IMPACT OF THE COMMERCIAL AGRICULTURE DEVELOPMENT PROJECT (CADP) ON PRODUCTIVITY AND POVERTY STATUS OF FARMERS IN NIGERIA

BY

AYUK, JOSEPHINE OLUWATOYIN
AE/PH.D/11/004

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DECLARATION

I hereby declare that this thesis titled "Impact of the Commercial Agriculture Development Project on Productivity and Poverty Status of Farmers in Nigeria" represents my own work which has been done after registration for the degree of Ph.D at the University of Calabar, Calabar and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. All borrowed information has been duly acknowledged in the text and a list of references provided.

Josephine Oluwatoyin Ayuk
Student

Signature: .....

Date: 10/03/2021

CERTIFICATION

We certify that this thesis entitled "Impact of the Commercial Agriculture Development Project (CADP) on Productivity and Poverty status of Farmers in Nigeria by Ayuk, Josephine Oluwatoyin (Reg. Number: AE/Ph.D/11/004) carried out under our supervision has been found to have met the regulations of the University of Calabar. We therefore, recommend the work for the award of a Doctor of Philosophy Degree (Ph.D) in Agricultural Economics (Agricultural Development and Policy).

1. Dr. Ekanem Abasiekong Etuk — Signature: .....
   (Chief Supervisor)
   Qualification/ Status: Ph.D/ Associate Professor — Date: 10/03/2021

2. Prof. Sylvanus Obi Abang — Signature: .....
   (Supervisor)
   Qualification/ Status: Ph.D/ Professor — Date: 10-03-21

3. Prof Susana Ben Ohen — Signature: .....
   (Head of Department)
   Qualification/ Status: Ph.D/ Professor — Date: 10-03-21

4. DR VICTOR ABANYAM ATAH — Signature: .....
   (Graduate School Representative)
   Qualification/ Status: Ph.D — Date: 10/03/2021

5. Prof. Olubunmi Abagun Omotesho — Signature: .....
   (External Examiner)
   Qualification/ Status: Ph.D/ Professor — Date: 10/03/2021

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ABSTRACT

The study assessed the impact of the Commercial Agriculture Development Project (CADP) on productivity and poverty of farmers in Nigeria using a counterfactual approach. The specific objectives of the study were to: determine the level of productivity of beneficiaries and non-beneficiaries; examine the socioeconomic determinants of productivity of CADP beneficiaries and non-beneficiaries; investigate the impact of the CADP on the productivity of project beneficiaries non-beneficiaries, analyze the impact of the Project on poverty status of beneficiaries non-beneficiaries; analyze its impact on commercialization of beneficiaries and non-beneficiaries and ascertain the pro-poorness of the Project. Secondary data collected by the Project through structured questionnaires from 1800 households of beneficiaries and non-beneficiaries were used for the study. However, 1199 households comprising 678 non-beneficiaries and 521 non-beneficiaries were used for analysis due to missing data. Propensity score matching was used to select comparable observations which reduced the sample size to 1142 observations: 655 beneficiaries, 487 non-beneficiaries. Data were analyzed using descriptive statistics, propensity score matching technique, total factor productivity (TFP) index, Foster-Greer-Thorbecke (FGT) poverty measures, Tobit regression, Average Treatment effect on the Treated (ATT) and Poverty equivalent growth rate (PEGR) pro-poor measure. Results showed that the mean TFP for beneficiaries at the endline (2016) is 0.922, while that of non-beneficiaries is 0.615. This shows that the TFP of beneficiaries is higher compared to that of non-beneficiaries. The impact of CADP on productivity (TFP) of beneficiaries using ATT shows that they had their productivity increased by 37.5 % as a result of participating in the CADP. The significant determinants of productivity are: household size, farm size and grant. FGT poverty indices were lower for CADP

Beneficiaries than the non-beneficiaries. The impact of the CADP on poverty using the income of beneficiaries as proxy showed that those who participated in CADP have their income increased by ₦446,073.89 and are better off in terms of their welfare compared to those who did not participate in the program. For the impact on commercialization, the ATT of 0.08 is positive and significant at the 10 % level. The positive value shows that CADP had a significant impact on the commercialization of participants. Also the PEGR for non-beneficiaries is higher than the actual growth rate while that of beneficiaries is less than the actual growth rate implying that CADP was not pro-poor. The study concludes that even though the CADP impacted positively on the productivity and poverty of beneficiaries but it was not pro-poor hence there is a need to ensure that the poor are effectively targeted in such development programmes. The study recommends among others that policy measures should be oriented towards improving access of farmers to land and credit facilities and also ensure that the poor are effectively targeted when development interventions are being designed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agriculture is the major occupation in developing countries, with emphasis on food availability, foreign exchange and employment generation. According to World Bank (2019), the development of agriculture remains a major effective tool to end hunger and feed a projected 9.7 billion people by 2050. In order to meet this projected demand, production of almost 50 % more food, feed and biofuel would be needed by the agricultural sector than it did in 2012 (FAO, 2017). However, agricultural productivity for Sub-Saharan Africa has continued to fall short of expectations owing to snailish production growth and the sudden annual fluctuations in output being a pervasive issue in developing countries, thus leading to their continued poverty and advancing food insecurity. There is no gainsaying the fact that the agricultural output needs to increase, this is particularly so in sub-Saharan Africa and South Asia, where outputs require to be more than twice by half of this century (2050) to respond to demands compared to other continents whose anticipated rise is expected to be about one-third of what currently exists (FAO, 2017). For developing economies to achieve notable advances in promoting economic growth, reducing poverty and enhancing food security, there must be conscious efforts at enhancing more fully the productive capacity of the agricultural sector.

Against this background, most developing countries, have considered it a top priority in their development plans to include activities that can bring about increased productivity of the agricultural sector. Increased foreign direct investment in this sector, government pledges, the commitment of public spending under the Comprehensive Africa Agricultural Development Programme (CAADP), and

significant donors' intervention in the agricultural sector support this assertion. In a bid to harness the potential benefits of the agricultural sector, there have been many large scale commercial investments in the sector by well- meaning governments, donor organizations and even the private sector. There is no doubt that African Agriculture is in a phase of rapid commercialization.

The quest for food security and agricultural transformation in Africa led to the launch of the Comprehensive Africa Agriculture Development Programme (CAADP) in July 2003 which the African Heads of States endorsed as part of a "New Partnership for Africa's Development (NEPAD)". CAADP was targeted at helping African countries in attaining an elevated path of economic growth through agricultural-sector-led development with the main thrust of eliminating hunger, reduce poverty, attain food security, and encourage export expansion (World Bank, 2008).

Agricultural productivity is a critical factor to development especially in developing countries where majority still rely on agriculture for their livelihoods. It determines food prices which in turn determine cost of wages and how competitive tradable goods are, with synergetic real income effects of increased output for farming households (World Bank, 2007). Productivity and poverty are closely related and evidence abounds to show the several sequence of channels through which increased agricultural productivity can mitigate poverty. This includes: changes in real wages, employment creation, non-farm multiplier effects (rural), and effects from food prices (Schneider and Gugerty, 2011).

A declining productivity of the agricultural sector threatens growth and efforts at reducing poverty are thwarted, while increasing productivity of the agricultural sector guarantees growth and consequently poverty reduction. There are empirical

evidences which support the hypothesis that agricultural growth contributes to poverty reduction. For instance, Ravallion and Datt (1992) using a "Computable General Equilibrium (CGE)" model showed that agricultural sector growth grossly impacted on poverty alleviation in India. Part of their findings is that growth of the rural areas contributes to poverty alleviation in the urban areas while urban growth has no effect on rural poverty.

Prior to the millennium, it appeared the goal of international development was centered on poverty reduction. Taking into consideration the opinions and interests of the poor, a more inclusive understanding of poverty has emerged as it now encompasses not just income and consumption but also economic vulnerability and sociopolitical conditions of powerlessness. Therefore, a multidimensional strategy for reducing poverty which comprises three pillars of: expansion of income-earning opportunities, security enhancement, and empowerment promotion; has been proposed. This shift in paradigm represents a significant milestone in understanding the living dynamics of poor people as well as the search for solutions to curb the menace of poverty.

A critical scrutiny of the post-2015 development agenda reveal the centrality of agricultural development in the achievement or otherwise, with food security and poverty reduction having direct link with agriculture. Hence, there are efforts by development actors at different levels to translate identified priorities into policies that are implementable and aimed at increasing agricultural productivity especially for small holder farmers. These efforts are widespread in both the developing and developed countries. Nigeria also is not left out as the agricultural sector is experiencing massive revolution with a view to increase productivity. For instance, a review of Nigeria's Gross Domestic Product (GDP) share of agriculture from 1981 to

2018 shows that the average value for the country during that period was 22.86 % with a minimum of 12.24 % in 1981 and a maximum of 36.97 % in 2002 after which it began to dwindle again up to 2018 (World Bank 2019). Indeed the Nigerian agricultural sector has not been able to sustain an impressive performance as expected.

Attempting to end this pattern, government implemented undertook myriads of programmes for the purpose of reforming the economy for sometime with special focus on the agricultural sector. Such reforms were aimed at achieving food security, employment generation, availability of raw materials for industries, foreign exchange earnings, as well as technological improvement in agricultural practices to remove the drudgery of traditional practices thereby improving the lives of the citizenry (Ugwu and Kanu, 2012).Indeed, sound and realistic agricultural policies propel sustainable agricultural development as seen in the developed nations of the world. It is important that these policies are pro-poor for it is only then that poverty can be effectively targeted. Promotion of pro-poor growth must be done in such a way that the benefits accruable to the poor is more than that of the rich to ensure notable reduction in poverty incidence. A growth strategy is in favour of the poor when it is devoid of systematized biases against them and also adopts direct pro-poor policies. Examples of policies that favour the poor are: sufficient spending by government on basic education, basic health care, greater opportunities to loans, with encouraging establishment of home grown small industries (Kakwani and Pernia, 2000).

The goal of poverty alleviation and development processes is to improve the quality of life. Successive Nigerian governments have implemented projects targeted at alleviating or reducing poverty. These may be broadly split into sectorial and multi-sectorial based on approach. Those designed for the agricultural sector in order

to tackle poverty are:"Operation Feed the Nation (OFN) and Green Revolution of 1970s, Peoples Bank of Nigeria - 1989 and Community Bank 1990. The World Bank supported Agricultural Development Projects (ADPs) and River Basin Development Authorities (RBDAs) both established in 1975, National Agricultural Land Development Authority (NALDA) 1991, Fadama Development Projects (1993), and Commercial Agricultural Development Project (CADP) in 2009".

The multi-sectorial programmes where the agriculture sector is involved includes: "Directorate of Food, Road and Rural Infrastructure (DFRRI)- 1986, National Directorate of Employment (NDE) -1986, Better Life Programme (BLP) 1987, Family Support Programme (FSP)-1994, Family Economic Advancement Programme (FEAP) -1997, Poverty Alleviation Programme (PAP) – 2000, National Poverty Eradication Programme (NAPEP)- 2001. Other programmes include Community Action Programme for Poverty Alleviation (CAPPA) – 1997, National Economic and Empowerment Development Strategy (NEEDS) -2004, Small and Medium Enterprises Development Agency of Nigeria (SMEDAN)".

The Commercial Agriculture Development Project (CADP), aided by World Bank, is one programme in the agricultural sector that was implemented by the Nigerian government. The Project became effective in 30th July 2009 and was implemented from then till 31st May 2017. It had three main components of "Agricultural Production and Commercialization, Rural Infrastructure and Project Management; Monitoring, Evaluation and Studies". Although revised when restructuring was done in 2014. Overall, the project development objective of "strengthening product systems and facilitating access to markets for selected value chains" were aligned with Nigerian government's strategic vision and World Bank's country partnership strategy (World Bank, 2008).

The development objectives of CADP as reflected in the financing agreement had specific information on targeted value chains: i) strengthening agricultural production systems, ii) facilitating market access by "small and medium scale commercial farmers" engaged in different eight "value chains" captured. The value chains involved are: aquaculture, cocoa, dairy, fruit trees, maize, palm oil, poultry and rice. States that participated in the Project are: Cross River, Enugu, Kaduna, Kano and Lagos; each state representing different geo-political and ecological zones to demonstrate the practicability of commercial agriculture in Nigeria.

The approach used by Commercial Agricultural Development Project is the demand-driven approach where all the Commodity Interest Group (CIGs) identified their priority needs and addressed them based on socially inclusive approach, while capacity building training was conducted for the successful implementation of Commercial Agricultural Development Project (World Bank, 2008). Commodity Interest Groups (CIGs) were utilized for implementation of projects from inception to 2014 when the Project was restructured and the women and youth component of the project was now drafted into the project. The State Project Implementation Units (PIUs) were responsible for the implementation of all project components designed to achieve the main outcomes.

CADP was expected to aid the country in attaining her maximum agricultural potential as evidenced in its main thrust of supporting access to technologies for productivity enhancement, improving access to markets, high level capacity building and improving access to infrastructures such as Roads and Energy. This is because the country's agricultural productivity has failed to grow as expected being characterized by: Obsolete technological innovations, slow uptake of existing improved technologies, unfriendly investment climate, and failed infrastructures. A review of

the theory of change for the Project revealed three key expected outcomes of increased production, yield and sales. The long term outcomes are improved farmer welfare and non-oil growth. This is expected because increased production, yield and sales would have significant positive impact on farmers' welfare which would translate to poverty reduction and also bring about overall economic growth in the economy. This study therefore assessed the impact of the commercial agriculture development project (CADP) on productivity and status of poverty for farmers in the states that participated in the Project in Nigeria.

1.2 Statement of the problem

A scrutiny of the Nigerian Agricultural sector from the years succeeding independence reveals that several programmes have been implemented by successive governments. Since the sector serves as the main source of food and livelihood in Nigeria, it automatically becomes the fulcrum on poverty reduction and food security strategies rest. The concern in agricultural productivity is not unconnected with the fact that income grows as productivity grows which in turn affects savings and investment and consequently, improvement in welfare and reduction in poverty in the economy.

A review of some of the programmes aimed at revamping the agricultural sector with the aim of reducing poverty showed that some of them were not able to achieve the desired objectives due to policy inconsistencies and poor implementation. Within the past few decades, the President Obasanjo led administration flagged the Cassava Project 2004-2005, while late President Yar Adua implemented the seven-point agenda with emphasis on food security; President Goodluck Jonathan initiated agricultural transformation programme. These programmes notwithstanding, the

outlook has been grim with productivity estimates for Nigeria showing fluctuations in productivity growth and the agriculture GDP share fluctuating over the years.

The economic growth of Nigeria remained modest as it is stunted by a weak macroeconomic framework. Import is on the rise pushing the current account into deficit. Without significant structural reforms, the growth of GDP is expected to remain muted over the medium term at around 2 % annually (World Bank, 2019). The agricultural sector has lagged behind even though the sector employed around two-thirds of Nigeria's total labor-force, and contributed 21.2 % to 2018 GDP. Over the years however, the performance of this important sector had been characterized by sluggish productivity growth due to multiple factors. There is no doubt that the sector has been unable to match Nigeria's rapid population growth; although it can be said the Nigerian economy is thriving, around 48 % of its populace lives below the poverty line (World Bank, 2020).

High poverty incidences rendered government programmes ineffective making their impact contentious. Some analysts have argued that these programmes have benefited the poor while others opine that despite positive real growth, poverty had been on the increase. The findings of Gafar and Osinubi (2005) showed that in Nigeria, growth slightly favoured the poor even though the very poor have not benefitted from the growth. This call to question the nature of growth pursued as well as underlying macroeconomic policies.

The Commercial Agricultural Development Project (CADP) was designed to create a friendly business environment for agriculture with a view to steadily shift from minimal to commercial agriculture. This was to be achieved through improving access to improved technology, infrastructure, finance as well as market outlets of the small and medium scale farmers. CADP is ended and the success stories of the

Project were reported by Salisu (2012) and Bako (2012) that it increased productivity, income, food security as well as assets in Kaduna State (these two studies were conducted before the end of CADP).

Although there have been studies on the CADP in the country (Salisu, 2012; Bako, 2012; Ngene, 2013), none of them has so far considered whether the Project was pro-poor or anti-poor. The fundamental evaluation problem for all projects irrespective of the sector is to determine what would have happened had there been no project. The central question any impact evaluation attempts to answer is the question of how individuals who benefited from an intervention would have fared if they had not benefitted from it – this is the counterfactual. Hence, in a bid to know the impact of a project on a given indicator, information on those who benefitted from intervention and those who did not would be compared to conclude on the impact. However, since it is not possible for those who benefitted and those who did not to be the same, it becomes necessary to create another group from the population who were not exposed to the intervention – the counterfactual group. This group must be as much as possible similar to the group that had benefitted from the intervention to allow for attribution of any differences outcomes to the project.

This study evaluated the impact of CADP on agricultural productivity and poverty status of beneficiaries in the five states that participated in the Project namely: Cross River, Enugu, Kaduna, Kano and Lagos States in Nigeria using a counterfactual approach. The questions of relevance addressed in this study are:

(1) Did the CADP increase the productivity of beneficiaries?

(2) What was the impact of socioeconomic variables on the productivity of CADP beneficiaries?

(3) How did the project impact on the poverty status of beneficiaries?

(4) Did CADP impact commercialization among beneficiaries?

(5) Was the CADP pro-poor?

1.3 Objectives of the study

The main objective of the study is to determine the impact of CADP on the productivity and poverty of farmers in Nigeria.

The specific objectives of this study are to:

1. Determine the level of productivity for beneficiaries and non-beneficiaries;
2. Examine the socioeconomic determinants of productivity of beneficiaries and non-beneficiaries;
3. Investigate the impact on the productivity of project beneficiaries and non-beneficiaries.
4. Analyze the impact on poverty status of 'beneficiaries and non-beneficiaries';
5. Analyze the impact on commercialization of beneficiaries and non-beneficiaries;
6. Ascertain the pro-poorness of Commercial Agricultural Development Project.

1.4 Research hypotheses

The following null hypotheses are tested:

H_O1 There is no significant difference between the productivity of CADP beneficiaries and non- CADP beneficiaries.

H_O2 There is no significant difference between the poverty status of CADP beneficiaries and non-CADP beneficiaries.

H_O3 There is no significant difference in commercialization between CADP beneficiaries and non-CADP beneficiaries.

1.5 Scope of the study

The study covered the production stage of beneficiary and non-beneficiary farmers in the five states that participated in the Commercial Agriculture Development Project in Nigeria.

1.6 Justification of the study

There have been several attempts to boost agricultural productivity with a view to increasing income and consequently reduce poverty. Evidences abound to support the fact that no other sector has such a comparably high impact on poverty. Growth in the agricultural sector stimulates growth in other sectors related to the economy, which, in turn, results in employment generation and reduction of poverty. This results in increased demand for agricultural goods, acting as a growth multiplier in the agricultural sector (Brown and Haddad, 2020). The regional differences in the reduction of poverty over the last few decades could be adduced to the adoption of technology and its attendant impact on agricultural productivity in different parts of the world. These differences have sparked increased public and private participation in development efforts through investments and there is the need to provide evidence of impact in order to justify continuous investment or otherwise (Maredia, Shankar, Kelley and Stevenson, 2013). Therefore, this study will be relevant to poverty reduction efforts which are important in the development agenda of developing nations

In an attempt to increase productivity among Nigerian farmers by increasing the production and income as a strategy to meet up with the goal of poverty reduction, the Federal Government of Nigeria in collaboration with the World Bank came up with the Commercial Agricultural Development Project. The emphasis being placed on agriculture by successive governments through the initiation of several

development programmes since independence justifies the need for an empirical evaluation on the impact of the CADP in the pilot states. Generally, development programs are concerned with how best to improve the wellbeing of people of the society. In attempting to do this, there is need to examine how best policies or programmes are working. In formulating strategies aimed at poverty reduction, separation of benefits that accrue to the poor as distinct from general economic growth is crucial for poverty analysis. If development is to be achieved in the developing world, much more pro-poor growth should be their focus (Son, 2007). However, to the best of the knowledge of this author, the description and quantification of the link between productivity and poverty using farm incomes as proxy has not been widely researched. There is no doubt that indicators measuring the impact of productivity gains on income generation and poverty are useful for policy-making and monitoring especially in developing countries.

The findings of this study would serve as a guide to policy makers, donor agencies and other organizations on how to address issues pertaining to agricultural productivity, poverty and commercialization in Nigeria. Also, it will contribute to existing literature on impact of developmental programmes which is of utmost concern to policy makers who need to know whether such programmes are generating intended outcomes and impact. The academia and the general public as well will benefit immensely for future interventions.

1.7 Organization of the study

After this introductory chapter, the second chapter focuses on the review of literature and empirical literature as well as theories relating to the studies main constructs - Agricultural Productivity, poverty, pro-poor growth and commercialization. The third chapter focuses on the methodology while the fourth

chapter is the data presentation and analysis. Conclusion, summary and policy recommendations as well as suggestion for further studies would be the focus of the fifth chapter.

1.8 Definition of terms

Productivity

This is the index of the ratio of the value of total output to the value of total input used in the production process. It could also be referred to as the measure of increasing output per unit of input used in achieving the desired objectives of engaging in production process.

Poverty

This is a condition where people's level of income falls below some minimum level necessary to meet their basic needs like housing, clothing and feeding. The minimum basic level of income as stated 'by the World Bank in this case is $1.90 per day'. This implies that any family or individual living below the benchmark of $1.90 per day is regarded as poor.

Commodity interest groups (CIG)

These are registered cooperative groups made up of 10-20 farmers who have been into the business of farming in a particular value chain for a period of not less than 3-5 years, driven by the passion for farming and are registered with CADP apex farmers association CADA indicating the area of intervention that they seek to obtain from the project.

Commercial agriculture development association (CADA)

This is an association of all farmers who have indicated interest to benefit in CADP intervention or farmers who are already beneficiaries of the project. All CIGs that have benefited or intending to benefit must be registered with CADA.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical framework

The theoretical frame of productivity, poverty, pro-poor growth and commercialization theories serves as the bases for this study.

2.1.1 Theory of productivity

Productivity is a key factor in production performance of firms and nations. Efforts at amplifying national productivity can bring about increased standard of living as more real income increases purchasing power, improved housing and education and contributes to social and environmental programs. The economic theory of productivity measurement has its roots in the work of Jan Tinbergen (1942) and Solow (1957) who formulated productivity measures in a production function context, linking them economic growth analysis. Over the years however, the field has expanded further due to major contributions by some scholars. Now, 'this theoretical approach to productivity measurement offers' a consistent and -well-founded approach as it integrates the theory of the firm, index number theory and national accounts.

The standard framework for estimating productivity change is derived from the theory of production which is expressed in the form of production function. It describes the technical relationship between the inputs and outputs of a production process (Coelli, Rao and Battesse, 1998). It defines the maximum output(s) attainable from a given vector of inputs. The underlying assumptions for this postulate are: (i) the production process is mono-periodic, (ii) 'all inputs and outputs are homogenous (iii) the production function is twice continuously differentiable'(iv) the production function and the output and input prices are known with certainty (v) there is no

budget constraint and (vi) the goal of the firm is to maximize profit (minimize cost for a given level of output). Econometrically, this theory can be expressed in its functional Cobb-Douglas form for two variable inputs as:

$Y = AL^{b1}K^{b2}e$

Where;

Y= level of output

L and K = variable inputs

A = multiplicative constant

b^1 and b^2 are the coefficient of L and K and they represent the direct measure of elasticity of the respective factors of production.

e = error term.

The sum of b^1 and b^2 bespeak the nature of returns to scale. Although the production function of Cobb-Douglas has the disadvantage that it cannot show both increasing and diminishing marginal productivity in a single response curve and that does not allow it to give a technical optimum which may lead to the over estimation of the economic optimum. Despite these disadvantages researchers still find the Cobb-Douglas production function useful in survey analyses where the inputs involved have many variables and it is necessary to measure returns to scale, intensity of factors of production and overall efficiency of production. Coelli *et al.* (1998) noted that it is easy to mathematically manipulate and estimate.

Econometric approaches to productivity measurement basically involves measuring the parameters of a specified production function like cost, revenue, or profit function, as well as other parameters of the production technology. This additional information cannot be generated by the 'growth accounting or index number approaches'. In addition, since the input and output information is the

cornerstone of econometric approach, it allows for greater flexibility in specifying the production technology.

I. The index number theory to productivity measurement

The use of economic index numbers (IN) to measure productivity, production, and input use tends to be more effective than using physical measures. A real number that measures changes in a set of related variables is an index number (Coelli *et al.*, 1998). These numbers could serve for comparisons over time or space or both and are used in measuring changes in price and quantity over time, and especially to estimate the differences in the levels across firms, industries, regions or countries. The number theory is important to the aggregation of inputs and outputs. The precise importance of the theory to productivity measurement is related to the economic assumptions about the underlying aggregation functions.

In estimating productivity, the IN approach involves dividing quantity index of an output by the quantity index of an input to yield a productivity index (McLellan, 2004). This can be expressed as follows:

$$A_t = \frac{Q_t}{X_t} \qquad \text{...} (1)$$

Where;

$t = 0, \ldots, T$

A_t is a productivity index,

Q_t is an output quantity index and

X_t is an input quantity index

Every index considered individually stands for the growth accumulated from period 0 to period t. When X_t is a single input, such as labour or physical capital, A_t is a partial productivity index; for example labour and capital productivity. However, when there

are 'two or more inputs in X_t then A_t is a multifactor productivity index'. The multifactor productivity is most often formed using labour and physical capital.

In constructing productivity indices, disaggregated prices and quantities of outputs and inputs are used. The heterogeneous nature of outputs and inputs makes it impossible to add every output to obtain an output quantity index or every input to obtain an input quantity index. Instead, disaggregated data based on the volumes of outputs and inputs are weighted to obtain output and input quantity indices. When forming output and input quantity indices, the prices of the output and input or their nominal shares usually serve as representative weights.

The economic index numbers which are usually used in constructing output and input indices as identified in literature are four. There include: Fisher Ideal, Laspeyres, Paasche and Tornqvist. The indices align with different methods of approximation as shown in 'the formulae of their aggregator functions, with correspondingly different' properties. The most widely used traditionally among the indices are Laspeyres and Paasche, however, there is increasing awareness and application of the Tornqvist and Fisher Ideal.

2. Growth accounting and productivity estimation

Growth accounting allows for decomposition of output growth into that of the diverse inputs (such as capital and labour) and changes in total factor productivity. The accounting demands that 'a production function defining the level of output that can be produced at some particular time given the availability of a certain level of different inputs and total factor productivity' be specified.

The production function can be presented thus:

$$Y_t = A_t f(K_t, L_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where Y_t = output at time t,

A_t = total factor productivity at time t,

K_t = capital stock at time t, and

L_t = a measure of available labour at time t.

According to McLellan (2004), the growth accounting approach has many underlying assumptions which are very important. Firstly, the technology or the total factor productivity term, A_t, can be separated (see equation 2). Secondly, the 'production function exhibits constant returns to scale'. Thirdly, 'it is assumed that producers behave efficiently in that they attempt' to maximize profits. Fourthly, perfect competition is assumed and all participants in the market are price-takers whose impact is limited to adjustment of quantities but have no individual impact on prices.

$$\dot{Y} = \dot{A}f(K, L) + \frac{\partial f}{\partial K}\dot{K}A + \frac{\partial f}{\partial L}\dot{L}A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

...the dots show'first partial derivative with respect to time. Dividing (3) by Ygives':

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + A\frac{\partial f}{\partial K}\frac{\dot{K}}{Y} + A\frac{\partial L}{\partial L}\frac{\dot{L}}{Y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Note that the subscript 't' has been dropped for simplicity.

Output elasticity 'with respect to labour (w_L) and output elasticity with respectto capital (w_K) can be written as':

$$w_L = \frac{\partial Y}{\partial L}\frac{L}{Y} = A\frac{\partial f}{\partial L}\frac{L}{Y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$w_K = \frac{\partial Y}{\partial K}\frac{K}{Y} = A\frac{\partial f}{\partial L}\frac{K}{Y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Equation (4) can consequently be written as

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + w_K\frac{\dot{K}}{K} + w_L\frac{\dot{L}}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

Making $\frac{\dot{A}}{A}$ the subject of the formula

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} + w_K\frac{\dot{K}}{K} - w_L\frac{\dot{L}}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Where;

$\frac{\dot{A}}{A}$ = total factor productivity growth

$\frac{\dot{Y}}{Y}$=the growth rate of real output

w_K= share of income paid to capital and,

w_L= share of income paid to labour

The above expression shows that 'Total Factor Productivity (TFP) is a residual which is that part of the total growth of real output that cannot be explained by growth in two inputs- labour or capital alone'.

Since the goal of the CADP is to boost production, yield and sales by funding the dissemination of a of improved technology packages based on best practices which included: 'propagation, use of high quality seeds and seedlings of improved, exotic, high yielding and pest and disease resistant varieties, improved agronomic practices' etc, use of index numbers is very relevant to this study. The index numbers which also measures differences in productivity levels across firms will be used to analyze the differences in productivity measures of beneficiaries and non-beneficiaries.

3. The stochastic production function frontier to productivity measurement and efficiency

The Stochastic Frontier uses parametric methods to estimate efficiency and productivity. Using the stochastic frontier method to measure productivity will require the application of distance function using Malmquist index. Distance functions "allow one to describe a multi-input, multi-output production technology without the need to specify a behavioural objective such as cost minimization or profit maximization". The function could be input or output based. The distance function of an input describes the 'production technology by looking at a minimal proportional contraction

of the input' vectors, 'given an output vector', whereas that of 'an output considers a minimal proportional expansion of the output vector, given an input vector'.

The output distance function can be defined on the output set P(x) as follows:

$d_o(x,y) = \min\{\delta : y/\delta) \in P^t(x)\}$

'The distance function $d_o(x,y)$, will take a value which is less than or equal to one if the output vector, y, is an element of the feasible production set, P(x). Also, the distance function will take value of unity if y is located on the outer boundary of the feasible production set, and will take a value greater than one if y is located outside the feasible production set.

The Malmquist index measures the Total Factor Productivity (TFP) change between two data points by calculating the ratio of the distances of each data point relative to a common technology'. 'Malmquist output oriented TFP change index between period *s* (the base year) and period *t* is given by':

$$Mo(y_s, x_s, y_t, x_t) = [d_o^s(y_t, x_t)/d_o^s(y_s, x_s) * d_o^t(y_t, x_t)/d_o^t(y_s, x_s)]^{1/2} \quad \ldots\ldots\ldots (9)$$

'Where the $d_o^s(x_t, y_t)$ represents the distance from the period t observation to the s technology. A value of Mo greater than one will indicate positive TFP growth from period s to period t while a value less than one indicates a TFP decline'.

Equation (9) can also be rewritten as:

$$Mo(y_s, x_s, y_t, x_t) = d_o^t(y_t, x_t)/d_o^s(y_s, x_s)[d_o^s(y_t, x_t)/d_o^t(y_t, x_t) * d_o^s(y_s, x_s)/d_o^t(y_s, x_s)]^{1/2} \quad \ldots\ldots\ldots (10)$$

It should be noted that 'the ratio outside the brackets measure the change in the output oriented' measures of 'Farrell technical efficiency between period s and t' (see equation 11.)

$$\text{Efficiency change} = d_o^t(y_t, x_t)/d_o^s(y_s, x_s) \quad \ldots\ldots\ldots (11)$$

'i.e. Change in efficiency in period t divided by change in efficiency in period s and';

Technical change = $[d_o^s(y_t, x_t)/d_o^t(y_t, x_t) * d_o^s(y_s, x_s)/d_o^t(y_s, x_s)]^{1/2}$..... (12)

Assume a parametric case of a stochastic production function defined as follows:

$\ln(Y_{it}) = f(X_{it},t,\beta) + V_{it} - U_{it}$ i=1,2,...N, t=1,2,...,T ..... (13)

'Where Y_{it} is the output of the i^{th} firm in the t^{th} year;

X_{it} denotes a (1XK) vector of inputs

f(.) is a suitable functional form

t = time trend representing technical change;

β = vector of unknown parameters to be estimated;

the V_{it}s are random errors, assumed to have $N(0,\sigma_v^2)$ distribution, independent of the U_{it}s; and U_{it}s are technical inefficiency effects', measures of technical efficiency and technical change can be used to calculate the Malmquist TFP index via equations (10-13).

'Technical Efficiency measures are obtained as:

$TEit = E(\exp(-u_{it}/e_{it})$ ..... (14)

Where $e_{it} = v_{it}-u_{it}$ can be used to calculate the efficiency change component. That is, by observing that

$d_o^t(x_{it}, y_{it}) = TE_{it}$ and

$d_o^s(x_{is}, y_{is}) = TE_{is}$

We can calculate efficiency change as'

TE_{it}/TE_{is} ..... (15)

Works by Farrell (1957) as cited in Coelli *et al.* (1998) stated that, the efficiency of a firm comprises two components of; technical efficiency which refers to a firm's ability to obtain maximal output of a given set of inputs, and allocative efficiency, which reflects the ability of a firm to optimize the inputs considering their respective prices and production technology. A combination of these two measures

combine to provide a measure of total economic efficiency. The assumption that all firms are profit maximizers or cost minimizers is disregarded and it is most appropriate for public sector analysis and non- profit organization.

2.1.2 Poverty: Concept and theoretical framework

Poverty has varied influence on many aspects of the human existence, including; physical, moral, and psychological; its pervasive nature makes it impossible for a succint and universally accepted definition of poverty. The international poverty line was updated in 2015, by the World Bank to us$1.90 a day, from us$1.25 a day.

There exists 'three main schools of thought on poverty'. These are; the Basic Needs, Capability, and Welfarist. Though they are divergent in their approaches, they unify in the fact that "something", defined by each school is not at a reasonable minimum level. This means that an individual 'is judged to be poor whenever he or she is lacking, with respect to the reasonable minimum, the particular "thing" in question'. The nature of that missing thing has been the focus of conceptual debates regarding poverty.

The welfarist, defined that "something" as economic 'well-being at the individual level' or economic welfare at the aggregate level. Well-being is systematically used at the individual level while welfare is used at the aggregate level. This approach simplified 'the concept of well-being to' utility sometimes referred to as standard of living. To the welfarist, utility is likened to psychological feelings like happiness, pleasure, desire and fulfillment derived after consuming a commodity (Asselin and Dauphin, 2001). The 'approach is anchored in classical micro economics where' welfare or utility accounts for the behaviour and well-being of individuals. This school posits that, "Poverty exists in a given society when one or more persons

do not attain a level of economic well-being deemed to constitute a reasonable minimum by the standards of that society". To the welfarist, the utility level is a function of the income; 'poverty is then defined as a socially unacceptable level of income thus policies' aimed at poverty reduction will be geared towards boosting the productivity of the poor. Hence, the approach recommends policies for employment generation, increasing productivity with a view to boost income in order to fight poverty. This school is the dominant in the approaches to poverty reduction and is a leader among development organizations and the World Bank in particular favour and promotes the concept.

The other two schools which are non-welfarist are the Basic Needs school approach and Capability school approach. The Basic Needs school dates back to the early 1900s with the studies of Rowntree and only took form in the seventies, in defense of the individuals who are in need and are being neglected. This school argues that the "something" the poor lack is minimal'subset of goods and services which are essential' in meeting the basic needs of every human. "Basic needs" implies that satisfaction of these needs is needed prior condition to qualitative living; though they were never interpreted as originators of well-being. The attention of Basic needs school is more on the basic commodities the individual requires rather than utility. Under this approach, 'the attention is on individual requirements relative to basic commodities' and not utility. 'The basic goods and services include: food, water and sanitation, shelter, clothing, basic education, basic health services, and public transportation'. These needs transcend adequate nutrition, shelter and clothing which are those necessary for existence. The Basic Needs theorize 'that a set of selective policies makes it possible to satisfy the basic human needs though it still recognizes the intentions of policies target at increasing revenue in the fight against poverty'.

The third school is the capability school, an economic theory conceived by its principal advocate, Amartya Sen, in the 1980s. The core focus of the theory is on what individuals are capable of doing, claiming that an individual is of greater value than utility. Capability of an individual to have 'a good life is defined in terms of the set of valuable 'beings and doings' like being in good health and having loving relationships with others'. The state of 'beings and doings' are called functionings which is able to alter from such basic physical functions as being well-fed, sufficiently clothed and protected, avoiding illnesses that can be prevented and the likes, to more complex social achievements like involvement in decision making in the community, being able to appear in public without shame, and so on (Sen, 1983). The capability school alludes to the set of valuable functionings that a person has effective access to. As a result, an individual's capability typifies the effective freedom to choose between different combinations of being. As such, poverty here is viewed as deprivation in the capability to live a good life hence policies aimed at expanding capabilities will be relevant in fighting poverty.

The Welfarist approach which recommends policies aimed at 'increasing productivity, employment and thus income in order to alleviate poverty' is more relevant to this study considering that the long term outcome of the CADP is improved welfare encapsulating increased productivity, increased income and improved standard of living.

2.1.2.1 Measurement of poverty

A statistical function that converts 'the comparison of the indicator of household well-being and the chosen poverty line into one aggregate number for the entire population'or a subgroup of the population is the poverty measure (Coudouel *et al.*, 2002). There are several models for measuring poverty. Some of these models

are: FGT weighted poverty measure (Foster, Greer and Thorbecke, 1984), Sen Index (Sen 1976), Human Development Index (HDI) etc. There are several measures in existence, but the three most commonly used which are described as follows.

a. Incidence of poverty (Headcount index)

Simplest and best known poverty measure/index and is simply a 'ratio of the number (or %age) of poor individuals to the total number (%age) of individuals in the population'. The index 'measures the number of %age of the population living below the poverty line'. It is 'based on a poverty line derived by costing a minimum basket of essential goods for basic human survival, using the' information of non-poor households on income, consumption or expenditure (Lok-Dessallien, 2000). However, one of the limitations of the Headcount index is that it failed to show the degree to which the poor are immiserated and rests on the assumption of homogenous 'income distribution of the poor population'. The focus is solely on the numbers of the poor and not on the depth of poverty. Although headcount index provides useful information magnitude of the poverty problem, it does not consider that individuals are different and is insensitive to those differences especially with respect to the depth or severity of their poverty.

b. Depth of poverty (poverty gap)

Depth of poverty or 'poverty gap is the difference between the poverty line and the mean income of the poor, expressed as a ratio of the poverty line' (World Bank, 1993). The result is the average depth of poverty or the poor's degree of immiseration of the poor. Poverty gap informs on the extent at which 'households are from the poverty line'. It 'captures the mean aggregate' income or 'consumption shortfall relative to the poverty line across the whole population'. Addition of all the shortfalls of the poor, given the assumption of zero shortfall for the non-poor, and

dividing the total by the population gives the poverty gap. In essence, it is an estimate of 'the total resources needed to bring all the poor to the level of the poverty line (divided by the number of individuals in the population)'. The measure is also relevant for nonmonetary indicators, as long as the measure of the distance is meaningful.

c. Poverty severity (squared poverty gap)

Poverty severity considers the 'distance separating the poor from the poverty line (the poverty gap)'and inequality among the poor. By this, a higher weight is placed on the households that 'are further away from the poverty line'. The limitation of the poverty gap measure is that it is not relevant for some of the nonmonetary indicators and cannot be applied for such.

d. Disparity of Income Distribution

This measure includes a combination of Lorenz Curve (LC) and Gini Coefficient (GC) to present the distribution of poverty (Atkinson, 1970; Gastwirth and Glauberman, 1976 cited in Danaan, 2018). 'The LC is a graphical representation of the variance in the extent of income distribution with the cumulative %age of the poor population on the vertical axis and cumulative %age of income of the poor on the horizontal axis.' On the other hand, Gini coefficient measures the income distribution based on the Lorenz Curve. It is 'the difference of a country's actual income distribution from a theoretically equal distribution'. When the GC is high, 'a higher level of income inequality 'is implied while a low GC implies a more equitable distribution of income. Its limitation however lies in its failure to ascertain 'the number of people below the poverty line' which makes it subject to a lot of criticism. This study used the measures of: Headcount index, poverty gap, and poverty severity

in analyzing the impact of the CADP on poverty status on beneficiaries. Their preference stemmed from the fact that these measures are quantifiable and provide estimates of the magnitude of the poverty problem.

2.1.3 Pro-poor growth

There is a paradigm shift in the field of Development from the theory that broad economic development is good for everyone in the society and only few today are of the view that the trickle-down theory works in practice. The concern of how much the poor benefits from the growth process is redefining approaches targeted at addressing poverty to include pro-poor measures. Such measures include: addressing economic poverty (increasing access of the poor to affordable credit; promoting income-generating opportunities), building human capacities (ensuring sustained access to education for all especially the girl-child, vocational skills training) and addressing political aspects of poverty (facilitating collective action, enlightenment of the poor and vulnerable of their rights, building negotiation capacities etc.). Others are: addressing socio-cultural aspects of poverty (facilitating full gender equity, giving voice to the voiceless especially in community decision making process, supporting groups discriminated against to claim their rights) and building protective capacities (building peoples resilience).

Pro-poor policies are not complete in themselves but aid to an end in that they are aimed at achieving pro-poor growth. There are different definitions of the term pro-poor growth. According to Pernia (2003), it is economic growth whereby the poor benefit proportionally 'more than the non-poor, that' is, the income levels of the poor increased relatively to those of the non-poor. Others like Ravallion and Chen (2003); DFID (2004), define it as economic growth that resulted in reductions of absolute poverty. The different interpretation of the concept by Economists has resulted in

different measurements as well. For instance, Kakwani and Pernia (2000), posited that 'a growth pattern is pro-poor if the' income of the poor grows at an increasing rate relative to the income of the non-poor. Literature refers to this definition as the relative approach. On the other hand, Ravallion and Chen (2003) came up with an opposing view that 'a growth pattern is pro-poor' if and only if the income of the poor grows irrespective 'of how much the non-poor may have gained. This is the absolute approach'. An in-between definition has also been introduced as seen in Osmani (2005). What makes these approaches different is their choice of a benchmark for comparison.

They have been five approaches commonly used for defining and measuring pro-poor growth, in recent years. On the basis of methodology and other empirical leanings, Son (2007) using issues that are related to these approaches analyzed the strengths and weaknesses of each approach. The analysis was done in view of: (i) choice of approach in definition; that is use of the 'general or strict approach to' define 'pro-poor growth, and further, the relative or absolute approach under the strict'; (ii) requirement of a specific poverty line or poverty measure (partial or full approach) and (iii) satisfaction of the monotonicity axiom.

1. General versus strict

Having growth and understanding how the benefits therein are distributed across the entire population comprising poor and non-poor are very crucial to poverty reduction. "One major stream and indeed general definition of pro-poor growth is growth where poverty declines, irrespective of (i) or (ii) or both". With 'this definition, growth will always be pro-poor whenever' there is reduction in poverty. The approach used by Ravallion and Chen (2003) falls under this definition. Whereas 'the strict definition of pro-poor growth emphasizes how the benefits of growth are

distributed among the poor and' non-poor in society. Under the strict definition, the sole focus is 'on growth that leads to poverty reduction' and the benefits of growth accrue largely to the poor (Son, 2007). The 'strict definition of pro-poor growth' has been widely applied by scholars like McCulloch and Baulch (2000); Kakwani and Pernia (2000); Kakwani and Son (2007); Son (2004). A typical example is seen in the 'case of People's Republic of China (PRC)' where economic growth has been notably remarkable and widely acknowledged by the international community. It was however discovered that the growth notwithstanding, there has been rising inequality in the country as the 'benefits of the growth have been flowing more to the' non-poor than to the poor, in which 'case the general approach will always argue that growth is pro-poor, but the strict approach will claim otherwise' (Son, 2007). Concerning the general approach, 'growth is defined as pro-poor if the income of the poor increases by $1 'while that of the very rich increases by $1million. This scenario, however, will always be anti-poor 'based on the strict approach to defining pro-poor growth'. Since the term "pro-poor" 'literally means in favor of the poor' it is pertinent to ensure that it is analyzed from a distributional perspective.

A further classification of the studies that utilized the strict approach to define pro-poor growth can be done 'into relative or absolute approach'. Economic growth that proportionally 'benefits the poor more than the non-poor' is focus of the relative concept. This implies that 'while growth reduces poverty, it also addresses inequality. Relative approach is used as it 'looks into the relation between growth and poverty reduction because it implies a reduction in relative inequality'. In the same vein, 'a measure of pro-poor growth is absolute' when after a comparison of the absolute benefits from growth is done, the poor gains more than the non-poor. The implication of this definition is that absolute inequality would fall during the course of growth. It

provides the 'strongest requirement for achieving pro-poor growth'. As a consequence, there is more difficulty in achieving 'absolute pro-poor growth than relative pro-poor growth (Kakwani and Son, 2007)' in Son (2007).

2. Partial versus full approach

Growth in the partial approach, is classified as either 'pro-poor or anti-poor without' a specific poverty line and measure. Ravallion and Chen (2003) suggested a measure which falls under the partial approach to the end that growth that favours the poor is also defined though not completely on the "first-order dominance (FOD) condition". Also, a study by Son (2004) on measuring growth that accrue to the poor 'can be also categorized as partial because a growth process is primarily determined to be' in favour of the 'poor or not using stochastic dominance curves'. The superiority of the approach is 'that it is valid for all poverty lines and measures'. It is however restricted in its failure to satisfy the dominance condition, which is a requirement for inference on 'whether a growth process' favours the poor or not. By this, the dominance conditions approach may be referred to as "partial." There is also the limitation of the inability of the partial approach to provide information on the degree of 'pro-poorness of a' particular growth.

Under the full approach however, there is always 'a conclusive result as to whether or not growth is pro-poor'. The works of some Economists such as Kakwani and Son (2007), Ravallion and Chen (2003), McCulloch and Baulch (2000), and Kakwani and Pernia (2000) can be categorized 'under the full approach' where growth is estimated using 'a rate or an index of pro-poor growth', as opposed to a curve thus giving a complete ranking of growth processes. For successful implementation, a poverty measure as well as poverty line which are chosen by value judgment are required.

3. Monotonicity criterion

The implication of the monotonicity criterion is that the enormity 'of poverty reduction should be a monotonically increasing function' of pro-poor growth rate. An essential though not 'sufficient condition for poverty reduction' is maximizing growth (Son, 2007). This criterion favours 'a measure of pro-poor growth that captures a direct linkage (or has monotonic relation) with poverty reduction'. This implies that policies aimed at reducing poverty should consider the distribution of such benefits among the individuals in the society and not just growth. As such, a pro-poor growth measure that satisfies the monotonicity criterion provides a necessary and sufficient condition for the reduction of poverty (Son, 2007).

2.1.3.1 Measurement of pro-poor growth

The measurement of "pro-poor growth" differs among scholars just like its interpretation. However, its measurement differs significantly from the standard poverty measurement. Though scholars are not unanimous in their approach to the definition and measurement of pro-poor growth, literature revealed five measures, insights on each approach is discussed here. 'There is no consensus as to how pro-poor growth is defined and how it is measured. Nevertheless, the comparative study of five alternative measures of pro-poor growth provides insight on each approach and is hereby discussed'.

A. Poverty bias of growth (PBG)

One measure of pro-poor growth proposed by McCulloch and Baulch (2000) is the "poverty bias of growth (PBG)". The focus of PBG is particularly on reduction of inequality. It 'is derived from the negative of the inequality component obtained from the symmetric poverty decomposition methodology suggested by Kakwani

(2000)', who broke down 'the change in poverty' to "growth and distribution effects". 'Growth effect measures the change in poverty when' income distribution is fixed, while 'distribution effect captures the change in poverty when inequality changes in the absence of growth'. Distribution effect can be positive or negative depending on whether growth is accompanied by improving or worsening inequality. In evaluating the pro-poorness or otherwise of growth, PBG provides estimates on the 'extent to which the observed pattern of growth deviates from a distribution-neutral benchmark' (Son, 2007).

Under PBG, decision as to whether the poor has benefitted from growth is done 'by comparing the actual' income 'distribution with that which would have occurred under the distribution-neutral scenario' (Son, 2007). This measure shows a relative approach to pro-poor growth definition. The PBG measure is limited by its failure to meet the monotonicity criterion at all times. Since poverty is also a function of the growth effect, 'higher values of the PBG' does not necessarily mean 'greater reduction in poverty'. It is only upon assumption of constant growth effect 'which is highly unlikely', that 'the PBG measure will satisfy the monotonicity criterion'.

B. Pro-poor growth index (PPGI)

Using the idea of poverty decomposition, Kakwani and Pernia (2000) reflected that poverty reduction is a function of the 'rate of growth and the change in income distribution and' considered growth as pro-poor only 'when the benefits that accrue to the poor are proportionally more than those received by the non-poor' (Son, 2007).In measuring the degree of pro-poorness, Kakwani and Pernia proposed 'a pro-poor growth index (PPGI)' which 'shows the relation between total poverty reduction and poverty reduction that result from a distribution-neutral growth'. The 'relation is expressed in the ratio of poverty elasticities'. A pro-poor growth scenario has a PPGI

of greater than one (>1), and in the case of trickle-down, the PPGI lies between zero and one (0<1), whereas a negative PPGI (<0) indicates immiserizing growth scenarios. This index did not satisfy the monotonicity criterion just like the PBG.

C. Poverty equivalent growth rate (PEGR)

In order to make up for this failure of the PPGI which only captures how growth benefits are distributed 'among the poor and non-poor but' failed to 'consider the level of actual growth rate, Kakwani and Son (2003)' went ahead to propose the poverty equivalent growth rate (PEGR) measure. They posited that PEGR is that 'growth rate that will result in the same level of poverty reduction as the present growth rate if the growth process had not been accompanied by any change in inequality PEGR' estimate is obtained 'by multiplying PPGI by the growth rate of mean income'. The poor is said to have benefitted from the growth process when the 'PEGR is greater than the mean income growth rate' and otherwise when the PEGR estimate is less than the mean income. A PEGR estimate of between zero 'and the mean income growth rate', implies 'growth accompanied by an increasing' inequality 'wherein poverty still declines'. The scenario is referred to as "trickle-down" process 'since the poor receive proportionally less of the benefits of growth than the non-poor'. The gains or losses of the growth rate due to changes in the income distribution is reflected in difference between the PEGR and the benchmark growth rate (actual growth rate of mean income).The gains imply pro-poor growth scenario, while the losses imply anti-poor growth scenario. What makes the PEGR more appealing 'is that it links the changes in inequality with the gains or losses of the growth rate: a decrease in inequality leads to gain in growth rate' while an increase rate 'leads to loss in growth rate. The PEGR can be calculated separately for the entire class of

poverty measures including the headcount ratio, poverty gap ratio, severity of poverty index', as well as Watts's measure (Son, 2007).

This measure is quite endearing to scholars due to its advantage of addressing both the size of growth as well as the benefits which accrued to the poor from the growth process. Furthermore it satisfies the monotonicity criterion at all times in the sense that 'proportional reduction in poverty is a monotonically increasing function of the PEGR'. In order to 'accelerate reduction in poverty', PEGR should be maximized.

D. Growth incidence curve (GIC) and poverty growth curve (PGC)

Ravallion and Chen (2003) used a Growth Incidence Curve (GIC) to analyze a growth process. A GIC indicates 'growth rates in income at different %ile points'. A positive curve at all %ile points shows 'unambiguous reduction in poverty between two periods'. The implication of this is 'that as the GIC shifts upward at all points, the reduction of poverty is greater'. The limitations of GIC are two. Firstly, '(unlike the PEGR), GIC can be defined only for the Watts poverty measure' since 'Ravallion and Chen (2003) define the pro-poor growth rate as the area under the GIC up to the headcount ratio, which is shown to be equal to the change in the Watts poverty index'. Secondly, 'the GIC violates the monotonicity criterion. This occurs because Ravallion and Chen estimate their pro-poor growth measure using numerical integration up to the headcount ratio in the initial period. Their measure does not utilize the poverty rate in the terminal period. Kakwani and Son (2007) have proven that Ravallion and Chen's measure satisfies the monotonicity axiom under highly restrictive situations. These situations may occur: (i) when growth rates are positive or negative at all %iles below the headcount ratio at initial period; and (ii) when nobody crosses the poverty line between the base and terminal period'.

After the GIC, Son (2004) later 'proposed a poverty growth curve (PGC)' which 'can be estimated by the growth rate of mean income of the poor up to the pth %ile. Like the GIC suggested by Ravallion and Chen (2003), however, the PGC may be classified as a partial definition of pro-poor growth. As such, the PGC may not always provide conclusive results on the nature of pro-poor growth. Nevertheless, this curve can be computed without knowing a poverty line or poverty measure. Compared to the GIC, moreover, the PGC will always give more stable results: while the latter is derived from cumulative mean incomes, the former estimates income at each %ile. Estimating the mean at each %ile tends to be highly unstable'.

For the CADP which is the focus of this study, 'the value chains chosen by each of the participating states were based on the respective comparative advantage and their contribution to agricultural growth'. Investment in rural infrastructures (roads) is one of the main components of the CADP and a positive relationship exists 'between access to infrastructure and agricultural productivity and growth'. It is important to know if the poor has benefitted from the growth brought about by the Project. The most relevant of the approaches discussed is the PEGR which provides information on the magnitude of growth as well as the benefits of growth received by the poor.

2.1.4 Commercialization and measurement

Commercialization has various definitions depending on the focus and breadth, and its measurement is determined by these two factors. For the CADP which is being studied, commercialization is viewed from the perspective of increasing the proportion of marketed output following (Govereh, Jayne and Nyoro, 1999; Okezie *et al.*, 2008). Commercialization with respect to agriculture could 'be defined as the degree to which a farm household is connected to markets'. The

connection as recorded by Jaleta, Gebremedhin and Hoekstra (2009) 'can be observed at any given point in time, or as a dynamic process whereby a household increases its interaction with input or output markets over time'. The process contains as part the replacement of integrated farming systems by specialized crops, livestock, poultry, and aquaculture products. The process is endogenous and is followed by 'economic growth, urbanization and' shifting 'labour from the agricultural sector (Pingali and Rosegrant, 1995)'.

Agricultural commercialization implies a shift, which is often gradual, from subsistence to modernized farming, requiring 'that production and input decisions are based on profit maximization and reinforcing vertical linkages between input and output markets'. When properly harnessed, commercialization can produce 'welfare gains for farmers through comparative advantage and increased total factor productivity growth'. Conventional wisdom suggests that the passage from 'subsistence (or semi-subsistence) to commercial agriculture' is key for the economic development of low-income countries. The comparative advantage accruable allows 'agricultural commercialization' to enhance 'trade and efficiency, leading to economic growth and welfare improvement at the national level'. The expected result is the stimulation of 'a virtuous' circle 'which raises household income' and subsequent improvement in access, intake, 'food security and nutritional outcomes inside rural households'. For the CADP, commercialization was construed to involve; the 'participation in input and output market and the degree of participation in' such markets. That degree is ordinarily measured by the amount of commodities produced and 'offered to the market as compared to the total production'. Therefore, the production of production of marketable surplus from the selected enterprises over what is needed for own consumption was a major determinant

Theoretical underpinning of agricultural commercialization draws from agricultural transition, population and livelihood outcomes and its transition and the importance of increased agricultural productivity, labour productivity, market development and the growth of the industrial sector. This increased productivity can be achieved through commercialization. Commercialization is the pivot 'to the structural transformation process as greater input market orientation increases the demand for industrial goods and technology essential for production, increases household welfare through employment generation and increased labor productivity and enables the transfer of surplus in the form of food, labor and capital from the agrarian sector to the other sectors' (Pingali *et al.*, 2019)

There are various measures used by literature to distinguish 'a farm household as commercialized'. This includes whether the farm 'is producing a significant amount of cash commodities, or selling a considerable proportion of agricultural output'. Defining commercialization based on the 'resources allocated to cash crops may be misleading, as food crops are also often sold'. Three possible 'indices for measuring different and complementary aspects of commercialization' have been suggested to include: (a) 'proportion of agricultural output sold to the market and input acquired from market to the total value of agricultural production; (b) the ratio of the value of goods and services acquired through market transactions to total household income, including in-kind transaction; and (c) the ratio of the value of goods and services acquired by cash transactions to total household income' (Von Braun, 1994). The indices, with particular reference to 'variations of the first two, are the measures of commercialization most widely used in the literature'. Several theories support commercialization (Fafchamps and Shilpi, 2003; Garrett and Chowdhury, 2004).These models revolves around classic agricultural land use and

urbanization as it relates to agricultural commercialization. The part of 'infrastructure and market access in agricultural commercialization' in providing 'more opportunities for adoption of new technologies and enterprises' which characterized the CADP is also strongly supported in theory.

2.2 Analytical/methodological review

2.2.1 Impact assessment

An 'evaluation whose purpose is to attribute outcomes and impacts to project operations' is known as impact assessment (IA). It provides a framework for 'measuring the effectiveness of the activities' of an organization 'and judging the significance of the changes brought by the activities'. Impact assessment seeks to assess the alterations in the 'well-being of individuals, households, communities or firms that can be attributed to a particular project, program or policy'. Central to an impact assessment is the question of 'what would have happened to' beneficiaries of 'an intervention if they had not' benefitted from the program. It is targeted 'at providing feedback to help improve the design of programs and policies'. Impact evaluation could be conducted ex-ante or ex-post. The 'ex-ante analysis is part of the needs analysis and planning activity of the policy cycle' which 'involves doing a prospective analysis of what the impact of an intervention might be' for the purpose of policymaking. It involves quantitative techniques that attempts to predict the effects of a proposed policy. On the other hand, ex-post assessment is done to observe and identify with precision the direct and indirect effect of a policy to see whether the actual effects are those expected (Bourguinon and Pereira Da Silva, 2003; Todd, 2006).

Evaluating the 'impact of a program on a series of outcomes is equivalent to assessing the causal effect of the program on those outcomes'. Impact is the

difference between the relevant outcome indicator with the program and that without it (Ravallion, 2007). Differently put, it is that outcomes difference traceable to 'being in a project relative to control area for a person or' individual or 'unit randomly drawn from' a population of potential participants. This difference is often referred in the literature as Average Treatment Effect.

Impact evaluation can also look at unintended consequences of a particular intervention on beneficiaries. These consequences may either be positive or negative. Some areas addressed by impact evaluation include: how did the program affect beneficiaries? Are there any improvements which directly result from the program? What could be improved upon in the program? etc. The answers to 'these questions cannot be' merely 'measured by the' outcome of the intervention. However, 'there may be other factors or events that are correlated with the' outcome of the intervention but not caused by it.

The 'beneficiary's outcome in the absence of the intervention would be its *counterfactual*. *Counterfactual* is a hypothetical situation that says what would have happened to participants had they not participated in a program'. It refers to the state of affairs 'a participating subject would have experienced had he or she not been exposed to the program'. The 'counterfactual logics' attempts 'to answer the question: 'what would have happened without the intervention?' by comparing an observable world with a theoretical one, where the latter is intended to be identical to the former except for the presence of the cause and effect (Lewis 1973)'. The term 'counterfactual' is used to describe the latter because it cannot be observed empirically. To determine the counterfactual, the 'effect of the intervention' is netted out 'from other factors, this is' a complex task and not as simple as it sounds.

In impact evaluation, the term 'treatment effect' is of paramount interest and it makes reference 'to the causal effect of a binary (0–1) variable on an outcome variable of interest'. In Economics for example, it includes; the influence 'of government programmes and policies, such as those that subsidize training for disadvantaged workers, and the effects of individual choices like' participation in input subsidy programme. The main 'econometric problem in the estimation of treatment effects is selection bias, which arises from the fact that treated individuals differ from the non-treated for reasons other than treatment status' in itself. The effects of treatment 'can be estimated using social experiments, regression models, matching estimators, and instrumental variables'; which are broadly classified under experimental approach and non-experimental (quasi experimental) approaches.

2.2.2 Challenges in evaluating agricultural projects

There exist three challenges facing any impact assessment study. These challenges which are interrelated are: setting up a viable 'counterfactual that is, what would happen in the absence of the project' (the forecasted outcome in the absence of the intervention); attributing impact to a particular treatment; 'and coping with long and unpredictable time' lag (Alston and Pardey, 2001; Salter and Martin, 2001). Essentially, 'impact evaluation attempts to answer an essentially counterfactual question: how would individuals who participated in the program have fared in the absence of the program? How would those who were not exposed to the program have fared in the presence of the program?' Hence, in a bid to grasp the 'impact of a project on a given indicator, information would ideally be available on project beneficiaries with the project and those same beneficiaries without the project'. That indicator could then easily 'be compared between these two states to see if the project had an impact'. It is not often realistic to have beneficiary farmers 'simultaneously in the

project and out of the project making it necessary to find a substitute group of farmers to act as the counterfactual—that is, what would happen in the absence of the project'? In order to have an unbiased and legitimate counterfactual, it requires that the 'control group would need to be exactly like the project beneficiaries, or treatment group, except they would have not received the project'. This allows for attribution of 'any differences in the indicator to be from the project'.

It becomes imperative therefore that for a valid impact evaluation to be arrived at, a fundamental objective is 'to establish a credible comparison group, a group of individuals who in the absence of the program would have had outcomes similar to those who were exposed to the program'. The 'group should give us an idea of what would have happened to the members of the program group if they had not been exposed, and thus allow us to obtain an estimate of the average impact on the group in question'. With careful evaluation design, especially that which is factored in into the design phase of the project, 'prior to implementation, it is possible to create reasonable' counterfactuals thereby avoiding biased estimates of impact (Winters, Salazar and Maffioli, 2010).

The challenges which 'are specifically related to the evaluation of farmer-targeted agricultural projects' are: Bias and spillover effects. There are usually two 'sources of bias - program placement or targeting bias'; here 'the location or' the 'target population of the' intervention 'is not random'. There is also self-selection bias where farmers may choose to participate in a given project. These participants are of course have differences in their background, experiences, endowments and abilities. Hence, an attempt to assess the 'impact of a project by comparing those that chose to be in the project to those that did not' may be faulty as the observable 'differences in the indicator of interest may reflect not only the impact of the project, but also any'

unlearned 'differences between participants and non-participants'. Also, if farmers having 'certain attributes are chosen by the project to participate', selection is clearly an issue. For instance, take a project that 'focuses on farmers with limited land access, those with larger landholding are unlikely to be a good comparison'. The key 'objective of a sound impact' evaluation 'is to find ways to get rid of' these biases or to find ways to account for them.

2.2.3 Incorporating spillover effects

Spillover effects refer to secondary effects resulting from a primary effect. They are impacts of a project on non-participants. The spillover effects encompass 'externalities and interaction effects as well as general equilibrium effects'. The 'externalities and interaction effects are common in agriculture since agricultural practices, both production practices as well as mechanisms for interacting with the market, are often transferred from farmer to farmer'. Indeed, most 'agricultural extension and technology transfer projects are often designed' with a view to have spillover effects. For example, 'they may seek to train a limited number of farmers in a certain technology 'with the intention 'to create a critical mass of knowledge that spreads to other non-participant farmers. General equilibrium effects refer to how a project can have broader effects on the local economy'. The example here is, where 'projects can lead to changes in prices for inputs or for a particular output', and can thus 'be considered a general equilibrium effect'. If not considered, they may lead to incorrect estimates of impact. The challenge in designing agricultural development project is designing 'an evaluation that captures both direct' effects, 'spillover effects and the overall project' effects.

Agricultural research results in both technology and institutional development, and the effects of technologies and institutions spill over geographically. They may be

picked up by public and private entities for distribution. They may result in general equilibrium effects on employment and incomes (de Janvry and Sadoulet, 2002). Also, in identifying the counterfactual, this should be considered to ensure an uncontaminated control group. When effects such as highlighted 'are expected to be substantial they should be measured' (Winters *et al.*, 2010).

2.2.4 Considering the methodological options

The methodological approach is a function of the type of project and the available data or the ones that can be collected. Often times, multiple method employed to determine project impact. This is to check the robustness of the estimate of impact obtained. According to Winters *et al.* (2010), it is beneficial to consider alternative approaches as opposed to just an individual approach, to allow for verification the accuracy of impact estimates when designing evaluation strategy in project design.

2.2.4.1 Experimental approach

Experimental research, often considered to be the "gold standard" 'in research designs, is one of the most rigorous of all research designs' (Bhattacherjee, 2012). This design allows for manipulation of one or more independent variable(s) (as treatments), and 'are randomly assigned to different treatment levels (random assignment), and the results of the treatments on outcomes (dependent variables) are observed'. A common example is Randomized Control Trials (RCT). RCT is a type of scientific experiment which seeks to solve the problem of bias when testing a new treatment. It has its root in medical science but now widely applied in social research and have recently become popular in development evaluations and the agricultural development context (Ashraf, Karlan and Yin 2009; Duflo, Kremer and Robinson.

2011; Saenger, Torero and Qaim, 2014). This method is recommended for evaluating the impacts of interventions including improved agricultural technologies because they hold constant many confounding factors (Khandker, Koowal and Samad, 2010).

RCT perfectly addresses the attribution 'issue in impact evaluation' which is that, 'it is not possible to know what would have happened to project participants in the absence of the project'. The closest to this ideal 'would be a group that meets all the criteria to participate in the project and has a similar range of characteristics to the participants'. In RCT, this group is randomly assigned 'to a treatment group, who will 'be exposed to 'the project, and a control group, who will not receive 'exposure to project. Randomization addresses the challenge of selection as the mean outcome for programme participants (beneficiaries) relative to that of the control group provides an estimate of the Treatment on the Treated (TOT). Newman *et al.* (1994) has emphasized that in designing programs of sufficient interest warranting an impact evaluation, policy makers should consider randomized control design as this methodology yields the most robust results. For random experiments, baseline data and impact data on indicators of interest for treated group and control group are required.

The strength of this approach lies in the fact that it produces reliable estimates of program impact when properly designed and implemented, and enables development actors to know the effects of a single specific intervention, which often times tend to be hidden in data observed on a development package encompassing multiple interventions. In practice however, experiments are not only costly but individuals being aware of an ongoing experiment, might vary their actions and thereby influence the evaluation results, this is known as randomization bias. A way of overcoming this bias is not to inform individuals, as much as possible, that they are

not in the program. In order to detect a significant result, sample size must be sufficiently large to be able to detect a significant result. A major weakness of this approach is that it does not consider the possibility of spillovers from the treated to the untreated group.

2.2.4.2 Non-experimental/quasi experimental approach

In estimating treatment effects, there is no general approach. Different methods have been 'used in impact evaluation to address the fundamental question of missing counterfactual', with each of them having 'its own assumptions' on the nature of the 'potential selection bias in programme participation' as well as targeting. These assumptions determine the choice of appropriate model for analyzing project impacts. These methods include the before and after approach, with and without analysis, 'propensity score matching (PSM), difference in difference' estimators (DiD), Instrumental Variables (IV) and Regression Discontinuity (RD) approach.

i. Before-after estimator (reflexive comparison)

'The before-after estimator uses pre-programme data collected for selected programme participants and compares them with the data collected for the same enterprises (programme participants) after implementation of the programme'. The evaluation problem can be viewed as the problem of a missing data and is being addressed by using pre-programmed data to impute the missing counterfactual outcomes for programme participants (Todd, 2006). Under this approach to evaluation, impact indicators for beneficiaries before project implementation are compared to after the project. The difference is viewed 'as the estimate of Treatment on the Treated'. The 'problem with this reflexive comparison is that the observed

changes in time' T_0 => T_1 ('before and after the programme) cannot be clearly attributed to the programme; they might have occurred anyway'.

ii. Comparison of programme participants with arbitrary chosen nonparticipants (with and without)

The "with and without" comparison compares the outcome of beneficiaries with that of non-beneficiaries, with the difference constituting the impact. This 'approach relies on the assumption that in the absence of the programme the outcome indicator' of interest for 'participants would be the same as for non-participants. This assumption would be justifiable if the average performance of participants were almost identical with average performance of non-participants'. However, this is usually not the case because most 'programmes measures often target specific groups (by setting eligibility criteria); participants either outperform or under-perform' nonparticipants. 'If differences in performance of both groups prevail even without the programme, the selection bias in this estimator would be substantial'. Hence, this approach may lead to overestimation of the impact of an intervention.

iii. Difference-in-difference estimator (DiD)

Another research design for estimating causal effects is the 'difference in difference' (or "double difference") estimator which 'is defined as the difference in average outcome in the treatment group before and after treatment minus the difference in average outcome in the control group before and after treatment. It is literally' a "difference of differences". Its popularity in empirical economics and social sciences lies in its usefulness in 'estimating the effects of certain policy interventions and policy changes that do not affect everybody at the same time and in the same way'. In a DiD 'model, the relevant comparison is changes in the indicator over time. Thus, the comparison in a DiD model is between the trends in the control

iv. Propensity score matching (PSM)

'Propensity Score Matching (PSM) is a statistical matching technique that attempts to estimate the effect of a treatment or intervention by accounting for the covariates that predict receiving the treatment'. The matching allows for development of a counterfactual identical to the group that received treatment as much 'as possible in terms of observed characteristics'. The basis of PSM is that where experiment design was not factored into an intervention from the onset, 'assignment to treatment is frequently non-random, and thus, farmers receiving treatment and those excluded from treatment may differ in' other characteristics apart from treatment status 'that affect both participation and the outcome of interest'. PSM allows researchers 'to construct a statistical comparison group based on a model of probability of participating in the treatment using observed characteristics. Participants are then matched' with non-participants 'on the basis of this probability or propensity score'. This method creates what can be referred to as a "quasi-experiment" 'since the control group is *statistically equivalent* to the treatment group'. PSM was proposed 'by Rosenbaum and Rubin (1983), who suggested matching beneficiaries and non-beneficiaries solely on their 'propensity score'.

Propensity score is 'the estimated probability of being a beneficiary given observable characteristics'. It can be 'calculated by using a probit or a logit model in which the dependent variable is a dummy variable equal to one for participants and zero 'for non-participants'. Propensity score, reduces the problem of matching from a multi-dimensional plane to a one-dimensional plane. Each beneficiary is matched to non-beneficiaries 'most similar in terms of probability of being a beneficiary. This probability is calculated on the basis of individual characteristics. The Average Treatment Effect (ATE) of the' programme is then 'calculated as the' main

'difference in outcomes across' the two groups. Different matching methods are identified in literature as follows: a) nearest neighbour matching, b) caliper and radius matching, c) stratification and interval matching, d) kernel matching, e) local linear matching. The average effect is estimated for each outcome after forming 'the two groups of participants and non-participants 'by computing the difference in means of outcome of interest between the two groups.

Two conditions identified in literature for the application of PSM are: the *Conditional* Independence Assumption (CIA) and Overlap Condition. 'The *Conditional Independence Assumption* implies that after controlling for some set of covariates X the potential outcomes for treated and control (Y_1, Y_0) are independent of treatment status. The implication of this assumption is that participation in the project does not depend on the outcomes'. The assumption of *common* support or overlap 'condition ensures that treatment observations have comparison observations' "nearby" in the propensity score distribution (Heckman, LaLonde and Smith 1999). In other words, to assure comparability, 'non-participants with similar propensity to the participants' are identified.

Some advantages of PSM includes the fact 'that; it facilitates the identification of a counterfactual when the selection bias to be addressed is clearly due to observable characteristics of farmers', does not require randomization prior to program, 'may provide a good comparison with randomized estimates' where 'selection bias from unobserved characteristics is likely to be' negligible, and can be used where baseline data is non-existent. However, PSM data requirement is high making 'its application to agricultural projects challenging given the cost of data collection in rural areas'. Also, it is not appropriate for use 'when unobservable farmers' characteristics might affect both the outcome variables and the program

placement. These could be the case when beneficiary farmers self-select themselves in the program because of motivational, attitudinal or skill related characteristics and the outcome variable is also related to their motivation, attitude and skills, such in the case of productivity measures'.

v. Instrumental variables

Another approach to 'evaluation is the instrumental *variable* (IV)-based methods which are designed to remove both overt and hidden biases and deal with the problem of endogenous treatment'. It is commonly used to account for selectivity in adoption and/or in the location where technologies are promoted is instrumental (Hammig, 2011). The instrumental variable model is useful 'when a project includes some degree of self-selection and there is a concern that unobservable differences between those that received the project and those who do not might lead to biased estimates of impact'. Most often in 'agricultural projects, farmers self-select themselves into the project. For a project' which 'aims to increase agricultural income for farmers who self-select themselves into a training course for seed and fungicide management, some intrinsic characteristics that determined farmers' participation in the training might also affect their income. Such' characteristics include: 'leadership capabilities, their entrepreneurship abilities, their motivations, their drive to succeed, etc. Any comparison between participants and non-participants will include the impact of the project as well as the intrinsic characteristics of participating farmers. In such cases' therefore, estimation by regression would not bring out the 'causal effect of project participation on the variable of interest'. With this, 'the unobserved characteristics, captured by the error term would be correlated with both income and training'.

In order to overcome 'this problem, an instrument or set of instruments' which 'can serve to predict project participation (relevant), but is not correlated with the outcome variable' is required. 'In this example, a variable that predicts training participation, but does not affect agricultural income would be the instrument needed. If an instrument is found, a two stage least squares (2SLS) procedure can be implemented in order to estimate project impact'. It is however cumbersome finding an instrument after implementation. One way of avoiding this 'is to implement the' project 'with a random encouragement design' where some farmers 'are randomly encouraged to participate through different mechanisms' while others are not. IVs 'can be used to correct for the bias generated by non-compliance in an experimental design' and helps in solving the problem of unobserved heterogeneity. The two major weaknesses of this approach includes the arduous task of finding an instrument after project implementation, and can only be used to identify an average treatment effect, hence the results may lack external validity. When treatment effects vary substantially over a heterogeneous population, alternative techniques are needed and the econometrics of such analyses are still in development.

vi. Regression discontinuity

Regression discontinuity is useful when evaluating projects with clearly defined 'threshold for participation. For example, a project may target only small farmers with less than 5 hectares of cultivated land, farmers below the poverty line or farmers whose agricultural earnings are below the regional average. Based on this procedure, any farmer above this threshold is ineligible and every farmer below the threshold is treated'. Though 'the difference between farmers on either side of the threshold may be quite small or may be well understood. This suggests a clear threshold that defines project treatment and allows for applying regression

discontinuity design. The main idea behind regression discontinuity is that at the margin of the threshold, the assignment to treatment and control is close to be random. In other words, farmers who are in the neighborhood of the cutoff (below or above) are very similar and, therefore, represent a good counterfactual for the treatment group'.

The 'two types of regression discontinuity are: sharp and fuzzy. The sharp discontinuity refers to the type of targeting in which the threshold clearly determines participants and nonparticipants. For instance, all the farmers who own less than 5 hectares of land receive a voucher to buy fertilizer or all the farmers who earn less than US$2.00 per day receive a subsidy to buy seeds. Assume that x represents the variable that determines treatment (e,g. number of hectares of land, income, etc.), with a sharp discontinuity design, there is no value of x at which both treated and control can be found (Imbens and Lemieux, 2008). Fuzzy discontinuity differs' from 'sharp discontinuity in that the variable x does not perfectly' determine 'treatment and control but influences the probability of treatment'. Hence, 'variable x can be used as an instrumental variable to predict treatment and the model can be estimated using two-stage least squares as explained' in the section on instrumental variable. 'RD can be comparable to an experiment in the' neighbourhood close to the threshold. But in order to draw meaningful conclusions, 'it requires a good number of observations next to the discontinuity'. And as with the case for instrumental variables, this 'method can only estimate a local treatment effect', meaning that 'the results are valid only for participants close to the threshold, thus' rendering the results unusable for extrapolation to other units located far away from it (Winters *et al.*, 2010). In this study, the problem of selection based on observable characteristics was addressed by 'using propensity score matching (PSM) project beneficiaries and non-beneficiaries

who are as similar as possible in terms of observable characteristics expected to affect project participation as well as outcomes'.

2.2.4.3 Policy relevant treatment effect parameters

Treatment effect refers to the causal effect of a binary (0-1) variable on an outcome variable of scientific or policy interest. The term has its roots in medical literature interested 'in causal effects of binary, Yes-or-No 'treatments'. Any empirical study of treatment effects' starts with simple comparisons between those who received treatment and those who did not. Regression methods or matching can also be used 'to control for demographic or background characteristics'. The limitation of simple comparison and 'even regression adjusted' ones is that they 'may provide misleading estimates of causal effects'. These comparisons may reflect what is known as omitted variables bias or selection bias which is due to 'unobserved and uncontrolled differences in potentials between the two groups being compared'. This 'bias is the most serious econometric concern in the estimation of treatment effects'.

There are a number of average causal effects in the context of treatment effects which are of policy relevance in any impact assessment. These are: 'Average Treatment Effect (ATE), Average Treatment Effect on the Treated (ATT) and Average Treatment effect on the Untreated (ATU)'. The first two express the counterfactual nature of a causal effect. ATE 'is the population average treatment effect which is the difference of the expected outcomes after participation and non-participation'. ATE provides answer to the question on the effect if farmers in the population were randomly assigned to treatment. ATU is the effect of an intervention on the subgroup that did not receive treatment - the untreated. This measure most times is not of 'importance to policy makers because it includes the effect for whom' support was not intended- spillover effect. The most important evaluation parameter is

ATT as it concentrates solely on the effects on those for whom the programme is actually intended. The parameter focuses directly on project participants. ATT provides information on the effectiveness of a programme and whether a programme 'should be shut down or retained. It is informative on the question of whether the' participants on a programme benefitted from the programme in gross terms, that is, it determines the realized gross impact of a programme (Heckman and Vytlacil, 2003).

2.2.4.4 Counterfactual framework

There are many frameworks for causal inferences of potential outcomes but the most widely applied is the counterfactual framework. In the framework, the parameter of 'interest is the average treatment effect defined by Rosenbaum and Rubin (1983)'. If the outcome indicator for a project 'is household income, the average impact of a project on beneficiaries 'that is: average treatment effect 'on the treated (ATT) is defined as the difference between the expected income earned by beneficiaries for participating on the project and the expected income they would have received if they had not participated in the project'. This can be denoted as follows:

$$ATT=E(Y_1|p=1) - E(Y_0|p=1) \quad \text{----------(16)}$$

Where:

ATT = average impact of treatment on the treated;

P= participation in the project (p=1 for participation and p=0 for non-participation in the project.

Y_1 = outcome (household income) of project beneficiary after participation in the project;

Y_0 = outcome (household income) of the same beneficiary if he did not participate in the project.

However, 'income of beneficiaries had they not participated in the project' cannot be observed - $E(Y_0|p=1)$ – this is the counterfactual income of beneficiaries. A simple comparison of incomes of beneficiary households with those of non-beneficiaries 'can result in biases since' the 'two groups may' possess different characteristics which will make them different. These differences may result in their 'different incomes regardless of their participation in the project. Adding and subtracting' the expression $E(Y_0|p=0)$ on the right side of the equation (1) gives:

$$ATT = [E(Y_1|p=1) - (E(Y_0|p=0)] - [E(Y_0|p=1) - (E(Y_0|p=0)] \text{ ---------- (17)}$$

'The first expression in the first square bracket', which is 'the difference of income of beneficiaries and non-beneficiaries', is observable; while the second expression is not because of $E(Y_0|p=1)$. This second expression represents the bias which results 'from estimating ATT as the first expression. This bias results because' $E(Y_0|p=1)$ is not equal to $E(Y_0|p=0)$; it is the income that beneficiaries received without the programme 'may not be equal to the income beneficiaries would have received without' the programme.

Bias can arise from two main sources which are programme 'placement or targeting bias' where 'the location or target population of the' programme is not random. As seen in the case of CADP which specified eligibility criteria for farmers for instance, beneficiaries 'must have been engaged in farming business for at least three years, be involved in one or more' of 'the selected value chains'. The second type is self-selection bias where farmers though meeting the criteria, 'choose whether or not to participate, and thus may be different in their' abilities, endowments and experiences. The way to address this problem is by random assignment of farmers to treatment; using experimental approach to construct the counterfactual situation through 'random assignment of households to treatment' groups and control groups;

the 'treatment groups being' beneficiaries while control group is non-beneficiaries. This was already described earlier. This was not included in the design of the CADP being studied thus rendering this approach not feasible.

'Propensity score matching (PSM) is a commonly used' method under the quasi experimental approach. This method selects from the population 'non-beneficiaries with similar observable characteristics expected to affect' programme participation and also outcomes. An estimation of the 'difference in outcomes between the two matched groups' is 'interpreted as impact of the project on beneficiaries (Smith and Todd, 2005)'. PSM helps to match beneficiaries and non-beneficiaries based on observable characteristics only and therefore 'subject to the problem of selection on observables'. However, Baker (2000) has posited 'that selection on unobservable is empirically less important in accounting for evaluation bias'. Also, administering questionnaire to both groups in such a way 'that outcomes and personal characteristics are measured in the same way for both groups, and participants and controls placed in' the same 'environment', sustainably reduces bias through matching.

2.3 Empirical literature review

This section reviews the literature on impact of projects and government interventions in developing nations. This section thus focuses specifically on both international and domestic researches that have examined the impact of projects and government interventions on poverty, pro-poor growth and agricultural productivity literature.

2.3.1 Studies on productivity

Abass *et al.* (2017) investigated the impact of adoption of mechanized cassava processing on the production efficiency of farmers in Uganda using the stochastic

production function. The study used translog functional form to compare efficiency measures of farmers who adopted mechanized cassava processing and those who did not. The findings of the study revealed a higher technical efficiency for adopters relative to non-adopters with 0.69 and 0.52 respectively which implies that adopters of mechanized cassava processing were more technically efficient. The study also found that farming experience, education, membership of farmer association, access to markets, sale of cassava to processors and farmers who planted cassava as sole crop were significant determinants of technical inefficiency among the respondents. The study recommended that mechanized cassava processing could transform primary production for increased yields, higher incomes and production efficiency of smallholder farmers who are highly significant in Uganda's agricultural sector.

Fawole and Rahji (2016) analyzed the determinants of productivity for Cocoa in Ondo State, Nigeria using primary data collected from 140 farmers in three local government areas using multistage random sampling technique. Data was analyzed using descriptive and inferential statistics and Ordinary Least square. The findings of the study showed that cocoa production was in stage II of production in the study area with return to scale (RTS) of 0.956.The decreasing RTS though less than unity implies productive cocoa production in the study area. The variables that significantly determined productivity were: quantity of fertilizer, labour, farmers' educational status were major determinants of cocoa productivity in the study being statistically significant.

Bako, (2016) in his study assessed the impact of Commercial Agriculture Development Project (CADP) on dairy production and rural livelihood in selected Local Government Areas of Kaduna State, Nigeria. Using multi-stage sampling technique, 120 respondents were selected as the sample size who benefitted from the

Project. Primary data was collected from the 120 respondents from Giwa, Kachia and Birningwari LGAs respectively. Analysis of the data was done using descriptive statistics and Wilcoxon-signed-rank test statistic to assess the impact of CADP on assets, productivity and income of the respondents. The analysis of impact showed that CADP significantly impacted on assets, productivity as well as income of respondents. Beneficiaries were found to have experienced a positive increase in their assets, productivity and income by NGN 48,636.83,0.12litre/cow/day and NGN 18,202 per annum respectively. The Wilcoxon-signed-rank test value of 6.47, 5.89 and 7.64 implied significant positive impact on assets, productivity and income at I % level of probability respectively. It went further to recommend extension of the Projectto other states for improved dairy production and rural livelihood.

Salisu (2016) analyzed the impact of the Commercial Agricultural Development Project on productivity and food security status of maize farmers in Kaduna State, Nigeria. Using a multistage-sampling technique, a cross sectional data 230 respondents made up of participants and non-participants of CADP was used for this study. Analysis was done using logit regression analysis and Z-test statistical tools. The results from the logit regression analysis revealed that sex, marital status, farm size, membership of association, level of awareness and access to inputs were the factors influencing the farmers' participation (74.5 %) in CADP in Kaduna state at 1 % level of significance. According to the findings there was a significant difference in the productivity of participants from that of non-participants at I % level of significance and a positive impact of CADP on the productivity of participants at 385.86kg/ha. The food security profile revealed that participants had a lower food insecurity level than the non-participants. The study recommended diversification of

livelihood activities in order to increase farm-family income and thereby increase productivity.

Davis *et al.* (2012) studied the impact of Farmer Field Schools (FFSs) on Agricultural productivity and poverty in East Africa using a longitudinal impact evaluation alongside quasi-experimental method to provide evidence on economic and production impact of a farmer field school (FFS) project. The study found that FFSs had positive impact on production and income among women, low-literacy, and medium land size farmers and that participation in FFS increased income by 61 %. Overall, participants experienced improvement in agricultural income and crop productivity. The authors then inferred that farmer field schools when considering approaches to increase production and income of small-scale farmers in East Africa, and further recommended use of FFS in targeting women and producers with literacy challenge.

Elias, Nohmi, Yasunobu and Ishida (2013) evaluated the effect of agricultural extension program participation on farm productivity using three *kebeles* (peasant associations) in Ethiopia as case study. The study used 1112 plot-level data collected from 300 selected farm households, comprising of extension participants and non-participants. Analysis was done with Ordinary Least Square (OLS) estimation method, Heckman Treatment Effect Model (HTEM) and Propensity Score Matching (PSM). The result of the OLS revealed that participants increased their productivity by about 6 %. Analysis by PSM further verified the positive effect of extension program participation on farm productivity. The study concluded that extension program has a positive effect on farm productivity in the study area and recommended policies to improve access qualitative extension services be expanded to all farmers.

Verter (2015) assessed the determinants of crop productivity in Nigeria, using OLS regression and Granger causality approaches. The result of the OLS suggested that four key determinants are related to crop productivity in the study area. These are: fertilizer usage, size of land cultivated, loans and producer price index. Also, the results from the Granger causality/Block exogeneity Wald test based on a Vector Autoregressive (VAR) model provided a bi-directional relationship between fertilizer consumption to crop production while it confirmed a unidirectional causality between cultivated land and crop productivity in Nigeria. The study recommended that access of farmers be increased to affordable loans and fertilizer subsidy.

Samson and Obademi, 2018 examined the determinants of agricultural credit and its impact on productivity of farmers in Oyo State, Nigeria using Ibarapa region as a case study. Primary data was collected through structured questionnaires while descriptive statistics, probit model and regression analysis were used to analyze the data. The study found that the farm size, labor cost, cost of seeds and amount of credit obtained impacted positively on productivity while the Chow-test revealed a significance difference in output of credit beneficiaries compared to that of non-beneficiaries. The study recommended increased savings mobilization by microfinance banks and long loan repayment period of about two years and a low interest rate of at most 5 %. It further recommended insurance of farmers against losses and gender sensitivity especially since women are also efficient in farming activities.

2.3.2 Studies on impact of projects and interventions

Phillip *et al.* (2017) assessed the impact of the Commercial Agriculture Development Project on the beneficiaries in the five states that participated in the Project and on key outcome indicators. Comparing baseline and endline estimates,

there were increases in the value of production and volume of sales for all the commodities. The findings revealed that the CADP contributed significantly to market access and commercialization with the commercialization ranging from 64.7 % for maize, to 100 % for cocoa. The impact of project on commodity productivity showed that there was a general increase in endline productivity estimates for all commodities relative to that of baseline with the least being 16 % for Guava and palm fruits highest at 131.7 %. There was an exception in dairy which witnessed a drop of -17 %.The report showed a decrease in poverty incidence among the total reporting participants from 48.2 % at baseline to 46.8 % at endline. The impact of the project on the combined participants and non-participants is larger in the full sample and in the different sub-groups examined. Specifically, the average increase in income for the whole sample was ₦2,732,334.00, and for the participants, the average increase in income was ₦2,003,677.00. This is the homogeneous aspect of the impact analysis. Both sample ATE and ATT for the whole responding households are statistically significant at the 1 % level.

Akinlade (2012) assessed the impact of *Fadama*-II project on rural household poverty in Nigeria using secondary data from the Fadama Project by International Food Policy Research Institute (IFPRI) in 2006/2007 farming year. A total of 1738 matched observations were used for the study. Analysis for the study was done using descriptive statistics, propensity score matching, double difference estimator, and FGT weighted poverty indices. The major findings of the study showed that at a poverty line of ₦35,299.0 per annum, 52.2 % of Fadama Beneficiaries were poor before the project. There was reduction in Poverty incidence (PI) by 34.0 % for female Fadama beneficiaries compared with 7.8 % for male. Also, Poverty Incidence

of Fadama beneficiaries that engaged in up-stream farming activities reduced by 14.2 % compared with 7.1 % for those in non-farm activities.

Mulugeta and Bekele (2012) using a cross sectional data collected from randomly selected 200 farm households in Southeast Ethiopia studied the potential impact of adoption of agricultural technology on household food consumption status. Data analysis was done using propensity score matching. The results showed that adoption of improved wheat technologies positively impacted on farmers' food consumption per adult equivalent per day. The Average Treatment Effect on the Treated (ATT), ranged from 377.37 calories per day to 603.16 calories per day from the three algorithms used. This suggested that that efforts to disseminate existing wheat technologies will highly contribute to food security among farm households.

Josephat and Likangaga (2015) analyzed the effect of District Agricultural Sector Investment Project (DASIP) on earnings of participant farmers in rural Tanzania using agricultural data from five regions on the country. Primary data were collected from both participants (359) and non-participants (519). Propensity score matching (PSM) was used to select the counterfactual group. The study found no significant difference between the earnings of participants and non-participant farmers and recommended longer lasting group activities rather for effects to be noticed.

Oni and Olaniran (2008) in their study analyzed the impact of the Fadama II project on beneficiaries and non-beneficiaries in rural Oyo State, South West Nigeria using data collected from 450 rural households of purposively selected 150 beneficiaries and 150 non beneficiaries within Fadama II focal LGAs, and 150 non beneficiaries outside Fadama II focal LGAs. Using Propensity Score Matching technique to select the counterfactual group reduced the sample size to 412 observations. The major findings showed high prevalence of poverty among non-

beneficiaries within Fadama II LGA (73 %) followed by non-beneficiaries outside Fadama II LGA (69 %) and Fadama II beneficiaries (38 %). According to the study, key factors that influenced poverty were: household size, educational status, utilization of credit and being a beneficiary of the Fadama Project. The study recommended an extension of the project to non-beneficiary communities and further suggested that birth control programmes be promoted among respondents. It also recommended acquisition of formal education by respondents.

Awotide, Diagne and Omonona (2012) assessed the impact of adoption of improved rice varieties on productivity and welfare of farming households in Nigeria using a cross sectional data of 481 rice farmers drawn from three states representing the major rice producing ecologies (Irrigated, upland and lowland) in Nigeria. The study adopted the Local Average Treatment Effect (LATE) estimation technique to provide estimate of the impact. Results from the study revealed that access to seed significantly determined adoption, and a higher poverty incidence among non-adopters compared to adopters. Further, it found that technology adoption significantly impacted on rice productivity (358.89 kg/ha) and total households' expenditure (₦32890.82) suggesting that adoption of improved rice varieties significantly generate an improvement in farming household living standard. The study recommended intensification of efforts to increase farmers' timely access to adequate quality improved rice seed. It went ahead to recommend that programs that could lead to increase in improved rice adoption should be intensified in order to achieve the much desired poverty reduction and generate an improvement in rural farming households' welfare in Nigeria.

Martey, Dogbe, Etwire and Wiredu (2015) in their study examined the impact of participation in Agricultural Value Chain Mentorship Project (AVCMP) on

efficiency and income of soybean farmers in Northern Region of Ghana using propensity score matching analysis to estimate impact on a cross-section of 200 smallholder farmers (participants - 51, non-participants - 149). The study used treatment effect estimation approach to assess the impact of participation in AVCMP on technical efficiency and farm income. The major findings of the study revealed that though participation in farmer mentorship project impacts positively on farm technical efficiency by 28 %, participation did not significantly translate into higher farm income suggesting that exposing farmers to agricultural development projects may directly increase their technical capability within the short term but does not guarantee higher income. The study recommended that in designing future agricultural development projects, specific needs of farmers must be considered and incorporated for wider participation, ownership and sustainability.

Nguezet, Diagne, Okoruwa and Ojehomon (2011) examined the impact of adopting the New Rice for Africa varieties (NERICAs) on income and poverty among rice farming households in Nigeria. The study collected cross-sectional data of 481 farmers from the upland, lowland and irrigated rice ecologies of Nigeria which were analyzed with instrumental variables estimators to estimate the Local Average Treatment Effect (LATE) of the adoption of NERICA varieties on income and poverty reduction. The findings showed that adoption of NERICA variety robustly impacted positively and significantly on farm household income and welfare. The findings also suggested that adoption increased per capita expenditure and income by averages of 49.1 % and 46.0 %, respectively, thereby reducing their probability of falling below the poverty line. The study recommended that in order to raise incomes and reduce poverty among rice farming households, NERICA varieties should be made available to rice farmers.

Nkonya *et al.* (2008) conducted an assessment of the impact of Fadama II Project on beneficiaries in Nigeria using propensity score matching (PSM) and double difference (DD) method to compare the impact indicators. The results showed farmers who participated in the Project had their income increased by about 60 %. Investment in infrastructure positively impacted access of beneficiaries to markets and transportation costs. The findings also revealed that Fadama II increased the demand for postharvest handling technologies but did not have a significant impact on the demand for financial management and market information. Fadama II reduced the demand for soil fertility management technologies. The study recommended for synergy between government and donor agencies to implement multipronged community driven development project instead of isolated and scattered ones.

Omonona, Oni and Uwagboe (2006) examined the myriads of factors that influences adoption of improved cassava varieties and its impact on the welfare of rural farmers in Edo State, Nigeria using cross-sectional data from 150 cassava farmers which includes both adopters and non-adopters of improved varieties of cassava in the state. Analysis was done using the Tobit regression model, Foster, Greer and Thorbecke (FGT) class of measures was used to determine the incidence, depth and severity of poverty among farming households. The study found that sex, age, access to extension agents, access to inputs and crop yield significantly and positively influenced adoption of improved cassava varieties. The FGT measures were found to be higher among households who did not adopt improved varieties. Determinants of household poverty were found to be: age, household size, years of education and extent of commercialization influenced household poverty negatively, implying that a unit increase in any of the variables will lead to a decrease in household poverty while household size positively affected household poverty. The

implication with respect to poverty alleviation measures are: Priority should be given to investment in human capital, intensified extension services to farmers.

2.3.3 Studies on agricultural commercialization

Adenegan (2015) investigated the effect of agricultural crop (cassava) commercialization on household income among farmers in Oyo State, Nigeria. Cross sectional data was collected through structured questionnaires. Using a multistage sampling procedure, a total of 203 cassava farmers were used for the study. The study analyzed the extent of commercialization by cassava growers, factors affecting commercialization by smallholder farmers, effect of commercialization on household income and constraints to full commercialization of cassava. Data was analyzed using descriptive statistics, Household Commercialization Index (HCI), ordinary least square regression and probit regression model. The study found out that 97 % of farmers crops were commercialized while the average household commercialization index was 0.9. Regression analysis result shows three variables were significant determinants of agricultural commercialization (gender, education and farm size. Three variables: total cassava produce, gender and farm size were positive and significantly related to income implying that if household income is to be increased, any of these variables should be increased. The study identified major constraints to full commercialization among cassava farmers in order of importance as: poor road, credit inaccessibility, unattractive market prices and transaction bottlenecks. The study recommended strengthening of policies that encourage effective integrated marketing information, guaranteed market for produce, road rehabilitation and access to credit so as to ensure full commercialization.

Ele, Omini and Adinya (2013) determined the household commercialization index (HCI), variation in commercialization level among households in the three

agricultural zones, and also identified the micro-level factors determining the level of commercialization in Cross River State. Using descriptive, statistical and econometric methods data collected from a sample of 120 households were analyzed. The study found that showed that the degree of commercialization in the study area is moderately high (about 60.40 %). Averagely, households sold about 56.10 %, 66.60 % and 58.50 % of their total production (in grain equivalent terms) for the Southern, Central and Northern zones respectively. The Tobit regression analysis result revealed factors determining commercialization level of respondents as: Food crop output, farming experience, access to extension service, size of cultivated land, membership in cooperatives and household size. The study recommended that policies aimed at improving food crop production and aimed at creating enabling environment for income generation should be formulated as well as those which encourage formation of cooperatives to provide a strong mitigation strategy and advance participation in the output market and strengthening of extension delivery.

Agwu *et al.* (2012) determined extent of commercialization among smallholder farmers in Abia State, Nigeria. The authors used multi-stage sampling technique to select two local government areas were selected from each of the three agricultural zones, and a random selection of twenty farmers from three communities. A total of one hundred and eighty (180) farmers / respondents were used for the study. The commercialization index obtained from the result revealed that none of the farmers was able to attain a ratio above 30 %. This implication of this is that farmers in the study area are not oriented towards commercialization. The variables which significantly influence commercialization among farmers include: Household size, income, farming experience, farm size, distance to market, membership of society and access to credits being significant at various levels. The study advocated for creation

of market, provision of storage facilities, capacity building on business management and value addition by government.

Iheke and Arikaibe (2012) studied the impact of agricultural intensification on poverty alleviation among rural farming households in Imo State, Nigeria. Data was collected using structured questionnaire and interview schedules after a process of multistage random and purposive sampling. Data was analyzed using Regression analysis and computation of Chow's statistic. Their findings revealed that households not involved in intensification were poorer while the Chow's test revealed a positive impact on poverty reduction by agricultural intensification. The study recommended sensitization and persuasion of rural farming households to intensify agriculture for increased productivity and income with a multiplier effect on poverty reduction.

Wasseja (2016) assessed the impact of Mwea Rice Commercialization Scheme con household welfare of farmers in Eastern Kenya. The study used a cross-sectional data collected using stratified sampling from 368 respondents. Estimation of the causal relationship and impact of commercialization on welfare was done with the Pearson's correlation coefficient and regression analysis. The analysis showed significant positive relationship between commercialization and household welfare, with key variables of market access and internal farming activities positively and significantly contributing to improved household incomes and farm outputs. The regression analysis predicted a 16.9 % improvement in household welfare if farmers actively worked on improving market access and internal farm activities like fertilizers and pesticides. The study recommended that farmers strengthen areas that can improve their farm outputs and also foster linkages to markets. It went further to recommend establishment of saving schemes by farmers as a panacea to improve farmers' household welfare and standards of living in the area.

2.3.4 Studies on poverty and pro-poor growth

Mitiku (2014) analyzed the impact of agricultural commercialization by smallholder farmers' on rural poverty in Jimma Zone, South West Ethiopia. Primary data was collected from 280 respondents selected through multi stage random sampling technique. Secondary data was also used for the study. FGT and logit model were the major tool of analysis. The results showed that 43 % of the respondents were poor and that their commercialization had no effect on their poverty level. The logit model revealed that sex, age and educational level of household head, family size, farm income, access to credit in the previous farming season and distance from settlement centre to nearest market place had significant effect on rural household poverty. The study advocated for policies that to improve the access of smallholder farmers to: education, credits, market information and roads.

Kakwani and Son (2007) analyzed pro-poor growth of three countries using PEGR. These countries are: Korea, Thailand and Vietnam. The study found that for Korea, the PEGRs were overall higher than the actual growth rates during the 1990s before the financial crunch experienced by the country. The implication of this result is that the poor benefited proportionally much more than the non-poor, which was seen in the significant reduction in poverty; the head-count ratio in Korea decreased from 39.6 % in 1990 to 8.6 % in 1997. As the financial crunch commenced, the actual growth rate surpassed the PEGR between the two-year period (1997 and 1999). The implication of this is that the financial crunch experienced in the country adversely affected the poor more than the non-poor. For Thailand, an analysis of the PEGR for the 1988-1992 period showed that growth was anti-poor as the actual growth rate was greater than the PEGR. The period of 1992-1996 however showed that PEGR was greater than the actual growth, characterizing growth as pro-poor for that period. In

Vietnam, during 1992-1997, the PEGR was consistently higher than the actual growth rate, showing pro-poor growth which benefitted the poor than the non-poor.

Ouedraogo (2019) analyzed the extent to which an increase in food crop yield strengthens the relationship between agricultural commercialization and rural poverty reduction in Burkina Faso. Using primary data from a sample of 1178 smallholder farm households in rural Burkina Faso, a logit model, which included an interaction term between crop commercialization index and food crop yield was estimated. From the results it was found that commercialization can result in welfare loss when crop yield is low, while the intensity of crop supply is a crucial factor of poverty reduction with a when the level of yield is high. The findings suggested that structural transformation of the agricultural sector in Sub-Saharan Africa has the potential to bring about significant growth in rural income, particularly when staple crops are the driver of this transformation. The study recommended that policies should also be designed to promote the growth of food crop yield so as to enhance the contribution of agricultural commercialization to poverty reduction.

Gafaar and Osinubi (2005) evaluated the impact of macroeconomic policies on pro-poor growth in Nigeria over a period of forty years (1960-200). In their study, the authors empirically evaluated the impact of microeconomic policies on how economic growth has favoured the poor in Nigeria using secondary data covering the period 1960-2000. They analyzed pro-poor growth using the Kakwani and Pernia (2000) Pro-poor Growth Index (PPGI). The main findings of the work revealed that that economic growth in Nigeria has been slightly pro-poor, with the implication that those who are far below the poverty line have not really been enjoying the benefits of growth, and that the benefits that actually gets to the poor has been decreasing at an increasing rate. Overall, the study concluded that growth in Nigeria is not necessarily

always pro-poor. The study recommended that the Nigerian government should make poverty reduction the highest priority and that macroeconomic policies should not be at the expense of the poor but should always consider them.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Area of study

The CADP, a World Bank assisted project, was implemented in Nigeria in five (5) States as a pilot project. These States are: Cross River, Enugu and Lagos in the South; Kaduna and Kano in the North (Figure 1). The project supported outputs in each State viz.: 'Cross River (Oil Palm, Cocoa, and Rice), Enugu (Fruit Trees, Poultry, and Maize), Kaduna (Fruit Trees Dairy, and Maize), Kano (Rice, Dairy, and Maize) and Lagos (Poultry, Aquaculture, and Rice)'. The states made their choice of enterprise was informed by their 'respective comparative' advantages and contributions 'to agricultural growth'. On the strength of 'market equivalents' obtained during appraisal, selected value chains were 'expected to have high demand and markets' with 'capacities to absorb additional production'. The five States were considered due to availability of relevant data for the study.

Nigeria is a West Africa country with a population of about one hundred and ninety million, nine hundred thousand (190.9 million) - based on 2017 estimate - with an average population growth rate of about 2.6 %. It occupies 923,768 km^2 land area that lies 'between longitude 3^0 and 15^0 east, and latitude 4^0 and 14^0 North'. The country is bounded by Cameroun in the East, 'Republic of Benin in the West', Niger in the North, and Chad in the North East. The coast of Nigeria in the south is located 'on the Gulf of Guinea in the Atlantic Ocean'. Constitutionally, power in the country is decentralized and distributed among the thirty six (36) States having seven hundred and seventy four (774) Local Government Councils. The percentage of employment of the population by the agricultural sector in Nigeria from 1991 to 2020 revealed an

average value 43.84 % with a minimum of 34.66 % in 2020 and a maximum of 50.25 % in 1991(theglobaleconomy.com, 2021).

Cross River State lies in the coastal plains of the South-South Nigeria and 'derives its name from the Cross River, which passes through the State.' It is located in latitude 5°45'N, and longitude 8°30'E, where it occupies 20,156 square kilometers landmass. The state is bordered by Benue State to the north, to the west is Ebonyi and Abia States, the east is Cameroon Republic and southern boundaries having Akwa-Ibom and Atlantic. The climate of Cross River State is basically tropical humid where rainfall is usually seasonal and at times very heavy. Average temperature ranges between 15 °C and 13 °C with the annual rainfall ranging between 1,300 and 3,000 mm (FMARD, 2009). The vegetation is a mixture of mangrove swamps, some rainforest, through derived savannah, to montane parkland. There are 18 Local Government Areas in Cross River namely: Abi, Akamkpa, Akpabuyo, Bakassi, Bekwara, Biase, Boki, Calabar Municipal, Calabar South, Etung, Ikom, Obanliku, Obubra, Obudu, Odukpani, Ogoja, Yakurr, Yala. The state participated in the CADP, its focus was on three commodities/value chains, such as, Oil Palm, Cocoa, and Rice with the thrust being essentially on production, processing and marketing, among groups.

Enugu State, Nigeria, lies between latitude $5^0$56'N and $7^0$06'N and longitude $6^0$53'E and $7^0$55'E. The boundary of the state in the north-east is Ebonyi State, in the north it is Benue and Kogi States, while in the south it is Abia State, in the east it is Imo State and on the west Anambra State. It covers an area of about 8,022.95 square kilometers with a population of about 3,257,278 (National Population Commission, 2006). The state is located in the humid, tropical rain forest zone. The temperature is characteristic of a tropical climate having mean daily temperature of 26.7 °C.

Average temperature differences between the maximum and minimum range is about 8 °C (11 °C during dry season).

The state is among five states that participated in the CADP from 2009. The commodities/value chains focus of the state were three, namely, poultry, fruit trees and maize with priority on production, processing and marketing, among groups. The Local Government Areas in the state are seventeen with five agricultural zones. These include Enugu North, Nkanu, Udi Agwu, Oji-River, Ezeagu, Igbo Eze North, Enugu South, Igbo-Eze South, Isi-Uzo, Nsukka, Igbo-Ekiti, Uzo-Uwani, Enugu East, Aninri, Nkanu East and Udenu.

Lagos State is a State in the Southwestern geopolitical zone of Nigeria; with latitude 6.52 ^{0}N and 3.60 ^{0}E. It is bounded with Ogun State both in the North and East and on the west by the Republic of Benin. The South boundary stretches for 180 kilometres along the coast of the Atlantic Ocean. Lagos state is the smallest State in the Federation, it seats on an area of 3,577 square kilometers, 22 % or 787 square kilometers of which consists of lagoons and creeks. There are 20 Local Government Areas in Lagos state as follows: Lagos Mainland, Ikeja, Eti-Osa, Lagos Island,Epe, Ibeju Lekki, Ikorodu, Surulere, Ifako-Ijaye,Agege, Ajeromi Ifelodun, Alimosho, Amuwo Odofin, Apapa, Badagry, Kosofe, Mushin, Oshodi Isolo, Ojo and Shomolu. Lagos State is pivotal to the Nigerian economy and has been dubbed Nigeria's commercial nerve centre, given its sustained relevance as the focal point of economic activities. The Gross Domestic Product (GDP) of the state accounted for 26.7 % of Nigeria's total GDP and more than 50 % of non-oil GDP. The non-oil industrial capacity of Nigeria located in Lagos is over 50 %. The state participated in the CADP with the government focusing on three value chains of Poultry, Aquaculture, and Rice.

Kano State is prominent for its production of groundnuts as well as for its solid mineral deposits. The state seats in North-Western Nigeria 11°30′N 8°30′E. The area of cultivable land is about 18,684 square kilometers and it is said to be the most extensively irrigated State in the country. Major food crops cultivated in the state are millet, cowpeas, sorghum, maize and rice for local consumption while groundnuts and cotton are produced for export and industrial purposes. There are forty four local government areas in Kano state as follows: Dawakin Kudu, Dawakin Tofa, Doguwa, Ajingi, Albasu, Bagwai, Bebeji,Tsanyawa, Tudun Wada, Tofa, Warawa, Wudil, Bichi, Bunkure, Dala, Dambatta, Gabasawa, Garko, Garun Malam, Gaya, Kabo, Karaye, Kibiya, Kiru, Kumbotso, Kura, Kunchi, Madobi, Makoda, Minjibir, Kano Municipal, Nassarawa, Gezawa, Gwale, Gwarzo,Rimini Gado, Rogo, Shanono, Sumaila, Takai and Tarauni. Like the others, Kano state participated in CADP focusing on three value chains of; Rice, Dairy and Maize.

Another state covered by the CADP in the North is Kaduna State. Kaduna state is located between latitude 10°31'35.08"N and longitude 7°26'19.64"E. It has a population of 760,084 people according to National Population Commission (2006) population census and a projected population of about 8.9 million in 2019 (Kaduna State Bureau of Statistics, 2019). It has an estimated cultivable land area of about 45,786 km^2 with only about 30,000 km^2 under cultivation by traditional low income group (Wikipedia, 2013). Kaduna State has a common boundary with Abuja in the North-east and six other states comprising of Kano, Katsina, Zamfara in the North-North, while Nasarawa and Plateau are in the North-east and Niger in the North-west. It has several ethnic sets some of which are; Adara, Atyap, Baju, Fulani, Gbagyi, Gwong, Ham, Hausa, Jaba, Kagoro, Koro, Kurama Ninzo and Numana among many others. It has an estimated cultivable land area of about 46053 km^2 with only about

30,000 km^2 under cultivation by traditional low-income group. The area is marked with the distinct seasons of wet and dry season, the wet season commences in the month of April in the Southern part of the State and between May and June in the northern part of the State. Thereafter the dry season commences from October to March and is characterized by the hot dry north easterly harmattan winds.

The mean annual rainfall decreases markedly from South to North of 1524-635 mm (Sani and Lawal, 2003). The southern part of the State has a vegetation that is southern guinea savannah type, while the northern part has the northern guinea savannah type. The state shares common boundary with Abuja in the north east and six other states of which are Kano, Katsina, Zamfara, in the North-North, Nasarawa, Plateau in the North-East and Niger in the North-West. Agricultural activities are the main occupation of people in the State and characterized predominantly by mixed cropping of such crops as: Maize, sorghum, millet, cowpea, rice, cassava, cocoyam, sugar cane, tomatoes, pepper, acha, potato, etc. Rain-fed agriculture is mostly practiced in the state with little Fadama agriculture (Yakubu, 2005). People engaged in other business ventures like blacksmith, hunting, butchery, trading, craft men (Yakubu, 2005).

3.2 Data for the study

The study used secondary data that were collected in the five participating states (Cross River, Enugu and Lagos in the South; Kaduna and Kano States in the North) at the endline by the project for assessing the impact of the Commercial Agriculture Development Project. Multi-stage sampling technique was used in the sample selection. In determining the sample size and distribution for each State, a few significant strata were considered, as it relates to the framework and implementation of the CADP. These include (i) types of value chains, types of

Commodity Interest Group (CIG), size of operation (small or medium) and gender. For the beneficiary category, the list of commodity interest group (CIG) beneficiaries in the various strata (producer, processor & marketer) provided by the State CADP office formed the sampling frame for the study. Beneficiaries were then randomly selected. The non-beneficiary category was purposively selected based on their willingness to participate in the survey.

Secondary data collected by the Project through structured questionnaires from 1800 households of beneficiaries and non-beneficiaries were used for the study. However, 1199 households comprising 678 non-beneficiaries and 521 non-beneficiaries were used for analysis due to missing data. Thereafter, propensity score matching which reduced the sample size to 1142 observations: 655 beneficiaries, 487 non-beneficiaries was used to select comparable observations. These matched observations were then used to analyze the impact of the CADP.

3.3 Analytical Techniques

A large part of the analysis was done using Stata Version 14. The tools for data analysis included descriptive statistics, TFP, Tobit regression model, Foster, Greer and Thorbecke (FGT) poverty measures, Average Treatment Effect on the Treated (ATT) and the Poverty Equivalent Growth Rate (PEGR).

3.4 Applying Statistical Matching to Impact Evaluation

The impact of CADP intervention on selected outcomes - productivity and poverty of farmers- to be determined using a quasi-experimental analytical method. This analytical tool is considered adequate since the Project had been implemented. The quasi experimental design is alternatively referred to as non-experimental design since the participants in the CADP were not randomly selected as CADP beneficiaries

voluntarily selected themselves by belonging in the LGAs and value chains covered in the project. The problem of self-selection in voluntary programs limits the reliability of non-experimental procedures for program impact evaluation (Heckman, Ichimura, Smith and Todd, 1998). The matching procedure makes sample selection analytically random. Also, propensity score matching evades the curse of dimensionality usually encountered while trying to match participants and non-participants on possible characteristics (Rosenbaum and Rubin, 1983). The following steps are involved in applying statistical matching to impact evaluation;

i. calculation of the propensity score;

ii. matching the unit using the propensity score;

iii. assessing the quality of the match, and,

iv. estimating impact and its standard error. The sample was matched using the propensity score matching (PSM) in order to find a sample of non-CADP beneficiaries with similar characteristics as CADP beneficiaries in order to determine the impact of the project on beneficiaries.

1. Estimating the propensity score

The propensity score is the conditional probability of receiving a treatment given pre-treatment characteristics (Rosenbaum and Rubin, 1983). There are many methods of computing the propensity score but this study adopted the method of computation using binary Probit regression model as shown:

$P(X) \triangledown Pr\{ D=1|X\} = E\{ D|X\}$ ..... (18)

Where:

D = {0, 1} is the indicator of exposure to treatment (dependent variable)

D=1 if treated (beneficiary) and

D = 0 if not treated (non-beneficiary).

The model used is as follows:

a. CADP beneficiaries compared with Non-CADP beneficiaries.

b. D=1 represents CADPB while

c. D=0 represents NCADPB

CADPB stands for commercial agriculture development project beneficiaries, while NCADPB stands for non-commercial agriculture development project beneficiaries.

X is the multidimensional vector of pretreatment characteristics which are the explanatory variables. The Xs are expected to jointly determine the probability to participate in the Project and the outcome. These explanatory variables are as follows:

X_1 = Sex (Male =0, Female =1)

X_2 = Age of respondent (years)

X_3 = Distance to town (km)

X_4 = Distance to market (km)

X_5 = Waiting time for transport to market (mins)

X_6 = Credit (naira)

X_7 = Own land (Yes/No)

X_8 = Years of schooling

X_9 = Farming experience (years)

X_{10} = Household size (number)

The results were used in computing the propensity scores required for PSM estimation of the ATT. Each sampled participant and non-participant had an estimated propensity score $P\hat{}(X|T = 1) = P\hat{}(X)$.

2. Matching the unit using the propensity score

After estimating the propensity score, the score was computed for each unit and the actual matching done. Common radius matching along with local linear

matching LLM are non-parametric matching estimators that use weighted averages of all individuals in the control group to construct the counterfactual outcome. In this study the common radius matching method was used. The procedure involved matching with replacement, only among propensity scores within a certain range. Once this is done, the level of excellence of the match is assessed through checking the common support between treatment and non-treatment using the minima and maxima criterion. The approach required deleting all observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group. The common support condition improved the quality of the match once imposed.

3.5 Total factor productivity

The Total Factor Productivity (TFP) analysis was used to achieve objective 1 which is to determine the level of productivity of beneficiaries and non-beneficiaries. According to Key and McBride (2003) as cited in Odok (2018), the total factor productivity can be arrived at as an inverse of unit variable cost. Since TFP is defined as the ratio of total output to the total variable cost in a production process, let total output be given by Y (kg) and total variable cost (TVC) in naira, then TFP is:

$$TFP = Y/TVC \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

Alternatively,

$$TFP = Y/\sum PiXi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

Given that:

Pi= unit price of ith variable input,

Xi= quantity of ith variable input

The advantage of this method is that it does not consider Total Fixed Cost (TFC) since it does not affect profit maximization and resource-use efficiency; besides it is fixed and a constant (Bamidele, Babatunde and Rasheed, 2008).

Total Factor Productivity (TFP) analysis was employed to analyze the data for the study.

From the Theory of Costs;

$AVC=TVC/Y$ ..... (20)

Where:

AVC= Average Variable Cost (₦)

However, $TFP = Y/TVC = 1/AVC$ ..... (21)

TFP is the inverse of AVC

The Total Factor Productivity (TFP) adopted here was computed using the model as used by Ali and Byerlee (2014); Odok (2018).

$$V_{To}/V_{Tn} = \frac{\sum_{i=1} P_{\alpha i} Q i}{\sum_{t=1} PxtXt}$$

Where

V_{To} = Value of total output in naira/ha

V_{Tn} = Value of total input in naira/ha

P_{α} = Price per unit of output in naira

Q = Quantity of output

i = Type of output (i ranges from 1 - nth output type)

p = Price per unit of input in naira

X = Quantity of input

t = Type of input (t ranges from 1 - nth input type)

It measures how technically efficient respondents utilized available inputs to produce the respective outputs. The value is on a scale of 0 to 1; a value tending to one implies increase in productivity; the higher the value, the higher the productivity.

In order to measure productivity performance, there is need to specify the price and quantity of each output and input. That requires accurate specification of quantities because productivity is essentially a weighted average of the change in output quantities divided by a weighted average of the change in input quantities. Once productivity is obtained for both the beneficiaries and non-beneficiaries, the differences in productivity of CADP and non-CADP households were analyzed using ATT described in equation (25).

3.6 Tobit regression model

The model was instrumental to achieving objective 2 which examined the socioeconomic determinants of productivity of CADP beneficiaries and non-beneficiaries. The Tobit model is a brain child of James Tobin (1958) and a stretching out of the probit model. In the Tobit model, the data sample is divided into two groups of n_1 about which there is information on the regressors and the regressands and another group n_2 about which information is provided only on the regressors but not on the regressands. A sample in which information on regressands is available only for some observations and not for others is considered a censored sample. Therefore the Tobit model is referred to as a censored regression model. The censored models are typically applied when the data set has a meaningful proportion (say 5 % or higher) of data at the boundary of the sample support. The process inherent regarding censoring may be explicit in data collection, or it may be a by-product of economic constraints. The Tobit model is estimated by the maximum likelihood method because the ordinary least square method is unsuitable because the parameters are biased and inconsistent. According to Greene, (2003) the Tobit model is specified as:

$$y_i^* = x_i'\beta + \varepsilon_i \quad \text{.....} \quad 22$$

$$y_i = \begin{cases} 0 & \text{if} \quad y_i^* \leq 0 \\ y_i^* & \text{if} \quad y_i^* > 0 \end{cases}$$

Where $y_i^*$the censored is variable, β is the parameter to be estimated, x is a vector of explanatory variables and ε is the error term. Here, the dependent variable is productivity while the independent variables are: sex, age, level of education, household size, Area of land cultivated/farm size, receipt of credit, land ownership. These variables were selected based on review of related studies (Ajibefun, Battese and Daramola, 2002; Adeoti 2002). The general functional form of this model is given below:

$$Yi=\beta_0+\beta_1X_1+\beta_2X_2 + \beta_3X_3+ \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \varepsilon_i \quad \text{.....} \quad (23)$$

The variables are defined as follows:

X_1 = Sex

X_2 = Age

X_3 = Level of Education

X_4 = Household Size (number)

X_5 = Years of farming experience

X_6 = Area of land cultivated (ha)

X_6 = receipt of credit (dummy)

X_7 = Landownership (dummy)

Bis are unknown parameters to be estimated.

ε_i = error term

3.7 Foster, Greer and Thorbecke (FGT) model of poverty measures

The FGT model was instrumental to achieving part of objective 3 which is the poverty status of beneficiaries and non-beneficiaries before using the ATT to

determine the impact of the CADP on them. Several methods exist in the literature for the analysis of poverty among households. However, it is important that a poverty index or a family of indices be decomposable by groups since different poor groups may not be uniformly poor. A method that is sensitive to this requirement was proposed by Foster, Greer and Thorbecke (1984) and had been widely applied (Oni and Olaniran, 2008; Akinlade, 2012).

A common challenge in poverty analysis is deciding the poverty line (PL), the line that distinguishes the poor from the non-poor. Those above the poverty line are assumed to be able to attain some minimum living standard. A family of poverty indices has been proposed that accounts for varying degrees of poverty among poor individuals by Foster *et al.* (1984)). For this study the poverty line was estimated from the two-third of mean per capita income of sampled households.

The computing expression for measurement of poverty by the Foster-Greer-Thorbecke (FGT) index is as follows:

$$P_{\alpha} = N^{-1}\sum_{i=1}^{H}{}_{=1}\frac{[Z-yi]^{\alpha}}{Z} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (24)$$

Where;

Z = Poverty line defined as 2/3 of mean per capita income

yi = income of household i,

m = the number of poor households in sample N and

P_{α} = the poverty index, whose value is conditioned by parameter α.

α = degree of poverty opposition that takes the value 0,1or 2 (Foster, 1984).

For α=0, Pα is simply m/N and called the head count (P_0) which measures the occurrence of poverty that is; proportion of the total population of a given group that is poor based on poverty line. α=1 is the poverty gap index which the depth of poverty that is; on average how far the poor is from the poverty line; α=2 is the squared

poverty gap which measures the severity of poverty among households. It is interpreted as the amount of income required to raise people in poverty up to the poverty line. This indicator assesses the extent to which individuals fall below the poverty line as a proportion of the poverty line. Impact of CADP on poverty status was determined using ATT described in equation (25).

3.8 Average treatment effect on the treated (ATT)

After matching and it was deemed of good quality, the sample matched was then used to compute the Average Treatment Effect of the Treated (ATT) to determine programme impact on three outcomes of productivity, poverty and commercialization. This is defined by Rosenbaum and Rubin (1983) as follows:

$$E(Y^1-Y^0|D=1) = E(Y^1|D=1) - E(Y^0|D=1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (25)$$

Where $E(Y^1|D=1)$ is the observed outcome of the treated while participating in the programme, and $E(Y^0|D=1)$ is the counterfactual outcome; that is the expected outcome had they not participated on the project. Standard errors using bootstrapping were computed as described by Lechner (2002). The method is commonly used for estimation of standard errors in case analytical estimates are biased or unavailable.

3.9 Poverty equivalent growth rate

The Poverty Equivalent Growth Rate (PEGR) was used in realizing objective 6. The PEGR was proposed by Kakwani and Pernia (2000) as a measure of pro-poor growth that captures a direct linkage or monotonic relation with poverty reduction, indicating how the advantages of growth are shared by the poor and non-poor in the society. It is derived by multiplying the Pro-poor Growth Index (PPGI) by the growth rate of mean income. The baseline and endline data was used in estimating the PEGR. An estimate of the PEGR which is denoted by (γ^*) is given as:

$\gamma\hat{}^{*} = (\delta\hat{}/\eta\hat{})\gamma = \phi\hat{}\gamma\hat{}$ ..... (26)

where $\phi = \delta/\eta$ ..... (27)

δ is total poverty elasticity

$\eta\hat{}$ is growth elasticity of poverty

$\phi = \delta/\eta$ is the pro-poor index developed by Kakwani and Pernia (2000)

an estimate of total elasticity of poverty can be estimated as follows:

$\delta\hat{} = (\text{Ln}\,[\theta\,(z, \mu_2, L_2(p)] - \text{Ln}[\theta\,(z, \mu_1, L_1(p)])/\gamma\hat{}$ ..... (28)

and $\gamma\hat{} = \text{Ln}\,(\mu_2) - \text{Ln}\,(\mu_1)$ ..... (29)

μ_1 is mean income at baseline

μ_2 is mean income at endline

$L_1(p)$ is the Lorenz curve in the baseline year

$L_2(p)$ is the Lorenz curve in the endline year

Equation (29) is an assessment of growth rate of mean income

and $\eta\hat{}$ is an assessment of the growth elasticity of poverty, which should satisfy

$\delta\hat{} = \eta\hat{} + \zeta\hat{}$ ..... (30)

where; $\zeta\hat{}$ is an assessment of the inequality effect of poverty reduction. Kakwani (2000) poverty decomposition methodology can then be used to calculate $\eta\hat{}$ and $\zeta\hat{}$. Therefore,

$\eta\hat{} = \underline{1}[\ln(\theta(z,\mu_2,L_1(p) - \text{In}(\theta(z\,\mu_1 L_1(p) + \ln(\theta(z\,\mu_2 L_2(p)) - \ln\theta\,z\,\mu_1 L_2((p)]/\gamma\hat{}$ .....(31)2

$\eta\hat{}$ is always negative unless $\mu_1 = \mu_2$

$\zeta\hat{} = \underline{1}[\ln(\theta(z,\mu_1 L_2(p) - \ln\theta z\mu_1 L_1(p) + \ln\theta\,z\,\mu_2 L_2(p) - \ln\theta\,z\,\mu_2 L_1(p) / \gamma\hat{}$ ..... (32)2

(31) and (32) will always satisfy equation (30). This method can be adopted to estimate the PEGR for the entire class of poverty measures. The proportional reduction in poverty is equal to $\delta\hat{}\,\gamma\hat{}$, which is equal to $\eta\hat{}\,\gamma\hat{}^{*}$

From equation (14) growth is pro-poor if $\hat{\gamma}^{*}$ is greater than $\hat{\gamma}$. The larger the PEGR ($\hat{\gamma}^{*}$), the greater the percentage reduction in poverty between the two periods. If PEGR is seen to be greater than the actual growth rate, then growth is pro-poor but if PEGR is less than the actual growth rate, then growth is anti-poor.

Test of hypotheses

Hypotheses 1, 2 and 3 were tested using the ATT equation which estimated the impact of the CADP on three outcomes which are: productivity, poverty status and commercialization. Given the results obtained from this study, the hypothesis 1, 2 and 3 which stated no significant difference between the productivity, poverty status and commercialization of beneficiaries and non-beneficiaries were rejected.

CHAPTER FOUR

RESULTS AND DISCUSSION

The socioeconomic characteristics considered in the study were: Access to credit, credit source, farm size, household size, gender, land ownership, years of education, and years of farming experience. The results of poverty status of respondents and impact of CADP on productivity and poverty and commercialization of respondents are also presented as well as the pro-poorness of CADP.

4.1 Statistical matching of respondents

The probit regression model served to estimate the propensity scores that were used in matching of respondents. One probit model was estimated for comparison that is the beneficiaries of CADP were compared with non-CADP beneficiaries across the states that participated. The dependent variable for the model which is a binary variable indicates whether the household participated in the CADP or not. The result obtained using the model is presented in Appendix 1.The probit model for program participation shows that eight out of the ten variables are significant determinants of participation in CADP. The p-value derived using the model being less than 0.05 ($p<0.05$) indicates there is goodness of fit and all the explanatory variables have been able to account for the change in the dependent variable. The probability of participation in the CADP is affected significantly by sex, age, distance to town, distance to market, receipt of credit, land ownership, years of schooling and household size.

The observations that were off common support were left out of the analysis. Out of 1,200, only 1,142 beneficiaries and non-beneficiaries with comparable propensity scores were matched as presented in Appendix II. The results showed that the difference in the explanatory variables used in the probit model between the

matched groups of CADP beneficiaries and non-beneficiaries were statistically insignificant.

4.2 Socioeconomic characteristics of respondents

The socioeconomic characteristics of respondents both beneficiaries and non-beneficiaries are presented in Table 1. Across the two categories of respondents, majority are male constituting about 82 % among beneficiaries, and 86 % of non-beneficiaries, showing that more male participated in the CADP and also in agriculture generally relative to female. This is in line with the fact that farming is dominated by males. This agrees with the findings of Oni and Olaniran (2008). The NCADPB recorded a higher percentage (20.38 %) of those below 35 years old; while CADPB are lower (14.75 %). Those within the 36-55 years age range have almost the same percentage for both beneficiaries and non-beneficiaries with NCADPB being 60.04 % and CADPB being 60.54 %; while for those above 55 years, CADPB are higher (21.71 %) than NCADPB (17.58 %). This shows that those involved in farming are at the peak of their productive years. This may be due to the fact that farming is viewed as a retirement venture by civil servants at all levels. It is important to get youths to participate in agricultural activities.

Analysis of distribution by household size revealed that majority of respondents are within the range 6-10 members with CADPB being 47.13 %, NCADPB is 38.40 %. the beneficiaries tend to have more household members when compared to non-beneficiaries. This is expected to be brought to bear in the area of farm labour. Breakdown by educational status shows that 48.66 % of possess tertiary education, which is higher than that of NACDPB which is 36.48 %. Overall among those with tertiary education are highest (41.78 %) followed by those with secondary education (40.28). This indicates that majority of respondents are educated. This is

TABLE 1

Distribution of beneficiaries and non-beneficiaries of CADP program across socio economic characteristics

Socioeconomic Characteristic	Non-Beneficiaries	Beneficiaries	Total
Sex			
Female	98(14.48)	94(18.01)	192(16.01)
Male	579(85.52)	428(81.99)	1,007(83.99)
Total	677(100)	522(100)	1,199(100)
Age			
<25	25(3.69)	8(1.53)	33(2.75)
26-35	113(16.69)	69(13.22)	182(15.18)
36-45	192(28.36)	160(30.65)	352(29.36)
46-55	228(33.68)	156(29.89)	384(32.03)
56-65	101(14.92)	109(20.88)	210(17.51)
>65	18(2.66)	20(3.83)	38(13.17)
Total	677(100)	522(100)	1,199 (100)
Household Size			
1-5	259(38.26)	134(25.67)	393(32.78)
6-10	260(38.40)	246(47.13)	506(42.20)
11-15	98(14.48)	72(13.79)	170(14.18)
>15	60(8.86)	70(13.41)	130(10.84)
Total	677(100)	522(100)	1,199(100)
Educational status			
No formal	16(2.36)	5(0.96)	21(1.75)
Primary	139(20.53)	55(10.54)	194(16.18)
Secondary	275(40.62)	208(39.85)	483(40.28)
Tertiary	247(36.48)	254(48.66)	501(41.78)
Total	677(100)	522(100)	1,199(100)
Accessed Credit			
No	586(85.56)	240(45.98)	826(68.89)
Yes	91(13.44)	282(54.02)	373(31.11)
Total	677(100)	522(100)	1,199(100)
Farm Size			
1-5	4(0.59)	39(7.47)	43(3.59)
6-10	672(99.26)	383(73.37)	1,055(87.99)
11-15	1(0.15)	84(16.09)	85(7.09)
>15	0(0.00)	16(3.07)	16(1.33)
Total	677(100)	522(100)	1,199(100)
Farm Experience			
1-10	264(39)	164(31.42)	428(35.70)
11-20	225(33.23)	201(38.51)	426(35.53)
21-30	142(20.97)	95(18.19)	237(19.77)
>30	46(6.79)	62(11.88)	108(9.01)
Total	677(100)	522(100)	1,199(100)

Source: Author's own estimation using CADP Nigeria Data, 2020
(figures in parenthesis are %ages)

good for the agricultural sector as it is a shift from the usual practice of uneducated peasant farmers being involved in agriculture. On receipt of credit within the years of their operation, among CADPB, those who accessed credits are higher as 54.02 % of them have accessed credit. This is a far cry from the 85.56 % of NCADPB who did not access any form of credit with only 13.44 % of them having accessed credit. Overall for both beneficiaries and non-beneficiaries, those who did not access credit is higher (68.89 %) than those who did (31.11 %).

Majority of respondents fall within the 6-10 ha farm size with land cultivated (87.99 %) followed by 11-15 ha (7.09), while 3.59 % cultivated 1-5 ha, with the least being 1.33 % for the >15 ha category. This is the order followed by CADPB as shown on the Table. The fact that the 6-10ha is highest is understood as one of the cardinal foci of CADP was commercialization; vast area of land is required for commercial farming. On years of farming experience, those who fall within 1-10 years' experience are 31 % for NCADPB and 31.42 % for CADPB; the 11-20 years category which is highest has 32.33 % for NCADPB and 38.51 % for CADPB. Those with 20-30 years' experience are 20.97 % of NCADPB and 18.19 % for CADPB. The least is the >30 years' experience which has 6.79 % for NCADPB and 11.88 % for CADPB.

4.3 Productivity level of CADP beneficiaries and non-CADP beneficiaries

The aim of objective 1 was to determining the level of productivity of CADP beneficiaries and non CADP beneficiaries; the results areas presented in Table 2 and it shows the level of productivity of beneficiaries and non-beneficiaries. The mean TFP for CADPB at the endline (2016) is 0.922 with a standard deviation of 2.106, while that of NCADPB at the same point in time is 0.615 with a standard deviation 1.449. This shows that the TFP of CADPB is higher compared to that of NCADPB. The fact that the beneficiaries had access to grants from CADP might have affected

TABLE 2

Level of productivity of beneficiaries and non-beneficiaries

Variable	Obs	Mean	Std. Dev.	Min	Max
Mean TFP pooled (beneficiaries and non-beneficiaries at endline)	1,198	0.7487494	1.770955	0.0008358	27.68626
Mean TFP for beneficiaries at endline	521	0.9219527	2.10612	0.0008358	27.68626
Mean TFP for non-beneficiaries at endline	677	0.6154571	1.449284	0.0354304	27.61178

Source: Author's own estimation using CADP Nigeria Data, 2020.

their productivity. The use of TFP as a tool of analysis shows how resources are efficiently utilized by beneficiaries of Project interventions. This result is in consonance with the findings of Salisu (2016) who found that the productivity of CADP participants in Kaduna state was greater than that of non-participants.

4.4 Determinants of productivity among households

The result of the determinants of productivity among households is found in Table 3. The log likelihood for the Tobit model is -2359.98 and the chi-square is 48.17 and strongly significant at 5 % level. With this, the overall model is significant and gave a good fit to the data. The result indicates that out of the 8 explanatory variables captured in the model, only three were found to significantly influence productivity. The variables that did not significantly influence productivity of respondents are: sex, age, years of schooling, farm experience and land ownership. While the variables that were significant in influencing productivity are: household size, farm size and credit.

However, the results showed a negative relationship between productivity and household size which is negatively significant at 10 % level. This negative relationship is surprising as it is incongruent with a'priori expectation. Nevertheless, it is consistent with the findings of Fawole and Rahji (2016). This negative relationship between productivity and household size might be as a result of many factors. On the other hand, farm size significantly and positively influenced productivity at 5 % significant level. The result suggests that a 1 % increase in farm size increases productivity by 12.87 % thus corresponding with the findings of Oyekale (2007) and Verter (2015) that recorded a positive relationship between agricultural production and land expansion in Nigeria. This refutes the inverse-farm size hypothesis which is said to be due to market failures.

TABLE 3

Estimates of Tobit Regression for the determinants of productivity among households

Variables	Coefficient	Std. Err.	T	P>t
Sex(male)	0.1437376	0.1410196	1.02	0.308
Age	-0.0049301	0.0052134	-0.95	0.345
Years of schooling	-0.0047403	0.0118538	-0.4	0.689
Household size	-0.0189126*	0.0102729	-1.84	0.066
Farm experience	0.0073769	0.0062943	1.17	0.241
Farm Size	0.1287495**	0.0227008	5.67	0.000
Credit (Yes)	0.2963973**	0.1100997	2.69	0.007
Landownership(Yes)	0.1750108	0.1142356	1.53	0.126
_cons	0.1025454*	0.3066863	0.33	0.738
Sigma	1.734982	0.0354442		
Prob>chi^2	0.000			
LR chi^2 (8)	48.17			
Pseudo R^2	0.0101			
Log likelihood	-2359.98			

**p<0.05,* p<0.1

Source: Author's own estimation using CADP Nigeria Data, 2020.

Also positively significant at 10 % level is receipt of credit. The result shows that access to credit by farmers' impact positively on productivity. It suggests that one unit increase in credit results in 29.6 % increase in productivity. This corroborates the works of Samson and Obademi, (2018) who also find that the amount of credit received by farmers in Ibarapa, Oyo State, Nigeria has a positive impact on productivity. It however contradicts the findings of Verter (2015) who recorded the relationship between commercial loans to agriculture and crop performance in Nigeria to be inverse.

4.5 Impact of CADP on productivity of beneficiaries and non-beneficiaries

The impact of CADP on beneficiaries as shown in Table 4, gives the Average Treatment Effect on the Treated (ATT). The ATT of 0.375 indicates positivity and significance at 5 % level implying that the CADP positively impacted the productivity of participants who experienced a 37.5 % increase in their productivity. The Average Treatment Effect on the Untreated (ATU) shows the spillover effect of the Project on non-participants, while the Average Treatment Effect (ATE) is the intention to treat which excludes the spillover. The results agrees with the findings that participation in agricultural cooperatives increases productivity of smallholder farmers in Ethiopia (Elias *et al.*, 2013) and that of Martey *et al.* (2015) whose results through the estimation of ATT revealed that involvement in farmer mentorship project impacts positively on farm technical efficiency by 28 %.

TABLE 4

Impact of CADP on Productivity of Beneficiaries and Non-Beneficiaries

Variable	Sample	CADP Beneficiaries	Non-CADP Beneficiaries	Difference	S.E.	T-stat
TFP	Pooled	0.92195273	0.61517198	0.30678075	0.10279687	2.98
	ATT	0.88833213	0.51287476	0.37545737	0.12855028	2.92
	ATU	0.62188994	0.69496391	0.07307397		
	ATE			0.20202381		

Source: Author's own estimation using CADP Nigeria Data, 2020

4.6 Poverty status of beneficiaries and non-beneficiaries by socioeconomic characteristics

Table 5 shows the distribution of poverty Incidence, depth and severity across household socioeconomic characteristics. The result from sampled observation indicated the incidence of poverty (Po) to be generally higher for NCADPB and lower for CADPB. This may be the effect or otherwise of participation in the Project. For the beneficiaries, poverty incidence among the male is 0.014 while that of the female is 0.01; but for the non-beneficiaries, the Po for the male is 0.021 while that of the female is 0.026. The index of poverty depth (P_1) for male beneficiaries is 0.531 which is lower than that of the female 0.791. This scenario is seen in the squared poverty gap (P_2) index as well whether it be for beneficiaries or non-beneficiaries where the index for the male is lower than that of the female. For CADPB, the P_2 is 0.409 for male and 0.722 for female while that of NCADPB male is 0.687 and female is 0.835. On a general note, the indices for the female are higher than that of the female.

For the different age sub groups, P_0 is higher for the NCADPB in all subgroups and lower for CADPB. Among the beneficiaries however, the poverty incidence is found to be reducing as the age increases; this holds true for P_1 and P_2 as well. For CADPB, the P_0 for the under 25 category is 0.034 which is lower than the 0.037 of their NCADPB counterpart. However, the P_1 for this age category for CADPB is slightly higher at 0.424 than that of their NCADPB counterparts which is 0.367. The same scenario is reflected in the P_2 which is 0.423 for CADPB and 0.305 for NCADPB. For the 26-35 age category however, the CADPB appear better off as the P_0, P_1 and P_2 are lower for CADPB compared to NCADPB. For CADPB, the P_0, P_1 and P_2 are 0.021, 0.814 and 0.786 respectively; whereas for the NCADPB, the indices are: 0.025, 0.927 and 0.925. This order is maintained in the remaining age categories.

TABLE 5

Distribution of poverty incidence, depth and severity across household socio economic characteristics

Socio economic characteristics	Non-Beneficiaries			Beneficiaries		
	P_0	P_1	P_2	P_0	P_1	P_2
Sex						
Male	0.021	0.768	0.687	0.014	0.531	0.409
Female	0.026	0.871	0.835	0.013	0.791	0.772
Age						
<25	0.037	0.367	0.305	0.034	0.424	0.423
26-35	0.025	0.927	0.925	0.021	0.814	0.786
36-45	0.018	0.721	0.646	0.014	0.579	0.482
46-55	0.023	0.784	0.702	0.010	0.526	0.403
56-65	0.017	0.821	0.727	0.010	0.494	0.352
>65	0.040	0.827	0.759	0.011	0.451	0.277
Household Size						
1-5	0.042	0.921	0.992	0.023	0.969	0.963
6-10	0.020	0.737	0.662	0.011	0.383	0.318
11-15	0.005	0.740	0.637	0.005	0.527	0.353
>15	0.002	0.789	0.672	0.004	0.686	0.498
Educational status						
No formal	0.004	0.680	0.624	0.015	0.379	0.167
Primary	0.018	0.730	0.621	0.009	0.580	0.485
Secondary	0.025	0.763	0.670	0.015	0.518	0.395
Tertiary	0.020	0.820	0.769	0.016	0.617	0.518
Credit Access						
Yes	0.025	0.842	0.792	0.017	0.738	0.646
No	0.015	0.328	0.207	0.14	0.590	0.480
Farm Size						
1-5	0.003	0.773	0.625	0.002	0.825	0.689
6-10	0.014	0.802	0.742	0.014	0.558	0.448
11-15	0.056	0.526	0.445	0.003	0.708	0.502
>15	0.570	0.599	0.384	0.000	0.000	0.000
Farm Experience						
1-10	0.028	0.851	0.815	0.019	0.710	0.667
11-20	0.023	0.763	0.689	0.012	0.562	0.471
21-30	0.017	0.754	0.667	0.011	0.429	0.271
>30	0.004	0.769	0.658	0.009	0.519	0.307

Source: Author's own estimation using CADP Nigeria Data, 2020.

As expected, the indices are found to be reducing as level of education and years of farming experience increases. This scenario holds true for both CADPB and NCADPB. This agrees with a'priori expectations because level of education and years' of experience are expected to be brought to bear in farming practices and consequently improvement in yield and income. For farm size, poverty incidence of NCADPB is higher than that of CADPB and is found to be increasing as farm size increases. For the CADPB however, the sub group of 6-10 has had the highest poverty incidence and decreasing as the farm size increases. For credit access, among the CADPB, P_0, P_1 and P_2 are 0.017, 0.738 and 0.646 respectively; these are higher compared to those who did not access credit with the indices standing at 0.14, 0.590 and 0.480. These results are quite interesting as credit depending on the source and the terms have a tendency of further immiserating the poor. On a general note, the indices of poverty incidence depth and gap are higher for non-beneficiaries compared to the beneficiaries.

Table 6 shows an aggregation of the indices for both beneficiaries and non-beneficiaries and the summary presented. The P_0 index for beneficiaires is 0.0140 implying that 1.4 % of the beneficiaries are living below the poverty line of ₦171,094.30 monthly. For non-beneficiaries, the $P_0$is 0.0216 which implies that about 2.16 % of them live under the poverty line. The poverty gap index P_1=0.562 for beneficiaries is lower than that of non beneficiaries which is 0.787. This therefore establishes the fact that beneficiaries will require the lowest %age of expenditure to grant freedom to the poor to a non-poor condition. The poorest among the poor within the beneficiaries account for 45.15 % of the poor population (P_2=0.4155); which is lower than that of non-beneficiaries which is 0.7143. The lower poverty incidence among beneficiaries is probably due to their participation in CADP which

TABLE 6

Summary poverty status of respondents

Poverty measures	Non-Beneficiaries	Beneficiaries	Pooled
P_0	0.0216	0.0140	0.0173
P_1	0.7870	0.5620	0.6757
P_2	0.7143	0.4515	0.5843

Source: Author's own estimation using CADP Nigeria Data, 2020.

makes them better off compared to their counterparts who did not participate in the Project. This is in line with the findings of Oni and Olaniran (2008) who compared the FGT poverty indices of *Fadama* II project beneficiaries and non-beneficiaries in Oyo State, South West Nigeria, and found that the indices were lower for the beneficiaries compared to non-beneficiaries. As stated earlier, the indices for beneficiaries are lower than that of non-beneficiaries indicating the potential of the CADP has to reduce poverty. The poverty depth and severity indices showed that non-beneficiaries are far below the poverty line and that poverty is more severe among the non-beneficiaries compared with beneficiaries.

4.7 Impact of CADP on poverty status using income as a proxy

Table 7 and Figure 2 shows impact of participation in CADP on poverty of beneficiaries using income as a proxy. The ATT of 446,073.89 is indicative of positivity and significance at the 5 % level implying that CADP positively impacted the income of beneficiaries compared to non-beneficiaries. The income is used as a proxy for welfare to measure the impact on poverty status of beneficiaries. It shows that those who participated in CADP have their income increased by ₦446, 073.89 and were better off in terms of their welfare compared to those who did not participate in the program. This still confirms that the CADP has the potential to improve the welfare of the beneficiaries.

4.8 Impact of CADP on Commercialization of beneficiaries and non-beneficiaries

Table 8 shows impact of participation in CADP on commercialization among the participants. The Average Treatment Effect on the Treated (ATT) is the impact on the treated taking into consideration the distinctive features of participants and non-participants. The ATT of 0.08 is indicative of positivity and significant at the 10 %

TABLE 7

Impact of CADP on poverty status using income as a proxy

Variable	Sample	Treated	Controls	Difference	S.E.	Stat
Farm Inc16	Unmatched	1,980,508.82	1,107,730.02	872,778.799	155236.851	5.62
	ATT	1,597,775.52	1,151,701.63	446,073.892	139976.094	3.19
	ATU	1,095,613.62	1,234,003.29	138,389.674	-	-
	ATE			266,244.001	-	-

Source: Author's own estimation using CADP Nigeria Data, 2020.

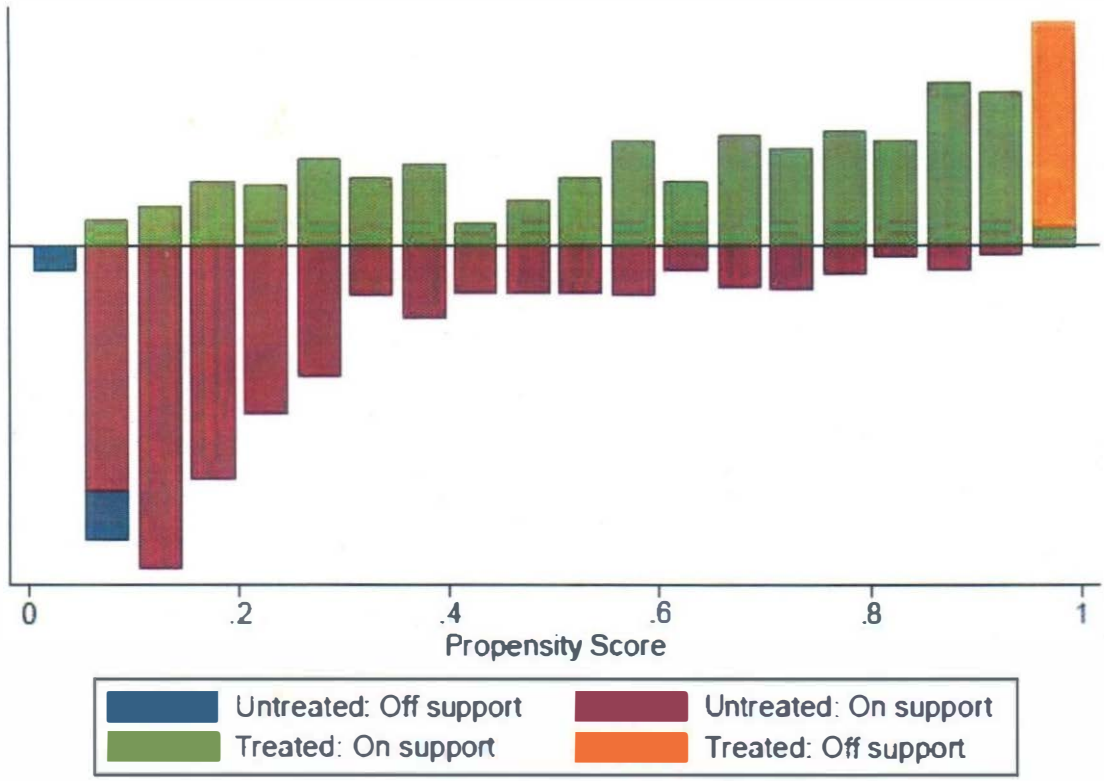

FIG. 2: Impact of CADP on poverty status.

TABLE 8

Impact of CADP on Commercialization

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Commercialization Index	Unmatched	0.09129655	0.07731608	0.01398047	0.00481676	2.9
	ATT	0.08334828	0.07368363	0.00966465	0.00569133	1.7
	ATU	0.07715206	0.07341133	-0.0037407	.	.
	ATE			0.00182971	.	.

Source: Author's own estimation using CADP Nigeria Data, 2020

level of significance. The positive value shows that CADP has a significant impact on the commercialization of participants. Also that those who participated in CADP will have their commercialization increased by 0.9 % compared to those who did not participate in the program. This indicate that taking part in CADP has led to increase in commercialization among the participants this could lead to increase in revenue generated by the participants and it could also bring about an overall improvement in welfare of the participants. The ATU shows the spillover effect of the Project on non-participants, while the ATE is the intention to treat which excludes the spillover.

4.9 Determining the pro-poorness of CADP

4.91 Pro-poor Indices for CADP Beneficiaries and Non-Beneficiaries

Table 9 gives estimates and confidence intervals for the growth rate of beneficiaries between 2009 and 2016 which is the variable g. There are also estimates of two other pro-poor indices apart from the PEGR index of Kakwani and Son (2003); Ravallion and Chen (2003) index, Kakwani and Pernia (2000) index.

From Table 9 which provides pro-poor estimates for CADP Beneficiaries using the PEGR as earlier discussed, the mean growth rate in income - 1.875, is higher than the PEGR -1.528. For the poor to have benefitted from the intervention, the PEGR should be higher than the actual growth rate. With this result, when the PEGR is subtracted from the growth rate, a negative value is obtained. This implies that CADP benefitted mainly the rich and not the poor. Also, the PPGI Kakwani and Pernia index for beneficiaries of 0.815 lies between 0 and I indicates a trickle down growth. The implication of this is that the poor received dimentionally less of the benefits of growth than the non-poor. This is in line with the findings of Gafaar and Osinubi (2005) that the very poor has not benefitted in the growth in Nigeria within the period analyzed, but contrary to the findings of Akinlade 2012 who assessed the

TABLE 9

Pro-poor indices of CADP beneficiaries

Pro-poor indices	Estimate	STE	LB	UB
Growth rate(g)	1.87554	0.236532	1.410867	2.340214
Ravallion & Chen (2003) index	6.347877	9.763965	-12.833702	25.529457
Ravallion & Chen (2003) – g	4.472337	9.768689	-14.718523	23.663196
Kakwani & Pernia (2000) index	0.814998	0.088767	0.640613	0.989382
PEGR index	1.528561	0.235873	1.065181	1.99194
PEGR – g	-0.34698	0.153075	-0.647699	-0.04626

STD: Standard error, LB: lower bound of 95 % confidence interval, UB: upper bound of 95 % confidence interval

Source: Author's own estimation using CADP Nigeria Data, 2020.

pro-poorness of Fadama II Project in Nigeria and found that the PEGR for participants was higher than that of non-participants which implied that the Fadama II Project was pro-poor. It is important that the poor is properly targeted in development programmes in order to reduce poverty and reduce the inequality between the poor and the rich.

From Table 10 which shows the pro-poor indices for non-beneficiaries of CADP, the PEGR is far higher at 3.783 than the mean growth rate which is 1.437. Also, the Kakwan and Pernia (2002) index for non-beneficiaries is 2.633>1 which implies that the poor benefitted proportionally from the growth more than the non-poor.

TABLE 10

Pro-poor indices for CADP non-beneficiaries

Pro-poor indices	Estimate	STE	LB	UB
Growth rate(g)	1.436617	0.158694	1.125025	1.748208
Ravallion & Chen (2003) index	1.978191	17.705383	-32.785871	36.742254
Ravallion & Chen (2003) – g	0.541575	17.708934	-34.229462	35.312611
Kakwani & Pernia (2000) index	2.633333	0.230728	2.180305	3.086362
PEGR index	3.78309	0.492527	2.816026	4.750154
PEGR – g	2.346474	0.321437	1.715341	2.977606

STD: Standard error, LB: lower bound of 95 % confidence interval, UB: upper bound of 95 % confidence interval

Source: Author's own estimation using CADP Nigeria Data, 2020.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study analyzed the impact of the Commercial Agriculture Development Project (CADP) on productivity and poverty status of farmers in Nigeria. the study was necessitated by the fact that government has been intervening in the agricultural sector with projects and policies aimed at increasing productivity and poverty with a view to improve the welfare of the populace. The CADP was one of such interventions which was implemented in 5 states of Nigeria from 2009 to 2017 but its impact on productivity and poverty status of farmers using the counterfactual approach had not been previously carried out. The data used was obtained from a secondary source through a survey conducted in five World Bank supported CADP states by the Project in 2017. These states are: Cross River, Enugu, Lagos, Kaduna and Kano all in Nigeria. The available data contained information on a sample of 1800 households but a total of 1,199 households were used for this study. To achieve the major objective, the study employed five specific objectives. Specifically, it determined the level of productivity of CADP beneficiaries and non-CADP beneficiaries, examined the impact of the Project on their productivity, examined the socioeconomic determinants of productivity of CADP beneficiaries, determined the impact of CADP on poverty status of beneficiaries, determine the pro-poorness of CADP and the impact of the Project on agricultural commercialization. Data was analyzed using descriptive statistics, propensity score matching, Total Factor Productivity (TFP) Index, Foster-Greer-Thorbecke (FGT) weighted poverty index, Household Commercialization Index, Average Treatment effect on the Treated (ATT) and Poverty Equivalent Growth Rate (PEGR).

The results of the specific objectives are summarized below:

The level of productivity of CADP beneficiaries and non-beneficiaries were computed using the Total Factor Productivity (TFP) index. The mean TFP of CADP beneficiaries of 0.92 is higher than that of non-beneficiaries which is 0.62.

The result of the impact of CADP on productivity (TFP) of beneficiaries using ATT shows that they had their productivity increased by 37.5 % as a result of participating in the CADP. The ATT of 0.375 is positive and significant at 5 % level. This is in line with the objective of the Project to increase total production of selected crops belonging to participating small and medium scale commercial farmers.

The result further showed the importance of household size, farm size and credit receipt as significant determinants of productivity among respondents.

FGT poverty indices were lower for CADP beneficiaries than those of non-beneficiaries.

The impact of the CADP on poverty using the income of beneficiaries as proxy result, the Average Treatment effect on the Treated (ATT) showed that those who participated in CADP have their income increased by ₦446, 073.89 and fared better in terms of their welfare compared to those who did not participate in the project.

The ATT of 0.09 is positive and significant at the 10 % level of significance. The positive value shows that CADP has a significant impact on the commercialization of participants. Also that those who participated in CADP will have their commercialization increased by 0.9 % compared to those who did not participate in the program.

The result of the PEGRs shows that CADP was not pro-poor. Also the PEGR for non-beneficiaries was higher than the actual growth rate while that of beneficiaries is less than the actual growth rate.

5.2 Conclusion

This study examined the impact of the Commercial Agriculture Development Project (CADP) on productivity and poverty of farmers in Nigeria using a counterfactual approach. The study revealed that the CADP increased productivity of farmers by 37.5 % and impacted positively on the poverty status of beneficiaries as well as their commercialization though minimally. Socioeconomic factors that were significant determinants of productivity are: household size, farm size and receipt of credit. Those who participated in CADP have their income increased by ₦446, 073.89 and were better off in terms of their welfare compared to those who did not participate in the program.

However, the Project was not pro-poor as the PEGR of beneficiaries was lower than the actual growth rate which means that the growth occasioned by the CADP was anti-poor and not pro-poor. Even though the CADP impacted positively on the productivity and poverty of beneficiaries, it was not pro-poor hence there is a need to ensure that the poor are effectively targeted in such development programmes. This will address the inequality that characterizes the economy of Nigeria. This study has contributed to knowledge by carrying out an independent assessment of the CADP with the secondary data from the Project using a counterfactual approach.

5.3 Recommendations

Since CADP decreased the probability of being poor and increases the commercialization index of participants. If the project is to be continued the following implementation options are recommended:

- The CADP was implemented in 5 states of the federation in its pilot phase. If it is to be continued, the Project should be scaled up and its targeting mechanism should be reviewed as well as some of its operations. This will ensure that more beneficiaries are accommodated.
- Farm size and access to credit among other factors significantly influenced productivity; policy measures should be oriented towards improving access of farmers to land and credit facilities.
- The project design and targeting mechanism should be reviewed to make the programme pro-poor. Availability and up-to-date social register would prove indispensable in targeting the poor.
- These options should also be a policy takeaway for other agricultural intervention programmes in Nigeria.

5.4 Contribution of this study to knowledge

Generally, the impact assessment report indicates that the accomplishments of the CADP ware positive for all the components. However, the approach for the impact assessment adopted did not provide controls for factors outside the project that could affect outcomes. The major contribution of this study is the distinctive approach of investigating counterfactual non-beneficiaries as well as project beneficiaries which allows for better attribution of the outcomes to the project. The contribution is important to evaluating not only the CADP but also the many other impact studies of projects conducted without using comparison groups. This study used the quasi-experimental method of control for the other factors that could affect project outcomes. The overarching focus of the study is on quantifying the impacts of the project on productivity which is one of the objectives of the CADP and poverty status which stands as an indicator for measuring the longer term outcome of improved

farmer welfare. Also, this study has been able to describe and quantify the link between productivity and poverty using farm incomes as proxy. There is no doubt that indicators measuring the impact of productivity gains on income generation and poverty are useful for policy-making and monitoring especially in developing countries.

5.5 Areas of further studies

This study is limited in its ability to cover other stages of the value chain as it only examined the impact of the CADP on productivity at the production stage. It is hereby suggested that researches in the future should examine the impact of the CADP on productivity at the processing and marketing stages.

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APPENDICES

APPENDIX I

Probit Regression Estimates of CADP Participation before matching

Explanatory variables	Coeff.	Std. Err.	z	P>z
Sex	-0.5387108**	0.1885259	-2.86	0.004
Age	0.0161368**	0.0077057	2.09	0.036
Distance to town	-0.0131798**	0.0059141	-2.23	0.026
Distance to market	0.0473319**	0.0065064	7.27	0.000
Waiting time for transport to market	-0.0003113	0.0049303	-0.06	0.95
Credit (yes)	2.3792**	0.1669903	14.25	0.000
Own land(yes)	0.4240245**	0.1618151	2.62	0.009
Years Schooling	0.0870929**	0.0189442	4.6	0.000
Household Size	0.0722433**	0.0150269	4.81	0.000
Farm experience	0.004944	0.0086147	0.57	0.566
Constant	-3.880917**	0.4662194	-8.32	0.000
Wald chi2(10)	256.74			
Prob > chi^2	0.0000			
Sample size	1,200			
Pseudo R^2	0.2342			
Prob > chi^2	0.0000			
Log likelihood	-629.17271			

**p<0.05

Source: Author's own estimation using CADP Nigeria Data, 2020.

APPENDIX II

Common support

	Common support		
Treatment Assignment	Off support	On support	Total
Untreated	23	655	678
Treated	34	487	521
Total	57	1,142	1,199

Source: Author's own estimation using CADP Nigeria Data, 2020