.000	0.1544***	0.000
Private Investment	0.1330***	0.000	0.1330***	0.000	0.1327***	0.000	0.1330***	0.000
NAGPE	0.0040	0.925	0.0048	0.910	0.0044	0.917	0.0047	0.910
ODA	0.0250***	0.000	0.0248***	0.000	0.0246***	0.000	0.0247***	0.000
REMIT	-0.0150	0.124	-0.0159	0.125	-0.0161	0.119	-0.0161	0.120
Labour	-1.8100***	0.000	-1.8084***	0.000	-1.8111***	0.000	-1.8093***	0.000
Constant	7.7510***	0.000	8.2735***	0.000	8.1552***	0.000	7.9712***	0.000
Private Investment	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	**P>|Z|**	**Coefficient**	P>|Z|
Component of Expenditure per Farmer($_{t-2}$)	0.6115***	0.017	0.6152***	0.016	0.6142***	0.017	0.6125***	0.017
NAGPE	-0.0390	0.834	-0.0396	0.835	-0.0397	0.834	-0.0401	0.833
Unemployment	-0.7790*	0.086	-0.7832*	0.084	-0.7753*	0.087	-0.7740*	0.088
CAADP	0.0860	0.789	0.0813	0.799	0.0836	0.794	0.0863	0.787
Electricity Consumption	3.0510***	0.000	3.0569***	0.000	3.0500***	0.000	3.0492***	0.000
Constant	-10.8920***	0.001	-8.7973***	0.006	-9.2516***	0.003	-9.9617***	0.002

Agric Expenditure Per Farmer	Coefficient	P>|Z|	Coefficient	P>|Z|	Coefficient	P>|Z|	Coefficient	P>|Z|
Agric GDP Per Farmer$_{(t-1)}$	-0.3406***	0.012	-0.3380***	0.013	-0.3381***	0.012	-0.3341***	0.014
NAGPE	0.2004***	0.013	0.1981***	0.014	0.1985***	0.013	0.1986***	0.013
Private Investment	0.1804***	0.000	0.1803***	0.000	0.1796***	0.000	0.1781***	0.000
Mechanisation	1.4175***	0.000	1.4190***	0.000	1.420876***	0.000	1.4120***	0.000
Government Type	0.5570***	0.000	0.5540***	0.000	0.5550***	0.000	0.5555***	0.000
Constant	2.1447***	0.000	-1.3170	0.297	-0.5498	0.663	0.5924	0.639
Breusch-Pagan test of independence: Chi^2	7.8530**	0.049	7.8480**	0.0493	7.7690**	0.0510	7.8190**	0.050

Source: Computed by the Authors, *** =Significant at 1%, **= Significant at 5%, * =Significant at 10%

Table 7 indicates that expenditures on subsidy, irrigation, R&D and rural development yield the Benefit Cost Ratio (BCR) of 0.74, 4.74, 1.18 and 2.16 respectively. This indicates that an extra Naira spent on irrigation, R&D, rural development and subsidy will yield returns of ₦4.74, ₦2.16, ₦1.18 and ₦0.74 respectively. This also suggests that government investments in irrigation, R&D and rural development will increase agricultural productivity better than investments in subsidy programmes. The importance of public expenditure on irrigation to bring much needed agricultural productivity and economic development has also been established by Gemmell *et al* (2012). Irrigation system can help tackle the problem of aridity in Nigeria with increasing aridity and desertification in many parts of the country. Changes in the climatic conditions in many parts of the country, with incessant changes and alteration in the rainfall pattern and period, resulted in many parts of the region becoming more arid (Amissah-Arthur, 2005). While an FAO report has indicated that Nigeria is a country where the population has already exceeded the carrying capacity of the developed land and labour resources when cultivated at low levels of technology, the potentials are available through irrigation development to increase agricultural productivity by three to seven times (FAO, 1995). While irrigation potential estimates in Nigeria vary from 1.5 to 3.2 million hectares, available information reveals that less than 1% of this potential is utilized in Nigeria (FAO, 2005; Alabi, 2014). Fan and Saurkar (2006) had also indicated that spending on agricultural research is crucial type of expenditure to increase agricultural productivity. Other studies have also proved that expenditure on research and development is more beneficial than input subsidies (Seck *et al*., 2013; Stads and Beintema, 2015, Asare and Essegbey, 2016).

Table 7: Benefit Cost Ratio (BCR) of Components of Agriculture Public Capital Expenditure in Nigeria

Expenditure Components	$\frac{\partial(Yt)}{\partial(AGPCEt)}$ (A)	$\frac{\partial(Yt)}{\partial(AGPSt)}$ (B)	$\frac{\partial(AGPSt)}{\partial(AGPCEt)}$ (C)	C*B (D)	$\frac{d(Yt)}{d(AGPCEt)}$ (E)	$\frac{Mean\ (Yt)}{Mean\ (AGPCEt)}$ (F)	BCR =E*F
Subsidy	0.1530	0.1330	0.614	0.081662	0.234662	3.162377	0.74
Irrigation	0.1531	0.1330	0.615	0.081795	0.234895	20.19516	4.74
Rural Development	0.1544	0.1330	0.613	0.081529	0.235929	5.010756	1.18
Research and Development	0.1546	0.1327	0.614	0.081478	0.236078	9.167635	2.16

Source: Computed by the Authors

5.0 Preliminary Conclusion and Recommendations

The study concluded that agricultural public budgets were unpredictable as 23% of the budgets were not implemented. Capital expenditure shared 55% of total agricultural public expenditure and it consistently fell below recommended 60% for effective agricultural performance. The study also revealed that agricultural public expenditure shared 1.52% of total government expenditure in Nigeria, and that only 7% of what agriculture contributed to the economy was spent on the sector. While recurrent and total agricultural public expenditure do not have impact on agricultural productivity, agricultural public capital expenditure had positive and significant impact on agricultural productivity which materializes with lag. The study implies that agricultural public capital expenditure can complement agriculture private investment. It also submits that agriculture private investment has not increased significantly after the Maputo Declaration of 2003. A budget discrimination against agricultural public capital expenditure in Nigeria was indicated in the study. Finally, the study demonstrated that agricultural public spending on irrigation did not only have highest Benefit Cost Ratio of 4.74 (compared with 0.74 for input subsidy), but it also induces more agricultural private investment than spending on R&D, rural development and subsidy programmes.

We recommend that agricultural budget execution rate should be improved through quick passage and timely implementation of the budgets. Agricultural public expenditure should be realigned to favour investments in irrigation, R&D and rural development which currently attracted lower budgetary allocations in Nigerian agricultural budgets.

References

Action Aid (2015). The need to cultivate our farmers' futures. Action Aid, Abuja, Nigeria. Also available at https://nigeria.actionaid.org/publications/2015/need-cultivate-our-farmers-futures.

Adesina, A.A. and J, Baidu-Forson (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea in West Africa. *Agricultural Economics* 13:1-9.

Adetiloye, K. A (2012). Agricultural financing in Nigeria: An assessment of the Agricultural Credit Guarantee Scheme Fund (ACGSF) for food security in Nigeria. *Journal of Economics*, 3(1):39-48.

AfDB/Africa Development Bank (2016). 2015-2019 Draft agriculture and agribusiness strategy. African Development Bank, Tunis, Tunisia.

Alabi, Reuben Adeolu (2014). Impact of agricultural foreign aid on agricultural Growth in Sub Saharan Africa: A Dynamic Specification. AGRODEP Working Paper 0006. International Food Policy Research Institute, Washington D.C, USA. http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128230/filename/128441.pdf

Alabi, Reuben Adeolu, Adams, Oshobugie Ojor and Godwin Abu (2016). Does an inorganic fertilizer subsidy promote the use of organic fertilizer in Nigeria? AGRODEP Working Paper 0036. International Food Policy Research Institute, Washington D.C, USA. http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/131475/filename/131698.pdf

Alene, A.D. and O, Coulibaly (2009). The impact of agricultural research on productivity and poverty in sub-Saharan Africa. *Food Policy*, 34(2):198–209.

Allen, S, Badiane, O and J, Ulimwengu (2012). Government expenditure, social outcomes and marginal productivity of agricultural inputs: The case of Tanzania. Paper presented at the International Association of Agricultural Economists (IAAE) Triennial Conference, Brazil, 18-24 August, 2012.

Alley, I., Asekomeh, A., Mobolaji, H., and Y., Adeniran (2014). Oil price shocks and Nigerian economic growth. *European Scientific Journal*, 10(19), 375-391.

Amissah-Arthur, A (2005). Value of climate forecasts for adjusting farming strategies in Sub-Saharan Africa. Available at http://www.springerlink.com/content/k6670m213n234813/fulltext.pdf.

Anderson, E., de Renzio, P. and S. Levy (2006). The role of public investment in poverty reduction: Theories, evidence and methods. Working Paper 23, Overseas Development Institute, London, UK.

Arjun, M and P, Alan (1975). Poverty, agriculture and energy: Energy Policy Report. In Ford Foundation Energy and Agriculture in the Third World. Washington D.C, USA.

Arrow K. J and M. Kurz (1970). Optimal growth with irreversible investment in a Ramsey Model. *Econometrica*, Vol 38(2): 331-344.

Asuamah, Y. S (2018). Econometric modelling of the link between investment and electricity consumption in Ghana. MPRA Paper No. 89789. Available at https://mpra.ub.uni-muenchen.de/89789/

Asare, R. and G.O, Essegbey (2016). Funding of agricultural Research and Development (R&D) in Ghana: The Case of Council for Scientific and Industrial Research (CSIR). *Technology and Investment*, 7(2): 40-45.

Ashipala J and N. Haimbodi (2003). The impact of public investment on economic growth in Namibia. Working Paper Number 88. The Namibian Economic Policy Research Unit, Namibia.

Aschauer, D.A (1989). Is public investment productive? *Journal of Monetary Economics*, 23:177-200.

Ayunku, P.E L. M. Etale (2015). Effect of agriculture spending on economic growth in Nigeria: Empirical evidence. *Research Journal of Finance and Accounting* , Vol 6(2): 137-143.

Badiane, O., Benin, S. and Makombe, T. (2016). Strengthening the continental agricultural agenda and accountability framework:The road from Maputo to Malabo. In Africa agriculture status report 2016: Progress towards agricultural transformation in Africa.

Bahta, Y.T., Willemse, B.J. and B. Grove (2014). The role of agriculture in welfare, income distribution and economic development of the Free State province of South Africa: a CGE approach. *Agrekon*. 53(1):47-74.

Barder, O. (2012). Development and complexity. Presentation and podcast made at CGD. Available online: http://www.cgdev.org/doc/CGDPresentations/complexity/player.html.

Barrett, C. B (2001). Does Food aid stabilize food availability? *Economic Development and Cultural Change* 49 (2): 335-349.

Barro, R. (1991). Output effects of government purchases. *Journal of Political Economy* 89(6):1086-1121.

Barro, R. (1990). Government spending in a simple endogenous growth model. *Journal of Political Economy* 98(5):103–125.

Barro, R and X, Sala-i-Martin (1992). Convergence. *Journal of Political Economy*, *100* (2): 223–51.

Beintema, N.M., and G.B. Ayoola (2004). Agricultural science and technology indicators: Nigeria. Agricultural Science and Technology Indicators Country Brief no. 10. IFPRI, Washington, DC

Benin, S (2017). Return to public agriculture spending in the cocoa and non-cocoa subsectors of Ghana. Paper presented at the annual Bank conference on Africa. Berkeley, California. June 5-6, 2017.

Benin, S. (2015). Returns to agricultural public spending in Africa South of the Sahara. Discussion Paper 01491, IFPRI, Washington, DC.

Benin, S. and Yu, B. (2013). Complying with the Maputo Declaration Target: Trends in public agricultural expenditures and implications for pursuit of optimal allocation of public agricultural spending. ReSAKSS-Africa Wide Annual Trends and Outlook Report 2012. International Food Policy Research Institute (IFPRI), Washington, D.C, USA.

Benin, S., M. Johnson, E. Abokyi, G. Ahorbo, K. Jimah, G. Nasser, V. Owusu, J. Taabazuing, and A. Tenga (2013). Revisiting Agricultural Input and Farm Support Subsidies in Africa: The Case of Ghana’s Mechanization, Fertilizer, Block Farms, and Marketing Programs. IFPRI Discussion Paper 1300. International Food Policy Research Institute (IFPRI), Washington, D.C, USA.

Benin,S, Tewodaj Mogues, Godsway Cudjoe, Josee Randriamamonjy (2012). ‘Public expenditure and agricultural productivity growth in Ghana’. In T. Mogues and S Benin(eds). *Public expenditures for agriculture and rural development in Africa. IFPRI publications*, Washington, D.C, USA.

Benin, S., Mogues, T., Cudjoe, G. and Randriamamonjy, J. (2009). Public expenditures and agricultural productivity growth in Ghana. International Association of Agricultural Economists, Conference, Beijing, China, August 2009, pp. 16-22.

Breusch, T. S. (1978). Testing for autocorrelation in dynamic linear models. *Australian Economic Papers* 17: 334–355.

Breusch, T. S., and A. R. Pagan (1980). The lagrange multiplier test and Its applications to model specification in econometrics. *Review of Economic Studies* 47: 239–253.

Cameron, A.C and P.K Trivedi (2010). *Microeconometrics Theories and Applications*. Cambridge University Press, Cambridge, UK.

Cameron, A.C and P.K Trivedi (2009). *Microeconometrics Using Stata*. Rev. ed. College Station, TX: Stata Press.

CBN (2018). Central Bank of Nigeria Annual Report and Statement of Account, Abuja, Nigeria, CBN Publication.

Constant, N. B. Z. S. and Y, Yaoxing (2010). An econometric estimation of import demand function for Cote D‟Ivoire. *International Journal Of Business and Management*, Vol. 5, No. 2, pp.77-84.

Cooksey, B. (2013). The Comprehensive Africa Agriculture Development Programme (CAADP) and agricultural policies in Tanzania. Going with or against the grain? FAC Political Economy of Agricultural Policy in Africa (PEAPA).

Debski, J (2018). Do remittances increase agricultural productivity? The case of Ghana. Masters of Economics Thesis. School of Economics and Management, Lund University, Sweden.

De Mello Jr., L. R. (1997). Foreign direct investment in developing countries and growth: A selective survey. *Journal of Development Studies*, 34 (1), 1-34.

Devarajan, S., Swaroop, V. and H. Zou (1996). The composition of public expenditure and economic growth. *Journal of Monetary Economics*, 37(2):313-344.

Dorosh, P and S. Haggblade (2003). Growth linkages, price effects and income distribution in Sub-Saharan Africa. *Journal of African Economies*, Volume 12, (2):207–235

Durbin, J. (1954). Errors in variables. *Review of the International Statistical Institute* 22: 23–32.

Durbin, J. (1970). Testing for serial correlation in least-squares regressions when some of the regressors are lagged dependent variables. *Econometrica* 38: 410–421.

ECA (2009). Implementation of the Comprehensive Africa Agriculture Development Programme(CAADP). A Report of Committee on Food Security and Sustainable Development in Africa. Economic Commission for Africa. Addis Ababa, Ethiopia.

Eluhaiwe, P.N. (2010): 2010 Economic and Financial Review. Central Bank of Nigeria, Abuja, Nigeria.

Ewubare, D. B and J. A Eyitope (2015). The effects of public expenditure on agricultural production output in Nigeria. *Journal of Research in Humanities and Social Science,* Vol 3(11): 7-23

Fan, S. (2008). *Public expenditures, growth, and poverty: Lessons from developing countries*. Baltimore, MD: Johns Hopkins University Press.

Fan, S. and X. Zhang (2004). Investment, reforms and poverty in Rural China. *Economic Development and Cultural Change* 52(2):395-422.

Fan, S., Zhang, X. and N. Rao (2004). Public expenditure, growth and poverty reduction in rural Uganda. Development Strategy and Governance Division Discussion Paper 4, International Food Policy Research Institute, Washington, D.C., USA.

Fan, S., Hazell, P. and S.Thorat (2000). Government spending, agricultural growth and poverty in rural India. *American Journal of Agricultural Economics* 82(4):1038-51.

Fan, S. and Rao, N. (2003). Public spending in developing countries: trends, determination and impact. Working Paper, International Food Policy Research Institute, Washington, DC, USA.

Fan, S. and, A Saurkar (2006). Public spending in developing countries: trends, determination and impact (mimeo). FAO (Food and Agriculture Organisation of the United Nations), Rome, Italy.

Fan, S., Johnson, M., Saurkar, A. and T. Makombe (2008). Investing in African agriculture to halve poverty by 2015. IFPRI Discussion Paper 751, International Food Policy Research Institute, Washington, D.C., USA.

Fan, S., A. Gulati, and S. Thorat (2007). Investment, subsidies, and pro-poor growth in rural India. IFPRI Discussion Paper no. 716, International Food Policy Research Institute, Washington, D.C.

Fan, S., Nyange, D. and N. Rao (2005). Public investment and poverty reduction in Tanzania: Evidence from household survey data. Development Strategy and Governance Division Discussion Paper 18, International Food Policy Research Institute, Washington, D.C., USA

FAO (2013). Promoting investment in agriculture for increased production and productivity. Food and Agricultural Organization (FAO) of the United Nations. Italy, Rome.

FAO (2012a). The State of food security in the World. Food and Agricultural Organization (FAO) of the United Nations. Italy, Rome. Also available at http://www.fao.org/3/a-i3027e.pdf

FAO (2005). The state of food and agriculture. Food and Agricultural Organization (FAO) of the United Nations. Italy, Rome. Also available at http://www.fao.org/3/a0050e/a0050e00.htm.

FAO(2001). Agricultural investment and productivity in developing countries. FAO Economic and Social Development Paper 148. Rome, Italy. http://www.fao.org/3/x9447e06.htm

FAO (2001a). Current and emerging issues for economic analysis and policy research. FAO Food, Agriculture and Rural Development Division, Rome, Italy. http://www.fao.org/3/X9808E/X9808E07.pdf

FAO (1995). Irrigation in Africa in figures. Rome: Food and Agriculture Organization.

FAOSTAT (2019). Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy. Available at: http://www.fao.org/faostat/en/#data/QC

FAOSTAT (2018). Suite of Food Security Indicators. Available at: http://www.fao.org/faostat/en/#data/FS.

Fosu, O. E. and Magnus, F. J. (2006). Bounds Testing approach to cointegration: An Examination of Foreign Direct investment, trade and Growth relationships. *American Journal of Applied Sciences,* vol.3, N0. 11, pp. 2079-2085.

Gemmell, N., Kneller, R. and I, Sanz (2012). Does the composition of government expenditure matter for economic Grow th? Available online: https://pdfs.semanticscholar.org/b08e/8e14987a4f19a81ed62c67070f62dd36e851.pdf

Godfrey, L. G (1978). Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econometrics* 46: 1293–1301.

Gollin Douglas, Lagakos David and M. E Waugh (2014). The agricultural productivity gap. *Quart. J. Econ.* 2014;129(2):939–993.

Greene, W.H. (2012). *Econometric analysis*. 7th Edition, Macmillan Publishing Company. New York, USA.

Greene, W.H. (1993). The econometric approach to efficiency analysis. In Harold, O.F., Knox Lovell, C.A. and Schmidt, S.S. (Eds). *The measurement of productivity efficiency: Techniques and applications*. Oxford University Press, New York, 92-250.

Goyal, Aparajita, and John Nash (2017). *Reaping Richer Returns: Public Spending Priorities for African Agriculture Productivity Growth.* Africa Development Forum series. Washington, DC: World Bank

Guandong, B.Y.D and W.M Muturi (2016). The relationship between public expenditure and economic growth in South Sudan. *International Journal of Economics, Commerce and Management*, Vol 10(6): 235-259

Herrera, S (2007). Public expenditure and growth. Policy Research Working Paper 4372. World Bank, Washington, D.C, USA.

Hill, B. (2012). *Farm incomes, wealth and agricultural policy: Filing the CAP's core Information gap*. 4th Edition. CABI, Oxfordshire, UK.

IFAD (2012). Smallholders, food security and the environment. Available at https://www.ifad.org/documents/10180/666cac24-14b6-43c2-876d-9c2d1f01d5dd.

IFDC (2013). Report: Improved fertilizer blends double maize harvests for Mozambican farmers. https://ifdc.org/wp-content/uploads/2014/12/improved-fertilizers-for-mozambique_09july2014.pdf

IFPRI (International Food Policy Research Institute)(2013a). Agricultural Science and Technology Indicators (ASTI) database. Available online at http://www.asti.cgiar.org/data/.

IFPRI/International Food Policy Research Institute (2013). Agricultural science and technology indicators (ASTI) database. Available online: http://www.asti.cgiar.org/data/.

IFPRI/International Food Policy Research Institute (2012). Food Security Portal. Available at http://www.foodsecurityportal.org/nigeria/resources.

IFPRI/International Food Policy Research Institute (2006). The Role of agriculture in development: Implications for Sub-Saharan Africa, Development Strategy and Governance Division (DSGD) Discussion Paper No. 29, International Food Policy Research Institute (IFPRI), Washington, D.C., USA

IITA (2012). Yam improvement for income and food security in West Africa. Available at http://www.iita.org/iita-project/yifswa-ii/

IMF (International Monetary Fund) (2014). *Government Finance Statistics Manual*. Washington, DC.

Iganiga, B.O and D.O. Unemhilin (2011). The impact of Federal Government agricultural expenditure on agricultural output in Nigeria. *Journal of Economics* 2(2): 81-88

Ihugba, O.A Nwosu Chinedu and A.C Njoku (2013). An assessment of Nigeria expenditure on the agricultural sector: Its relationship with agricultural output. *Journal of Economics and International Finance,* Vol 5(5): 177-186.

Iheke, O.R (2016). Remittances and the economy: The Nigerian experience. *Scientific Paper Series in Management, Economic Engineering in Agriculture and Rural Development*, Vol 16(3):145-152

Itodo, A.I., Apeh, S. and S. Adeshina (2012). Government expenditure on agricultural sector and economic growth in Nigeria. *Journal of Humanities and Social Science*, 8(4), 62 – 67.

Islam, N (2011). Foreign aid to agriculture: Review of facts and analysis. IFPRI Discussion Paper 01053. Washington, D.C, USA.

Jambo, N (2017).The impact of government spending on agricultural growth: A case of Zambia, Malawi, South Africa and Tanzania. Thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Agriculture (Agricultural Economics) in the Faculty of AgricSciences at Stellenbosch University, South Africa.

Jayne, T.S and S, Rashid (2013). Input subsidy programmes in Sub-Saharan Africa: A synthesis of recent evidence. *Agricultural Economics* 44(6): 547-562.

Johansen, S. (1988). Statistical analysis and co-Integrating vectors. *Journal of Economic Dynamics and Control*, 12(2-3):231−254.

Kadhim, Z. R (2018). An investigation of current status of agricultural mechanisation in Iraq and future suggestions. *ARPN Journal of Agricultural and Biological Science*, VOL. 13, (12):149-164

Kakwani, N. and H.H Son (2006). How costly is it to achieve the millennium development goal of halving poverty between 1990 and 2015? International Poverty Center Working Paper 19, UNDP, New York, USA.

Kalibata, A (2010). Agricultural aid to Africa is living aid. Available on the internet at http://blog.bread.org/2010/10/listen-to-these-african-voices-as-our-governments-take-action-we-need-the-international-community-to-do-its-part-as-we.html

Khan, M.S. and Reinhart, C.M. (1989). Private investment and economic growth in developing countries. International Monetary Fund, Research Department, Washington, D.C, USA.

KNOMAD/ Global Knowledge Partnership on Migration and Development (2019). Migration and remittances: Recent developments and outlook. Available at https://www.knomad.org/data/remittances

Knoema (2019). Average depreciation rate of the capital stock. The real interest rate. Available at https://knoema.com/atlas/Nigeria/topics/Economy/Financial-Sector-Interest-rates/Real-interest-rate.

Kristkova, Z.S., Van Meijl, H.and M, Van Dijk (2016). Projections of long-term food security with R&D driven technical change- A CGE analysis. *Wageningen Journal of Life Sciences*, 77:39-51.

Kumi, T. (2017). The electricity situation in Ghana: Challenges and opportunities. CGD policy paper. Center for Global Development. Available at https://www.cgdev.org/publication/electricity-situationghana-challenges-and-opportunities.

Kwiatkowski, Denis, Peter C. B. Phillips, Peter Schmidt and Y. Shin (1992). Testing the null hypothesis of stationary against the alternative of a unit root. *Journal of Econometrics*, 54: 159-178.

Lawal, W.A. (2011). An analysis of government spending on agricultural sector and its contribution to gross domestic product in Nigeria. *International Journal of Business and Social Science*, 2(20), 244-250.

Lipsey, R. E. (2001).Foreign Direct Investment and the Operations of Multinational Firms: Concepts, History and Data. NBER Working Paper No. 8665, Cambridge, UK.

López, R., and G. I. Galinato (2007). Should governments stop subsidies to private goods? Evidence from Rural Latin America. *Journal of Public Economics* 91: 1071–94.

Lorka, M. (2014). Towards implementation of the Malabo Declaration and mutual accountability. IFPRI, Washington D.C, USA.

Lu, Wen-Cheng (2017). Electricity consumption and economic growth: Evidence from 17 Taiwanese industries. *Sustainability* 9(50):1-15

Massey, Alarcon, R, Gonzaliz, H and J, Durand (1987). Returns to Azlan: The social Process of international migration from Western Mexico. Berkeley and Los Angeles. The University of California Press.

Mbaku, J.M and M.S Kimenyi (1997). Macroeconomic determinants of growth: Further evidence on the role of political freedom. *Journal of Economic Development*, 22(2):119-131.

McCullough, E.B (2017). Labour productivity and employment gaps in Sub-Saharan Africa *Food Policy*. Vol 2 (67): 133–152.

Mckay, A., O, Morrissey and C. Vaillant (1999). Aggregate agricultural supply response in Tanzania. *Journal of International Trade and Economic Development*, 8(1): 107-123.

Mink, S (2016). Findings across agricultural public expenditure reviews in African Countries. Discussion Paper 01522. IFPRI, Washington, DC.

Mogues, T., M. Morris, L. Freinkman, A. Adubi and S. Ehui (2012a). "Agricultural public spending in Nigeria" in T. Mogues and S. Benin (eds.) *Public Expenditures for Agricultural and Rural Development in Africa*, London, UK: Routledge/ Taylor & Francis

Mogues, T., Yu, B., Fan, S. and L. McBride (2012b). The impacts of public investment in and for agriculture, Synthesis of the existing evidence, ESA Working Paper No. 12-07 October 2012.

Mogues, T., M. Morris, L. Freinkman, A. Adubi and S. Ehui (2008a). Agricultural public spending in Nigeria. IFPRI Discussion Paper 00789. International Food Policy Research Institute (IFPRI), Washington, D.C, USA.

Mogues, T., Ayele, G., and Z. Paulos (2008). The bang for the Birr: public expenditures and rural welfare in Ethiopia. IFPRI Research Report 160. International Food Policy Research Institute. Washington, D.C., USA.

Moroza, J (2008). Dynamic linkages between Baltic and international stock markets. Thesis submitted to the School of Economics and Management, Lund University. Available at http://biblioteket.ehl.lu.se/olle/papers/0002862.pdf.

NewAfrican (2014). How Africa can feed itself: Beyond food aid and corporate greed. New African Pan African Magazine., Page 12-13, Number 537, An IC Publication, London, U.K.

NBS (2018). Review of the Nigerian Economy. National Bureau of Statistics, Abuja, Nigeria.

NBS (2014). Federation Account Allocation Committee (FAAC): February 2017 Disbursement. National Bureau of Statis tics, Abuja, Nigeria. Also available at *nigerianstat.gov.ng/download/532*

NEPAD/New Partnership for Africa's Development (2014). About CAADP. Available online at https://www.nepad-caadp.net/about-caadp.php.

Ngene, E., Nwokoye, A. and K. Ukaoha (2012). Report of the Maputo Declaration Dialogue on Agriculture. NANTS-Agric/MDD/Report.

Nickell, S. (1985). Error correction, partial adjustment, and all that: An expository note. *Oxford Bulletin of Economics and Statistics*, 47(2): 119-129.

Nwosu, F.O., Oguoma, N.N., Ben-Chendo, N.G., and A. Henri-Ukoha (2010). The agricultural credit guarantee scheme Fund: Its roles, problems and prospects in Nigeria's quest for agricultural development. *Researcher*, Vol. 2, pp. 87-90.

OECD (2014). Government support for agriculture. OECD Factbook 2014: Economic, Environmental and Social Statistics, OECD Publishing. Available online at http://dx.doi.org/10.1787/factbook-2014-92-en.

Oguntade, E.A (2014). Food losses in cassava and maize value chain in Nigeria. Analysis and recommendations for reduction strategies. Deutsche Gesellschaft für Internationale Zusammenarbeit(GIZ), Bonn, Germany.

ONE (2014). Ripe for Change: The promise of Africa's agricultural transformation. Available at http://one.org.s3.amazonaws.com/pdfs/ONE_Ripe_for_Change_infographic_EN.pdf

Olomola, A., Mogues, T., Olofinbiyi, T., Nwoko, C., Udoh, E., Alabi, Reuben Adeolu., Onu, J and S Woldeyohannes (2015). Agriculture public expenditure review at the federal and subnational levels in Nigeria (2008-12). The World Bank, Washington, D.C, USA.

Olomola, Aderibigbe S.; Mogues, Tewodaj; Olofinbiyi, Tolulope; Nwoko, Chinedum; Udoh Edet, Joshua; Reuben Alabi; Onu, Justice Inyanda and Woldeyohannes, Sileshi (2014). Analysis of agricultural public expenditures in Nigeria. IFPRI Discussion Paper 01395. IFPRI, Washington, D.C, USA.

Ozor, N. and K. Urama (2013). The role of technology in ensuring adequate food security in Africa. *Development*, 56(2): 266-273.

Payne J, E and A.P Sahu (2004). Random walks, co-integration, and the transmission of shocks across global real estate and equity markets. *Journal of Economics and Finance* 28:198–210.

Romer, P. M (1994). The origins of endogenous growth. *Journal of Economic Perspectives*. Volume 8(1): 3–22

Romer, P. M (1987a). Crazy explanations for the productivity slowdown. In Fischer, S.(ed.). *NBER Macroeconomics Annual*. Cambridge: MIT Press, 163–202.

Romer, P.M. (1986). Increasing returns and long-run growth. *The Journal of Political Economy*, 94:1002-1037.

Romer, P.M and C, Lucas (1990). Are no-convexities important for understanding growth*? American Economic Review*, 80(2):97-103.

Rosegrant, M. W., C. Ringler, and T. Zhu. (2009). Water for Agriculture: Maintaining Food Security under Growing Scarcity. *Annual Review of Environment and Resources*34 (1): 205-215.

Rostow, W.W. (1960). The five stages of growth-A summary. In the stages of economic growth: A non-communist manifesto. Cambridge: Cambridge University Press. pp. 4–16.

Rudloff, B. (2012). Kein schöner Land. Gesucht: Ein Schutzschirm gegen Risiken aus europäischen und deutschen Landinvestitionen in Entwicklungsländern, SWP-Studie. Berlin, Germany.

Sanginga, N (2015). Root and tuber crops. Available at https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Rootand_Tuber_Crops__Cassava__Yam__Potato_and_Sweet_Potato_.pdf

Seck, P.A, Agboh-Noameshie, A, Diagne, A. and I, Bamba (2013). Repackaging agricultural research for greater impact on agricultural growth in Africa. *Journal of Food Security* 1(2):30-41.

Selvaraj, K.N (1993).Impact of government expenditure on agriculture and performance of agricultural sector in India. *Bangladesh Journal of Agricultural Economics* 16 (2):12-22

Somma, A (2008). The ten percent that could change Africa. IFPRI Forum. International Food Policy Research Institute, Washington, D.C., USA.

Stads, G.J. and N, Beintema (2015). Agricultural R&D expenditure in Africa: Analysis of growth and volatility. *European Journal of Development Research,* 27:391-406. Available online: http://dx.doi.org/10.1057/ejdr.2015.25.

Thirtle, C., J. Piesse, and L. Lin (2003). The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia, and Latin America. *World Development* 31 (12): 1959–1975.

Ubani, O. (2013). Determinants of the dynamics of electricity consumption in Nigeria. *OPEC Energy Review*,37(2), 149-161.

Udoh, E. (2011). An examination of public expenditure, private investment and agricultural sector growth in Nigeria: Bounds testing approach. *International Journal of Business and Social Science*, 2(13), 285-291.

Uguru, M.I (2012). Genetics for farming and food security in Africa: Lessons from Nigeria. Paper presented at the 2012 ATPS Annual Conference and Workshops held from 19-22 November, Addis Ababa, Ethiopia.

UNECA (2009). Implementation of the Comprehensive Africa Agriculture Development Programme. A Report of Committee on Food Security and Sustainable Development in Africa. Addis Ababa: Economic Commission for Africa.

UNIDO (2018). Agricultural mechanization in Africa: Time for action, planning investment for enhanced agricultural productivity. Report of an Expert Group Meeting of United Nations Industrial Development Organization (UNIDO) Vienna, Austria.

USDA (2016). U.S. agricultural trade summary. Available at https://www.export.gov/apex/article2?id=Nigeria-Agriculture

Wanzala, M.N. (2011). Implementation of the Abuja Declaration on fertilizer for an African Green Revolution. Seventh Progress Report January-December 2010. Prepared by the Policy Alignment and Program Design Directorate, NEPAD Planning and Coordinating Agency, June 2011.

Vasco (2011). The impact of international migration and remittance on agricultural production patterns, labour relationship and entrepreneurship: The case of Ecuador. Kassel University Press, GmbH, Kassel, Germany.

Verter, N., (2017). The impact of agriculural foreign aid on agriculture in Nigeria. *Bulg.J. Agric. Sci*., 23 (5): 689–697.

Wieck, C., Rudloff, B and A, Heucher (2014).Agri-investment and public spending in selected vulnerable countries-will they contribute to reduce food insecurity. Discussion Paper 2014:1. Institute for Food and Resource Economics. University of Bonn, Germany

Wooldridge, J. M (2013). *Introductory Econometrics: A Modern Approach*. 5th ed. Mason, OH: South-Western.

WDI (2019). World Bank World Development Indicators Database. Available at http://data.worldbank.org/ data-catalog/world-development-indicators.

World Bank (2019). Migration and development brief. Available on the internet at http://documents.worldbank.org/curated/en/719531507124177735/pdf/120240-WP-PUBLIC-3-10-2017-22-22-41-MigrationandDevelopmentBrief.pdf.

World Bank (2011). *Practitioners' Toolkit for Public Agriculture Expenditure Analysis.* Washington, DC.

World Bank (2007). Nigeria—A fiscal agenda for change: Public expenditure management and financial accountability review. Poverty Reduction and Economic Management, Africa Region, World Bank, Washington, D.C. USA

World Bank (2007a). World Development Report 2008. Washington, D.C, USA

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association* 57: 348–368.

Zellner, A., and D. S. Huang (1962). Further properties of efficient estimators for seemingly unrelated regression equations. *International Economic Review* 3: 300–313.

Zhang, X. and S.Fan (2004). How productive is infrastructure? A new approach and evidence from rural India. *American Journal of Agricultural Economics* 86(2):492-501.

Appendix 1: Food Crops Yields in Selected African Countries (metric tonne /hectare)

Crop	Year	Nigeria	Ghana	Cameroun	Benin	Central Africa	Ivory Coast	Togo
Yam	1990	10.68	7.35	3.93	11.15	6.57	9.96	9.07
	2016	8.55	16.98	11.09	14.79	8.11	5.99	8.94
% Change		**-20**	**131**	**182**	**33**	**23**	-40	-1
Cassava	1990	11.65	8.42	16.44	7.977	2.843	5.51	7.688
	2016	9.13	18.96	14.69	15.67	2.846	6.35	3.799
%Change		**-22**	**125**	-11	96	00	15	-51
Maize	1990	1.130	1.189	1.854	0.859	0.734	1.190	0.965
	2016	1.590	1.95	1.793	1.376	0.800	1.978	1.224
%Change		**41**	**64**	-3	60	9	66	27
Rice	1990	2.07	1.65	4.99	1.40	1.67	1.20	1.31
	2016	2.03	2.82	1.30	3.42	1.48	2.51	1.65
%Change		**-2**	**71**	-74	144	-11	109	26

Source: Computed from FAOSTAT (2018)

Appendix2: Summary Statistics of the Variables (Logarithm forms)

Variables	Mean	Minimum	Maximum	Unit
Non-Agric. Public Expenditure Per Capita	14.58843	13.58223	15.17649	Naira at 2010 constant prices
Recurrent Agriculture Expenditure Per Capita	4.841635	2.694627	7.847763	Naira at 2010 constant prices
Capital Agriculture Expenditure Per Capita	5.065906	4.345103	5.811141	Naira at 2010 constant prices
Total Agriculture Expenditure Per Capita	5.746159	4.624973	7.897296	Naira at 2010 constant prices
Farmers-Population Ratio	-2.22604	-2.645075	-1.795768	Ratio
Agriculture GDP Per Farmer	12.98778	12.1216	14.0166	Naira at 2010 constant prices
Agric. Subsidy Expenditure Per farmer	4.106968	3.38439	4.85203	Naira at 2010 constant prices
Rural Infrastructure Expenditure Per farmer	2.59198	1.870263	3.33577	Naira at 2010 constant prices
Agriculture R&D Expenditure Per farmer	1.416699	0.6931472	2.161021	Naira at 2010 constant prices

Agriculture Irrigation Expenditure Per farmer	0.6431134	-0.0801261	1.388791	Naira at 2010 constant prices
Remittance for Agriculture	3.802505	-1.416947	7.640415	Million USD
Agriculture ODA	2.110382	-2.995732	5.623476	Constant 2016 USD prices
Depreciation Rate	0.0501974	0.034481	0.071119	Percentage
Agriculture Private Investment	83.75712	6.587903	216.9905	Naira 2010 constant prices
Agriculture Private Investment (depreciated value)	3.957725	1.885235	5.379853	Naira 2010 constant prices
CAADP	0.32	0	1	Dummy
Types of Government(GOV)	0.53	0	1	Dummy
Agricultural Unemployment in Total Unemployment	1.375573	1.195981	1.8305	Percentage
Electricity Consumption	4.581747	3.929863	5.054971	Kilowatts
Tractors	1.731688	1.435084	1.902907	Tractor/100km^2

Source: Computed by the Authors

Appendix 3: Augmented Dickey-Fuller (ADF) test for unit root

	At Level		Differencing		
Variables	Test Statistics	5% Critical Value	Test Statistics	5% Critical Value	Order of Integration
Agric. GDP per Farmer	0.292	-2.978	-5.516	-2.980	1(1)
AGPE(total) per capita	-2.460	-2.978	-8.482	-2.980	1(1)
Agric Capital Expenditure per capita	-0.633	-2.978	-4.687	-2.980	1(1)
Agric Recurrent Expenditure per Capita	-2.351	-2.978	-8.132	-2.980	1(1)
Private Investment	-1.308	-2.978	-5.582	-2.980	1(1)
Unemployment	0.410	-2.978	-3.152	-2.980	1(1)
Labour (Farmer/Population Ratio)	-0.854	-2.978	-7.026	-2.980	1(1)
Subsidy Expenditure per Capita	-0.639	-2.978	-4.715	-2.980	1(1)
Rural Expenditure per Capita	-0.635	-2.978	-4.712	-2.980	1(1)
Rand D Expenditure per Capita	-0.637	-2.978	-4.717	-2.980	1(1)
Irrigation Expenditure per Capita	-0.635	-2.978	-4.676	-2.980	1(1)
Remittances	-0.551	-2.978	-5.906	-2.980	1(1)
ODA	-0.989	-2.978	-4.262	-2.980	1(1)
NAGPE	-1.505	-2.978	-7.627	-2.980	1(1)
Electricity Consumption	-2.391	-2.978	-7.945	-2.980	1(1)

Mechanisation (Tractors/100km^2)	-0.464	-2.978	-5.026	-2.980	1(1)

Source: Computed by the Authors

Appendix 4: Johansen tests for cointegration of the Agricultural Productivity, Private Investment and Agricultural Expenditure Equations

	Agric Capital Expenditure Equation		Agric Recurrent Expenditure Equation		Agric Total Expenditure Equation	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	432.4054	124.24	454.4802	124.24	445.0130	124.24
1	229.9628	94.15	258.2054	94.15	240.9114	94.15
2	138.8240	68.52	128.8147	68.52	140.1920	68.52
3	90.2164	47.21	66.7654*	47.21	79.3706	47.21
4	50.0261	29.68	24.0557	29.68	35.5624*	29.68
5	16.1030	15.41	5.7292	15.41	6.6678	15.41
6	6.5037*	3.76	0.6962	3.76	0.7217	3.76
	Private Investment Equation		**Private Investment Equation**		**Private Investment Equation**	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	198.4698	94.15	169.9692	94.15	175.8183	94.15
1	120.2857	68.52	110.7093	68.52	113.2685	68.52
2	61.5637	47.21	56.2091	47.21	61.6482	47.21
3	25.5150*	29.68	22.3255*	29.68	24.3322*	29.68
4	8.8099	15.41	6.1212	15.41	7.9785	15.41
5	0.3049	3.76	0.1579	3.76	0.1439	3.76
	Agricultural Expenditure Equation		**Agricultural Expenditure Equation**		**Agricultural Expenditure Equation**	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	268.4223	94.15	254.9447	94.15	239.3507	94.15
1	173.6051	68.52	132.9311	68.52	129.4132	68.52
2	95.0797	47.21	74.8032	47.21	69.0478	47.21
3	39.0624	29.68	32.2212	29.68	31.0655	29.68
4	13.2621*	15.41	14.7545*	15.41	13.9246*	15.41
5	0.0283	3.76	0.1570	3.76	0.3401	3.76

Source: Computed by the Authors

Appendix 5: Durbin's Alternative Tests for Autocorrelation for AGPCE, AGPRE and AGPTE

	Agric Capital Expenditure Model		Agric Recurrent Expenditure Model		Agric Total Expenditure Model	
Agricultural Productivity Equation	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	0.295	0.5918	0.322	0.5754	0.000	0.9932
Breusch-Godfrey LM test	0.385	0.5406	0.420	0.5230	0.000	0.9922
Private Investment Equation	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	0.307	0.5842	1.013	0.3235	0.869	0.3599
Breusch-Godfrey LM test	0.385	0.5403	1.237	0.2762	1.067	0.3112
Agricultural Public Expenditure Equation	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	1.362	0.2538	0.175	0.6794	0.008	0.9294
Breusch-Godfrey LM test	1.643	0.2113	0.220	0.6427	0.010	0.9205

Source: Computed by the Authors H_0: no serial correlation   *** Reject the H_0 at 5% Significance level

Appendix 6: Long and Short Run Impacts of Agricultural Recurrent Public Expenditure on Agricultural Productivity

Long Run			Short Run		
	F(6, 26)	462.10		F(7, 24)	5.84
	Prob > F	0.0000***		Prob > F	0.0000
	Adj R^2	0.9886		Adj R^2	0.5222
Agric GDP Per Farmer	Coefficient	P>(t)	ΔAgric GDP Per Farmer	Coefficient	P>(t)
Recurrent Agric Expenditure$_{(t-1)}$	-.010	0.660	Δ Recurrent Agric Expenditure$_{(t-1)}$	-0.001	0.948
Private Investment	.1352772	0.000	ΔPrivate Investment	.1270771	0.000
NAPGE	-.0223025	0.732	ΔNAPGE	.0384297	0.563
ODA	.0403229	0.000	ΔODA	.00698	0.539
REMIT	.0166428	0.222	ΔREMIT	.001068	0.941
Labour (Farmer-Pop Ratio)	-1.625581	0.000	ΔFarmer-Pop Ratio	-3.563546	0.157
Constant	9.051754	0.000	Constant	-.0458531	0.474
			ECM	-.7389238	0.001

Source: Computed by the Authors

*,** and *** = Significant at 10%,5% and 1% respectively, Δ= Differencing factor

Appendix 7: Long and Short Run Impacts of Total Agriculture Public Expenditure on Agricultural Productivity

Long Run			**Short Run**		
	F(6, 26)	465.36		F(7, 24)	5.63
	Prob > F	0.0000***		Prob > F	0.0000
	Adj R^2	0.9886		Adj R^2	0.5111
Agric GDP Per Farmer	Coefficient	P>(t)	ΔAgric GDP Per Farmer	Coefficient	P>(t)
Total Agric Expenditure$_{(t-1)}$	0.018	0.543	ΔTotal Agric Expenditure$_{(t-1)}$	0.013	0.512
Private Investment	0.142	0.000	ΔPrivate Investment	0.124***	0.000
NAPGE	-0.025	0.693	ΔNAPGE	0.039	0.575
ODA	0.042	0.000	ΔODA	0.010	0.421
REMIT	0.013	0.370	ΔREMIT	-0.001	0.958
Labour	-1.564032	0.000	ΔLabour	-3.740	0.147
Constant	9.063483	0.000	Constant	-0.051	0.438
			ECM	-0.766**	0.001

Source: Computed by the Authors *,** and *** = Significant at 10%,5% and 1% respectively

Δ= Differencing factor

Appendix 8: Johansen tests for cointegration in the Agricultural Productivity, Private Investment and Agricultural Expenditure Equations (Components of Agricultural Public Capital Expenditure)

	Irrigation		**Subsidy**		**R&D**		**Rural Development**	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	432.5687	124.24	432.9807	124.24	432.1171	124.24	432.5014	124.24
1	229.6124	94.15	229.1966	94.15	230.4965	94.15	232.2381	94.15
2	138.6587	68.52	138.3538	68.52	139.0342	68.52	138.3543	68.52
3	89.2722	47.21	89.7370	47.21	90.7674	47.21	89.9892	47.21
4	50.1657	29.68	49.8430	29.68	50.3727	29.68	49.9185	29.68
5	15.9874	15.41	16.1343	15.41	16.3280	15.41	16.0668	15.41
6	6.6525 *	3.76	6.3384*	3.76	6.5980*	3.76	6.5138*	3.76
	Private Investment Equation		**Private Investment Equation**		**Private Investment**		**Private Investment**	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	199.1705	94.15	198.4031	94.15	197.6227	94.15	198.6857	94.15
1	121.4478	68.52	120.5846	68.52	119.9606	68.52	120.5615	68.52
2	61.7223	47.21	61.7527	47.21	61.3954	47.21	61.7903	47.21
3	25.3804*	29.68	25.6909*	29.68	25.3607*	29.68	25.5690*	29.68
4	8.7780	15.41	8.7717	15.41	8.8199	15.41	8.8154	15.41
5	0.2960	3.76	0.3085	3.76	0.3130	3.76	0.3064	3.76
	Agricultural Expenditure		**Agricultural Expenditure**		**Agricultural Expenditure**		**Agricultural Expenditure**	
Maximum Rank	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value	Trace Statistics	5% Critical Value
0	268.4554	94.15	271.3603	94.15	268.6716	94.15	268.5888	94.15
1	173.9299	68.52	173.9583	68.52	173.4306	68.52	172.7452	68.52
2	95.3872	47.21	95.5888	47.21	95.0733	47.21	94.7126	47.21
3	39.0873	29.68	39.1495	29.68	38.9705	29.68	38.8709	29.68
4	13.3759*	15.41	13.2616*	15.41	13.2286*	15.41	13.2045*	15.41
5	0.0223	3.76	0.0344	3.76	0.0318	3.76	0.0366	3.76

Source: Computed by the Authors

Appendix 9: Durbin's Alternative Tests for Autocorrelation for Components of AGPCE

	Irrigation		**Subsidy**		**R&D**		**Rural Development**	
Agricultural Productivity Equation	F	Prob>F	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	0.285	0.5985	0.304	0.5863	0.312	0.5813	0.313	0.5808
Breusch-Godfrey LM test	0.371	0.5478	0.396	0.5347	0.407	0.5293	0.408	0.5288
Private Investment Equation	F	Prob > F	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	0.306	0.5846	0.303	0.5870	0.299	0.5890	0.301	0.5880
Breusch-Godfrey LM test	0.384	0.5406	0.380	0.5432	0.375	0.5454	0.378	0.5442
Agricultural Expenditure Equation	F	Prob > F	F	Prob > F	F	Prob > F	F	Prob > F
Durbin's Alternative test	1.306	0.2636	1.282	0.2679	1.316	0.2617	1.256	0.2726
Breusch-Godfrey LM test	1.578	0.2202	1.550	0.2242	1.590	0.2185	1.521	0.2285

Source: Computed by the Authors H_0: no serial correlation *** Reject the H_0 at 5% Significance level