The impact of public agricultural investment on food security and nutrition in ECOWAS

Research Dissertation

by

Madalitso A. Kamenya

Submitted in partial fulfilment of the requirements of the degree of

Master of Science in Agricultural Economics

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Sciences

University of Pretoria

May 2020

ABSTRACT

Public agriculture expenditure is an important growth catalyst. According to Comprehensive Africa Agriculture Development Programme and its Malabo Declaration, a 10% increase in public expenditure in agriculture should stimulate a 6% productivity growth in agriculture, leading to widespread development benefits including improving food security and nutrition. However, evaluation of the impact of public agriculture expenditure on food security and nutrition remains scanty. This study evaluated the impact of public agriculture expenditure on food security and nutrition using panel data of nine ECOWAS countries, which are Benin, Burkina Faso, The Gambia, Ghana, Mali, Niger, Nigeria, Senegal and Togo. This was achieved by evaluating the trends of public agriculture expenditure and food security and nutrition in the nine countries between the year 2000 and 2017. Further, assessing the impact of public agricultural expenditure on food security and nutrition using panel data from 2000 and 2016, controlling for other factors that affect food security and nutrition at the national level.

The trends revealed that public expenditure has improved in the nine ECOWAS countries as several countries have met the Comprehensive African Agriculture Programme's target of investing at least 10% of the national budget on the agricultural sector in several years. Likewise, food supply has improved and the levels of undernourishment has reduced. However, stunting, underweight and wasting are still high in these nine countries. Using the fixed effect generalised least squares model, it was found that a one-unit increase in public agriculture expenditure reduced undernourishment and improved average dietary energy supply adequacy each by 0.2%. The study concluded that public agriculture expenditure had an impact on food security. However, the impact may lag depending on the type of expenditure on agriculture. The study recommended disaggregating public expenditure data to isolate their impact. The analysis could be conducted in the design of national food security investment plans and to help identify strategies to accelerate improvements in food security and nutrition in African countries.

Keywords: ECOWAS, Public agricultural expenditure, food security and nutrition, panel data method, fixed effect generalised least squares model

DECLARATION

FACULTY OF NATURAL AND AGRICULTURAL SCIENCES

University of Pretoria

Declaration Regarding Plagiarism

I, Madalitso Ashtone Kamenya, student number 18193693

declare the following:

1. I understand what plagiarism entails and am aware of the University's policy in this regard.
2. I declare that this assignment is my own, original work. Where someone else's work was used (whether from a printed source, the Internet or any other source) due, the acknowledgment was given and reference was made according to departmental requirements.
3. I did not copy and paste any information directly from an electronic source (e.g., a web page, electronic journal article or CD ROM) into this document.
4. I did not make use of another student's previous work and submitted it as my own.
5. I did not allow and will not allow anyone to copy my work with the intention of presenting it as his/her own work.

Signature

22nd May 2020

Date

DEDICATION

I dedicate this thesis to my late mum who worked hard to make sure I am who I am today. To my family and friends for their prayers and constant support.

ACKNOWLEDGEMENTS

I take this opportunity to recognise all the people that have been key to the completion of this study.

- My supervisor Prof Sheryl Hendricks for her constant guidance, support, and motivation. Her confidence and belief in the study was encouraging both academically and emotionally.
- Dr. Colleta Gandidzanwa for co-supervising this work and for her encouragement and insight
- Dr John Ulimwengu and Dr Sunday Odjo from IFPRI for their constant insight and support in this study
- My research group, Nosipho Mabuza, and Emilian Kasililika Chikondi Mlagha for their support
- Mastercard Foundation Scholarship for awarding me the scholarship and for constant emotional support. The African Research Consortium's Collaborative Masters in Agricultural and Applied Economics (CMAAE) for funding the study.
- Dr. Elizabeth Mkandawire and Dr Clement Kweku for thier constant insight and support
- Miss Kholofelo Ledoka, Hope Mpata, Guadalupe Matias Kabia, Isaac Phiri, Letlama Setene, Nina Soko and Linda Sankhulani

Funding from the Feed the Future Innovation Lab for Food Security Policy award EDH-A-00-07-00005-00 is acknowledged for the opportunity to receive training on the methodology used in this study. The Feed the Future Innovation Lab for Food Security Policy was made possible through the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative. The contents are the responsibility of the study authors and do not necessarily reflect the views of USAID or the United States Government.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AU	African Union
ADESA	Average Dietary Energy Supply Adequacy
CAADP	Comprehensive African Agriculture Development Program
CGE	Computable General Equilibrium Model
ECOWAS	Economic Community of West African States
ECOWAP	Regional Agriculture Policy of West African States
FAO	Food and Agriculture Organisation of the United Nations
FDI	Foreign Direct Investment
FIES	Food Security Experience Scale
GDP	Gross Domestic Product
NAIP	National Agriculture Investment Plan
NAFSN	New Alliance for Food Security and Nutrition
PAE	Public Agriculture Expenditure
REC	Regional Economic Integration
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
SADC	Southern Africa Development Community
SAM	Social Accounting Matrix
SDG	Sustainable Development Goal
SOFI	State of Food Security and Nutrition in the World
UN	United Union
WHO	World Health Organisation
WB	World Bank
WDI	World Development Indicator

CHAPTER 1: INTRODUCTION

Agriculture is seen as an engine for growth towards the achievement of food security and improved nutrition in Africa (AU, 2018). Likewise, improving food security and nutrition are goals of the 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods to end hunger in Africa by 2025 (AU, 2014) as well as a Sustainable Development Goal (SDG), specifically goal two that seeks to end hunger and achieve food security by 2030 (UN, 2015b). Since agriculture is central to the achievement of the Malabo Declarations and the SDG two, then public expenditure in agriculture should be a national priority.

The Comprehensive African Agriculture Development Programme (CAADP) through the 2003 Maputo Declaration (AU, 2003) and its successor the 2014 Malabo Declarations (AU, 2014) bind African countries to invest 10% of their national budgets to the agriculture sector (AU, 2003; AU, 2015). This level of expenditure is expected to achieve productivity growth of at least 6% in the sector (AU, 2014). Increased productivity growth is required to lead to a reduction in poverty and improvement in food security and nutrition in the continent (AU, 2014).

CAADP and the Declarations are based on the premise that increased expenditure in agriculture will lead to increased productivity, which will lead to wide-spread development benefits for the population (AU, 2014). However, it is not known if this is true for food security and nutrition. Benin (2016) carried out an assessment of the impact of public expenditure on poverty reduction in Africa. Similarly, CAADP initially addressed the Millennium Development Goal (MDG) one that was to reduce extreme poverty and hunger by 2015. This led to the adoption of empirical tools to assess the poverty dimension of this goal; however, these tools have not yet been utilised to assess the hunger dimension of this goal.

This goal is reiterated in the Malabo Declaration and the indicators for measuring the progress of achieving this goal are explained in the Malabo targets and the corresponding Biennial review for CAADP implementation progress (AU, 2018). There is an urgent need to assist countries in establishing if their National Agriculture and Food Security Investment Plans are likely to achieve food security and nutrition-related targets given the previous trends during the Maputo Declaration era. As the first generation NAIPs acknowledged the need to invest in crop production, livestock

and fisheries but did not address the specific agricultural expenditures that governments needed to spend on to achieve overall productivity growth and eventually food security and nutrition (Ghana, 2010). Therefore, given that countries are on the verge of implementing the second generation investment plans (Wouterse & Taffesse, 2018). More so, it is of the essence to ensure that scarce public resources are allocated to public expenditures that yield the highest return in terms of achieving food security and nutrition targets.

Hence, the findings of the study will assist to bridge the knowledge gap by understanding the impact of public agricultural expenditure on food security and nutrition in nine ECOWAS countries, which are Benin, Burkina Faso, The Gambia, Ghana, Mali, Niger, Nigeria, Senegal and Togo. By reviewing different methodologies that have been used to analyse the impact of public expenditure on poverty reduction, economic growth and agriculture productivity and adopting a methodology that suited for this study (Benin, 2015; Fan & Zhang, 2008; Thurlow *et al.*, 2007). The Economic Community for the West African States has been chosen for this study because the countries in ECOWAS have made considerable progress in the implementation of CAADP as they are high up in the implementation phase of CAADP compared to countries in the other regions (De Pinto and Ulimwengu, 2017). That is, they have all signed the CAADP compact, have developed their National Investment plans and have secured more than one external funding (Wouterse and Taffesse, 2018).

1.1. Statement of the problem

Public agriculture expenditure has improved in many African countries since the adoption of the CAADP (Badiane *et al.*, 2013). On aggregate, ECOWAS countries such as Benin, Senegal and Niger have reached 10% spending on agriculture in any one single year between 2003 and 2017 (De Pinto & Ulimwengu, 2017). However, questions still emerge regarding the effectiveness and consequences of public agricultural expenditure on food security and nutrition because, although public expenditure has improved, not enough progress has been made to improve food security and nutrition in Africa. Considering that the levels of undernourishment and undernutrition are still high in the continent (FAO, 2019c). In 2019, it was estimated that 22.8% of the population faced hunger daily; with another 21.8% food insecure (UN, 2019)**.**

Several studies have analysed the impact of agricultural public expenditure on economic growth, poverty reduction and agriculture productivity (Beyene & Engida, 2016; Fan *et al.*, 2000; Fontan Sers & Mughal, 2019). Such evaluations have led to the development of empirical tools for analysing poverty, tools which have not yet been proven for assessment of the impact of public agriculture expenditure on food security and nutrition. Few studies included food security and nutrition in analysis (Benin, 2016; Beyene & Engida, 2016). However, these studies considered the availability and accessibility dimensions of food security only, bearing in mind that food security exists in four dimensions and for effective policy analysis, all dimensions of food security must be taken into account. Therefore, the study aimed to fill the knowledge gap by analysing the impact of public agriculture expenditure on food security and nutrition for nine ECOWAS countries, which if not explored would derail countries in achieving the Malabo food security targets by 2025 and SDG 2 of ending hunger by 2030. The study also provided an empirical methodology that assisted member countries in understanding if their National Investment Plans will lead to the achievement of the Malabo food security targets.

1.2. Research objectives

The overall objective of the study was to analyse the impact of public agriculture expenditure on food security and nutrition in ECOWAS

The specific objectives of the study are:

i. To evaluate trends of public agriculture expenditure and food security and nutrition within countries of ECOWAS between 2000 and 2017.
ii. To evaluate the impact of public agriculture expenditure on food security and nutrition using panel data from 2000 to 2016 in nine countries within ECOWAS.

1.3. Research hypothesis

The study was guided by the following hypotheses:

i. Trends of public expenditure and food security have not improved for nine countries within ECOWAS between 2000 and 2017.
ii. Public expenditure on agriculture has no significant impact on food security and nutrition for ECOWAS countries.

1.4. The organisation of the dissertation

This dissertation consists of six chapters. The first chapter provides the introduction and rationale for the study. The second chapter presents a review of relevant literature, highlighting the food security and nutrition conventions, commitments, including declarations at the global level, the African continent and the regional level. It further, presents an overview of food security and public agricultural expenditure in the world and Africa. It also reviews econometric approaches that were used to analyses the impact of public expenditure on development outcomes. Chapter three presents the public expenditure and food security trends. Chapter four presents the methodology for evaluating the impact of public expenditure on food security and nutrition (sub-objective two), followed by the results and discussion. The dissertation concludes in Chapter five with the major findings, the conclusions and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

Food insecurity and malnutrition continue to be of concern for countries in Africa, where the number of hungry people is on the rise according to the SOFI report (FAO, 2019). In 2019, it was estimated that 22.8% of the population faced hunger daily; with another 21.8% food insecure (UN, 2019)**.** These numbers are impeding the progress of achieving the Malabo targets as governments may not reach the food security and nutrition targets, they have committed to. However, governments still advocate for increased public expenditure in agriculture to reverse this and evidence suggest that substantial progress has been made in increasing public expenditure in agriculture between 2000 and 2018 (Badiane & Makombe, 2014; Badiane *et al.*, 2013; Covic & Hendriks, 2015; De Pinto & Ulimwengu, 2017). Regardless, the impact of this increased public agricultural expenditure on food security and nutrition is not known because the tools required for such an evaluation do not exist. As such, it is not known if the current National food security and nutrition investment plans will lead to widespread improvement in food security and nutrition as per Malabo targets, which eventually will lead to the achievement of the targets. Therefore, chapter 2 seeks to discuss why achieving food security is important as well as give a synopsis of the state of food security and public agricultural expenditure in the world and Africa. This chapter will elaborate on the different pathways through which public expenditure in agriculture impact food security and nutrition. Further, different empirical tools used to analyses the impact of public expenditure will be explored.

2.1. Food security and nutrition as a development priority for the World and Africa

"Food security is a situation that exists when all people, at all times, have physical, and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (CFS, 2012). Based on this definition, achieving food security and nutrition has been at the heart of the global development agenda for the past 25 years. Several Declarations, Commitments and Conferences have driven and stimulated the need to achieve food security and reduce malnutrition to attain national, regional, African and international development goals (Covic and Hendriks 2015). The first Declaration on food security and nutrition, the 1948 Universal Declaration of Human Rights UN (1948) stressed the right to food for all, which was later reiterated in the 1966 International Covenant on Economic, Social and Cultural Rights (UN,

1966). However, nutrition was later mentioned in 1976 in the International Convention on Economic, Social and Cultural Right (UN, 1976).

The first international conference on nutrition held in Rome in 1992 on the World Declaration and Plan of Action for Nutrition FAO (1992) placed emphasis on nutrition and through this Declaration countries committed to eliminate hunger and reduce all forms of malnutrition, particularly, in children and women. The summit recognised the need for political will and well-conceived policies and rigorous actions at national and international levels towards improving nutrition. This was followed by the 1996 World food summit, the Rome Declaration on World Food Security and World Food Summit Plan of Action FAO (1996) where countries reaffirmed the right to food and committed to reducing the number of chronically undernourished people on the planet by 2015. The Declaration placed emphasis on the importance of promoting optimal allocation and use of scarce public resources to foster agricultural growth and rural development. Further, highlighting the need for an enabling environment, politically, socially, and economically as a prerequisite in achieving sustainable food security for all.

Four years later, UN Millennium Development Goals (MDG) renewed global commitments to food security and nutrition (UN, 2000). The MGD focused on halving the proportion of people hungry by 2015. It focused on nutrition, which led to the prioritisation of nutrition in development programs and policies. At the second International Conference on Nutrition FAO (2014), member states signed the Rome Declaration where they reaffirmed to combat the challenges of malnutrition in all its forms and need for all to have access to safe and nutritious food. Further, Rome Declarations recognised the need for continued investments in agriculture and the role of food and agriculture systems in achieving food security. More recently in 2016, the Sustainable Development Goals UN (2016), especially goal 2, which seeks to end hunger and achieve food security and nutrition by 2030.

Drawing Inspiration from both MDG 1, in 2003 the AU launched the Comprehensive Africa Agriculture Development Programme (CAADP) framework for African food security and nutrition (AU, 2015). The main objective of the CAADP was to improve food security and nutrition by increasing agricultural productivity by increasing public expenditure in agriculture (AU, 2003). This led to the 2003 Maputo Declaration where member states committed to increasing expenditure in agriculture by 10% to achieve agricultural productivity growth of 6%

(AU, 2003). The 2014 Malabo Declarations on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods reinforced the agreements made in the former 2003 Maputo Declarations (AU, 2014). The Malabo Declarations committed member countries to reduce undernourishment by 5%, stunting by 10%, underweight by 5%, and wasting by 5% (AU, 2014). Therefore, understanding the food security status entails the progress the world has made to achieve food security given the numerous commitments by countries to achieve food security for all.

2.2. The state of food security in the world and its regions between 2000 and 2017

Tackling food insecurity and malnutrition are top of world development goals because the implications of doing nothing have both human costs and economic costs attached (Cohen *et al.*, 2008; FAO, 2018). Undernutrition leads to growth retardation, morbidity, mortality of under-five children, brain damage and reduced cognitive development, which affects the working capacity of children as well as adults (FAO, 2019c). Further, undernutrition affects early child development, which leads to stunted physical growth, higher chances of overweight, risk of chronic diseases such as diabetes and also poor cognitive development, which impacts productivity (FAO, 2017). In Africa alone, undernutrition results in loss of gross domestic product of 11% and the costs of obesity amount to 2 trillion USD, which is the value placed on the loss of economic productivity and direct health care costs (FAO, 2019c; McGovern *et al.*, 2017). Figure 2-1 provides an overview of food security in the world and its regions using the prevalence of undernourishment, which is an SDG indicator for tracking progress made in improving food security (UN, 2015a).

The proportion of people not meeting their minimum dietary needs for an active and healthy life declined around the world between 2000 and 2015 (Figure 2-1). Beyond 2015, a slight increase in the proportion of hungry people can be observed from 10.6% in 2016 to 11.3% in 2018. Indicating the slow progress made in ending hunger in the world. The prevalence of undernourishment has also declined in the regions of the world, for example, Africa, Asia and Latin America and the Caribbean reduced between 2000 and 2015 (Figure 2-1). Despite this decrease, the levels have been on the rise for all three regions beyond 2015 with Africa and Asia having the highest proportion of undernourished people. Specifically, for Africa the proportion of undernourished people increased from 18.3% to 19.8% between 2015 and 2017 (Figure 2-1). For Oceania, the proportion of undernourished people has remained low compared to the other regions but has been

rising steadily between 2015 and 2017. Although there is slow progress in achieving food security, the state has an obligation ensuring the realisation of food security and nutrition for all (UN, 1966). This obligation binds governments to facilitate food security by developing and adopting strategies that enhance the capability of achieving food security for all (Eide *et al.*, 1991). One such strategy is public expenditure on agriculture.

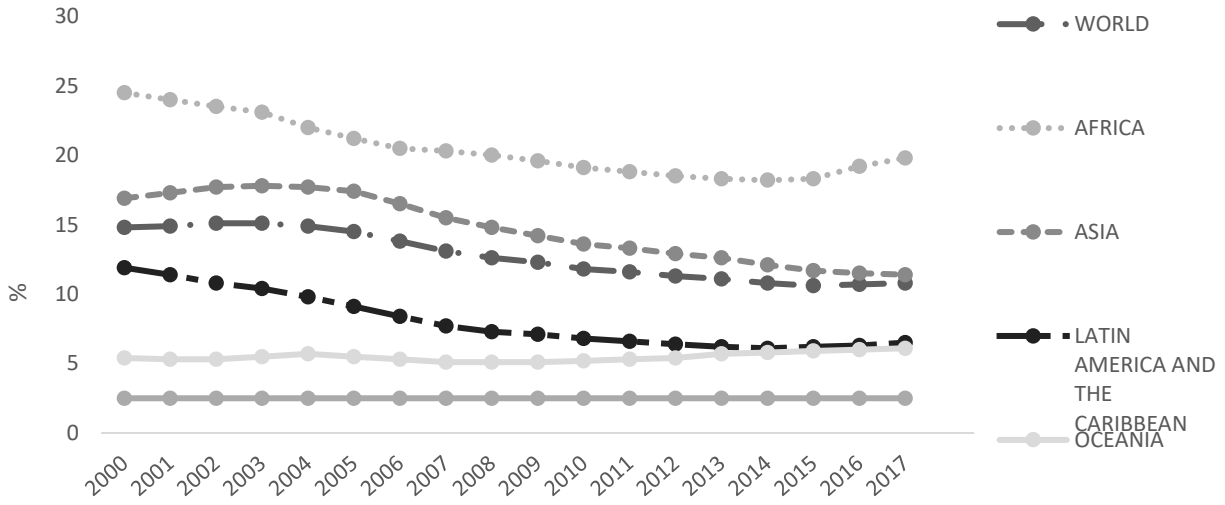

Figure 2-1: Prevalence of undernourishment in the world and its regions

Source: (FAO, 2019)

2.3.Overview of public expenditure in agriculture in the world and Africa

The study defines public agriculture expenditure as spending incurred by the government that provides direct or indirect support to agriculture (Mogues *et al.*, 2012). The role of agriculture in improving food security and nutrition cannot be disputed as both the Malabo Declarations and SDG 2 put agriculture central towards the achievement of food security and ending hunger in Africa (AU, 2014). As such public expenditure in agriculture is regarded as a strategy that the government can exploit to induce agricultural productivity, which will, in turn, lead to the achievement of the Malabo targets and ending hunger (Badiane *et al.*, 2013). Therefore, it is of the essence to understand the trend of public expenditure in agriculture, which gives insight on whether spending on agriculture has improved. Using the trends for the world and Africa, spending

on agriculture as a share of the total budget has remained relatively stable below 2% in the world between 2000 and 2017 (Figure 2-2). The highest expenditure share was recorded in 2008 where expenditure reached 1.85%, but starts declining beyond this point due to a spike in food prices (De Pinto & Ulimwengu, 2017).

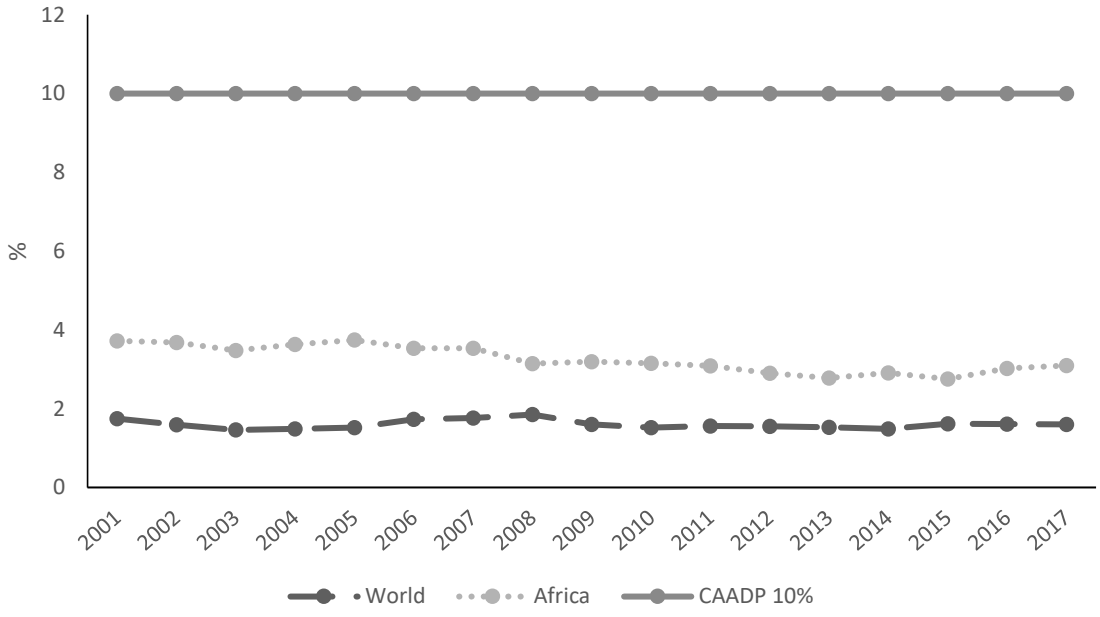

Figure 2-2: Government expenditure on agriculture in the world

Source: (FAO, 2019b)

Africa has been allocating a relatively higher share of its expenditure on agriculture (Figure 2-2). As most economies in Africa rely on agriculture to boost economic growth (Fontan Sers & Mughal, 2019). Prior to 2003 when CAADP was established, Africa's share of expenditure on agriculture was just more than double that of the world expenditure (3.7% in 2001 and 2002 and declined to 3.5% in 2003). However, since the inception of CAADP, this share expanded until 2006 but declined following the global crisis in 2007/8 (Figure 2-2). Africa has not met the 10% CAADP spending target and overall the percent share spent on agriculture is 3.3% between 2000 and 2017. Figure 2-2 points out that public expenditure has improved in agriculture but how does an improvement in public expenditure in agriculture translate to improvement in food security and nutrition and nutrition outcomes. Understanding the link between agriculture and nutrition enables the channeling of public expenditure to ensure optimal allocation (Hawkes and Ruel, 2008)

2.4. Impact Pathways of public agriculture expenditure

Food security and nutrition is an outcome of food availability, accessibility, utilisation and stability. Several pathways exist through which public agriculture expenditure can affect food security and nutrition outcomes (Hawkes & Ruel, 2008). The impact of public expenditure in agriculture on food security and nutrition can happen at the macro level and, if appropriately designed, can have both an impact at both the national and household levels. Literature identifies four pathways through which public expenditure in agriculture improves food security and nutrition at the national and household level. These pathways include; increased food production, increased agricultural income, reduction of food prices and improvement in women's social status and empowerment.

First, public expenditure on agriculture can influence the national level by directly improving agriculture production. Public expenditure in research and development enables technological advances such as high-yielding and disease-resistant varieties and biofortified seed varieties, which increase agriculture productivity and access to nutritious foods (Mogues *et al.*, 2012). Public expenditure in extension can improve human capital through technology transfer and adoption, improving productivity. Likewise, farm-level productivity can be improved by the provision of on input subsidies and loans. While spending on irrigation enables households to grow crops year-round, which leads to improved availability of foods and more sustained nutrition (Spencer, 1996).

In addition, these improvements in farm productivity spillover into household consumption (McGovern *et al.*, 2017). For example, the increased production of staple foods could lead to higher consumption of energy. Also, increased production of fruit, vegetables and animal source foods increases the intake of energy, protein and fats by households, which improves energy, dietary quality and micro-nutrient availability. Production decisions made by farmers have the potential to shape their diets through consumption of their own production (Hawkes & Ruel, 2008).

Secondly, increased agriculture production at the national level directly increases the productivity of other sectors of the economy such as manufacturing sector and service sector (Benin *et al.*, 2008a). Indirectly, such improvements in the national economy can generate GDP employment, increasing household income (Covic & Hendriks, 2015). Excess household production can be sold on the market leading to increased household incomes. Further, the creation of both farm and non-

farm of employment can generate additional household income. Additional income can improve food and non-food expenditure. Expenditure on improved and more diversified diets can translate into better nutrition (Mogues *et al.*, 2012). Non-food expenditure such as expenditures on health, education and household assets can improve social status, health care and livelihoods. This can have a significant impact on the health and nutritional status of children and women.

Thirdly, public agriculture expenditure can impact on the national and household economy by lowering prices of food (Benin *et al.*, 2008a). The link between public agriculture expenditure and food prices involves a range of supply and demand factors at the national level that influence prices of marketed food and non-food crops (McGovern *et al.*, 2017). These prices affect the incomes of net sellers and net buyers of food. For net buyers of food, lower food prices mean lower food expenditures, which frees incomes for purchase of other more nutritious foods and non-food commodities (Hawkes & Ruel, 2008). Non-food expenses can improve health care, education and acquisition of household assets (McGovern *et al.*, 2017).

Lastly, overall improvement in incomes, wages, prices and availability of technologies and inputs can have an impact on women's social status and empowerment if such interventions are appropriately and carefully targeted at women (Covic & Hendriks, 2015). Children's health, intra-household decision making, and resource allocation are dependent on the nutrition and health status of women. The income and resources that women control have strong implications for food security and nutrition. Women are more likely to invest in children's health and wellbeing (Hawkes & Ruel, 2008). However, women's time is crucial for the realisation of these factors. Heavy and prolonged manual work has implications for women's nutrition. Likewise, women's participation in agriculture can affect their health through exposure to agriculturally-associated diseases, contaminants and poisons as well as increased energy expenditure, which may affect their health and agricultural productivity and so also their income (Ruel *et al.*, 2013). Therefore, government expenditure in research and development, extension, irrigation and input subsidies should be appropriately and carefully designed to create technologies that encourage women's participation in agriculture, save time and energy and grant them control over productive assets.

Public agriculture expenditure can potentially improve food security and nutrition outcomes through different pathways. While significant evidence exists on the pathways that link public agriculture expenditure to household food security and nutrition (Ruel *et al.*, 2013), very little

research reports on the national-linkages of public expenditure in agriculture on food security and nutrition. This gives rise to a need to investigate the macro impacts of public agriculture expenditure on food security and nutrition at the national level. Further, understanding of the different empirical tools that exist in the literature to analyse the impact of public agriculture expenditure at the national level.

2.5.Approaches to evaluate public expenditure impact

Various approaches exist in the literature that has been used to evaluate the impact of public expenditure on poverty reduction and agriculture growth. These empirical approaches have their own limitations, which calls for care when choosing what approach to use to address a specific problem as well as interpretation of the results. The role of the key approaches used in impact studies of policy outcomes supports the selection of the empirical approach adopted for this study. Further, Table 2-1 summarises the methodologies discussed.

Table 2-1: Empirical methods modeling public expenditure

Author	Country	Model	Findings
Fan and Zhang (2008)	Uganda	Simultaneous equation model	Expenditure on research and extension had the highest impact on growth. Feeder roads contributed more to growth than high-grade roads. Expenditure on health and education had a sizable impact on growth and poverty reduction.
Fan *et al.* (2000)	India	Simultaneous equation model	Expenditure on research and extension has the strongest impact on growth. Expenditure on education, health, irrigation, and water and soil conservation had sizeable impacts on poverty reduction and growth
Fan *et al.* (2002)	China	Simultaneous equation model	Results consistent with (Fan & Zhang, 2008). Research and extension had a stronger impact on reducing inequality
Fan *et al.* (2008)	India	Simultaneous equation model	Expenditure on research, education and rural infrastructure had the highest impact on reducing poverty in India

Author	Country	Model	Findings
Benin and Odjo (2018)	Kenya	Simultaneous equation model	The composition of government expenditure was influenced by political, environmental and socioeconomic factors.
Fan and Rao (2003)	Africa, Asia & Latin America	Fixed effects model	Expenditure on agriculture, education and infrastructure was significant for growth in Africa compared to Asia and Latin America. Spending on irrigation, education and roads contributes to economic growth.
Benin (2015)	Africa South of the Sahara	Fixed effects model	Elasticity per hectare of land was higher for agriculture research than total agriculture expenditure. Aggregate returns to expenditure are higher for agriculture research than for total agriculture expenditure.
Fontan Sers and Mughal (2019)	Regions of Africa	Fixed effect model	Public expenditure on agriculture had no significant relationship with undernourishment.
Slimane *et al.* (2016)	55 Developing countries	Fixed effect model	Public expenditure on agriculture improved food security.
Thurlow *et al.* (2007)	Kenya	The computable general equilibrium model	Agriculture critical for poverty reduction 1.5 million people will be removed from poverty if public spending increases by 10%
Benin *et al.* (2008c)	Uganda	The computable general equilibrium model	Agriculture growth possible for Uganda if public expenditure on crops, fisheries and livestock increased. To achieve 6% agricultural growth public expenditure should increase by 25.3% each year
Benin *et al.* (2008b)	Zambia	The computable general equilibrium model	Agriculture growth possible for Uganda if public expenditure on crops, fisheries and livestock increased. To achieve 6% agricultural growth public expenditure should increase by 27% each year

2.5.1.Simultaneous equation model

Simultaneous equation models have widely been used in the analysis of public expenditure (Benin & Odjo, 2018; Fan *et al.*, 2008; Fan *et al.*, 2000). “Simultaneous equation model is a system of equations used in the empirical analysis”, (Wooldridge, 2016). The advantage of simultaneous

equation models is that they address the problem of endogeneity (Benin *et al.*, 2008a). If not addressed, endogeneity leads to biased estimates and which leads to incorrect conclusions. However, simultaneous equation models only analyse the direct impacts of policy and fail to evaluate the indirect impacts of a policy, for example, income distribution trickling down to household can not be assessed. Further, simultaneous equation models as already pointed out consist of a system of equations and incorrectly specifying one equation results in a bias, which affects all the structural equations in the system, which affects the estimated coefficients in the entire system of equation. In addition, the model requires disaggregation of data both across sectors and within sectors because it is more appropriate in assessing the effects of intra-sector and inter-sector public expenditure.

Fan and Zhang (2008) explored the effects of different types of government expenditures on agriculture growth and poverty reduction in Uganda using panel data from 1992, 1995 and 1999. In the study, it was found that expenditures in research and rural roads had the highest impact on reducing poverty and increasing agricultural productivity in Uganda. A similar study, introducing a component of inequality in the assessment of public expenditure on agriculture in China. Fan *et al.* (2000) found out that both education and research and development had a large impact on reducing inequality and poverty. However, the largest impact was from research and development.

Fan *et al.* (2000), observed that spending on research and extension including feeder roads had the largest impact on poverty reduction in India 1970-1993 using panel data. Fan *et al.* (2008) showed that government spending on research, education and rural infrastructure was more effective in reducing poverty than providing credit for fertilizer and irrigation equipment. Using time-series data from 1950 to 2014, Benin and Odjo (2018) investigated the determinants of government expenditure in Kenya. In their study, it was found that political factors, environmental and socio-economic factors affect the composition of government expenditures.

2.5.2.Fixed effect Model

The fixed effect model is a panel data estimation method used in a cross country analysis where the analysis focuses on comparing differences across countries and is used for ex-post analysis (Benin *et al.*, 2008a). The fixed effect model allows estimation of the impacts of public expenditure at the national level. Further, can be used where short time-series data exists. The limitation of the

model is that it assumes that all countries are identical and are on the same growth path which likely not the case. However, exceptions arise where countries have the same structural and production characteristics.

Fan and Rao (2003) investigated the impact of government expenditure on economic growth using public expenditures data from 1980 to 1998 for 43 countries in Africa, Asia and Latin America. It was found that spending on irrigation, education and roads contributed to GDP growth. Further, that expenditure on agriculture, education and infrastructure as a share of total expenditure were more likely to drive economic growth in Africa compared to Asia and Latina America. However, when agriculture expenditure was disaggregated by expenditure on research and non-research, expenditure on research led to higher productivity growth.

Benin (2015) also explored the returns to agriculture public spending in 34 African countries using panel data from 1980 to 2012. The study disaggregated expenditure by agriculture *per se* and agricultural research. The study found that returns with respect to expenditure in agricultural research were higher than from total expenditure in agriculture. Likewise, Fontan Sers and Mughal (2019) evaluated the impact of public agricultural expenditure on food security and nutrition in Africa using a fixed effect model. The study used the share of expenditure as a proportion of the total budget as the independent variable and controlled for economic conditions, political and natural hazards. The authors found that the relationship between public expenditure share and undernourishment and other indicators of food security was not significant.

Likewise, Slimane *et al.* (2016) analysed the impact of sectoral foreign direct investment (FDI) on food security and nutrition. Using panel data from 55 developing countries for 1995 and 2009, a composite indicator of food security was developed using four indicators - one from each dimension of food security. In their study, it was found that government expenditure improves food security and nutrition.

2.5.3. The computable general equilibrium model

A computable general equilibrium model is an economy-wide model that links all sectors of an economy (Lofgren *et al.*, 2002). A computable general equilibrium model captures economy-wide linkages between different sectors of the economy. Computable general equilibrium models use data from a country's Social Accounting matrix and the SAM is developed using data from a

specific year (Lofgren *et al.*, 2002). The CGE is used for ex-ante policy analysis and it evaluates the impact of a policy strategy before implementation to understand the economy-wide impacts of the strategy on all sectors of the economy. The major strength of the CGE is that it evaluates the direct and indirect impacts of a policy on the whole economy while its limitation is that it requires a large data set, which may not always be available.

Thurlow *et al.* (2007) used a 2002 Social Accounting Matrix for Kenya to investigate the impact of different growth paths on agriculture and rural investment on poverty reduction. The study found that irrigation, research and extension were important in accelerating growth for both food and export crops. Further, they found that if spending in agriculture was increased by 10 % (in accordance with the target set by the Maputo Declaration), 1.5 million people would be lifted above the poverty line in Kenya by 2015.

A study by Benin *et al.* (2008c) examined agriculture growth and different investment options for Uganda using a 2005 SAM for Uganda. It was found that broader-based growth in the number of crops grown and in the livestock and fisheries sectors is needed. Further, Uganda should increase spending in real value terms by 25.3% each year between 2006 and 2015 to achieve the 6% growth. A similar study was carried out in Zambia using a 2004 Social Accounting Matrix (SAM) (Benin *et al.*, 2008b). Likewise, similar results were found that for Zambia to attain the 6% agriculture growth, Zambia must not rely on maize only and higher value export crops but broader-based growth in livestock and fisheries department. To achieve this 6% growth, spending should reach 27% every year until 2015.

Beyene and Engida (2016) analysed the impact of public agriculture investment on growth, food security and poverty reduction in using a 2005 and 2006 Social Accounting Matrix for Ethiopia. A CGE model fitted with a micro-simulation model of household expenditure was used to measure food availability. Household consumption of staples was used as an indicator of food accessibility. The study explored public expenditure on irrigation and farmer training and it was found that spending on irrigation combined with farmer training had a stronger impact on improving food security and reducing poverty.

2.6.Summary

The CAADP and Malabo Declarations are based on the foundations that increasing public expenditure in agriculture will lead to increased widespread developments for the population. However, it is not known if this is so for food security and nutrition as tools to evaluate the impact of public expenditure on food security and nutrition do not exist. However, different approaches exist in the literature that was used to analyse the impact of public expenditure on poverty reduction. The use of these methods also come with their own strengths and limitations in policy analysis and their application depends on the question to be addressed and the type of data available. These methods have ranged from simultaneous equation models and fixed effect models to economy-wide models, the computable general equilibrium model. Recently, the fixed effect model was used to evaluate the relationship between public expenditure and food security in Africa (Fontan Sers *et al*., 2019). Using the regions of Africa, it was found that no significant relationship exists between public agriculture expenditure and food security measured by the prevalence of undernourishment. Meaning that public agriculture expenditure as a policy strategy for Africa is not achieving the set objectives of improving food security and nutrition. Therefore, this study narrows the analysis by conducting an impact evaluation of the impact of public expenditure on agriculture on food security and nutrition for nine ECOWAS countries. The study will provide an empirical tool that assists countries in the designing of the National Food Security Investment Plans (NFSIP) in identifying strategies lead to a broad-based improvement in food security.

CHAPTER 3: TRENDS IN PUBLIC EXPENDITURE AND CAADP TARGETS FOR THE YEARS 2000 – 2017

A historical perspective of public expenditre in relation to CAADP targets is necessary in evaluating the performance of different governments. Specific objective one set out to measure progress towards the attainment of the Malabo Declaration targets of increasing public agriculture expenditure by 10% to achieve agricultural growth of 6% (Badiane *et al.*, 2013). This chapter presents and discusses the public expenditure trends of different govenments. The sources of data, results of the analysis and discussion are presented in this chapter.

3.1. Data sources and methods

Specific objective one was addressed by evaluating the trends of public expenditure and food security and nutrition for nine ECOWAS countries. The study used nine countries in ECOWAS because of the availability of data in these countries. The share of expenditure in the total national budget and the size of expenditure in billion USD was used to analyse the trends of public expenditure. While the prevalence of undernourishment, stunting, wasting, underweight, average dietary energy supply adequacy and per capita food production variability were used to evaluate trends of food security and nutrition. The indicators were chosen because public expenditure indicators and prevalence of undernourishment, stunting, wasting and underweight are used to assess progress countries are making in achieving the Malabo targets thereby form part of the indicators included in CAADP technical guidelines (Covic & Hendriks, 2015).

Average dietary energy supply adequacy was used as a measure of the availability dimension, the prevalence of undernourishment for the accessibility dimension, stunting, wasting and underweight for the utilisation dimension and per capita food production variability for the stability dimension. Data were from the period 2000 to 2017 for all indicators except per capita food production variability whose data was between 2000 to 2016 for all nine countries. Data for public expenditure indicators and food security indicators used to track the Malabo targets were sourced from the Regional Strategic Analysis and Knowledge Support System (ReSAKSS) while data for the prevalence of undernourishment, average dietary energy supply adequacy and per capita food production variability was from Food and Agricultural Organisation (FAO).

3.2. Description of public expenditure and food security indicators used in evaluating trends

An evaluation of the trends reflects the progress countries have made in achieving food security and nutrition targets as well as the target of increasing public expenditure in agriculture by 10%. Public expenditure as a share of the total national budget and public expenditure size are used to reflect the progress made in increasing spending on agriculture to 10%. While the prevalence of undernourishment, stunting, wasting, underweight, average dietary energy supply adequacy and per capita food production variability reflects the food security trends. Table 3-1 summarises the indicators by their unit of measurement, sources of data and column 3 reflect the whether the indicator is included in the CAADP framework to track progress countries are making in reaching the Malabo targets. The Malabo targets require spending be increased by 10% and food security targets aim to reduce undernourishment to 5%, stunting to 10%, wasting to 5% and underweight to 5% by 2025 (Covic & Hendriks, 2015).

Table 3-1: Description of public expenditure and food security and nutrition indicators and sources of data

Indicator	Units	Malabo target	Years	Source
Public agricultural expenditure				
Public expenditure share	%	Yes	2000-2017	ReSAKSS
Public expenditure size	Billion USD	Yes	2000-2017	ReSAKSS
Food security and nutrition indicators				
Prevalence of undernourishment	%	Yes	2000-2017	FAO
Prevalence of stunting	%	Yes	2000-2017	ReSAKSS
Prevalence of wasting	%	Yes	2000-2017	ReSAKSS
Prevalence of underweight	%	Yes	2000-2017	ReSAKSS
Average dietary energy supply adequacy	%	No	2000-2017	FAO
Per capita food production variability	International dollar per person	No	2000-2016	FAO

Public agriculture expenditure as a share of total national budget measured commitments by countries to enhancing investment finance in agriculture (Covic & Hendriks, 2015). The indicator

was used to measure the progress countries have made towards spending 10% of their national budget to agriculture as required by Malabo Declarations. Public expenditure by size was also included in the analysis to compare whether improvements in the share of expenditure correspond to the amount of expenditure by size invested in agriculture.

Average dietary energy supply adequacy (ADESA) was used to measure the food availability dimension. It expressed the dietary energy supply of a country as a percentage of the average dietary energy requirement for the total population. The indicator measures whether the food available is enough to meet the calorie needs of a country's population. A 100% value shows that a country's supply is equal to its requirement while a value less than 100% means that the food supply of the nation is inadequate to meet the calorie requirements of the population. A value higher than 100% indicates that the country is producing enough food for the entire population. Average Dietary Energy Supply adequacy used together with the prevalence of undernourishment allows distinguishing undernourishment caused by insufficiency of the food supply, or poor distribution of food.

The prevalence of undernourishment measured food accessibility and it shows the proportion of the population whose daily food consumption was not adequate to provide the dietary energy levels needed to maintain a normal and active life (Jones *et al.*, 2013; Wanner *et al.*, 2014). The prevalence of undernourishment is an indicator included in the Malabo Biennial review and measures progress towards ending hunger by 2025 (Badiane *et al.*, 2013). Child stunting measures the proportion of children under five years of age who are stunted, as defined by height for age Z score below two standard deviations below the norm (World Health Organization, 2010).

The prevalence of wasting reflects body weight relative to height and shows weight falling significantly below the weight expected of a child of the same height. It assists in identifying the percentage of children under five years of age with acute malnutrition - with moderate wasting being less than two standard deviations below the norm and severe wasting being three standard deviations below the norm. Underweight is measured as a weight for age. It measures the percentage of children aged 0-59 months, whose weight is less than two standard deviations below the median weight. The indicator reflects acute and chronic undernutrition and measures both severe and moderate underweight. Fluctuations in food production, supply and prices provide important information regarding the vulnerability of countries and their population. Per capita food

production variability measured the net food production variability expressed in US dollars (Alexandri, 2015).

3.3. Trends of public expenditure and food security and nutrition

To address specific objectives one of the trends of public expenditure and food security was evaluated to understand the progress countries have made in achieving the Malabo targets of increasing expenditure in agriculture by 10% and achieving the food security and nutrition-related Malabot targets. The percentage share of expenditure from the total budget and size of expenditure was used to evaluate the public expenditure trends. While the prevalence of undernourishment, stunting, wasting, underweight, average dietary energy supply adequacy and per capita food production variability were used to evaluate the food security trends. The results are discussed below.

3.3.1. Trends of public expenditure on agriculture from 2000 to 2017

Figure 3-1 and 3-2 shows the proportion of the total government budget and the size of expenditure in agriculture respectively. It can be observed that public expenditure in agriculture slightly improved in African regions (Figure 3-1). Western, Southern and Central Africa experienced a rapid increase in spending on agriculture between 2003 and 2008. This was as a result of the inception of CAADP in 2003 (AU, 2003), which prompted growth in public agriculture expenditure in African countries. For example, during this period, Western Africa experienced a rise in expenditure share from 2.9% in 2003 to 4.7% in 2006 (Figure 3-1). The improvement may have resulted from commitments by governments to spending in the agricultural sector as agreed under CAADP (Badiane *et al.*, 2013). Interestingly, there was a decline in the share of expenditure for all regions between 2008 and 2016 as can be seen in Figure 3-2. This may be attributed to the financial crisis and the high food price crisis, which depressed government expenditure in agriculture (Badiane *et al.*, 2013; De Pinto & Ulimwengu, 2017). Countries responded differently to the impacts of the shocks in the regions. Figure 3-2 showed that for some regions the size of expenditure on agriculture increased. North and Central Africa increased the size of expenditure while for West, East Africa and Southern Africa the size of expenditures declined between 2008 and 2016. Regardless of the progress, the regions are far from reaching the targets set out in the Malabo Declaration of increasing public expenditure by 10%. This is because no region has ever

met the 10% expenditure target as agreed under Malabo Declaration since the inception of CAADP to dat (Figure 3-1).

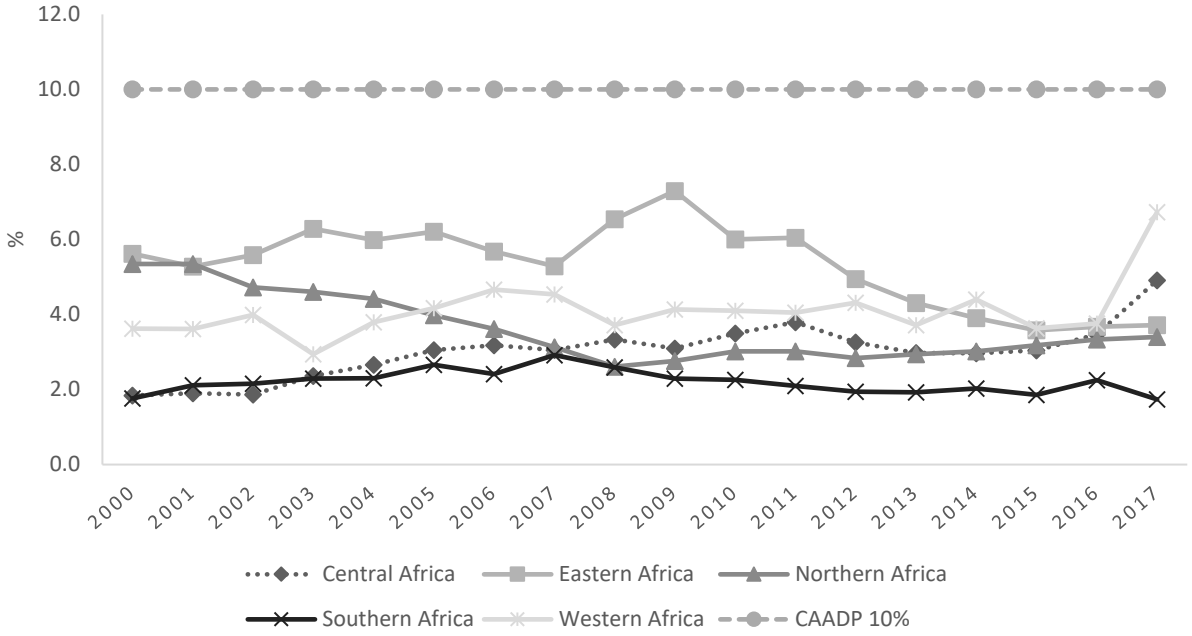

Figure 3-1: The share of expenditure in the regions of Africa
Source: (ReSSAKS, 2019)

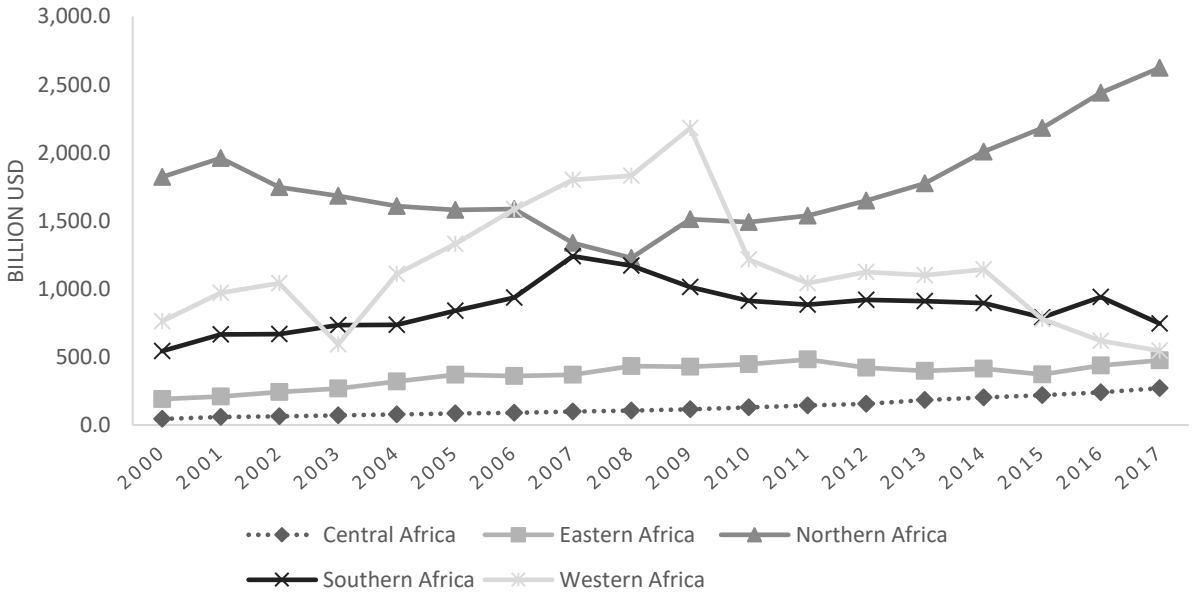

Figure 3-2: The size of expenditure in billion USD for the regions of Africa
Source: (ReSSAKS, 2019)

Figures 3-3 and 3-4 show the levels of agricultural expenditure by proportion and size for nine countries in ECOWAS between 2000 and 2017. All countries included in Figures 3-3 and 3-4 are signatories to the 2003 Maputo Declaration (now Malabo Declaration), which urges national governments to allocate 10% of their national budget to agriculture (De Pinto & Ulimwengu, 2017). Between 2003 and 2008, these countries experienced a rise in public agricultural expenditure as a share of total expenditure (Sulser *et al.*, 2014). Following the launch of CAADP in 2003 and later strengthened by the establishment of the Regional Agriculture Policy of West African States (ECOWAP), which led to a rapid increase in the share of expenditure on agriculture. However, due to the 2008 financial crisis and the high food price crisis, the share of expenditure declined in all countries (see Figure 3-3), which depressed expenditure in the sector due to reduced fiscal revenues (Badiane *et al.*, 2013; De Pinto & Ulimwengu, 2017).

Further, Figure 3-3 shows that out of the nine countries, five countries clearly failed to meet the 10% target between 2000 and 2017. However, countries such as Niger, Mali, Burkina Faso and Senegal managed to reach the target in any one year between the period 2000 and 2017. Overall, there was a slight improvement in public expenditures for countries in ECOWAS. The reason for this improvement maybe because of the stages these countries have reached in the CAADP process. According to Covic and Hendriks (2015) countries that were in the CAADP process longer or joined the CAADP process early had the highest share; relative to those that were further along in the implementation process. This holds because most countries depicted in Figure 3-3 were implementing CAADP. They had signed the CAADP compact, developed National Agriculture and Food Security Investment Plans (NAIP); and secured more than one external source of funding (De Pinto & Ulimwengu, 2017).

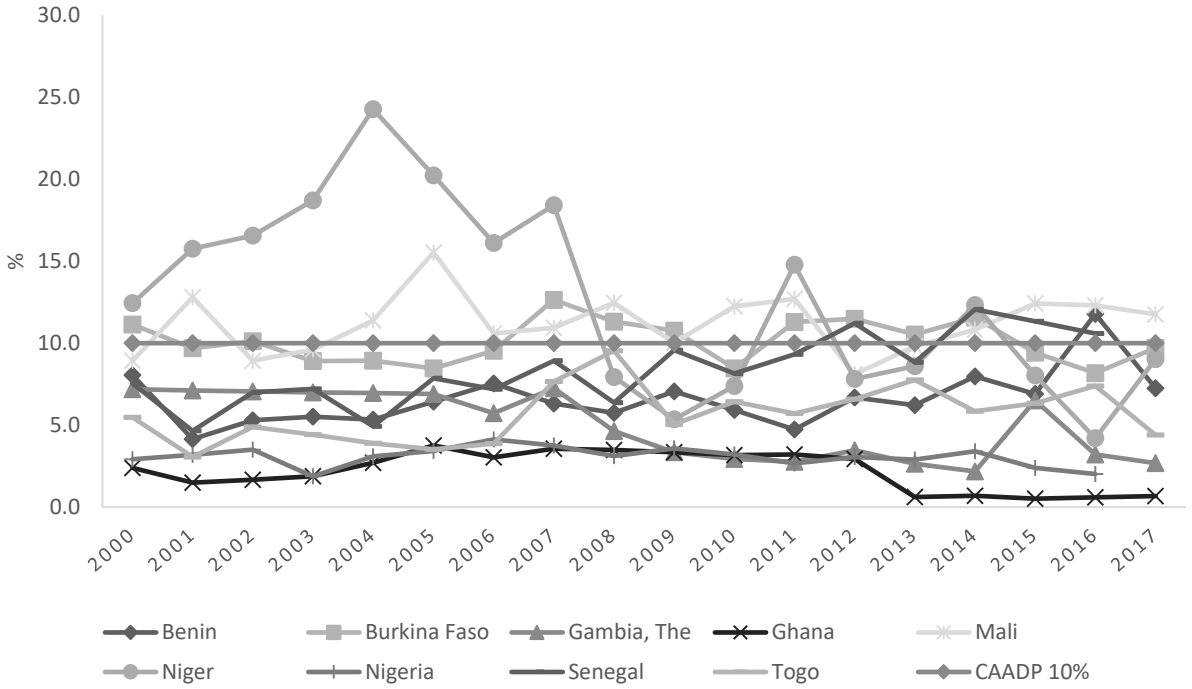

Figure 3-3: The share of expenditure for countries within ECOWAS

Source: (ReSSAKS, 2019)

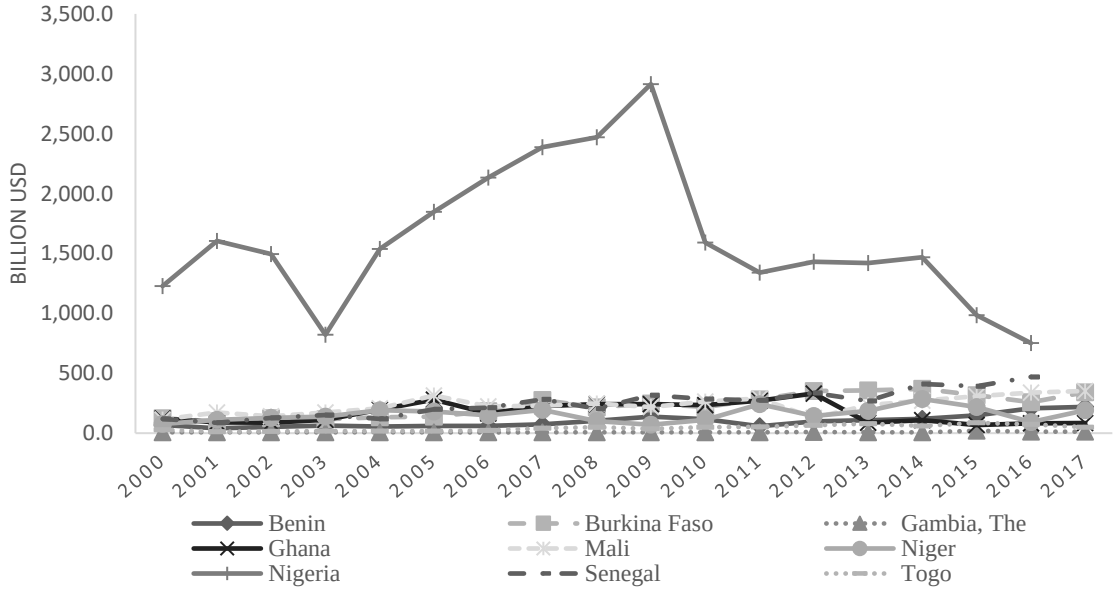

Figure 3-4: The size of expenditure in billions USD for countries in ECOWAS

Source: (ReSSAKS, 2019)

3.3.2. Average dietary supply adequacy for ECOWAS countries between 2000 and 2017

Average dietary energy supply adequacy showed that all countries were producing enough food to meet the food requirements of the population (Figure 3-5). This means that calorie supply for all the countries above the 100% threshold, was adequate for the entire population if distributed according to the requirements of individuals. As of 2017, Mali's energy supply was 141% higher compared to all countries and also 41% higher than what was required for the entire Mali population. Similarly, Nigeria's average dietary energy requirement was at 116%, slightly higher than Senegal and Togo but lower than the rest of the countries.

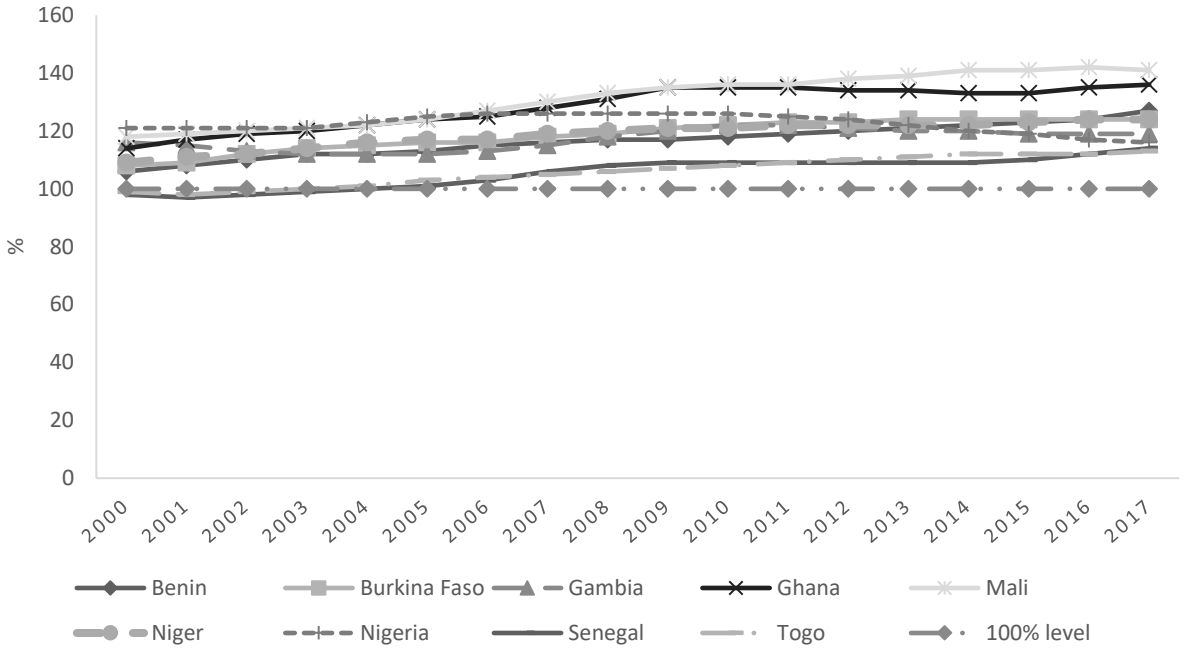

Figure 3-5: Average dietary energy supply adequacy for countries in ECOWAS

Source: (FAO, 2019)

An analysis of average dietary energy supply adequacy was critical to understanding the causes of deprivation. Food insecurity may not only be results of insufficiency in food production but other factors may exist that lead to food insecurity. However, a comparison between average dietary energy supply adequacy and prevalence of undernourishment distinguishes deprivation as a result of the insufficiency of food supply or poor distribution.

3.3.3. The prevalence of undernourishment

The proportion of hungry people declined in all the countries included in the study, between the years 2000 and 2017 (Figure 3-6), which demonstrates the progress made by these countries towards ending hunger. Countries such as Burkina Faso, Togo, Senegal, The Gambia, Mali and Ghana reduced the proportion of undernourished people between 2000 and 2017. This is because these countries were in the CAADP implementation process longer and went through most of the stages in the CAADP implementation process (Covic and Hendriks, 2015). However, although there was progress, the proportion of people ins some countries such as Nigeria and Niger had risen (Figure 3-6).

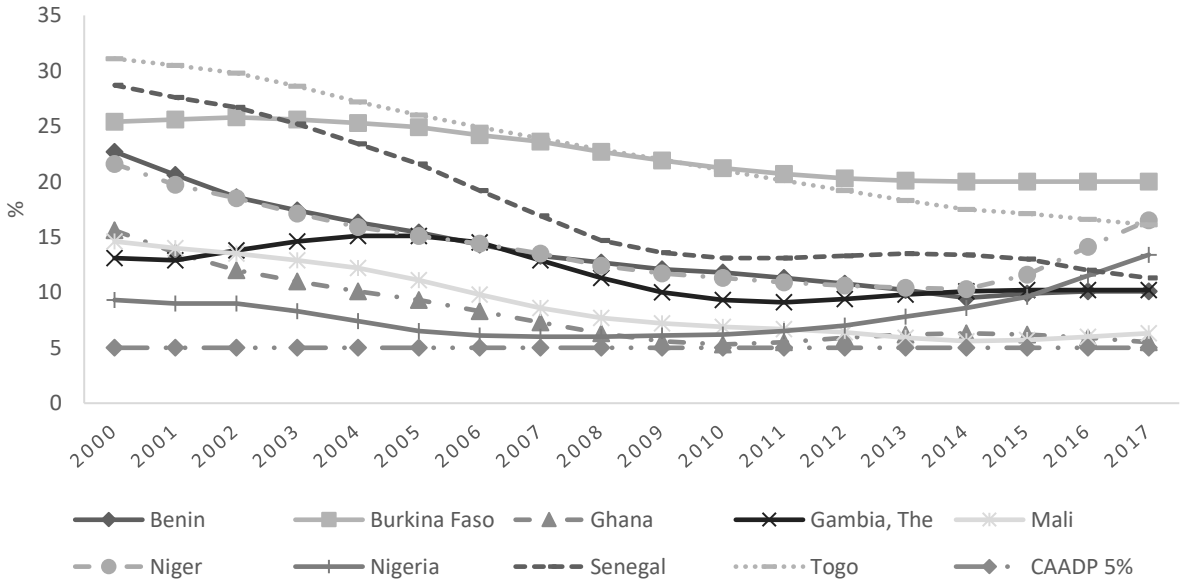

Figure 3-6: Prevalence of undernourishment for countries in ECOWAS

Source: (FAO, 2019a)

Nigeria's proportion of hungry people increased from 6.1% in 2009 to 13.4% in 2017, while for Niger this has expanded from 10.3% in 2014 to 16.5 % in 2017. Evidence for this can be found by looking at the absolute number of undernourished people in Figure 3-7. Nigeria had the highest number of people in the region compared to any other country. Several factors might have caused this expansion, including civil strife and climate variability; which eventually contribute to high food prices, making food accessibility difficult because the food source is undermined (Kah, 2017; Matemilola & Elegbede, 2017). FAO's 2018 State of Food Security Report recognises that

conflict, climate variability and extrem weather events are the key drivers derailing the achivement of food security and nutrition. An estimated 8.7 million people were estimated to be undernourished in 2006, which rose to 25.6 million people in 2017. Similarly, for Niger, the number of people undernourished rose to 3.6 million people in 2017 (Figure 3-7). Rising undernourishment levels increases the risk of different forms of malnutrition including a rise in stunting levels for children less five years of age (FAO, 2018).

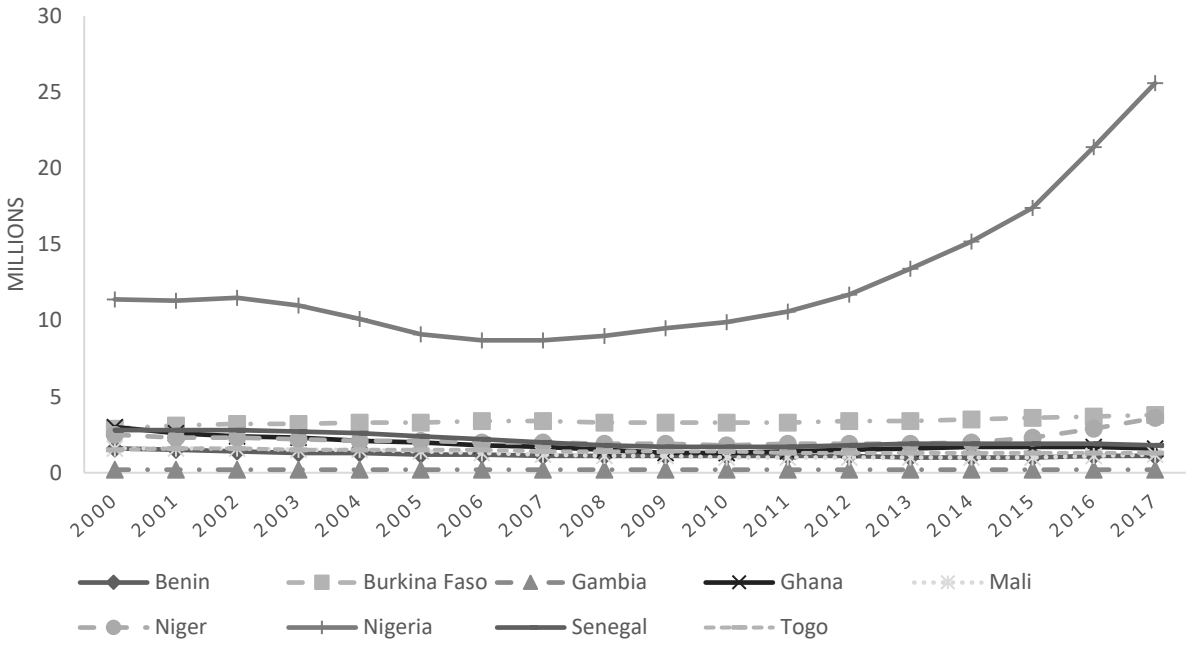

Figure 3-7: The number of undernourished people for countries in ECOWAS

Source: (FAO, 2019a)

3.3.4. Prevalence of stunting in children under five years of age

Figure 3-8 showed that the prevalence of stunting declined between 2000 and 2017, but the extent of progress made varied across countries. Although stunting levels declined, this decline was slow in reaching the 2014 Malabo Declaration targets. That is; reducing stunting levels to 5% by 2025. For example, the prevalence of stunting for Nigeria was at 44% in 2000 and had declined to 8% in 2017. It currently stands at 36%. Therefore, in as much as stunting levels had declined, the rate of decline was slow to achieve SDG and Malabo targets. Niger had the highest number of stunted children (47%) compared to all countries studied. Senegal had the lowest number of children that

were stunted compared to other countries currently at 18%. While Ghana, The Gambia and Burkina Faso made rapid progress in reducing the number of stunted children over the study period (Figure 3-8). The reasons for the slow progress in reducing the levels of stunting in the region partain to climate change and deterioration of enviromental conditions resulting from erratic rainfall and droughts, which have affected livelihoods and resilience capabilities (Fernández Portillo, 2015). The frequent occurrence of natural disaster, civil conflicts and health crisis (Ebola) has exposed the population to food insecurity and malnutrition (FAO, 2015). Further, gender inequality has affected food security and nutrition. Women play key roles in the attainment of food security and nurition, however, very few women control productive resources and asserts in the region. This impedes their overal contribution to agricultural production and increases vulnerability to food insecurity (Fernández Portillo *et al.*, 2015).

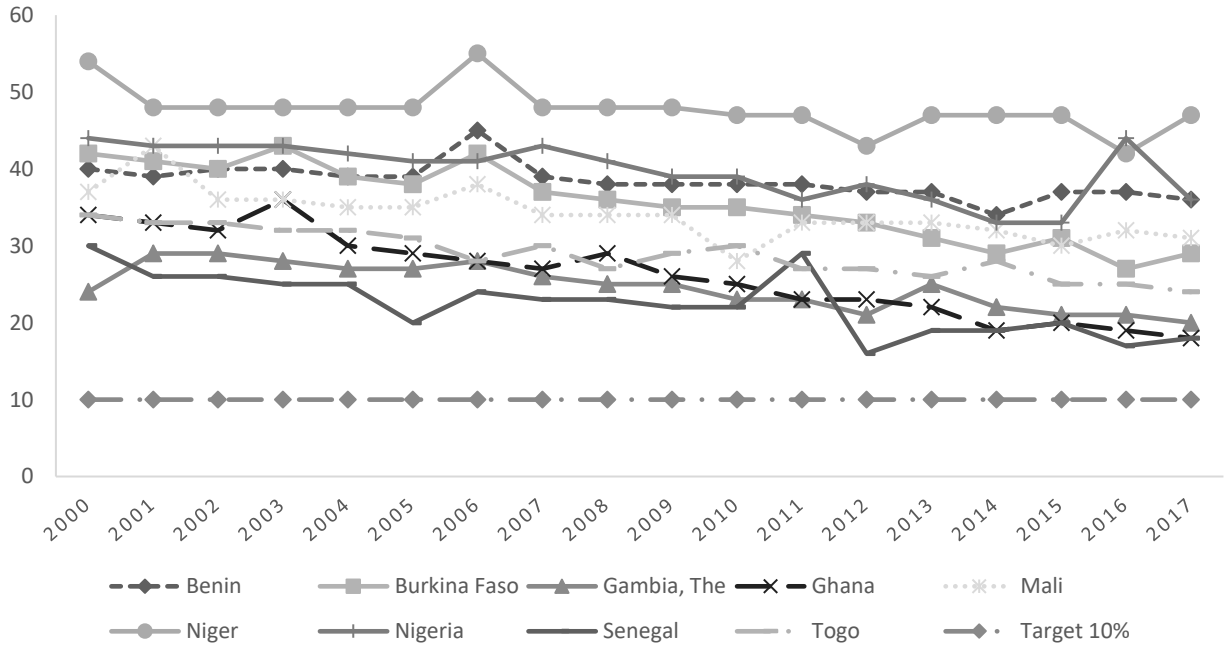

Figure 3-8: The prevalence of stunting for countries in ECOWAS

Source: (ReSSAKS, 2019)

3.3.5. Prevalence of wasting in children under five years of age

The prevalence of wasting in children less than five years of age for countries within Ecowas slightly improved (Figure 3-9). This can be seen by the decrease in wasting for countries such as

Burkina Faso, Ghana and Benin between 2000 and 2017. However, for countries such as Mali and Senegal, the levels of wasting remained relatively constant between 2000 and 2017. Measured against CAADP's target of reducing wasting levels to 5%, only Benin reached and surpassed the target between 2012 and 2017 and the levels continue to decrease in that country. Ghana also reached the 5% target in 2014 (Figure 3-9). The reason for the improvement in the levels of wasting in Ghana and Benin was likely due to improved coordianation among stakeholders through the New Alliance for Food Security and Nutrition (NAFSN), which led to improved policy enviroment, the facilitatation of responsible investment in agriculture and poverty reduction for households (Badiane, 2018). Additionally, Ghana and Benin agricultural policies included food security and nutrition, which signified that the main focus was not only about production, but recognised food security as multidimensional and requiring rigorous and coordinated actions by different stakeholders (Hendriks, 2019).

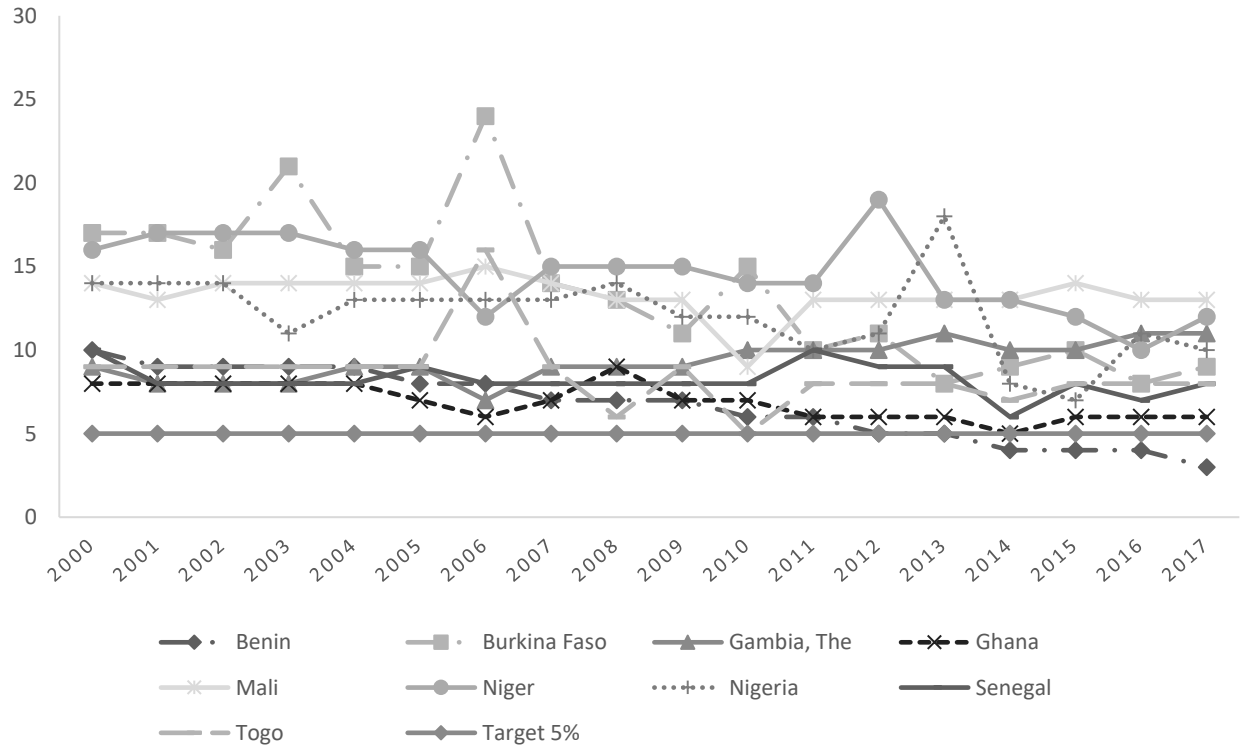

Figure 3-9: The prevalence of wasting for countries in ECOWAS

Source: (ReSSAKS, 2019)

3.3.6. Prevalence of underweight in children under five years of age

Countries made slow progress in reducing the levels of underweight in children less than five years for countries in Ecowas (Figure 3-10). Between 2000 and 2017 the prevalence of underweight for most of the countries only changed by a small margin. For example, the prevalence of underweight children in Niger in 2000 was at 45% and stood at 35% by 2017. Over a 17-year period, Niger only managed to reduce underweight levels by 10%. The prevalence of underweight was unstable for Nigeria between 2013 and 2017, rising and decreasing for the period. In 2013 undernourishment levels declined from 31% to 19% in 2015 (Figure 3-10). However, this rose again to 32% in 2016 and declined to 23% in 2017. Measured against the CAADP target of reducing underweight levels to 5%, it can be seen that no country had reached this target over the study period. However, compared to the other countries included, Ghana was close to reaching the CAADP target as its underweight level for 2017 was 9%.

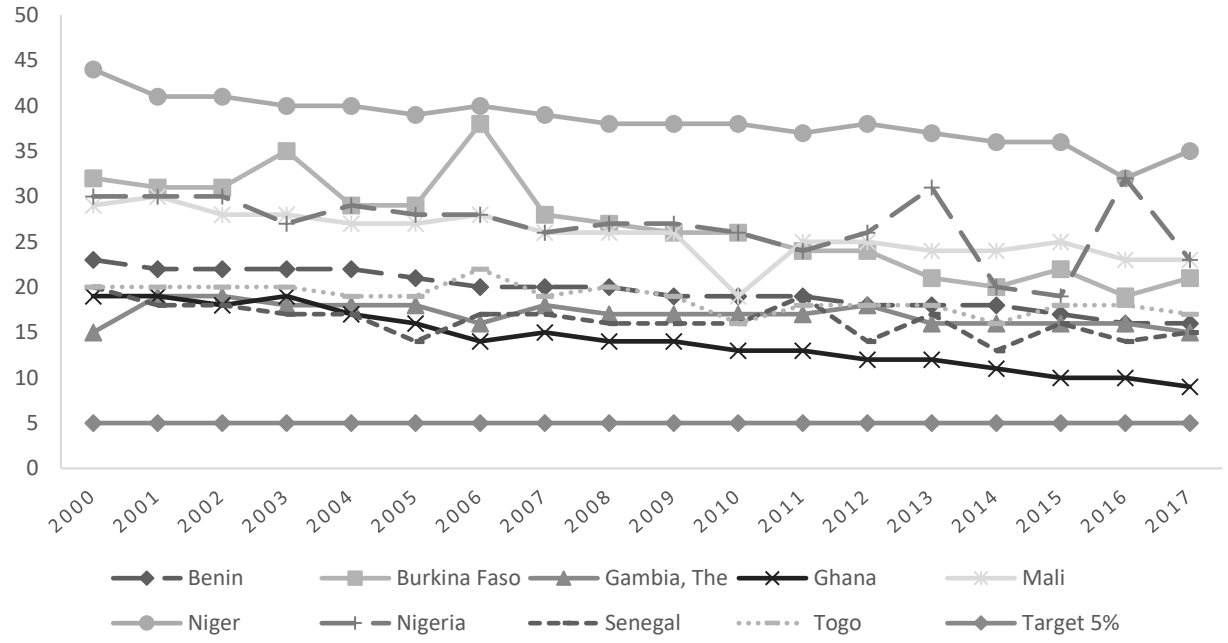

Figure 3-10: The prevalence of underweight for countries in ECOWAS

Source: (ReSSAKS, 2019)

3.3.7. Per capita food production variability

It can be seen that that variation in per capita food production per capita declined steadily in Senegal, Niger, The Gambia, Burkina Faso, Togo and Ghana between 2010 and 2016 (Figure 3-11). This may indicate that food production in these countries is showing signs of stability. For Togo, the variation in food production per capita was low between 2000 to 2007, indicating a more stable food production base in the country. Fluctuations with little variation between 2000 and 2006; then wider fluctuations between 2007 and 2015; can be seen for Benin, Niger, Senegal, Nigeria and The Gambia; indicating instability in the food production.

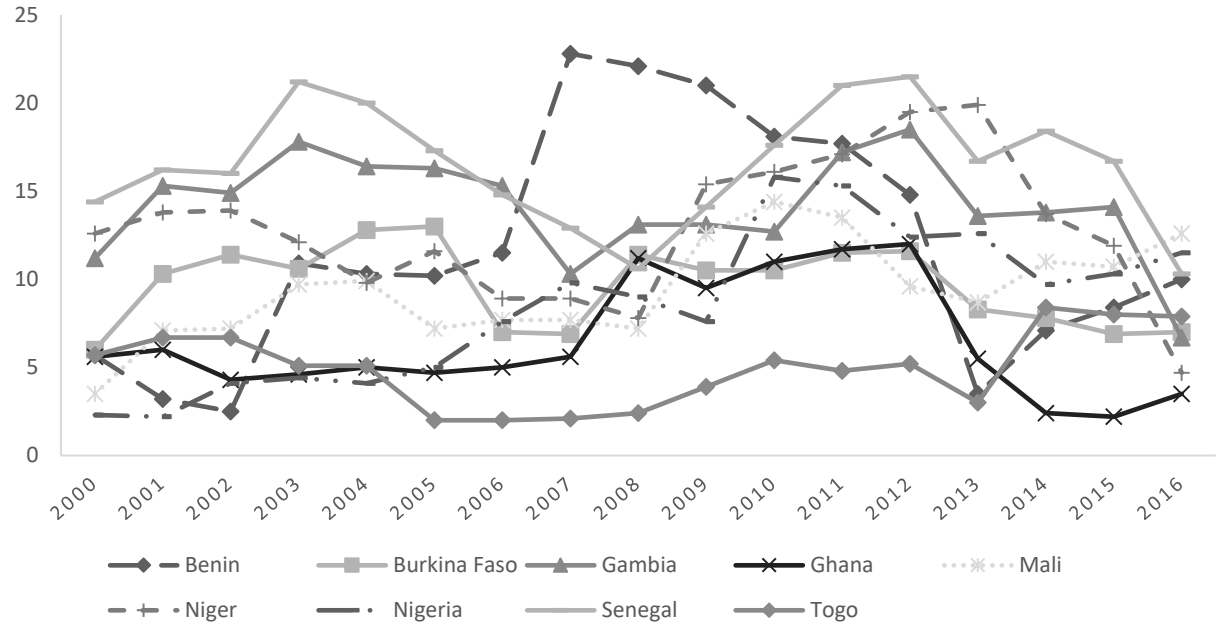

Figure 3-11: Per capita food production variability for countries in ECOWAS

Source: (FAO, 2019a)

3.4. Comparison of public expenditure and food security and nutrition Malabo targets

Several countries included in analysis met the 10% Malabo target of increasing public expenditure in agriculture in several years between 2000 and 2017. The section compares countries that have

achieved the 10% Malabo target in several years with their food security and nutrition targets to understand if the increased public expenditure coincides with the performance of these countries in improving food security and nutrition. Public expenditure share, undernourishment, stunting wasting and underweight are all included in the monitoring and analysis system of the Malabo Declaration. Column 8 reports the stage that these countries are at implementing CAADP.

Public expenditure by size has been increasing for all countries. The prevalence of undernourishment was high for all countries and it rose except for Benin and Mali where it declined. Similarly stunting, wasting and underweight is still high for these countries (Table 3-2). All the countries are on level four in the CAADP implementation process meaning that they have signed the CAADP compact, developed their National Investment Plans, have secured more than one source of funding. Improvement of public expenditure does not correspond with the achievement of food security and nutrition commitments (from Table 3-2).

Table 3-2: Comparison of public expenditure in agriculture and food security indicators included in the Biennial review

Country	10% several years	Size	Undernourishment	Stunting	Wasting	Underweight	CAADP process
Benin	✓	Increasing	Reducing	High	Low	High	Level 4
Burkina Faso	✓	Increasing	Increasing	High	High	High	Level 4
Mali	✓	Increasing	Reducing	High	High	High	Level 4
Niger	✓	Increasing	Increasing	High	High	High	Level 4
Senegal	✓	Increasing	Reducing	Reducing	Low	High	Level 4

Source: (De Pinto & Ulimwengu, 2017)

3.5.Summary of CAADP food security indicators and progress towards achieving Malabo targets by 2025

Table 3-3 summarises food security indicators included in the Malabo technical guidelines; that form part of the indicators for ending hunger. The table indicates whether countries are on course towards meeting the Malabo targets; by calculating the average marginal change over the 17 years from 2000 to 2017. This is followed by predicting how much countries will reduce undernourishment, stunting, wasting and underweight by 2025, using the calculated marginal change. Essentially, making a prediction about the feasibility of achieving the Malabo targets by

2025 depending on the progress made in the different countries. The last column indicates the countries that are on course to meeting the Malabo targets.

The following assumptions govern the analysis depicted in table 3-3. The study assumes that the marginal rate of change on average is the same for all the 17 years between 2000 and 2017. It also assumes that the marginal rate, which is an average of 17 years; is the same for the remaining eight years of implementing CAADP and achieving the Malabo targets by 2025. The study makes these assumptions in order to understand if the countries will achieve the Malabo targets if they continue on the same path. By assuming the same marginal change, the study also assumes that within this period all things remain constant, in that there will be no shocks to the economy leading to changes in the values of these indicators, either climatic, economic, political unrest or a change in the policy environment.

Table 3-3: Summary of Malabo targets

Country	Malabo Target	2017	2000	Marginal changes	Target 2025	Progress
Prevalence of undernourishment						
Benin	5%	22.7	10.1	-0.74	4.18	✓
Burkina Faso		25.4	20	-0.32	17.4	
The Gambia		13.1	10.2	-0.17	8.84	
Ghana		15.6	5.5	-0.59	0.78	✓
Mali		14.6	6.3	-0.49	2.38	✓
Niger		21.6	16.5	-0.3	14.1	
Nigeria		9.3	13.4	0.24	15.32	
Senegal		28.7	11.3	-1.02	3.14	✓
Togo		31.1	16.1	-0.88	9.06	
Prevalence of stunting						
Benin	10%	40	36	-0.24	34.1	
Burkina Faso		42	29	-0.76	22.9	
The Gambia		24	20	-0.24	18.1	
Ghana		34	18	-0.94	10.5	✓
Mali		37	31	-0.35	28.2	
Niger		54	47	-0.41	43.7	
Nigeria		44	36	-0.47	32.2	
Senegal		30	18	-0.71	12.3	
Togo		34	24	-0.59	19.3	
Prevalence of wasting						
Benin	5%	10	3	-0.41		
Burkina Faso		17	9	-0.47	5.2	✓
The Gambia		9	11	0.12	12	

Ghana		8	6	0.12	5	✓
Mali		14	13	-0.06	12.5	
Niger		16	12	-0.24	10.1	
Nigeria		14	10	-0.24	8.1	
Senegal		10	8	-0.12	7	
Togo		9	8	-0.06	7	
Prevalence of underweight						
Benin	5%	23	16	-0.41	12.7	
Burkina Faso		32	21	-0.65	15.8	
The Gambia		15	15	0	15	
Ghana		19	9	-0.59	4	✓
Mali		29	23	-0.35	20	
Niger		44	35	-0.53	30.8	
Nigeria		30	23	-0.41	19.7	
Senegal		20	15	-0.29	12.7	
Togo		20	17	-0.18	16.3	

Source: (FAO, 2019a; ReSSAKS, 2019)

Table 3-3 shows that only Benin, Ghana, Mali and Senegal are likely to reach the 2025 Malabo targets of reducing undernourishment levels to 5%; looking at the marginal change, which was an average for 17 years between 2000 and 2017. For stunting, however, the marginal rate of change revealed that only Ghana will reach the 2025 Malabo targets of reducing stunting to 10%. Regarding the levels of wasting in the region, Burkina Faso and Ghana showed that they were likely to achieve the Malabo targets of reducing wasting to 5% by 2025; by comparing the marginal changes. The levels of underweight remain high. It can be seen from Table 3-3 that only Ghana was on course with regards to targets on underweight compared to the other countries. Similarly, Ghana will reach the target of reducing underweight levels to 5% according to the Malabo targets.

CHAPTER 4: EVALUATION OF THE IMPACT OF PUBLIC EXPENDITURE ON AGRICULTURE ON FOOD SECURITY AND NUTRITION

Specific objective two set out to measure the impact that public agricultural expenditure on food security and nutrition. The impact was measured on four dimensions of food security, which are availability, accessibility, utilisation and stability. The methodology, results and discussion are discussed in this chapter.

4.1. Food security indicators used in the analysis

Four indicators of food security were included in the study as dependent variables. These are average dietary energy supply adequacy (ADESA), the prevalence of undernourishment, child stunting and per capita food production variability. The indicators were from each dimension of food security. The reason for this approach was that food security is multi-dimensional hence requiring a holistic approach for effective analysis and inform policy.

Undernourishment and stunting were selected because they are used to monitor food security and nutrition at a global level through SDG (FAO *et al.*, 2019) and in Africa through the Malabo Declarations (African Union, 2017). Additionally, the study used stunting as opposed to wasting and underweight, which are also being used in the Malabo technical guidelines because it is a better measure of health, diet and care provided to children during the first 1000 days (Horton & Hoddinott, 2014). It is also a better predictor of economic outcomes as stunting may result in poor cognitive development, which may affect economic growth through the loss of labour productivity (Schoenbuchner *et al.*, 2019). Undernourishment and stunting are used to monitor the access and the utilisation dimensions of food security respectively.

The average dietary energy supply adequacy and per capita food production variability were included as variables because of two reasons, firstly, they have been used by several studies as measures of food availability and stability (Fontan Sers & Mughal, 2019; Mihalache-O'Keef & Li, 2011; Slimane *et al.*, 2016). Secondly, the other food security indicators in the dimension of availability and stability had no long time series data ranging from 2000 to 2016 to be considered for analysis.

4.2. Explanatory variables used in the generalised least squares model

To measure the impact of public agricultural expenditure on food security and nutrition, the study used agricultural expenditure as a share of the total budget as a measure of agriculture expenditure. This measure corresponded to the 10% expenditure on agriculture as agreed under CAADP by heads of state in each country. The study expected public expenditure on agriculture to be positively related to average dietary energy supply adequacy, but negative for per capita food production variability, stunting and undernourishment.

The effects of public expenditure may materialise with a lag, because of this a five-year lag of the share of public expenditure was included. The five year lag was chosen because nutrition data are collected every five years for under-five children and micronutrients surveys even less frequently (Haddad, 2015). Additionally, public expenditure in agriculture impacts food security and nutrition through different pathways, which can be direct and indirect and short or longer-term (Hawkes & Ruel, 2008). For example, expenditure on inputs and subisdies directly improve agricultural productivity resulting in incresed food production where as indirectly excess production can be sold and the income used to buy other nutritious food or pay for healthy services (McGovern *et al.*, 2017). Therefore, adopting a five-year lag lenth allows us to understand the trickle-down impacts of public agriculture expenditure.

The study also included an interaction term as in Fontan Sers and Mughal (2019); to understand whether agriculture spending for these countries since the implementation of CAADP can be associated with improvement in food security and nutrition for countries within ECOWAS. The study expected the interaction term to be positively related to average dietary energy supply adequacy and negatively related to undernourishment, stunting and per capita food production variability.

The study controlled for other factors that affect food security and nutrition at a macro level, which include; log of GDP per capita, inflation, trade openness, level of democracy and rural population and gross production values. GDP per capita was expected to be positively related to ADESA and negatively related to undernourishment, stunting and per capita food production variability impact. However, inflation measured by the consumer price index was expected to be negative for ADESA and positive for the rest of the dependent variables. This was the case because an increase in GDP

per capita boosts incomes for individuals allowing consumption of more diversified nutritious diets; thereby improving food security and nutrition while an increase in food prices reduces people's accessibility to food (Belloumi, 2014; Mihalache-O'Keef & Li, 2011).

International trade concerns the flow in and out of goods and services and allows the integration of countries into the global economy. Trade openness measured by the sum of exports and imports of goods as a share of GDP was expected to impact food security and nutrition positively. This was because imports complement domestic production. In cases of deficit in domestic production (Slimane *et al.*, 2016). Exports provide the needed foreign revenue, which countries use to import food. For each dimension of food security, the study expected trade openness to be positively related to ADESA and negatively related to undernourishment, stunting and per capita food production variability.

The democracy level was measured by the political regime (Polity2) in the Polity IV dataset and ranged from -10 to 10, where higher values indicated greater democracy and lower values indicated autocratic governments. The variable controlled for the possibility that democratic governments respond well to the food security concerns of the population through redistributive policies and this variable was expected to be positive (Slimane *et al.*, 2016). Specifically, the study expected Polity2 to impact ADESA positively and negatively impact undernourishment, stunting and per capita food production variability.

Rural population growth is another determinant of food security and nutrition. It was chosen because the majority of the people in Sub-Saharan Africa reside in rural areas and the main livelihood strategy was agriculture (Fontan Sers & Mughal, 2019). Rural populations account for an increased demand for food. However, an increase in the rural population puts pressure on agricultural resources such as land, which reduces agricultural productivity and food (Malthus, 1992). The study expected the rural population to negatively impact all dimensions of food security included in the analysis.

Agricultural production is measured by the gross production value and a positive impact was expected from this variable. This was because agriculture is a key determinant of food availability (Swaminathan & Bhavani, 2013). Agriculture is also a source of income from selling and employment leading to income flows that allow households to diversify diets by purchasing

diversified nutritious food on the market. Specifically, the study expected agricultural production to impact positively ADESA and negatively stunting, undernourishment and per capita food production variability.

Note also that the study transformed the variables GDP per capita and gross production value to logarithms. This was because logarithmic values have no units and allow coefficients to be interpreted as elasticities.

Table 4-1: Description of dependent and independent variables and their sources

Variable	Definition	Source
Dependent Variables		
Average dietary energy supply adequacy	The dietary energy supply as a percentage of the average dietary energy requirement in each country	FAO
Prevalence of stunting	Height for age as a percentage of children who are under 5 and short for their age (%)	ReSAKSS
Prevalence of undernourishment	The proportion of people consuming less than the minimum dietary energy requirement (%)	WDI
Per capita food production variability	This measures net food production variability expressed in US dollars	FAO
Independent Variables		
Public agriculture expenditure	The share of public expenditure in total expenditure (%)	ReSAKSS
Five-year lag of expenditure	The share of public expenditure in total expenditure (%)	ReSAKSS
Log GDP per Capita	GDP per capita million constant 2010 prices	WDI
Inflation	Consumer Pricesv (Annual %)	WDI
Political regime (polity2)	Political regime	Polity IV
Trade openness	The sum of exports and imports of goods and services as a share of GDP (%)	WDI
Rural population (Annual)	The annual growth rate of the rural population (%)	WDI
Agricultural production	Value of agriculture production measured by the value of agriculture production (constant 2004-2006 million US$)	FAOSTAT

4.3. Model estimation

Various analytical methods have been used in literature to evaluate the impact of government expenditure on specified outcomes. These ranged from simultaneous equation models (Fan *et al.*, 2000) to economy-wide models (Beyene & Engida, 2016) to panel data estimation methods (Fontan Sers & Mughal, 2019). The nature of the problem and the availability of data influenced the use of these methods. A panel data estimation method was employed in this study to evaluate the impact of public expenditure on food security and nutrition for nine countries in ECOWAS. The study uses a panel data estimation method as opposed to the simultaneous equation method and CGE models because panel data estimation methods allow for cross-country analysis and also produce results even with short time series data. However, the limitation of the fixed effect model is that it assumes that all countries are identical and are on the same growth path, which is likely not the case.

The study did not use the simultaneous equation model because they require disaggregated data for analysis, which was not available for all countries in this study. Computable general equilibrium models were considered but no regional SAM existed for the countries as such performing the analysis for individual countries was beyond the scope of the study. Also, a computable general equilibrium model is used for ex-ante analysis to show the impact a policy strategy would have before implementation where the analysis for this study was ex-post to understand the impact of public agricultural expenditure on food security and nutrition. Therefore, because of this a panel data estimation method was considered for this study.

The study used a panel estimation method to control for unobserved individual time-invariant variations that may arise due to systematic differences across cross-sectional units (Jirata, 2018). These variations are probably due to differences in the policies, institutions, and economic structures of countries. Panel data estimation methods also control for endogeneity that may result from the omission of variables that were hard to measure or obtain, which, if not controlled, leads to bias (Baltagi, 2008).

There are two types of panel estimation methods, the fixed effect model and the random effect model. The fixed effect model examines the individual effects; assuming a correlation between the explanatory variables with individual effects; while the random effect model assumes that there is

no correlation between the individual effects with explanatory variables (Mundlak, 1978). A fixed effect model was adopted for this study, based on the assumptions that it was unlikely that the country's individual effects were correlated with the explanatory variables and also because the countries included in the analysis were not selected randomly from a list of countries.

A Hausman (1978) test was carried out to validate the use of fixed effect model. The test was based on the null hypothesis that the random effect model was consistent and efficient, by exploring the correlation between explanatory variables and unobserved effects. The use of a fixed effect model confirmed that the explanatory variables were correlated with the unobserved effects.

Fixed effect (FE) model as in Baltagi (2008) is given as a linear log function as follows:

$$\boldsymbol{Y_{it} = \beta_0 + \beta_1 X_{it1} + \ \beta_2 X_{it2-5} + \beta_3 X_{it3} + \beta_4 X_{it4} + \ \beta_5 X_{it5} + \beta_6 X_{it6} + \beta_7 log X_{it7} + \ \beta_8 X_{it8} + \beta_9 log X_{it9} + \sum_{k=9}^{17} \beta_k C_i + \alpha_i + \ U_{it}} \quad \text{Equation 1}$$

Where Y_{it} denotes a particular food security indicator for country i at time t, X_{it1} was the total share of expenditure, X_{it2-5} was a five-year lag of expenditure, X_{it3} was an interaction term for CAADP participation, X_{it4} was inflation, X_{it5} was trade openness, X_{it6} was political regime measures by polity, $logX_{it7}$ was the log of GDP per capita, X_{it8} was a rural population, $logX_{it9}$ was the log of gross production value, C_i was the dummy variables for countries (where i=1,2,……,9), α_i country-specific effects and U_{it} was the idiosyncratic error term.

The estimation procedure was carried out in two steps, the first step estimated a Hausman test, which allowed the use of a fixed effect model (equation 5.1). Then, diagnostic tests were performed on the estimated fixed effect model to test for serial correlation, heteroscedasticity and cross-sectional dependence. The tests were carried out because the presence of serial correlation, heteroskedasticity and cross-sectional dependence results in inconsistent and inefficient parameter estimates, which can obscure results (Wooldridge, 2016). Since the diagnostic tests confirmed the presence of these problems, the second step estimated the fixed effect generalised least squares model to correct for them.

4.4. Descriptive statistics for the variables used in the fixed effect model

Table 4-2 presented the descriptive statistics of the variables used in the model. The panel data set contained nine ECOWAS countries, which represented cross-sectional units with a time period of 17 years (2000-2016). The number of observations, therefore, was N × T, which yielded 153 observations indicating a balanced panel. All the variables had 153 observations except for the five-year lag of expenditure which had 148 observations and 152 observations for the CAADP interaction variable.

Table 4-2: Descriptive statistics of variables used in fixed effect generalised least squares model

Variables	Units	Observation	Mean	Standard deviation	Min	Max
Prevalence of undernourishment	%	153	14.32	6.69	5.3	31.10
Prevalence of stunting	%	153	33.37	8.50	16	55.00
ADESA	%	153	117.83	9.87	97	142.00
Per capita food production variability	USD	153	10.45	5.06	2	22.80
Total expenditure share	%	153	7.26	4.20	0.5	24.30
Five-year lag of expenditure	%	148	7.28	4.27	0.5	24.30
CAADP	%	152	3.11	4.19	0	14.80
Inflation	%	153	5.25	6.12	-3.10	32.91
Trade openness	%	153	60.47	19.00	20.72	118.10
Political regime (polity)	Index	153	3.29	4.52	-5	8
Log of GDP per capita	USD	153	6.46	0.64	5.07	8.08
Rural population	%	153	1.93	0.76	0.79	3.91
Log of gross production value	Million USD	153	14.62	1.42	11.55	17.54

Furthermore, the standard deviation was computed to show variability in the data. Stunting, average dietary energy supply adequacy and trade openness had a high standard deviation. High

standard deviation did not have any effect on the results of the fixed effect model. The variable, political regime measured the level of democracy in countries and ranged between -10 to 10. Countries that were between -10 and -6 were classified as autocratic, -5 to 5 anocracy (part democratic and part autocratic) and 6 to 10 were classified as democratic. All countries included in the analysis were between anocracy and democracy as all scored between -5 and 8. Furthermore, the variable for the rural population showed that a smaller proportion of the population resides in all nine countries reside in rural areas.

4.5. Correlation of the explanatory variables used in the fixed effect model

A correlation matrix was computed for all variables in the model to test for multicollinearity. Multicollinearity is a statistical phenomenon in which a perfect and exact relationship exists between variables that inflates the variance of the parameter estimates; leading to unreliable and unstable estimates of the coefficients (Wooldridge, 2016). If the correlation coefficient exceeds 0.8 then multicollinearity between two variables is a problem (Gujarati, 2009). Therefore, multicollinearity was not a significant problem between explanatory variables as no correlation coefficient exceeded 0.8 in Table 4-3.

The correlation coefficient measured the direction, strength of the relationship between the variables (Wooldridge, 2009). The relationship between total expenditure share, the lag of expenditure and the interaction variable for CAADP participation was positive, which was an indication that these variables were moving in the same direction. The relationship between total expenditure share was negative with the log of GDP per capita and gross production value. However, a positive relationship was expected from these variables because as expenditure on agriculture improves, agricultural production is expected to increase thereby increasing GDP per capita.

A positive relationship exists between total expenditure share, undernourishment, stunting and per capita food production variability while the relationship with average dietary energy supply adequacy was negative. This relationship was expected to be negative for undernourishment, stunting and per capita food production variability while positive for ADESA. These observations may be because the study was using an aggregate measure of expenditure and different expenditures have different impacts on food security and nutrition. Therefore, it could be that the

expenditures that the countries are spending on were not significant enough to lead to a shift in the food security indicators.

Inflation also showed a negative relationship with total expenditure share, which means that as inflation increases total expenditure share in agriculture decreases. High inflation squeeses expenditure leading to a reduction in total expenditure, as was witnessed in the 2008 high food price crisis, which depressed expenditure in the sector (Badiane *et al.*, 2013; Chakrabarti *et al.*, 2017); De Pinto and Ulimwengu (2017). An inconsistent relationship existed between inflation and food security indicators. Table 4-3 shows that inflation had a negative relationship with undernourishment and stunting while the relationship with ADESA and per capita food production variability was positive. A positive relationship was expected with all food security indicators because high inflation contributes to food insecurity and malnutrition (Meerman & Aphane, 2012).

Table 4-3: Correlation matrix of variables used in the fixed effect model

Variable name	Prevalence of undernourishment	Prevalence of stunting	ADESA	Per capita food production variability	Total expenditure share	Five-year lag of expenditure	CAADP	Inflation	Trade openness	Polity2	Log of GDP per capita	Rural population	Log of gross production value
Prevalence of undernourishment	1												
Prevalence of stunting	.038	1											
ADESA	-.704	.145	1										
Per capita food production variability	-.061	-.070	-.083	1									
Total expenditure share	.222	.333	-.043	.206	1								
Five-year lag of expenditure	.122	.340	.073	.147	.480	1							
CAADP	-.226	-.129	.298	.251	.279	.303	1						
Inflation	-.360	-.048	.228	-.283	-.572	-.354	-.370	1					
Trade openness	.068	-.424	-.179	-.192	-.269	-.123	.065	.171	1				
Political regime (polity)	-.349	.151	.267	.107	.124	-.152	.101	.092	-.145	1			
Log of GDP per capita	-.521	-.404	.296	.102	-.423	-.385	.196	.220	-.170	.353	1		
Rural population	-.314	.556	-.172	.227	-.668	.621	.196	-.512	-.142	.098	-.573	1	
Log of gross production value	-.420	.419	.459	-.270	-.144	-.126	.043	.351	-309	.619	.474	-.125	1

4.6. Hausman test results

The Hausman test was used to choose between fixed effect and random effect and the results are presented in Table 4-4. The null hypothesis of no correlation between the independent variables and the error term was rejected. Rejection of the null hypothesis prompted the use of the fixed effect model. However, for average dietary energy supply adequacy and per capita food production variability, the Hausman test returned a chi-square value of -75.86 and -41.50 respectively. Regardless of the small chi-square values, a fixed effect model was still estimated for average dietary energy supply adequacy and per capita food production variability.

Table 4-4: Hausman tests results

Model	Chi-square	Conclusion
ADESA	-75.86	Fixed effect
Undernourishment	37.19**	Fixed effect
Stunting	113.48**	Fixed effect
Per capita food production variability	-41.50	Fixed effect

* statistical significance at the 10% level ** statistical significance at the 5% level ***statistical significance at the 1% level *P<0.1, ** p<0.05, ***p<0.01

4.7.Results from the fixed effect generalised least squares model

To evaluate the impact of public expenditure on agriculture on food security and nutrition, a fixed effect generalised least squares model was estimated. It was estimated using four dimensions of food security, which were average dietary energy supply adequacy, undernourishment, stunting and per capita food production variability. The fixed effect generalised least squares model was estimated to correct for serial correlation, heteroskedasticity and cross-sectional dependence since these problems were present. Appendices (A) (B) (C) contains the results.

The model fitted the data well as the Wald chi-square values in Table 4-5 show that they were statistically significant (P<0.05) for all four models. The r-squared from all the four models ranged between 60% to 93.42% indicating about 60% to 93.42% of the variation in the dependent variable was explained by explanatory variables.

Table 4-5: Results from the fixed effect generalised least squares model

Variables	Average dietary energy supply adequacy	Undernourishment	Stunting	Per capita food production variability
Total expenditure share	-0.0286 (0.153)	-0.228** (0.0721)	-0.0043 (0.0809)	-0.143 (0.119)
Five-lag of expenditure	0.200* (0.118)	-0.0169 (0.0555)	-0.0289 (0.0623)	-0.0172 (0.091)
CAADP_expenditure share (interaction term)	0.440** (0.129)	-0.259** (0.0607)	-0.173** (0.068)	0.279** (0.0999)
Inflation	-0.082 (0.102)	-0.0134 (0.0477)	0.0402 (0.0536)	-0.0230 (0.078)
Trade openness	-0.014 (0.036)	-0.0162 (0.0171)	-0.0188 (0.0192)	0.0389 (0.0281)
Political regime (polity)	-0.091 (0.270)	0.3099** (0.1268)	-0.295** (0.142)	-0.0677 (0.2086)
Log of GDP per capita	4.179** (1.439)	-3.169** (0.676)	-4.580** (0.758)	4.342** (1.111)
Rural population	-3.080 (2.698)	-0.749 (1.266)	2.102 (1.421)	0.553 (2.0828)
Log of gross production value	6.129** (3.345)	-5.4823** (1.570)	-2.144 (1.762)	-9.639** (2.582)
Benin	4.905 (3.968)	-7.112** (1.863) **	15.756** (2.0905)	16.537** (3.0631)
Burkina Faso	6.065 (4.241)	4.807** (1.991) **	8.717** (2.235)	15.834** (3.274)
The Gambia	21.035** (6.221)	-21.326 (2.920)	-8.246** (3.277)	-6.560 (4.802)
Ghana	7.838 (6.928)	-6.954*8 (3.252)	8.195** (3.650) **	17.804** (5.348)
Mali	12.0777** (35.314)	-6.886** (2.494)	11.112** (2.700)	18.213** (4.102)
Niger	12.324** (7.454)	-3.435 (3.499)	17.112** (3.927)	22.209** (5.754)
Nigeria	-10.504 (11.651)	-4.180 (5.469)	26.297** (6.138)	35.745** (28.994)

Variables	Average dietary energy supply adequacy	Undernourishment	Stunting	Per capita food production variability
Senegal	-5.849** (3.0257)	-2.959** (1.420)	0.602 (1.594)	12.360** (2.336)
Constant	0.477	123.328	84.105	105.168
Observations	147	147	147	147
Number of countries	9	9	9	9
Wald chi-square	613.21**	1624.29**	2089.36**	222.27**
Overall R^2	82.62	91.70	93.42	60.19

* statistical significance at the 10% level ** statistical significance at the 5% level ***statistical significance at the 1% level *P<0.1, ** p<0.05, ***p<0.01

Among the nine variables considered in the model, three had a significant impact on availability dimension of food security, five for accessibility, three for utilisation and stability. Inflation and trade openness had no significant impact on any of the food security indicators. The statistically significant results are discussed below.

The total expenditure share in agriculture had a significant relationship with the prevalence of undernourishment. The negative coefficient with the prevalence of undernourishment indicated that a 1% increase in total expenditure share in agriculture reduced undernourishment by 0.22%, ceteris paribus. This was expected, as spending on agriculture is anticipated to improve agricultural production, which ensures the availability of food. Increased production also ensures households' capacity to produce food and boost income from the sale of excess food, which allows purchasing of more diversified nutritious food (Fan *et al.*, 2012; Mogues *et al.*, 2012). Slimane *et al.* (2016) found similar results that expenditure on agriculture had a positive impact on improving food security in 55 developing countries. However, the study results contradict the findings of Fontan Sers and Mughal (2019), who used data from African regions found that the share of expenditure on agriculture had no significant impact on the levels of undernourishment. In the paper by Fontan Sers and Mughal (2019), this relationship was found not significant even after substituting the share of agriculture expenditure with other crucial indicators of public expenditure.

A significant relationship existed for the interaction variable for CAADP participation with average dietary energy supply adequacy, the prevalence of undernourishment, prevalence of

stunting and per capita food production variability. An increase in agricultural spending by ECOWAS countries was associated with an increase in food energy supply (ADESA), reduction in rates of undernourishment, stunting and variability in food production since the implementation of CAADP. These results mean that increased expenditure levels since the adoption of CAADP can be associated with the falling rates of stunting, undernourishment and ADESA. These results concur with the findings of Fontan Sers and Mughal (2019), who found that increased expenditure levels since the adoption of CAADP can be associated with falling rates of undernourishment.

The political regime (polity) indicator had a significant relationship with undernourishment and stunting. A positive relationship with undernourishment indicates that undernourishment increased by 0.31% as governments become less democratic, ceteris paribus. The significant and negative coefficient on stunting indicates that as countries move and become more democratic, the rates of stunting are reduced by 0.3%. Slimane *et al.* (2016), using data for 55 developing countries, found that the relationship between the political regime and food security was not significant. The results show that democracy was essential towards the improvement of food security and nutrition, as democratic governments respond better to food security concerns of the citizens.

GDP per capita had a significant relationship with average dietary energy supply adequacy, undernourishment, stunting and per capita production variability. The relationship with ADESA is positive, indicating that a 1% increase GDP per capita led to a 0.04% increase in food energy supply. A negative relationship with the prevalence of undernourishment indicates that as GDP per capita increases by 1%, the rates of undernourishment declined by 0.03%. A 1% increase in GDP per capita leads to a decrease in stunting by 0.05%, ceteris paribus. The positive coefficient on per capita food production variability means as GDP per capita increases by 1%, the variability in food production increases by 0.04%. The results were as expected for ADESA, undernourishment and stunting, however, they were not anticipated for per capita food production. A rise in GDP per capita boosts incomes for households, which allows the consumption of more diversified nutritious diets, thereby improving nutrition, leading to a reduction in rates of undernourishment and stunting (Smith & Haddad, 2002). Furthermore, higher incomes also improve food supply through improvement in production, which results from the purchase of inputs for production (Hanif *et al.*, 2019).

The relationship between agricultural production measured by gross production value had a significant relationship with average dietary energy supply adequacy, undernourishment and per capita food production variability at a 5% level of significance except stunting. The positive relationship with average dietary energy supply adequacy indicated that a 1% increase in agricultural production increases food energy supply by 0.06%, ceteris paribus. Implying that, as agricultural production increased, the number of calories available for human consumption increased. A 1% increase in gross production value declined the rates of undernourishment by 0.06%, ceteris paribus. A negative coefficient for per capita production variability indicates that as agriculture production increase by 1%, the variability in food production was reduced by 0.1%. These results were in line and consistent with the findings of Slimane *et al.* (2016), who found that increased agriculture production positively improved food security using a panel data of 55 developing countries.

4.8.Summary of results from the fixed effect generalised least squares model

Table 4-6 provides a summary of the results from the fixed effect generalised least squares model on the impact of public expenditure on food security and nutrition for nine countries within ECOWAS. The study used food security indicators as dependent variables, one from each dimension of food security. Average dietary energy supply adequacy measuring availability, the prevalence of undernourishment for accessibility dimension, the prevalence of stunting for utilisation and per capita food production variability for stability dimension. The share of expenditure in the total government budget as a measure of public expenditure. The food security indicators were regressed each against the share of public expenditure controlling for other factors that have an influence on food security at the national level. Table 4-6 reports the signs from the findings of the fixed effect generalised least squares model.

Table 4-6: Summary of results from the fixed effect generalised least squares model

Variables	Average dietary energy supply adequacy	Undernourishment	Stunting	Per capita food production variability
Total expenditure share		↓		
Five-lag of expenditure	↑			
CAADP_expenditure share (interaction term)	↑	↓	↓	↑
Political regime (Polity)		↑	↓	↓
Log of GDP per capita	↑	↓	↓	↑
Log of gross production value	↑	↓		↓

From table 4-6, only the five-year lag of expenditure, the interaction term between the total share of expenditure and CAADP participation, the log of GDP per capita and log of gross domestic production value had a significant impact on average dietary energy supply adequacy. The relationship with the average dietary energy supply was positive for all the variables included in the model. The total expenditure share, the interaction term for CAADP participation, political regime, the log of GDP per capita and log of gross domestic production value had a significant impact on undernourishment. The direction of impact was negative for all the variables except political regime (polity), which had a positive influence on undernourishment. Three variables were significant for stunting. These are the interaction term between the total share of expenditure and CAADP participation, political regime and log of GDP per capita. The direction of influence for all the variables was negative. Lastly, the interaction term between the total share of expenditure and CAADP participation, political regime and log of GDP per capita and log of gross production value had a significant impact on political regime. The direction of impact was positive for the interaction term between the total share of expenditure and CAADP participation and log of GDP per capita and negative for the political regime and log of gross production value.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Agriculture is seen as the main driver towards the achievement of food security and nutrition for the African continent. The reason for this is that most economies in Africa depend on agriculture for economic growth. Several studies have investigated the role of public expenditure on agricultural productivity, poverty and economic growth. However, these studies have neglected the impact of public expenditure on food security and nutrition. The tools to carry out such an analysis have simply not been developed. Given the importance of agricultural public expenditure in achieving food security and nutrition objectives and the SDG two, it is necessary to evaluate the impact of public expenditure in agriculture on food security and nutrition.

The main objective of this study was to evaluate the impact of public agricultural expenditure on food security and nutrition in ECOWAS countries. The specific objectives of the study were (ii) to evaluate the trends of public expenditure in agriculture and food security in these countries and (ii) to estimate the impact of public expenditure in agriculture on four dimensions of food security. After careful assessment of the available data for the ECOWAS countries, nine countries were identified for further analysis, which includes Benin, Burkina Faso, The Gambia, Ghana, Mali, Niger, Nigeria, Senegal.

Public expenditure has been relatively unstable between 2000 and 2017 in the nine ECOWAS countries. However, both the share and size of agricultural public expenditure have improved in all nine countries. In several years between 2000 and 2017, Benin, Burkina Faso, Mali, Niger and Senegal have attained the CAADP target to spend at least 10% of public expenditure on the agricultural sector. Therefore, the null hypothesis that there was no improvement in public expenditure over this period was rejected.

The trend analysis showed that all nine countries produced enough food to feed their populations, measured by the average dietary energy supply adequacy. Food accessibility improved in the majority of the countries as the prevalence of undernourishment declined between 2000 and 2017. The prevalence of undernourishment declined in Burkina Faso, Togo, Senegal, The Gambia, Mali and Ghana. While in Nigeria and Niger the proportion of undernourished people rose between 2000 and 2017. However, the absolute number of undernourished people increased.

The levels of child stunting are still high in the region. None of the nine countries reached the Malabo target of reducing stunting by 5 percent between 2000 and 2017. Similarly, there was slow progress in reducing the levels of wasting and underweight in the region. The null hypothesis that food security did not improve in the nine countries between 2000 and 2017 was rejected. Food security (as measured by average dietary energy supply adequacy and the prevalence of undernourishment) improved in the nine countries.

The second objective of the study was to evaluate the impact of agricultural public expenditure on food security and nutrition in the nine ECOWAS countries. A fixed-effect generalised least squares estimation was applied to panel data from nine ECOWAS countries between 2000 and 2016. Four indicators of food security (ADESA, undernourishment, stunting and per capita food production variability), were tested. The results revealed that public agriculture expenditure share had an impact on the prevalence of undernourishment and average dietary energy supply adequacy. That is increasing public expenditure by 1%, undernourishment declined by 0.2% and likewise, average dietary energy supply adequacy increased by 0.2%. However, public expenditure share was not significant for stunting and per capita food production variability. Regardless of this result, the signs and the direction of the impact of public expenditure share on stunting and per capita food production was as expected. That public agriculture expenditure negatively impacted stunting and per capita food production variability. This is an indication that there are other factors that are key at explaining stunting such as expenditure in health or per capita food production variability such as natural disasters.The study also found out that the impact of public agricultural expenditure materialise with a lag, because the five year lag of expenditure improved food availability however did not have any impact on undernourishment, stunting and per capita food production variability. Further, the study also found out that participation of countries in the CAADP process improved food security and nutrition. Therefore, the null hypothesis that public expenditure in agriculture does not have an impact on food security and nutrition was rejected.

5.1.Conclusions

The study arrived at three conclusions. The first conclusion was that the nine countries included in the analysis have made considerable progress in improving food supply at the national level. However, progress towards achieving the 2025 Malabo targets has been slow and inadequate as the levels of undernourishment, stunting, wasting and underweight are high. The second

conclusion was that public expenditure by share and size has increased in the nine countries, with Benin, Burkina Faso, Mali, Niger and Senegal achieving the 10% Malabo expenditure target in some years between 2000 and 2016. However, the improvement in public expenditure in these countries does not correspond with the improvement in stunting, wasting and underweight as they are still high in these countries.

The third conclusion was that public expenditure has an impact on food security and nutrition. However, the impact is not on overall food security and nutrition but on the prevalence of undernourishment and average dietary energy supply adequacy. The reason for this may be because the study used an aggregate measure of public expenditure, depending on its construction and collection might not be an accurate measure of the impact of public expenditure on food security and nutrition, unlike the actual expenditures that governments are spending on. Therefore, the actual expenditures or the composition of the expenditures should be evaluated to identify the expenditures, which have the highest impact on food security and nutrition.

The lastly, the study concluded that the impact of public expenditure is likely materialise with a lag. The nature of the lag will depend on the type of public expenditure. Expenditure on specific public goods and services are likley to impact food security and nutrition in different ways and in variable time spans Therefore, there is a need to assess the composition of each expenditure package to understand the differential impact.

5.2.Recommendations

Firstly, the study recommended that there is a need to disaggregate public expenditure data to analyse the impact of each specific expenditure on research and development, irrigation, extension and infrastructure development on food security and nutrition. Disaggregating public agriculture expenditure data will assist countries to understand expenditures that have the highest impact on food security and nutrition. At the same time it will assist the countries to understand the time frame within which expenditures show impact because of the lag effects of public expenditures. Disaggregation should take place at the sector level (agriculture and health), subsector level (crop, fishery, livestock and forest) and functions (research and development, irrigation and extension). Such an analysis is crucial for governments, policymakers and donors because scarce public

resources will be spent on strategies that have the highest impact on improving food security and nutrition.

Secondly, the study also recommended that countries should embark on a similar analysis at the national level during the drafting phase of their NAIPs as well as after its implementation. Such an analysis will assist countries in identifying appropriate strategies that will lead to broader improvements infood security and nutrition. The outcomes of such an analysis could help detremine if the implemented strategies have achieved the ecpected food security. This is essential because governments will then be able to spend constrained resources on strategies that have a higher impact on food security and nutrition. Finally, in countries where data for other food security indicators are available, the same analysis should be conducted to understand the impact on other food security indicators.

Finally, the Malabo monitoring and analysis system should include other indicators of food security such as the average dietary energy supply adequacy and per capita food production variability to allow a wide assessment of food security at the national level. In line with this, indicators such as food security experience scale (FIES), that measure food security at micro-levels, both household and individual should be added to the analysis of food security to allow a wide assessment of food security dynamics at micro-level (household and individual).

5.3.Recommendation for improving the study

The results also showed that the relationship between the share of expenditure with average dietary energy supply adequacy, the prevalence of stunting and per capita food production variability was not significant. The result was not consistent with prior expectations. The reasons for the results that were not significant may have resulted from the following reasons;

Firstly, the effects of public expenditure materialise with a lag and they take a long time to show impact (Benin *et al.*, 2009). Expenditure in research and development takes longer to produce results because the process of developing and adopting new technology takes time; as opposed to spending on a road system, which generates results within a short time. To support this, the five-year lag of expenditure indicated a significant relationship with average energy supply adequacy and a not significant relationship with undernourishment, stunting and per capita food production variability. The relationship with average dietary energy supply adequacy was significant at the

10% level of significance with the positive coefficient indicating that time horizon improved food availability (production) by 0.2% for countries within ECOWAS.

Secondly, the quality and nature of expenditure that the countries were spending on; may have influenced the results that were not significant. The study used an aggregate measure of expenditure for the analysis, which represented a total of all expenditures in the agriculture sector. Therefore, not all expenditures have the same impact on food security. Some expenditures would significantly improve food availability through improvement in labour productivity directly. Some, such as safety nets would negatively impact agricultural productivity (Benin *et al.*, 2008a). Emergency food aid and farm support programs distort farm labour supply, thus impacting agricultural productivity (Van de Walle, 2003). Furthermore, the dominance of wages in the agriculture sector undermines the quality of expenditure, because after subtraction of wages little is left to spend on other productive expenditures (Akroyd & Smith, 2007).

Therefore, based on this, several limitations were noted and the study recommended the following to overcome them. The same analysis with other food security indicators could have been conducted to understand the impact of public expenditure on other food security indicators. Performing the same analysis would have allowed making comparisons if the results that were not significant with the food security indicators were due to a choice of a set of indicators.

Additionally, the study could have used longer time series data on public expenditure and food security for greater variation in the data. Further, the study could have disaggregated public expenditure data to understand the actual impact of different expenditure on food security and nutrition. Finally, since stability is required in all three dimensions of food security, therefore, the analysis could have included an indicator from the stability dimension of food security as a control variable.

5.4.Recommendations for further research

This study did not explore the specific impact of each expenditure in agriculture on food security and nutrition. However, research is needed to evaluate the impact of public expenditure on research and development, extension, irrigation and rural infrastructure on food security and nutrition. Understanding how the specific expenditures impact food security and nutrition will assist the government and policymakers to focus their efforts on agricultural expenditures that will lead to

the attainment of food security and nutrition. Furthermore, the impact of expenditure in other sectors such as health and nutrition on food security and nutrition should be explored for governments and policymakers to isolate the impact from agriculture on food security and nutrition and impact on food security and nutrition from other sectors.

Further research is needed to understand the forward and backward linkages of public agricultural expenditure with other sectors of the economy. Therefore, to achieve this, other methods of assessing the impact of public expenditure on food security should be explored. Such methods that perform this analysis include the partial equilibrium models for sector-level analysis and the computable general equilibrium model for economy-wide analysis.

Studies are needed to broaden this analysis to cover more countries in the African Union implementing CAADP and the regional blocks of the African Union. Such an analysis will allow countries to understand whether the changes that have occurred are as a result of the improvement in public expenditure in agriculture. Further, a single country analysis should be conducted because countries have different economic structures and resource endowments.

REFERENCES

AFRICAN UNION, 2017. Technical Guidelines for Preparing Country Biennial Review Report on Progress Made for Achieving the Malabo Declaration Goals and Targets. Addis Ababa: African Union.

AKROYD, S. & SMITH, L. 2007. Review of Public Spending to Agriculture. Main study & Country Case-Studies, A joint DFID/World Bank study.

ALEXANDRI, C. Population food security assessment: A methodological approach. Agrarian Economy and Rural Development-Realities and Perspectives for Romania. 6th Edition of the International Syrsw3xwsz1ymposium, 2015. Bucharest: The Research Institute for Agricultural Economy and Rural Development…, 2-8.

AFRICAN UNION, 2003. Maputo Declarations on Agriculture and Food Security. Assembly of the African Union Second Ordinary Session. Maputo, July**,** 10-12.

AFRICAN UNION, 2014. Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. Doc. assembly/au/2 (xxiii). Malabo, Guinea Bissau: African Union.

AFRICAN UNION, 2015. Agenda2063 Report of the Commission on the African Union Agenda 2063: The Africa we want in 2063. Addis Ababa: African Union.

AFRICAN UNION, 2018. Inaugural Biennial Review Report of the African Union Commission on the Implementation of the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. Addis Ababa: African Union.

BADIANE, O. & MAKOMBE, T. 2014. Beyond Middle Income Africa: Transforming African Economies for Sustained Growth with Rising Employment and Incomes. ReSAKSS Annual Trends and Outlook Report 2014. International Food Policy Research Institute (IFPRI).

BADIANE, O., MAKOMBE, T. & BAHIIGWA, G. 2013. Promoting Agricultural Trade to Enhance Resilience in Africa. ReSAKSS Annual Trends and Outlook Report 2013. International Food Policy Research Institute (IFPRI).

BADIANE, O., COLLINS, J., DIMARANAN, B. & ULIMWENGU, J. 2018. An Assessment of the New Alliance for Food Security and Nutrition. NEPAD.

BALTAGI, B. 2008. Econometric Analysis of Panel Data, John Wiley & Sons.

BELLOUMI, M. 2014. Investigating the Linkage between Climate Variables and Food Security in ESA countries. Regional Environmental Change, 42**,** 172-186.

BENIN, S. 2015. Returns to Agricultural Public Spending in Africa South of the Sahara. Internation Food Policy Research Institute (IFPRI).

BENIN, S. 2016. Impacts of CAADP on Africa's Agricultural-led Development. International Food Policy Research Institute (IFPRI).

BENIN, S., MOGUES, T., CUDJOE, G. & RANDRIAMAMONJY, J. 2009. Public Expenditures and Agricultural Productivity Growth in Ghana. International Association of Agricultural Economists 2009 Conference**,** 16-22.

BENIN, S., NIN-PRATT, A., FAN, S., BREISINGER, C., MOGUES, T., THURLOW, J. & DIAO, X. 2008a. Growth and Poverty Reduction Impacts of Public Investments in Agriculture and Rural Areas. ReSAKSS Working Paper, 7.

BENIN, S. & ODJO, S. 2018. Government Expenditures in Kenya, 1950–2014: Determinants and agricultural growth effects. International Food Policy Research Institute (IFPRI).

BENIN, S., THURLOW, J., DIAO, X., KALINDA, H. & KALINDA, T. 2008b. Agricultural Growth and Investment Options for Poverty Reduction in Zambia. International Food Policy Research Institute (IFPRI).

BENIN, S., THURLOW, J., DIAO, X., KEBBA, A. & OFWONO, N. 2008c. Agricultural Growth and Investment Options for Poverty Reduction in Uganda, International Food Policy Research Institute (IFPRI).

BEYENE, L. M. & ENGIDA, E. 2016. Public Investment in Irrigation and Training, Growth and Poverty Reduction in Ethiopia. International Journal of Microsimulation, 9**,** 86-108.

COMMITTEE ON WORLD FOOD SECURITY (CFS). 2012. Report of the 39th Session of the Committee on World Food Security (CFS), Rome, 15–20 October 2012. Rome: CFS.

CHAKRABARTI, S., DINESH, D. & GARRETT, J. 2017. The Nutrition Advantage: Harnessing nutrition co-benefits of climate-resilient agriculture. Rome (Italy): IFAD 49p. ISBN:978-92-9072-769-9

COHEN, M. J., TIRADO, C., ABERMAN, N.-L. & THOMPSON, B. 2012. World Food Insecurity and Malnutrition: Scope, Trends, Causes, and Consequences. In Thompson B.,

Cohen M. (eds) The Impact of Climate Change and Bioenergy on Nutrition. Springer, Dordrecht

COVIC, N. & HENDRIKS, S. 2015. Achieving a Nutrition Revolution for Africa: The Road to healthier diets and optimal nutrition. ReSAKSS Annual Trends and Outlook Report 2015. International Food Policy Research Institute (IFPRI).

DE PINTO, A. & ULIMWENGU, J. M. 2017. A Thriving Agricultural Sector in a Changing Climate: Meeting Malabo Declaration goals through climate-smart agriculture. International Food Policy Research Institute (IFPRI).

EIDE, A., OSHAUG, A. & EIDE, W. B. 1991. The Food Security and the Right to Food in International Law and Development. Transnat'l L. & Contemp. Probs., 1**,** 415.

FAN, S., GULATI, A. & THORAT, S. 2008a. Investment, Subsidies, and Pro-poor Growth in Rural India. Agricultural Economics, 39**,** 163-170.

FAN, S., HAZELL, P. & THORAT, S. 2000. Government Spending, Growth, and Poverty in Rural India. American Journal of Agricultural Economics, 82**,** 1038-1051.

FAN, S. & RAO, N. 2003. Public Spending in Developing Countries: Trends, determination, and impact. International Food Policy Research Institute (IFPRI).

FAN, S., ZHANG, L. & ZHANG, X. 2002. Growth, Inequality, and Poverty in Rural China: The role of public investments, International Food Policy Research Institute.

FAO. 1992. World Declaration and Plan of Action for Nutrition. Rome: FAO.

FAO. 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action. Rome: FAO.

FAO. 2014. Rome Declaration on Nutrition. Rome: FAO.

FAO 2015. Regional Overview of Food Insecurity: Africa. FAO

FAO. 2017. The State of Food Security and Nutrition in the World: Building Resilience for Peace and Food security. Rome: FAO.

FAO. 2019a. Food Security Indicators. Available at: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ [Accessed 2 September.2019].

FAO. 2019b. Government Expenditure in Agriculture. Available at: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ [Accessed 2 September. 2019]

FAO. 2019c. State of Food Security and Nutrition Report: Guarding against economic slowdowns and downturns. FAO, WHO, WFP, UNICEF-2019. Rome, Italy: FAO.

FERNÁNDEZ PORTILLO, L. A., LAHOZ, C., OSSORIO, L. & DE, E. 2015. Assessment on the Right to Food in the ECOWAS region. *Fao Fisheries And Aquaculture Department Of The United Nations*, 1-188.

FONTAN SERS, C. & MUGHAL, M. 2019. From Maputo to Malabo: Public agricultural spending and food security in Africa. Applied Economics, 1-18.

GHANA, M. 2010. Medium Term Agriculture Sector Investment Plan (METASIP)—2011–2015. *Accra, Ghana*.

GUJARATI, D. N. 2009. Basic Econometrics, Tata McGraw-Hill Education.

HADDAD, L. 2015. Linking nutrition to the data revolution.

HANIF, N., NISA, M. & YASEEN, M. R. 2019. Relationship between Food Security, Macroeconomic Variables and Environment: Evidence from developing countries. Journal of Applied Economics & Business Research, 9.

HAUSMAN, J. 1978. Specification Tests in Econometrics. Econometrica 46: 1251–1271.

HAWKES, C. & RUEL, M. T. 2008. From Agriculture to Nutrition: Pathways, synergies, and outcomes. World Bank: Washington DC.

HOLTZ-EAKIN, D., NEWEY, W. & ROSEN, H. S. 1988. Estimating Vector Autoregressions with Panel Data. Econometrica: Journal of the Econometric Society, 1371-1395.

HORTON, S. & HODDINOTT, J. 2014. Benefits and Costs of the Food and Nutrition Targets for the Post-2015 Development Agenda. Food Security and Nutrition Perspective Paper. Loweel, MA, USA. Copenhagen Consensus Center.

JIRATA, M. T. CHELULE, J.C. ODHIAMBO, R. 2012. Deriving some estimators of panel data regression models with individual effects. International Journal of Science and Research.

JONES, A. D., NGURE, F. M., PELTO, G. & YOUNG, S. L. 2013. What are we Assessing when we Measure Food Security? A compendium and review of current metrics. Advances in Nutrition, 4, 481-505.

KAH, H. K. 2017. 'Boko Haram is Losing, but so is Food Production': Conflict and food insecurity in Nigeria and Cameroon. Africa Development, 42, 177-196.

LOFGREN, H., HARRIS, R. L. & ROBINSON, S. 2002. A Standard Computable General Equilibrium (CGE) Model in GAMS, International Food Policy Research Institute (IFPRI).

MALTHUS, T. 1992. An Essay on the Principle of Population (based on Malthus's Second Essay). ed. D. Winch. Cambridge, Eng.: Cambridge University Press.

MATEMILOLA, S. & ELEGBEDE, I. 2017. The Challenges of Food Security in Nigeria. Open Access Library Journal, 4**,** 1-22.

MCGOVERN, M. E., KRISHNA, A., AGUAYO, V. M. & SUBRAMANIAN, S. 2017. A Review of the Evidence Linking Child Stunting to Economic Outcomes. International Journal of Epidemiology, 46**,** 1171-1191.

MEERMAN, J. & APHANE, J. 2012. Impact of High Food Prices on Nutrition. Rome: Food and Agriculture Organization of the United Nations.

MIHALACHE-O'KEEF, A. & LI, Q. 2011. Modernization vs. Dependency Revisited: Effects of foreign direct investment on food security in less developed countries. International Studies Quarterly, 55**,** 71-93.

MOGUES, T., YU, B., FAN, S. & MCBRIDE, L. 2012. The Impacts of Public Investment in and for Agriculture (No. 01217). IFPRI Discussion Paper. IFPRI. Washington DC.

MUNDLAK, Y. 1978. On the Pooling of Time Series and Cross-Section Data. Econometrica: Journal of the Econometric Society**,** 69-85.

RESSAKS. 2019. Tracking Indicators [Online]. Available at: https://www.resakss.org/node/11 [Accessed 2 September. 2019].

ROSEGRANT, M. W. & EVENSON, R. E. 1995. Total factor productivity and sources of long-term growth in Indian agriculture.

RUEL, M. T., ALDERMAN, H., MATERNAL & GROUP, C. N. S. 2013. Nutrition-sensitive Interventions and Programmes: How can they help to accelerate progress in improving maternal and child nutrition? The Lancet, 382**,** 536-551.

SCHOENBUCHNER, S. M., DOLAN, C., MWANGOME, M., HALL, A., RICHARD, S. A., WELLS, J. C., KHARA, T., SONKO, B., PRENTICE, A. M. & MOORE, S. E. 2019. The Relationship Between Wasting and Stunting: A retrospective cohort analysis of longitudinal data in Gambian children from 1976 to 2016. The American journal of clinical nutrition.

SLIMANE, M. B., HUCHET-BOURDON, M. & ZITOUNA, H. 2016. The Role of Sectoral FDI in Promoting Agricultural Production and Improving Food Security. International economics, 145**,** 50-65.

SMITH, L. C. & HADDAD, L. 2002. How potent is economic growth in reducing undernutrition? What are the pathways of impact? New cross-country evidence. Economic Development and Cultural Change, 51**,** 55-76.

SOFI 2018. The State of Food Security and Nutrition in the World 2018: Building climate resilience for food security and nutrition, Food & Agriculture Org.

SPENCER, D. S. 1996. Infrastructure and Technology Constraints to Agricultural Development in the Humid and Subhumid Tropics of Africa. African Development Review, 8**,** 68-93.

SWAMINATHAN, M. S. & BHAVANI, R. V. 2013. Food production & availability-Essential prerequisites for sustainable food security. The Indian Journal of Medical Research, 138**,** 383.

THURLOW, J., KIRINGAI, J. & GAUTAM, M. 2007. Rural Investments to Accelerate Growth and Poverty Reduction in Kenya. International Food Policy Research Institute (IFPRI).

UN. 1948. Universal Declaration of Human Rights. New-York: United Nations.

UN. 1966. International Covenant on Civil and Political Rights New-York: United Nations.

UN. 1976. International Covenant on Eradication of Hunger and Malnutrition. New-York: United Nations.

UN. 2000. Millennium Development Goals. New York: United Nations.

UN. 2015a. Transforming our world: The 2030 agenda for sustainable development. Resolution adopted by the General Assembly.

UN. 2016. Sustainable Development Goals. New York: UNDP.

VAN DE WALLE, D. 2003. Behavioral Incidence Analysis of Public Spending and Social Programs In: Bourguignon, F., 2003. The impact of Economic Policies on Poverty and Income Distribution: Evaluation of techniques and tools. World Bank. p.69.

WANNER, N., CAFIERO, C., TROUBAT, N. & CONFORTI, P. 2014. Refinements to the FAO Methodology for estimating the Prevalence of Undernourishment Indicator. Documento de trabajo n. ESS/14-05 de la División de Estadística de la FAO (disponible en http://www.fao.org/3/a-i4046e.pdf).

WOOLDRIDGE, J. M. 2009. Introductory Econometrics: A modern approach. 4th. CENGAGE Learning, Canada.

WOOLDRIDGE, J. M. 2016. Introductory Econometrics: A modern approach, Nelson Education.

WORLD HEALTH ORGANIZATION 2010. Nutrition Landscape Information System (NLIS) Country Profile Indicators: Interpretation guide.

WOUTERSE, F. S. & TAFFESSE, A. S. 2018. Boosting Growth to End Hunger by 2025: The role of social protection. International Food Policy Research Institute (IFPRI).

Appendix A: Wooldridge test for autocorrelation in panel data

Model	H_0	F-Statistic	P-Value	Conclusion
ADESA	No serial correlation	112.261	0.0000	Serial correlation present
Undernourishment	No serial correlation	166.642	0.0000	Serial correlation present
stunting	No serial correlation	5.963	0.0404	Serial correlation present
Per capita food production variability	No serial correlation	86.975	0.0000	Serial correlation present

Appendix B: Modified Wald test for GroupWise heteroskedasticity

Model	H_0	Chi-square	P-Value	Conclusion
ADESA	No heteroskedasticity	1138.65	0.0000	Heteroskedasticity present
Undernourishment	No heteroskedasticity	116.56	0.0000	Heteroskedasticity present
stunting	No heteroskedasticity	18.20	0.0000	Heteroskedasticity present
Per capita food production variability	No heteroskedasticity	29.56	0.0005	Heteroskedasticity present

Appendix C: Breusch-Pagan LM test for independence

Model	Null Hypothesis	χ^2	p-value	Conclusion
ADESA	Cross-sectional Independence	83.520	0.0000	Cross-sectional dependence
Undernourishment	Cross-sectional Independence	118.733	0.0000	Cross-sectional dependence
stunting	Cross-sectional Independence	50.159	0.0587	Cross-sectional dependence
Per capita food production variability	Cross-sectional Independence	69.807	0.0006	Cross-sectional dependence