The impact of public agriculture expenditure on food security and nutrition in the Southern African Development Community (SADC)

by

Emmillian Chifundo Kasililika-Mlagha

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University of Pretoria

Supervisors:

Prof Sheryl L Hendriks

Dr Colleta Gandidzanwa

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FACULTY OF NATURAL AND
AGRICULTURAL SCIENCES

University of Pretoria

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ABSTRACT

Food insecurity and malnutrition have worsened despite numerous commitments by African governments and their leaders to end hunger and all forms of malnutrition as captured in the Sustainable Development Goals and Africa's Agenda 2063. Africa's 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods set out the need to increase agricultural expenditure to reduce food insecurity and malnutrition. However, analyses of the impact of public expenditure on agriculture in Africa have focused on poverty reduction and economic growth, with very little analysis of the impact on food security and nutrition. This study sought to fill this gap with respect to countries in the Southern African Development Community (SADC). A panel data analysis for the years 2000 to 2016 was employed using a fixed-effect generalised least squares estimation. Four food security indicators were used, namely, the average dietary energy supply adequacy; the prevalence of undernourishment; the prevalence of stunting; and per capita food production variability. The share of public agriculture expenditure in total public expenditure was used as a proxy for government expenditure on agriculture. The results showed that public expenditure on agriculture was associated with a significant positive impact on the average dietary energy supply adequacy and per capita food production variability. In the study, increased government expenditure on agriculture was associated with a decline in the prevalence of undernourishment over this period. There was no sufficient evidence to show that government agriculture expenditure on agriculture was associated with changes in the prevalence of stunting. The nine SADC countries included in the analysis need to put more effort into acting on their commitments, strengthening strategies to address the issue of food insecurity and malnutrition. The nine SADC countries need to promote nutrition-sensitive agriculture and the diversification of agricultural production to improve nutrition. They also need to increase the development and use of biofortified food crops. As food security is essentially a public good, public resources are needed to stimulate research and development, the adoption of technologies and practices and sharing the knowledge of the benefits of these practices among communities.

Keywords: public agriculture expenditure; food security and nutrition; Malabo Declaration; fixed effects; Comprehensive Africa Agriculture Development Programme; Southern African Development Community

DECLARATION

I, Emmillian Chifundo Kasililika-Mlagha, declare that this dissertation, which I hereby submit for the degree Master of Science in Agricultural Economics at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signature _________________________

Date ______________________________

DEDICATION

This work is dedicated to my dear parents, Newton and Esther Kasililika-Mlagha, for continually supporting me and reminding me never to give up.

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LIST OF ABBREVIATIONS AND ACRONYMS

AERC	African Economic Research Consortium
AGRA	Alliance for a Green Revolution in Africa
ATOR	Annual Trends and Outlook Report
CAADP	Comprehensive Africa Agriculture Development Programme
CGE	Computable General Equilibrium
CMAAE	Collaborative Master of Science in Agricultural and Applied Economics
DESA	Department of Economic and Social Affairs
DRC	Democratic Republic of the Congo
ECA	Economic Commission for Africa
FAO	Food and Agriculture Organisation
FAOSTAT	Food and Agriculture Organisation Statistical Databases
GDP	Gross Domestic Product
NEPAD	New Partnership for Africa's Development
OECD	Organisation for Economic Cooperation and Development
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
RVAA	Regional Vulnerability Assessment and Analysis
SADC	Southern African Development Community
SDG	Sustainable Development Goals

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CHAPTER 1 : INTRODUCTION

Food insecurity and malnutrition continue to worsen despite the numerous commitments to ending hunger and all forms of malnutrition in Africa (FAO and ECA, 2018). Food insecurity and malnutrition pose a threat to development and human rights (Ilaboya et al., 2012; United Nations, 1948). The development of nations relies on the productivity of human capital (Alderman et al., 2005). A lack of productive human capital traps generations in perpetual poverty (Todaro and Smith, 2012). Proper nutrition is vital for the growth and development of children. If diets are inadequate, child mortality may increase and put future human capital at risk (Horton and Hoddinott, 2014b). Labour productivity and economic growth are dependent on proper nutrition, which is vital for cognitive development and education success (Horton and Hoddinott, 2014b).

In the Southern African Development Community (SADC), food insecurity and malnutrition continue to worsen due to economic downturns, conflicts and adverse climate events (FAO and ECA, 2018). The current COVID-19 pandemic also threatens food security and nutrition status (IFPRI,2020). It is predicted that more people will fall back into poverty as their livelihoods are disrupted by the control measures in place to curb the spread of the pandemic (James Thurlow, 2020; IFPRI, 2020). With more people falling into poverty, the COVID-19 pandemic might negatively affect food security and nutrition (Hartline-Grafton and Dean, 2017; IFPRI, 2020).

A 2019 Regional Vulnerability Assessment and Analysis (RVAA) programme report predicted that in the 2019-2020 consumption year, 41.2 million people in 13 out of 16 SADC countries (81.3 per cent) would be food insecure (SADC, 2019). The food insecurity estimates were higher than the 2018-2019 estimates, which stood at 29.4 million in 11 out of 16 SADC countries (SADC, 2018). Diets in the SADC region are primarily cereal-based (SADC, 2019). These diets lack essential nutrients, causing micronutrient deficiencies (folate, iron, zinc, vitamin A and iodine) (SADC, 2018). Micronutrient deficiencies cause widespread malnutrition among the population. Most countries in SADC are facing the triple burden of malnutrition, where undernutrition coexists with obesity, overweight and micronutrient deficiencies (SADC, 2018). As a result, food security and nutrition have been given priority in the SADC area (SADC, 2014).

Agriculture can improve food security and nutrition outcomes through various pathways (Hawkes and Ruel, 2008; Ruel et al., 2013). With the current COVID-19 pandemic, public funds are likely to be diverted to dealing with the health crisis. As a result, there might be a reallocation of budgets to prioritise the health sector at the expense of the agriculture sector as was the case at the start of the HIV/AIDS pandemic (Masuku et al., 2015; Jayne et al., 2005). However, a clear understanding of how developing the agriculture sector through investments could influence food security and nutrition may enable policymakers to make decisions on funding the current COVID-19 pandemic without disregarding the agriculture sector.

In an effort to make the world a better place, development plans have been formulated that seek to achieve common goals. Currently, the focus on the development agenda is guided by Sustainable Development Goals (SDGs) at a global level (United Nations, 2016). In Africa, there is Agenda 2063 and the Comprehensive African Agriculture Development Programme (CAADP) at a sectoral level that guides the development agenda (African Union Commission, 2015; NEPAD, 2009). Food security and nutrition cut across the three frameworks, demonstrating the priority that food security and nutrition have been given at the sector, continental and global levels. The frameworks also emphasise the need to invest in agriculture to ensure growth in the sector. In this study, the focus will be on the CAADP.

CAADP is a framework for the development of the agriculture sector in Africa (NEPAD, 2016). Agriculture plays a vital role in development in Africa since most of the countries are agro-based. CAADP was adopted in 2003 through the Maputo Declaration (NEPAD, 2016). CAADP aims to boost the agriculture sector, which, it was assumed, would translate into welfare improvements through poverty reduction and food security for all (Diao et al., 2012). CAADP has been implemented under two series of declarations, namely, the Maputo Declaration of 2003 and currently the Malabo Declaration of 2014 (NEPAD, 2016; African Union Commission, 2014). In both the Maputo and Malabo Declarations, heads of state and government committed to increasing investment in agriculture to at least ten per cent of the total budget. The ten percent increase in investment in agriculture was aimed at sustaining a six per cent growth in the sector (African Union Commission, 2014; African Union, 2003). CAADP is implemented at a national and regional level in Africa, requiring the development of investment plans in the agriculture sector (AU-NEPAD, 2010).

At the launch of the Malabo Declaration during the African Union Summit in 2014, an agreement was reached for a biennial review which would track the progress made by all the countries under the CAADP process (African Union Commission and NEPAD, 2017). The biennial review seeks to monitor the implementation of the Malabo Declaration. The tool in tracking Africa's agriculture progress through CAADP and the Malabo Declaration is the African Agriculture Transformation Scorecard (AATS) (African Union, 2020). The African Agriculture Transformation Scorecard shows that the SADC region by the year 2018 was not on track in the attainment of the Malabo Declaration goals (Matchaya et al., 2018). In the analysis, out of 16 countries, eight SADC countries were found to be on track in achieving the Malabo Declaration targets. Matchaya et al. (2018) recommended that the SADC needs to address some thematic areas, one of which involved ending hunger by 2025, improving resilience to climate change and investment in agriculture finance.

Governments and international organisations are advocating investment in agriculture as a means of contributing to the improvement of the food security and nutrition situation specifically in Africa (Food and Agricultural Organisation, 2012; International Food Policy Research Institute, 2018). Since the establishment of CAADP, studies have been conducted on the impact of agriculture investments on poverty and economic growth (Fan and Rao, 2003; Fan and Zhang, 2008; Benin et al., 2008b; Bathla, 2017). However, studies on the impact of government expenditure on agriculture on food security and nutrition have not been carried out in the SADC since the start of CAADP. Therefore, it is essential to know how increased public expenditure on agriculture contributes to food security and nutrition to have an empirical understanding of this impact.

1.1 Problem statement

In 2003 CAADP was established with the idea of fostering agriculture-led growth to reduce poverty and end hunger in Africa (NEPAD, 2009; African Union Commission, 2014). One of the strategies by governments for advancing agriculture-led growth has been through increased public expenditure on the agricultural sector.

Every investment requires an evaluation to measure the performance, and agricultural investments are not excluded (Mogues et al., 2012). Most academic scholars that have analysed the impact of agricultural expenditure have not focused on food security and nutrition. Most of the scholarly literature on public agriculture expenditure analysis (Fan and Rao, 2003; Fan and Zhang, 2008; Benin et al., 2008b; Bathla, 2017) has focused on the impact of public agriculture expenditure on poverty reduction and economic growth. In one study by Beyene and Engida (2016), where food security and nutrition were investigated, three dimensions of food security (stability, access and utilisation) were not included in the analysis. The study included only the food availability dimension.

More specifically, no empirical study has been done to investigate the impact of government agriculture expenditure on food security and nutrition in SADC since the establishment of CAADP. The lack of empirical evidence required to support policymaking might pose a challenge to developing policies that aim at improving food security and nutrition. Therefore, this study provides evidence of how government agriculture expenditure impacts food security and nutrition outcomes in nine SADC countries. In terms of choice of the study area, as highlighted earlier, food insecurity and malnutrition are among the challenges in the SADC region, making it suitable for the study. Besides, the countries in the region have been part of the Maputo and Malabo Declarations.

1.2 Objectives of the study

The overall objective of this study was to assess the impact of government agriculture expenditure on food security and nutrition in SADC countries.

The specific objectives of the study were to

(i) evaluate food security and nutrition and government agricultural expenditure trends in SADC member countries from 2000 to 2016;

(ii) evaluate the impact of government agricultural expenditure on food security and nutrition indicators in nine SADC countries for which data was available for the indicators under investigation.

1.3 Hypotheses

For the first objective, the null hypothesis tested was that SADC countries did not reach their Maputo Declaration targets for government agriculture expenditure, food security and nutrition. Under the Maputo, and later the Malabo Declarations, countries committed to increase their expenditure on agriculture to at least ten per cent of the total national budget

(African Union Commission, 2014). Also, the governments through the Malabo Declaration have been working to reduce the prevalence of undernourishment, underweight and wasting to five per cent, and stunting by ten per cent from the country-specific baseline levels, by the year 2025 in line with countries' commitments to the World Health Assembly targets for nutrition (African Union Commission, 2014).

For the second objective, the null hypothesis tested was that government agriculture expenditure was not significantly related to the changes in the food security and nutrition outcomes in the nine SADC countries for which data was available between the year 2000 and 2016. This assumption was based on the idea that in agriculturally-based countries, government expenditure influences agricultural productivity (Dube, 2018; Mogues et al., 2012) and improves citizens' social welfare (Amare and Shiferaw, 2017; Dzanku, 2015). For example, during the green revolution in Asian countries, there was a remarkable reduction in poverty, accompanied by improvements in food security and health (Pingali, 2012; Mogues et al., 2012; Pinstrup-Andersen and Hazell, 1985).

1.4 Organisation of the dissertation

The dissertation is organised into five chapters. Chapter one presented the introduction, which gives the context of the study. Chapter two provides a review of relevant literature illustrating the gap that exists in the literature. Chapter three presents trends that give context and background to chapter four which evaluates the potential impact of government agriculture expenditure on food security and nutrition. Lastly, chapter five presents the outcome of the hypotheses, the conclusions and recommendations.

CHAPTER 2 : REVIEW OF RELATED LITERATURE

Africa has been experiencing a rise in the numbers of people who are food insecure and malnourished (FAO et al., 2020) despite numerous agreements, notably the commitments in the CAADP's Maputo and now Malabo Declarations (African Union, 2003; African Union Commission, 2014). Economic downturns, climate variability and conflicts have threatened the progress in attaining food security and nutrition in Africa (FAO et al., 2017; FAO et al., 2018; FAO et al., 2019a). Food insecurity increases amidst economic slowdowns (FAO et al., 2019a). These economic stresses are deeply rooted in poverty, which contributes to food insecurity (SADC, 2014). Economic slowdowns tend to affect employment and household income as poor people spend most of their income on food as they are unable to afford nutritious food (FAO et al., 2019a).

Climate variability has made Africa more prone to natural disasters, as highlighted in Figure 2-1, which has adversely impacted food security and nutrition (FAO et al., 2018). The effects are more pronounced in regions that rely largely on a rainfed agriculture system. In the SADC region, most countries rely on rainfed agriculture (SADC, 2018) and of late have been struck by several climatic conditions. For example, in 2015-2016, there was El Niño; in 2018-2019 the drought; and in 2019-2020, some countries were hit by a cyclone in Southern Africa (SADC, 2019). The occurrence of the climatic shocks negatively impacts food security which was evident in the increase in the levels of food insecurity.

Conflicts have also largely contributed to food insecurity and malnutrition. People who live in areas that are characterised by conflict tend to be food insecure and undernourished (FAO et al., 2017). In SADC, Mozambique, Zimbabwe and the Democratic Republic of the Congo (DRC) have been affected by acute food insecurity due to conflicts (SADC, 2019). Economic slowdowns, climate change and conflict, pose a threat to food security as such, addressing these challenges have been prioritised on the global, continental, regional and country levels. In Africa, developing the agriculture sector has been viewed as a means of improving food security and nutrition status (NEPAD, 2009).

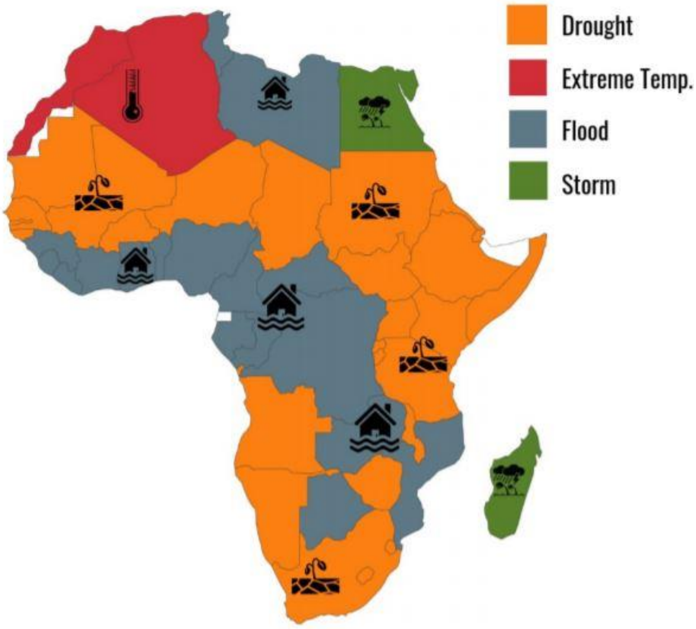

Figure 2-1: Disaster type affecting the highest number of people by country (2000-2019)

Note: Figure does not include the following: Cape Verde (drought); Comoros (storms); Mauritius (storms); Reunion (storms); Saint Helena, Ascension and Tristan da Cunha (storms); Seychelles (storms)
Source (CRED, 2019), Page 1

The importance of agriculture for human welfare cannot be overstated. It has been established that agriculture can take people out of poverty, especially in areas where agriculture is the primary source of livelihood (Ogundipe et al., 2016; Valdés and Foster, 2010; Dorward et al., 2004). Investment in agriculture is critical in boosting the sector to transform the lives of people (Food and Agricultural Organisation, 2012; Headey and Masters, 2019). African governments have an opportunity to develop agriculture through investments in infrastructure, extension and agricultural research and development, (Mogues et al., 2012). These investments are essential in ensuring an increase in agricultural productivity.

Few empirical studies have evaluated the impact of government expenditure on agriculture on food security and nutrition (Beyene and Engida, 2016). This chapter highlights the importance of food security and nutrition, the conceptual pathways that link agriculture to food security and nutrition, and the gaps in empirical studies with regard to government expenditure on agriculture impact.

2.1 The role of food and nutrition in the development agenda

Food security is attained 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 healthy life" (FAO, 1996). This definition makes four dimensions clear that need to be achieved for an individual or a country to be considered food secure. These dimensions include food availability, stability, utilisation and food access (FAO, 2008). Food availability entails the sufficiency in the food supply that can be made available through production or imports as well as food aid. Food access indicates the capability to be able to obtain the food with the resources that one must have quality and nutritious food to meet dietary needs (FAO, 2008). The utilisation of food is the ability to be able to make good use of the food given an adequate diet, health care, sanitation and clean water to ensure that one attains the desired nutritional well-being. In terms of stability, an individual or the population is supposed not to be at risk of losing out in the previously mentioned dimensions of food security, namely, access, availability and utilisation (FAO, 2008).

The right to food has been recognised as a universal human right due to the role it plays in the development of nations (FAO, 1996). Food security and nutrition are viewed as fundamental elements of development policy and economic (Hendriks, 2018; Hoddinott, 2016). In 2013 FAO reported that it was estimated that overweight, undernutrition and micronutrient deficiencies cost up to US $3.5 trillion for the global economy annually (FAO, 2013). Also, in Africa and Asia, it was estimated in 2016 that 11 per cent of the gross domestic product (GDP) is lost due to malnutrition (Achadi et al., 2016). Such high costs hinder governments' efforts to reduce poverty and achieve development goals (Global Panel, 2016). Improved nutrition promotes human development, increases the incomes of households, enriches livelihoods and increases employment opportunities across the food system (Hendriks, 2018). Poor nutrition from childbirth impairs cognitive development which, in the long run, affects a child's ability to perform at school and later reduces the employability in adult life (Global Panel, 2016; Hoddinott et al., 2008; Horton and Hoddinott, 2014a). Malnutrition also causes impaired physical growth, which increases an individual's susceptibility to diseases and reduces economic activity. The reduction in economic activity is manifested in lower work productivity and absenteeism from work (Global Panel, 2016). Low productivity caused by malnutrition is associated with an 11 per cent loss in lifetime earnings and a 3 to 16 per cent annual GDP loss in low-income countries (FAO, 2013; Global Panel, 2016).

The role of human capital in ensuring development cannot be overlooked. The future stock of human capital in countries is threatened by malnutrition (Horton and Hoddinott, 2014a; Global Panel, 2016). Food insecurity and malnutrition contribute to increased child mortality, which results in the loss of future human capital in a country (Hoddinott, 2016; Global Panel, 2016). It is estimated that 45 per cent of mortality in children under the age of five years is attributed to undernutrition (Black et al., 2013).

Food insecurity and malnutrition result in low body immunity, increasing the susceptibility to infections and diseases. For example, overweight and obesity are linked to an increase in non-communicable diseases (WFP and UN-ECLAC, 2017). Treating these infections and illnesses that could have been avoided leads to increased health care costs (Global Panel, 2016; Horton and Hoddinott, 2014a; Shekar et al., 2006). Rising health care costs slow down the economic development of a country (Global Panel, 2016). In most cases, the resources that would have been used to improve economic growth are used to cover healthcare costs (Hammond and Levine, 2010).

Food security and nutrition play a role in the development of nations through the improvement in human capital, health and economic growth. These benefits have led to the prioritisation of food security and nutrition at the global, continental, regional and national development agenda. In September 2015, countries affiliated with the United Nations (UN) adopted the universal 2030 Agenda for Sustainable Development which was to build upon the earlier Millennium Development Goals (MDGs). MDG one focused on eradicating extreme hunger and poverty between the years 2000 and 2015 (United Nations, 2015). The Sustainable Development Goals (SDGs) comprise of 17 goals and 169 targets (UN General Assembly, 2015). The framework recognises that eradicating hunger in all its forms is a pathway for human beings to attain their fullest potential without discrimination in a conducive environment. Specifically, the framework under SDG two highlights the need to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (UN General Assembly, 2015). The 17 goals also include indicators that are related to food security, and 12 even have nutrition-related goals (Hendriks, 2018).

In Africa, the development plans (Agenda 2063 and CAADP) also highlight the need for improved food security and nutrition. Agenda 2063 embraces the SDG goal, and the framework is set to guide the continental development agenda for five decades (African Union

Commission, 2015). Agenda 2063 points at the development of African solutions for African problems by Africans by focusing on seven aspirations. Under aspiration one, Agenda 2063 prioritises nutrition and hunger issues (African Union Commission, 2015) as part of the strategy to achieve a prosperous Africa based on inclusive growth and sustainable development by 2063. In addition, CAADP is being used as a policy framework for achieving food security and nutrition on the continent through agriculture (New Partnership for Africa's Development, 2009).

SADC has also recognised the role of food security and nutrition in the development agenda. The SADC Regional Indicative Strategic Development Plan highlights the need to prioritise sustainable food security (SADC, 2003) to reduce poverty (SADC, 2003). SADC has also developed a food and nutrition security strategy (SADC, 2014).

In 2003 African heads of state and government launched the Maputo Declaration. Later (2014), the Malabo Declaration reiterated the goals of the Maputo Declaration, aligning the targets with those of SGD two. The two declarations set out to ensure that Africa embarks on agriculture-led growth to eradicate poverty and improve food security and nutrition (African Union, 2003; African Union Commission, 2014). In both Declarations, the emphasis was placed on increasing public expenditure on agriculture by ten per cent of the total budget (African Union, 2003; African Union Commission, 2014). Expenditure on agriculture plays a vital role in developing the agriculture sector.

2.2 Conceptual pathways in which agriculture links to food security and nutrition

Agriculture has the potential to improve food security and nutrition through several pathways. These pathways include food access; women's status and empowerment; food prices; women's time; income; and women's health and nutrition (Ruel et al., 2013). In agriculture, farmers make the most important investment in agriculture at the farm level (Food and Agricultural Organisation, 2012). Farmers own the land and make the decisions on how best to use the land to ensure increased returns from their investments and also improvements in their well-being. Public investment in agriculture is the second most significant contributor to farm-level capital formation through the provision of public goods (Syed and Miyazako, 2013). These investments contribute to the development of the agriculture sector.

Figure 2-2 demonstrates the conceptual pathways which agriculture links with food security and nutrition. The framework highlights how agricultural production and household consumption decisions determine the health and nutrition status of an individual. The framework also shows how the natural environment, food and health contribute to the success of agricultural programmes and policies in improving food security and nutrition (Hawkes and Ruel, 2008). A better understanding of these pathways can bring about new initiatives and investments in which agriculture can improve food security and nutrition.

First, agriculture contributes to food access through household production. Food production has a direct way of influencing food security and nutrition (Hawkes and Ruel, 2008). Agriculture has the potential of providing households with macro-nutrients and a wide range of micro-nutrients (Fan et al., 2019b) through diverse food production. Traditionally, improving agricultural productivity to increase food access concentrated on enhancing the productivity of energy-dense foods and not on diverse micro-nutrient-rich food crops (Headey et al., 2012). However, micro-nutrients are essential for the improvement in the nutrition status in households (Bouis and Saltzman, 2017). In a case where food markets are not available to obtain diverse foodstuffs, diets for children are influenced by household food production. Moreover, a complex set of factors affect the food security and nutritional status of an individual or households. Herforth and Harris (2014) highlighted that own food production could improve food security and nutrition if food is stored and processed in a way that preserves the nutrient content.

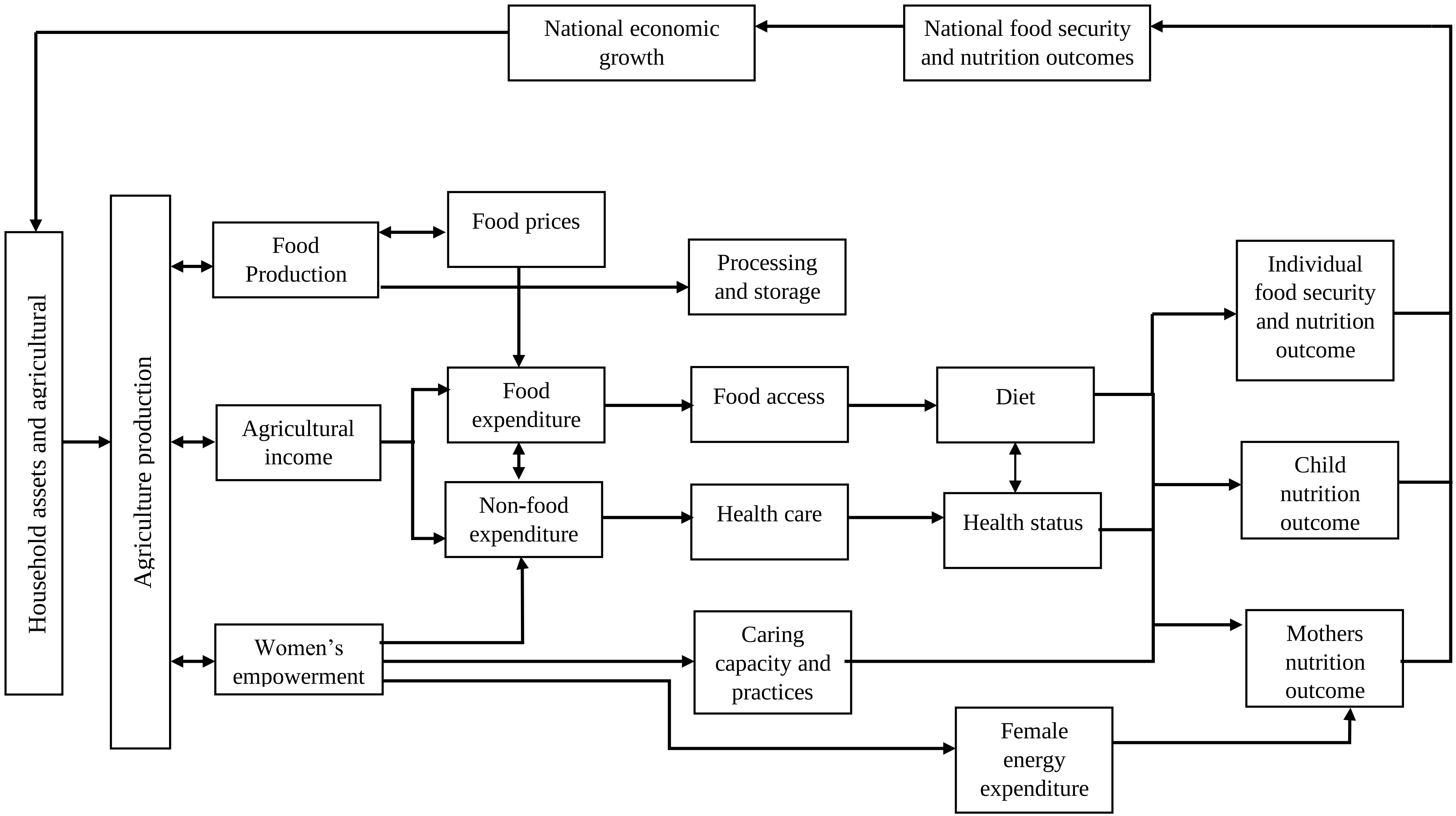

Figure 2-2: Conceptual pathways between agriculture and food security and nutrition

Source: Adapted from Herforth and Harris (2014), Page 3.

Food production affects food prices. Agricultural production and policies affect both demand and supply choices of citizens which in turn influence market prices (Ruel et al., 2013). Increased production reduces the costs of food and *vice versa* (Hawkes and Ruel, 2008), which in turn affects the incomes of sellers and the purchasing power of buyers. For the net buyer, increases in food prices threaten food security and nutrition by lowering access to nutritious foods (Zezza et al., 2009; Hawkes and Ruel, 2008). Healthy diets tend to be expensive (FAO et al., 2020) and an increase in food prices results in substitution of the nutritious foods for energy-dense cheap foods (Darmon and Drewnowski, 2015; Wiggins et al., 2015). The threat may be more pronounced among the poor who tend to spend a large proportion of their income on food (Dávila, 2010; Ruel et al., 2010). However, for the net seller, increased food prices benefit them more as it improves their income and they are able to afford a nutritious diet in their own households (Zezza et al., 2009). The agriculture sector can be leveraged by developing agriculture production policies (for example, setting market prices on agriculture produce, outputs and inputs) that ensure that buyers and sellers benefit from improved agriculture production.

Agriculture also plays a primary role in poverty reduction through the sale of surplus agricultural produce (Bank, 2007; Headey and Masters, 2019; Kadiyala et al., 2014). This income assists households to have their food, and non-food needs met (Hawkes and Ruel, 2008). The money is only useful if households can easily access food markets (Herforth and Harris, 2014) that have diverse nutritious food (Fan et al., 2019a). It is also essential that markets are functional all year round to enable sellers to supply nutritious food to buyers, thereby earning an income. Also, income from agriculture helps households to invest in appropriate health and sanitation practices (for example, the purchase of clean water, the construction of safe toilets, healthcare access) which are crucial in having a good nutrition status (Herforth and Harris, 2014). However, the effect of income from agricultural produce on food security and nutrition is not direct. The use of income from agriculture produced to purchase nutritious food is influenced by several factors. (Herforth and Harris, 2014; Ecker, 2019). These factors include the foods that are convenient to purchase and affordable, available and who decides on what is to be bought in a household (Hawkes and Ruel, 2008; Herforth and Harris, 2014; Kadiyala et al., 2014).

Women empowerment is another pathway that links agriculture and food security and nutrition (Hawkes and Ruel, 2008; Herforth and Harris, 2014; Kadiyala et al., 2014). Women empowerment involves decision-making power related to labour, time, productive assets and income (Herforth and Harris, 2014). Women tend to be the primary caregivers in their households. They also play an essential role in the economy, especially in agriculture (Hazel Malapit, 2019). It is estimated that women's contribution to crop agricultural labour ranges between 60 and 80 per cent in developing countries (FAO, 2011). Yet women often are disadvantaged in terms of productive asset ownership such as land (FAO, 2018a). They generally own less land than men (Doss et al., 2015). Women also lack decision-making power over the use of productive resources, for example, livestock, land, credit and agriculture equipment (Malapit et al., 2014). Increasing the agricultural income that women have power over has the potential of improving food security and nutrition (Herforth and Harris, 2014). When women earn income, they are more probable to use the money on healthcare and food, which can improve the diets and health status of the household members (Hawkes and Ruel, 2008; Herforth and Harris, 2014; Quisumbing et al., 1996).

Women's participation in agriculture also influences the way in which they allocate their time to income-generating and caregiving activities (Ruel et al., 2013). The time spent on agriculture can have both a negative and a positive impact on food security and nutrition in their households (Hazel Malapit, 2019). The positive effects emanate from earning some money through agricultural activities that contribute nutritious foods to the diet (Hawkes and Ruel, 2008; Herforth and Harris, 2014). On the other hand, women's participation in agriculture can mean that they spend more time away from home, having less time to feed and care for the children and themselves (Herforth and Harris, 2014).

Lastly, women's participation in agriculture also influences their health and nutrition. Women's health is affected by the physical setting in which they work as they take part in agricultural activities because they are exposed to infectious human and zoonotic diseases, affecting their health (Hoddinott, 2012; Ruel et al., 2013). Agriculture is also known to be a drudgery-prone occupation which results in stress and poor health (Mehta et al., 2012). Women's participation in agriculture might affect their nutritional needs as they spend more of their energy in the field. The exhaustion from agriculture work also negatively affects a child's nutrition if they are breastfeeding (Ruel et al., 2013; Kadiyala et al., 2014). A lack of good health that might result from women's participation in agriculture might also affect their earnings from the field (Ruel et al., 2013). Considering these negative impacts that result from women's involvement in agriculture, it becomes crucial that investments in agriculture should be gender-sensitive.

2.3 Public investment in agriculture – A global, African and regional comparison

Public investment is paramount in the development of nations through improved productivity and the reduction of poverty and inequalities (Fan et al., 2004; Furceri and Li, 2017). Public investments give room for the provision of public goods and services that the private sector is not able to provide in the country (Mogues et al., 2012). It also improves the distribution of resources that are scarce to ensure equality among the people, especially to help the poor who may otherwise not have the means of obtaining the resources (Fan, 2008; Mogues et al., 2012).

Most developing countries in Africa are agro-based (Goyal and Nash, 2017). A large portion of their income is generated through agriculture. Besides, agriculture is the primary livelihood source of the majority of the rural poor (Fan, 2008). Public investment through the provision of goods such as infrastructure, research and development, irrigation schemes, extension services and roads is vital in developing the agriculture sector (Mogues et al., 2012). Despite the important effect that investment in agriculture has on nations, the industry for a long time has faced underinvestment (Baland and Kotwal, 1998; Staatz and Dembele, 2008; Fan and Breisinger, 2011). However, the sector's role in economic growth and poverty reduction (Staatz and Dembele, 2008) has been acknowledged in Africa through the Maputo Declaration (African Union, 2003) and later reaffirmed through the Malabo Declaration (African Union Commission, 2014). The SDGs have also prioritised investment in agriculture. Under SDG two, investment in agriculture is being monitored through the agriculture orientation index for government expenditure (United Nations, 2016).

Globally, investment in agriculture as a share of the total budget has been below two per cent, with the highest level of 1.85 per cent (Figure 2-3) in 2008 during the world food crisis (FAO, 2019). After Asia, Africa had the second-highest agriculture expenditure level as a share of the total budget. In terms of Africa, most countries are agro-based (Goyal and Nash, 2017) which explains the trend at the continental level. However, the agriculture orientation index shows that most countries in Africa are not spending as much as what agriculture contributes to the economy. Also, Africa has been associated with inefficiencies in resource use (Goyal and Nash, 2017). Most African countries have underinvested in agriculture research and development despite the high returns of such investments (Mogues et al., 2012; Badiane and Collins, 2016).

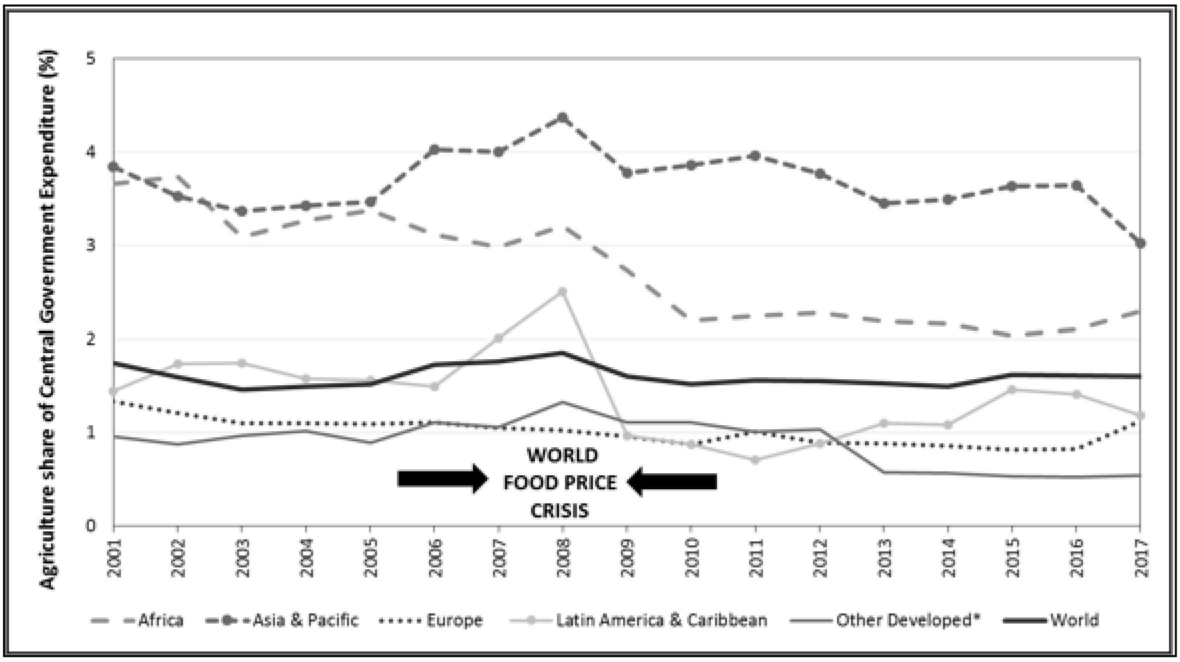

Figure 2-3: Share of central government expenditure on agriculture

Source (FAO, 2019)

There has been a negative trend in government expenditure on agriculture as a percentage of the total budget in Sub-Saharan Africa (Goyal and Nash, 2017). Southern Africa's government expenditure in agriculture as a percentage of the total budget has fluctuated around two per cent. Central Africa has recorded one of the lowest (0.52 per cent in 2002) levels in agriculture expenditure when compared to other regions since 2001. However, the spending on agriculture has fluctuated between 0.52 per cent and 2.69 per cent between 2001 and 2017. There has been a sharp decrease (From 9.87 per cent in 2001 to 1.38 per cent in 2017) in the expenditure on agriculture in Northern Africa. African heads of state committed to increasing spending on agriculture (African Union, 2003; African Union Commission, 2014). However, none of the African regions surpassed the ten per cent level of expenditure on agriculture as a percentage of the total budget since 2003 (Figure 2-4).

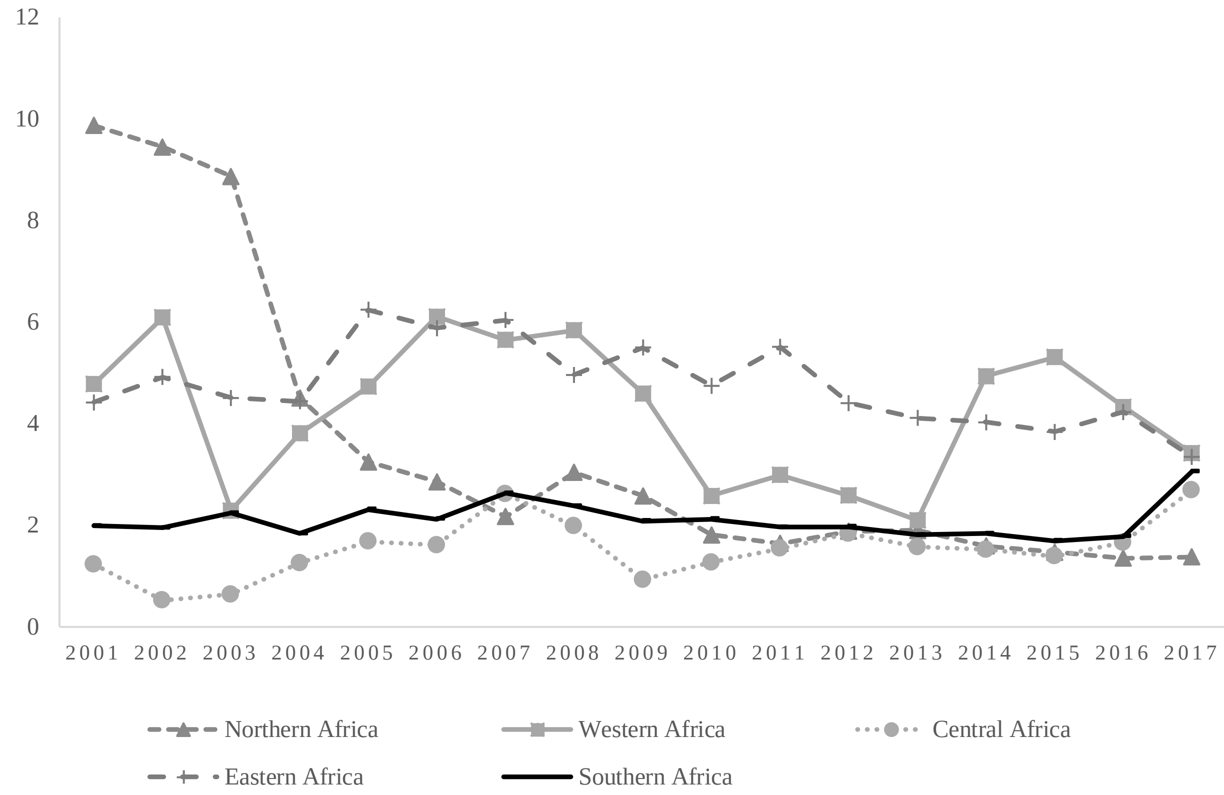

Figure 2-4: Share of central government expenditure on agriculture in Africa

Author's compilation using data from FAO (2019)

2.4 Approaches used in evaluating impact government of expenditure

In evaluating the impact of expenditure on development outcomes, there is no single method that has been used in empirical studies (Table 2-3). The literature review focused on fixed effects, simultaneous equation and Computable General Equilibrium (CGE) models. These methods are described in this section. The gives a brief overview of the background of these techniques and the impact of expenditure studies that used these models.

2.4.1 Fixed-effects models

The fixed-effect model is one method used to determine the way in which government expenditure affects various development outcome indicators. The technique is part of the panel data analysis methods (Asteriou and Hall, 2015; Wooldridge, 2015; Baltagi, 2008). The approach has been used as a control for unobserved effects that are specific to countries which do not vary over time (Asteriou and Hall, 2015). In a case where a panel of countries exists, the fixed-effects model takes account of elements such as geographic factors and natural endowments that vary between countries but do not change over time. The method also becomes essential in expenditure impact analysis for cross-country studies where long-time series data is not available for an extended period (Benin et al., 2008a; Wooldridge, 2015).

Public expenditure impact studies have also investigated how spending contributes to economic growth (Gisore et al., 2014). Gisore et al. (2014) used a fixed-effects model to examine the contribution of different government expenditures on economic growth in East Africa. They discovered that spending on health and defence had a positive and significant impact on economic growth in East Africa. On the contrary, it was established that expenditures on education and agriculture were not significant in contributing to economic growth in the East African region. A different study from Gisore et al. (2014), carried out by Benin (2015) investigated the returns of public spending in Sub-Saharan Africa. Benin (2015) employed the fixed effects model approach with the inclusion of an instrumental variable and various model specifications. The study used total expenditure and expenditure on research and development. It was established that there was a higher return from spending on research and development compared to the aggregate agricultural spending. The results showed that there was a need for further research on the effects of different components of expenditure on economic growth.

2.4.2 Simultaneous equation model

The simultaneous equation model contains a system of equations that are estimated together. Each of the equations in the system has a *ceteris paribus* interpretation (Wooldridge, 2015). The model has been developed to deal with the simultaneity problem. Simultaneity occurs when the explanatory variable are determined jointly with the dependent variable (Asteriou and Hall, 2015). The model can be used with time-series or panel data analysis. Using panel data is ideal as the estimation controls unobserved country effects while correcting for the simultaneity problem (Wooldridge, 2015).

The study by Fan et al. (2000) of the effect of public expenditure on productivity growth and poverty reduction in India used a 19-system simultaneous equation model. The study found that improved rural roads, irrigation, education and agricultural research and development explained productivity growth (Fan et al., 2000). Public expenditure was significantly and positively correlated with productivity growth. Rural roads and research and development had the highest impact on productivity growth and rural poverty reduction when taking the marginal effects of the government spending options into account. Spending on roads had the highest impact on poverty reduction, while research and development had the highest impact on productivity growth. However, a similar study by Fan et al. (2002) of the impact of public expenditure on growth, poverty and inequality in China revealed that education had the most significant impact on poverty reduction. Also, Fan and Zhang (2008)'s study in Uganda found that research and development had the most significant impact on poverty reduction. Recently, Benin and Odjo (2018) also used a simultaneous equation model in Kenya to analyse the effect of government expenditure on agricultural growth. They found that spending on health had the highest impact on agricultural growth, followed by spending on agriculture.

2.4.3 Computable General Equilibrium (CGE) Models

General equilibrium models have been used in literature to highlight the impact of various policies on different sectors of the economy (Lofgren et al., 2002; Perali and Scandizzo, 2018). These models use a system of equations to create a description of economy-wide interactions among various sectors of the economy (Lofgren et al., 2002). The equations that are used are derived from economic theory and are solved simultaneously to reach to an economy-wide equilibrium. An economic shock is introduced into the model to find the impact of a policy on the economy using the CGE model. The CGE models are forward-looking (*ex-ante*) and simulate the effect of a policy plan on the economy, given several scenarios (Benin et al., 2008a).

Jung and Thorbecke (2003) carried out a study using a CGE model to evaluate the impact of public expenditure on education on poverty alleviation, growth and human capital. In the study, their base scenario was no increase in public spending on education, having a constant expenditure on education. They then imposed a 15 per cent increase in public spending on education on three scenarios and compared it to the base scenario. Jung and Thorbecke (2003) found that public expenditure on education contributed to GDP growth and poverty alleviation. A well-targeted approach was needed for poverty alleviation.

A similar model was used in a study by Beyene and Engida (2016). Their study focused on analysing the impact of public investment in training and irrigation on agricultural-led growth, food security and poverty. In terms of food security, only the food availability dimension was considered, measured using a food availability index created using, the food price index, total labour force and total food crop production. The limitation of this study was that it only included one component of food security. The study found that expenditure on farmer training together with irrigation had the highest potential to improve economic growth.

A CGE model was also used by Benin et al. (2008b) to assess whether Uganda's economy will be able to reach its goal of agriculture growth to assess the possibility of Uganda achieving its CAADP target of sustaining an annual agricultural growth of six per cent by 2015. The study established that Uganda would not reach its target unless it increased investment in the agriculture sector and also improved the efficiency in public spending.

Table 2-3 provides a summary of the various approaches used in evaluating impact government of expenditure discussed in this section. Although there are many ways in which to analyse the impact of government expenditure, the choice of model depends on the availability of data and focus of the study. The study can be forward-looking or backward-looking. In a case where the study seeks to investigate the future impacts of expenditure in the entire economy or sector, the CGE model is a good choice.

Table 2-1: Summary of studies in public investment impact analysis

Author	Country	Model type	Impact focus	Investment/expenditure variables
(Fan et al., 2000)	India	Simultaneous equation	Impact on productivity growth and poverty	Irrigation, research and development, rural roads, rural education, soil and water conservation, health and rural community development
(Fan et al., 2002)	China	Simultaneous equation	Effect on production, poverty, and inequality	Irrigation, rural roads, rural education, rural telecommunication and Rural power
(Fan et al., 2008)	India	Simultaneous equation model	Agricultural growth, poverty reduction	Agricultural research, rural infrastructure, education, irrigation and subsidies
(Fan and Zhang, 2008)	Rural Uganda	Simultaneous equation	Economic growth and poverty reduction	Agricultural research and development, education, feeder roads, murram roads, and tarmac roads
(Benin, 2015)	Sub-Saharan Africa	Fixed effects model	Agricultural Productivity	Total expenditure and expenditure on agricultural research
(Gisore et al., 2014)	East Africa	Fixed effects model	Economic growth	Health, defence, agriculture and education
(Benin and Odjo, 2018)	Kenya	Simultaneous equation	Agricultural growth	Total government expenditure,

Author	Country	Model type	Impact focus	Investment/expenditure variables
				disaggregated government expenditure functions, i.e. administration, defence, law and order, education, health, agriculture, transport, and communication
(Jung and Thorbecke, 2003)	Tanzania and Zambia	Computable general equilibrium model	Human capital, growth and poverty	Education expenditure
(Benin et al., 2008b)	Uganda	Dynamic computable general equilibrium model	Poverty reduction	General agricultural expenditure
(Beyene and Engida, 2016)	Ethiopia	Computable general equilibrium model linked to a micro-simulation model	Growth and poverty reduction	Irrigation and training

Source: Author's compilation

2.5 Determinants of food security and nutrition at national level

The relationship between food security, nutrition and trade are multifaceted, and as such, the policy direction is not always straightforward. Trade has been viewed as an opportunity and a threat to food security and nutrition in the world (Clapp, 2015). Since the food price crisis of 2007/2008, food security and nutrition have gained prominence in trade policy discussions. The proponents of trade as a positive driver of food security refer to the comparative advantage, moving food from surplus areas to deficit areas and the impact of trade restrictions on food security (Zorya et al., 2014; World Bank and IMF, 2012; Bank, 2007). A comparative advantage ensures that benefits from trade increase food supply and raise household incomes, leading to improved food access and availability (Clapp, 2015).

On the contrary, proponents of trade being a threat to food security refer to the need for governments to prioritise national-level food supply first, before the trade (Clapp, 2015). The prioritisation of national-level supply before trading is proposed because trade liberalisation is considered as presenting risks to both the producer and consumer (Wittman et al., 2011; Moon, 2010; Maertens et al., 2012). For example, on the producer side, trade liberalisation may disadvantage small-scale farmers by the entry of transnational corporations and financial investors that may profit at the expense of the farmers (Clapp, 2015). Empirical studies have also shown that trade affects food security differently. Dithmer and Abdulai (2017), Nisa et al. (2017) and Anderson (2016) have shown that trade had a positive effect on food security outcomes. However, studies by Mary (2018) and Mary (2019) showed that trade negatively affected food security and nutrition outcomes in developing countries.

Sen (1981) has argued that income-earning and purchasing power are essential when it comes to food security. An increase in per capita GDP may lead to an increase in the national income. The increased national income is vital for governments to be able to improve the living standards of the citizens in countries (McGovern et al., 2017). Higher individual incomes also allow the consumption of more diversified nutritious diets, thereby improving food security and nutrition (Belloumi, 2014a; Mihalache-O'Keef and Li, 2011). However, increased incomes only contribute to food security and nutrition when money is used to purchase goods and services that promote good nutrition. Studies by Kaur and Kaur (2016), Fusco et al. (2020) and Smith and Haddad (2015) concur with the argument that per capita GDP has a positive influence on food security and nutrition outcome. In addition, Yaya et al. (2020) analysed the impact of economic growth on child stunting and found that an increase in income was strongly associated with improvements in the nutrition of children from rich countries compared to the poor in Sub-Saharan Africa.

The governance style (democracy or autocracy) of a country also influences food security and nutrition (Sen, 2001). Democratic governments may respond to food security concerns through redistributive policies (Sen, 2001; Mihalache-O'Keef and Li, 2011), improving food security. However, Slimane et al. (2016) have shown that polity2 does not significantly influence food security and nutrition, concurring with the results of Hitzhusen and Jeanty (2006).

Agricultural production has been known to affect food security and nutrition via the food availability dimension (Herforth and Harris, 2014; Hawkes and Ruel, 2008). Agriculture is a crucial determinant of food availability (Swaminathan and Bhavani, 2013). Agriculture can also be a source of income from selling and employment, leading to revenue flows that allow households to diversify diets by purchasing diversified nutritious food on the market (Hawkes and Ruel, 2008). Empirical studies have also shown that agriculture can positively influence food security outcomes. Slimane et al. (2016) concluded that agriculture production had a positive and significant influence on food security and nutrition outcomes.

Population growth accounts for increased demand for food (Fróna et al., 2019). As population growth increases, it puts pressure on agricultural resources such as land, which reduces agricultural productivity and food production as there is competition for land for agriculture, housing and other activities (Malthus, 1992). In cases where technological advances are not keeping pace with population growth, as is the case in most African countries, a higher population growth negatively impacts food security (Slimane et al., 2016). Scholarly literature (Rena, 2005; Hitzhusen and Jeanty, 2006; Feleke et al., 2005) concurs with the notion that population growth has adverse impacts on food security and nutrition outcomes.

Inflation is the rise in the general levels of prices (McConnell et al., 2018). The increasing cost of food and non-food commodities poses a threat to food security and nutrition. Inflation reduces the purchasing power of money (McConnell et al., 2018) and, as such, it affects economic access to food. In most cases, increasing food prices makes it difficult for the poor to achieve their food needs (Sanogo, 2009; Belloumi, 2014b). Studies by Arndt et al. (2016)

and Kaur and Kaur (2016) showed that rising food prices negatively affected food security and nutrition.

Food security and nutrition have been seen as a driver of economic and human development in the world. Given this, countries have prioritised food security and nutrition. Some research has been carried out that reveals that developing the agricultural sector has the ability to improve food security and nutrition in countries. Through such insights, countries in Africa have developed a strategy to develop the sector by increasing expenditure on agriculture by ten per cent. This study seeks to examine whether increased spending on agriculture brings about positive changes in food security and nutrition outcomes.

CHAPTER 3 : EVALUATING THE TRENDS IN PUBLIC AGRICULTURE EXPENDITURE AND FOOD SECURITY IN SADC FOR THE YEARS 2000-2016

3.1 Introduction

Countries in SADC have committed to the CAADP, a sectoral blueprint for improving the agriculture in Africa. Through the CAADP processes, the governments have committed to increasing agriculture expenditure by ten per cent (African Union Commission, 2014). Also, the countries committed to sustaining a minimum growth of six per cent in agriculture gross domestic product. The agricultural led-growth is aimed at ending hunger and malnutrition by 2025 (African Union Commission, 2014). This chapter evaluates the progress that has been made between 2000 and 2016 in fulfilling these commitments. The study focused on nine SADC countries. These countries include Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mozambique, South Africa and Zambia. The study initially planned to include 16 SADC countries. However, data was only available for nine countries.

3.2 Data sources and methods

The study used secondary data to evaluate the trends in public agriculture expenditure, food security and nutrition in the nine SADC countries. The study used data from the World Bank (2016), the Food and Agricultural Organisation (2019), and the Regional Strategic Analysis Knowledge Support System (2018).

Table 3-1 shows the data availability of the government and food security indicators in the SADC countries. A database was created, which included data from the years 2000 to 2016 to assess the changes in public agriculture expenditure, food security and nutrition from the MDG and SDG era in the SADC countries. The database included countries that had data for all the variables of focus under study. Countries were excluded from the analysis of sub-objective two if data was not available for all the data points from 2000 to 2016. Microsoft Excel 365 was used to analyse the data.

Table 3-1: Data availability in SADC countries for government expenditure, food security and nutrition indicators from the year 2000 to 2016

	The share public agriculture expenditure in total agriculture expenditure	**The monetary value of public agriculture expenditure**	**Average dietary energy supply adequacy**	**Per capita food production variability**	**The prevalence of undernourishment**	**The prevalence of stunting**	**The prevalence of underweight**	**The prevalence of obesity**
Data Source	(Regional Strategic Analysis Knowledge Support System, 2018)	Regional Strategic Analysis Knowledge Support System, 2018)	Food and Agricultural Organisation (2019)	Food and Agricultural Organisation (2019)	The World Bank (2016)	Regional Strategic Analysis Knowledge Support System (2018)	Regional Strategic Analysis Knowledge Support System (2018)	Food and Agricultural Organisation (2019)
Angola	1	1	1	1	1	1	1	1
Botswana	1	1	1	1	1	1	1	1
Comoros	0	0	1	1	0	1	1	1

Democratic Republic of Congo	1	1	0	1	0	1	1	1
Eswatini	1	1	1	1	1	1	1	1
Lesotho	1	1	1	1	1	1	1	1
Madagascar	1	1	1	1	1	1	1	1
Malawi	1	1	1	1	1	1	1	1
Mauritius	1	1	1	1	1	0	0	1
Mozambique	1	1	1	1	1	1	1	1
Namibia	1	1	0	0	1	1	1	1
Seychelles	1	1	1	1	0	0	0	1
South Africa	1	1	1	1	1	1	1	1
Tanzania	0	0	1	1	1	0	0	1
Zambia	1	1	1	1	1	1	1	1
Zimbabwe	0	0	1	1	1	1	1	1

Note: 1 indicates continuous data available for an indicator in the country from 2000 to 2016, 0 indicates otherwise. The countries marked with a grey shading were excluded from the study due to data unavailability in some years.

The percentage of public agriculture expenditure in total agriculture expenditure and the monetary value of this was used to evaluate trends in spending against the Maputo Declaration commitments (African Union, 2003). The average dietary energy supply adequacy, per capita food production variability, the prevalence of undernourishment, the prevalence of stunting, prevalence of underweight, prevalence of obesity and prevalence of wasting were used to evaluate food security and nutrition.

3.3 Trends in public agricultural expenditure in SADC, 2000-2016

The trend in government agriculture as a percentage of total expenditure varied across the nine SADC countries from 2000 to 2016, as shown in Figure 3-1. On average, the nine SADC countries spent 5.3 per cent of their total expenditure on the agriculture sector. Madagascar, Malawi, Mozambique and Zambia have made good progress towards the attainment of the ten per cent minimum expenditure in agriculture since 2006. These countries reached the CAADP target of ten per cent of total spending on agriculture in any one year (African Union Commission and NEPAD, 2017). However, Mozambique, Madagascar and Zambia have not consistently achieved this allocation since 2006. Malawi expenditure on agriculture as a share of total public spending has been above ten percent since 2007. Regardless, a large proportion of Malawi's budget was externally funded by development partners (Page, 2019; Donnelly, 2011).

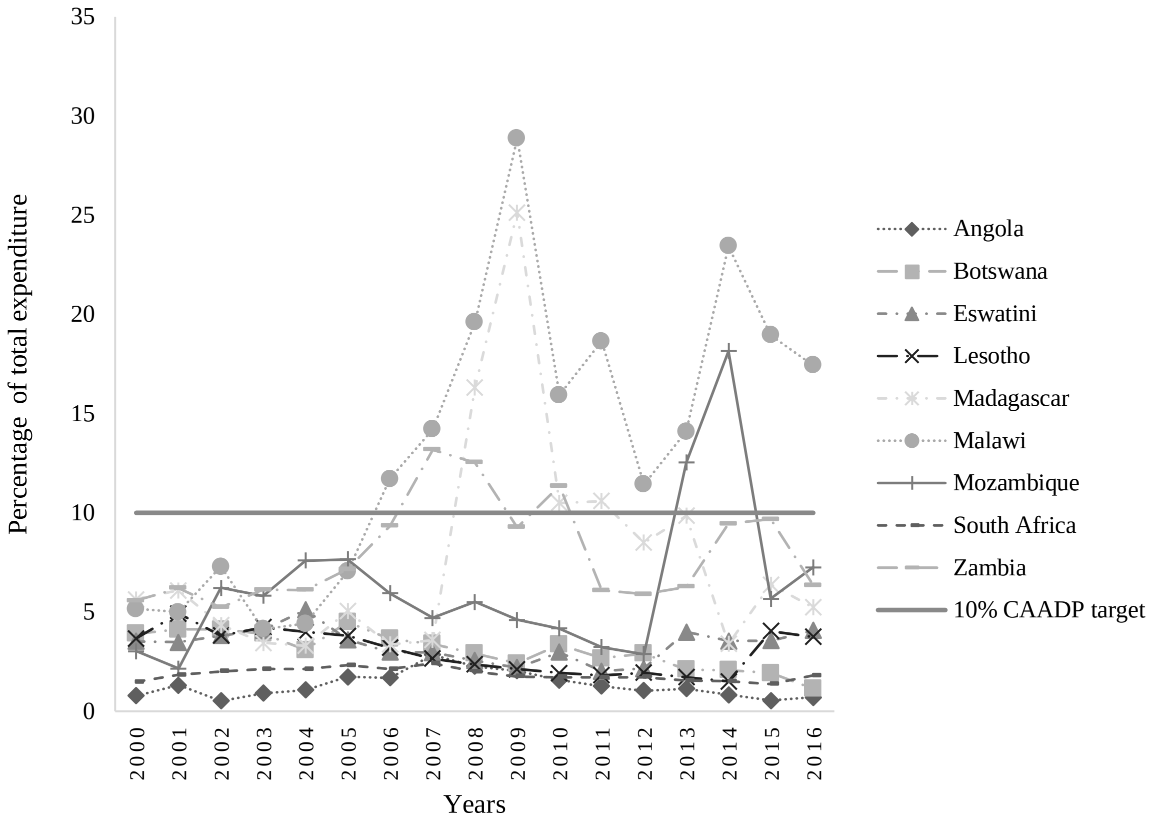

Figure 3-1: Public agricultural expenditure as a percentage of total public expenditure

Source: Authors own compilation using data from Regional Strategic Analysis Knowledge Support System (2018).

The share of total expenditure on agriculture has been low in Angola, Botswana, Eswatini, Lesotho and South Africa, with none of these countries reaching five per cent in any one year. The differences in the expenditure levels might have been because some countries started the CAADP processes earlier than others (Benin, 2016). For countries such as Botswana and South Africa, the share of agriculture expenditure would be expected to be relatively low as the countries are more developed and primary agriculture GDP contributes less to the overall economy (Goyal and Nash, 2017). In as much as the percentage of agricultural expenditure in the total public expenditure has been low in South Africa, this expenditure has been above US $100 billion per annum since 2001 (Figure 3-2). On the contrary, Malawi's share of government agriculture expenditure in relation to the total government expenditure was high. Yet, the country was spending less than US $50 billion per year from 2000 to 2016.

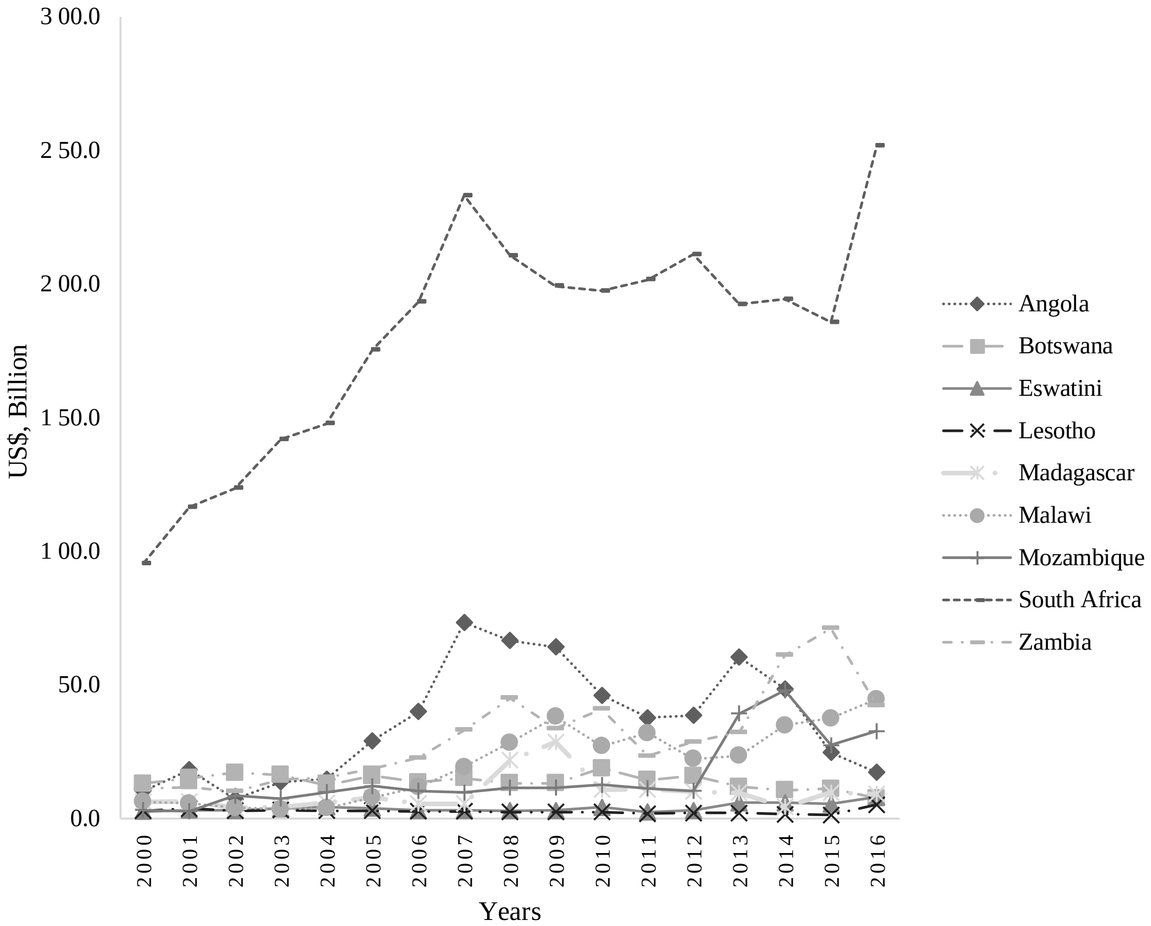

Figure 3-2: Size of public agriculture expenditure (constant 2010 United States of America dollars, billion)

Source: Author's own compilation using data from Regional Strategic Analysis Knowledge Support System (2018)

The size (dollar value) of public agriculture expenditure in Lesotho, Madagascar, and Botswana stagnated over time, as illustrated in Figure 3-2. The stagnation could have been a result of these countries reaching an equilibrium where the return of more spending on agriculture and non-agriculture levelled off (Benin and Yu, 2012).

3.4 Trends in food security and nutrition in SADC from 2000-2016

The study evaluated food security and nutrition trends in SADC from 2000 to 2016. Indicators that were part of the CAADP Biennial Review of the Malabo Declaration were assessed against its targets. These indicators included average dietary energy supply adequacy, per capita food production variability, the prevalence of undernourishment, stunting, underweight, wasting and obesity.

3.4.1 Trends in average dietary energy supply adequacy in SADC

The average dietary energy supply adequacy provided information on the adequacy of food energy supply in a country (Reddy, 2016). It also helps to understand whether undernourishment was due to an inadequate food supply or unequal food distribution (Reddy, 2016). If the average dietary energy supply adequacy was less than 100 per cent, the food supply was not adequate to meet the population's calorie requirement (Reddy, 2016). In the SADC region, some countries have been able to meet the calorie supply requirement between 2000 and 2016. The average dietary energy supply adequacy was 102.4 per cent. Eswatini, Lesotho, Malawi and South African were able to meet and exceed their population's calorie requirements in this period (Figure 3-3). The ability to meet the population's calorie requirement would have been a result of an increase in the dietary energy supplies in the countries which surpasses the average dietary requirements (FAO et al., 2013). Increase in energy supply was likely due to a rise in domestic production or importation of food in the countries.

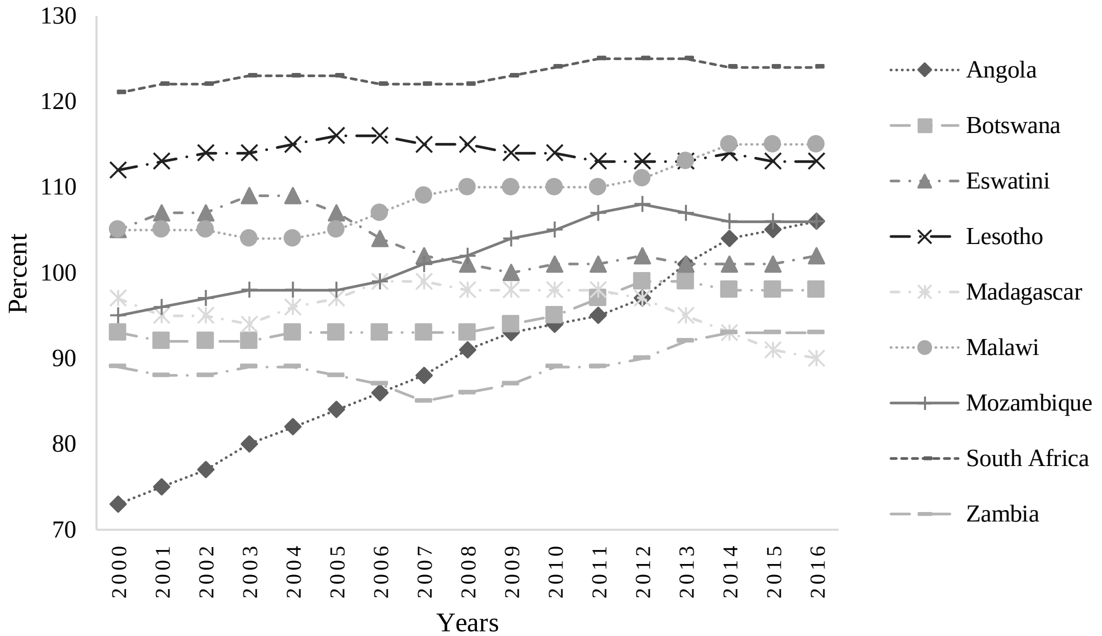

Figure 3-3: Average Dietary Energy Supply Adequacy (ADESA)

Source: Authors own compilation using data from the Food and Agricultural Organisation (2019).

Figure 3-3 also shows that Botswana, Madagascar and Zambia were not able to meet the required threshold in the period under study. These results depict that the countries were not able to increase their dietary energy supply to surpass the average dietary requirement due to inadequate production or imports. Despite some countries (Eswatini, Lesotho, Malawi and

South Africa) reporting adequate food supplies at the national level, not everyone was food secure over the years as the subsequent sections will reveal.

3.4.2 Trends in per capita food production variability in SADC

Per capita food production variability expresses the changes in the net food production value in constant 2000-2004 international dollars (Alexandri, 2015). The indicator measures the deviation of food production from the trend, and it also compares variations in food production across countries over time. This indicator is among the FAO shock indicators and depicts the vulnerability of countries to food supply shocks (FAO et al., 2013).

Per capita food production varied across the nine countries from 2000 to 2016. Botswana, Malawi, Mozambique and Eswatini experienced a high variability in food production (Figure 3-4), possibly due to their dependence on rain-fed agriculture and the effects of climate shocks (FAO and ECA, 2018). It is important to note that Malawi experienced a sharp decrease in the per capita food production variability in 2007. The sharp decline would have been as a result of the newly-implemented farm input subsidy programme (Asfaw et al., 2017; Dorward and Chirwa, 2011) which coincided with adequate rainfall and a few dry days during the 2006/2007 growing season (Kamanga et al., 2015; Sanchez et al., 2009)

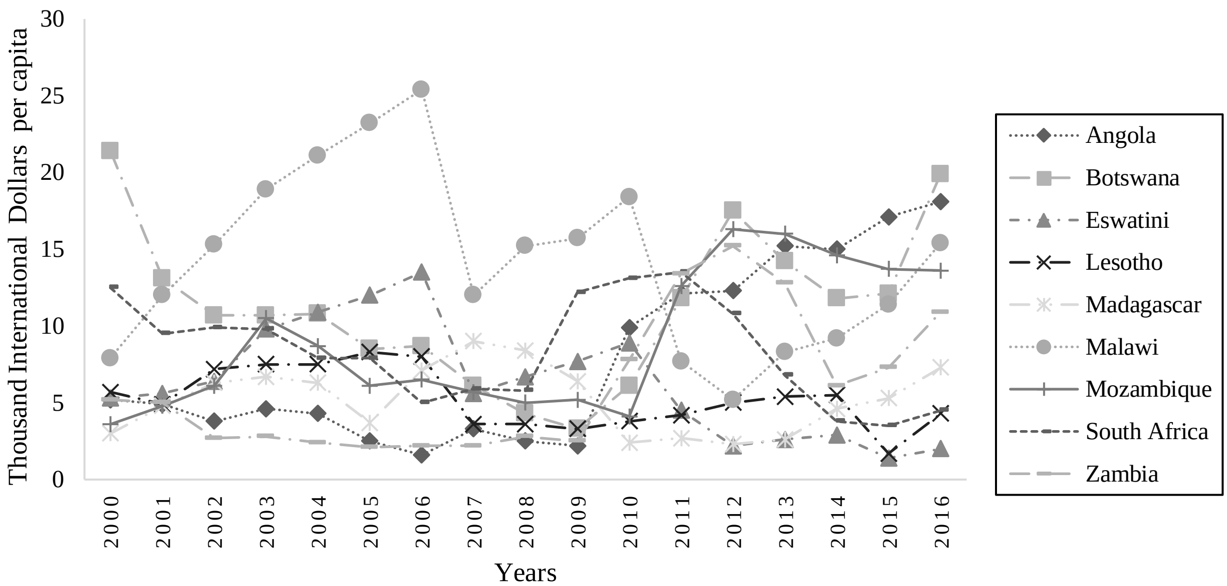

Figure 3-4: Per capita food production variability.

Source: Author's own compilation using data from the Food and Agricultural Organisation (2019)

3.4.3 Trends in the prevalence of undernourishment in SADC

The prevalence of undernourishment is an indicator of chronic hunger (Cafiero and Gennari, 2011). It measured the percentage of the population whose daily food consumption is not sufficient to provide the dietary energy levels to sustain an active life (Jones et al., 2013; Wanner et al., 2014). The indicator is used to monitor changes in hunger over time and across countries, expressed as a percentage of the population (Cafiero and Gennari, 2011).

In some SADC countries, the prevalence of undernourishment has varied over the years from 2000 to 2016. Angola had a sharp decrease in the level of undernourishment from 71.5 per cent in 2000 to 23.9 per cent in 2016. The changes in Angola are likely due to an increase in post-war agricultural production and an increase in food imports (FAO, 2012). Apart from increased agricultural production, Angola's government institutions and programmes aimed at ending hunger contributed to the reduction in undernourishment (Malabo-Montpellier Panel, 2017). Mozambique, Botswana and Malawi have experienced a decline in the prevalence of undernourishment since the year 2000, as shown in Figure 3-5. However, the prevalence of undernourishment slowly increased from 2011, 2014 and 2013 in Mozambique, Botswana and Malawi, respectively. The increase in undernourishment in several African countries has been attributed to increasing populations, poverty and low agricultural production in the countries (Benson, 2004; FAO et al., 2019a; Luan et al., 2013; Tiwari and Zaman, 2010).

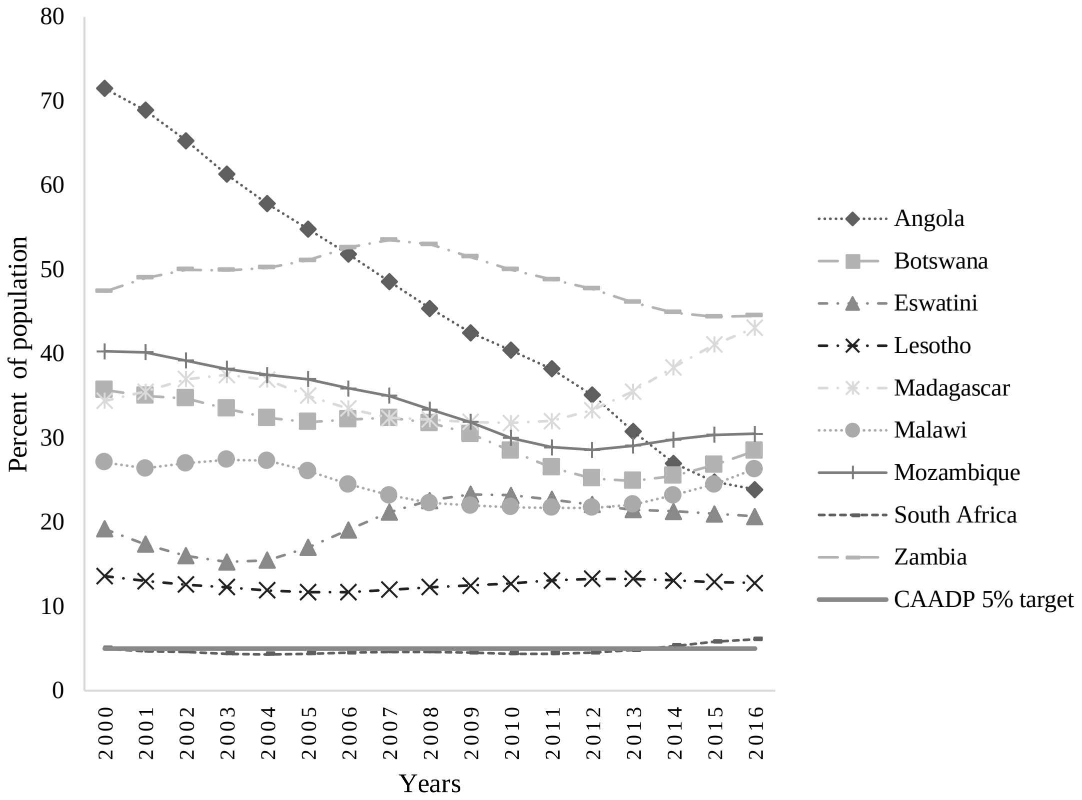

Figure 3-5: The prevalence of undernourishment

Source: Author's own compilation using data from The World Bank (2016).

In most cases, the poor do not have access to adequate and nutritious diets as they lack money to buy food on the market, or land and agricultural input to grow their food (Gonzalez, 2014). Also, the increased population growth in the country contributes to the rising food demand. In a case where the population increases more than the country's ability to produce food, undernourishment increases (Luan et al., 2013). Low agricultural production affects food availability for the farmer and the population that obtain food from the farmers through markets. Low production also results in reduced income for the farmers and high prices for those that purchase food, as undernourishment is likely to increase (Benson, 2004). The levels of undernourishment have been aggravated by a high incidence of droughts and floods in some countries in Southern Africa (FAO et al., 2018; SADC, 2019; CRED, 2019).

The CAADP goal is to lower the prevalence of undernourishment in Africa to less than five per cent by the year 2025 (African Union Commission and NEPAD, 2017). Most of the nine SADC countries are far from achieving the target (Figure 3-5). South Africa was able to maintain a prevalence of undernourishment of around five per cent since 2000 to 2016. The prevalence of undernourishment has decreased in Mozambique (40.3 per cent in 2000 to 30.5 per cent in 2016); Botswana (35.7 per cent in 2000 to 28.5 per cent in 2016) and Zambia (47.4 per cent in 2000 to 44.5 per cent in 2016). However, the levels were still far from the five per cent target in 2016. These results are a clear indication that some countries are on the right track in reducing the prevalence of undernourishment, but much more work needs to be done to meet the five per cent target by the year 2025. In Madagascar, on the contrary, there was an increase in undernourishment from 34.4 per cent in 2000 to 43.1 per cent in 2016.

3.4.4 The trend in the prevalence of stunting in SADC

Stunting is a chronic form of undernutrition. Stunting shows the cumulative effects of undernutrition and infections that might have occurred in the first years of a child's life (World Health Organisation, 2010). The prevalence of stunting indicator has also been recognised as part of child growth indicators that highlight the nutrition status and health of the population (Bogale et al., 2018). The prevalence of stunting measures the proportion of children aged five and below who are short for their age, as defined by height for age Z score < -2 (World Health Organisation, 2010).

In the SADC region, the prevalence of stunting reduced in Malawi, Eswatini, Madagascar, Mozambique, and Zambia from the turn of the century. The decrease in stunting might have been the result of an increased focus on nutrition in a several development agenda such as the SDGs and Agenda 2063 (African Union Commission, 2015; United Nations, 2016). SADC also has a food security and nutrition strategy that has been specially developed to ensure that there is reduced food insecurity and malnutrition in the area. However, in most of the nine countries, the stunting levels were between 25 per cent and 55 per cent (Figure 3.6). Under these circumstances, the likelihood of these countries reaching the Malabo Declaration goal of reaching ten per cent by the year 2025 (African Union Commission and NEPAD, 2017) seems unlikely (SADC, 2019). Madagascar was able to reduce stunting from 55 per cent in 2000 to 46 per cent in 2016 (Figure 3-6). Madagascar has been tackling the malnutrition problem through public and private sector initiatives aimed at improving nutrition. For example, there has been a private sector organisation in Madagascar known as JB, which ensures that poor people receive value-added nutritional products through developing their value chains (Chéret and Desjonquères, 2014).

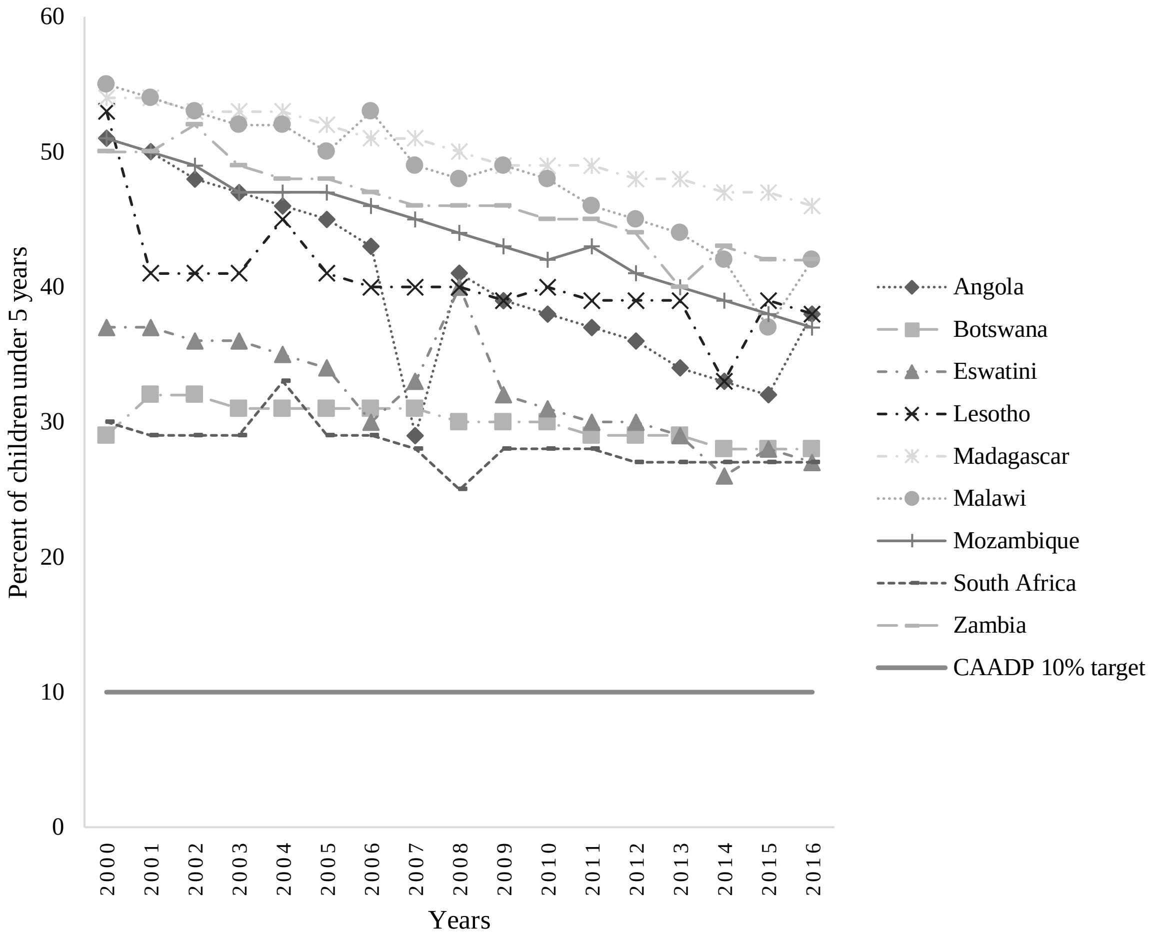

Figure 3-6: The prevalence of stunting

Source: Author's own compilation using data from Regional Strategic Analysis Knowledge Support System (2018).

These levels of stunting are alarming, considering the impact stunting has on the future development of individuals and a country (African Union Commission et al., 2014). Botswana and South Africa had low levels of stunting from 2000 to 2016 compared to the other countries, but over the years there were minimal changes. South Africa's prevalence of stunting was 30 per cent in 2000, going down to 27 per cent in 2016, while that in Botswana was 29 per cent in 2000 and 28 per cent in 2016 (Figure 3-6). In South Africa and Botswana, the prevalence of stunting has been associated with low levels of maternal education, inadequate household income and unemployment (Sanders and Reynolds, 2017; Nnyepi et al., 2006). Overall, the progress in reducing the prevalence of stunting is visible, but the pace is too slow to attain the Malabo Declaration targets by the year 2025.

3.4.5 Trends in the prevalence of underweight in SADC

The prevalence of underweight is a measure of acute or chronic undernutrition. It measures the percentage of children from birth to 59 months, whose mass was less than two standard deviations below the World Health Organisation child growth standards (World Health Organisation, 2010).

In most of the nine SADC countries, the prevalence of underweight reduced between 2000 and 2016, except for Madagascar (Figure 3-7). Madagascar had the highest prevalence of underweight (36 per cent in 2000 and 37 per cent in 2016), which was almost constant over the years. The situation has been primarily attributed to a lack of micro-nutrients, food insecurity, poor sanitation and poverty in the country (UNICEF, 2017). The prevalence of underweight in Eswatini dropped from nine per cent in 2000 to five per cent in 2016. The change has been associated with the use of nutrition-specific and sensitive interventions by different stakeholders in the country (SADC et al., 2018).

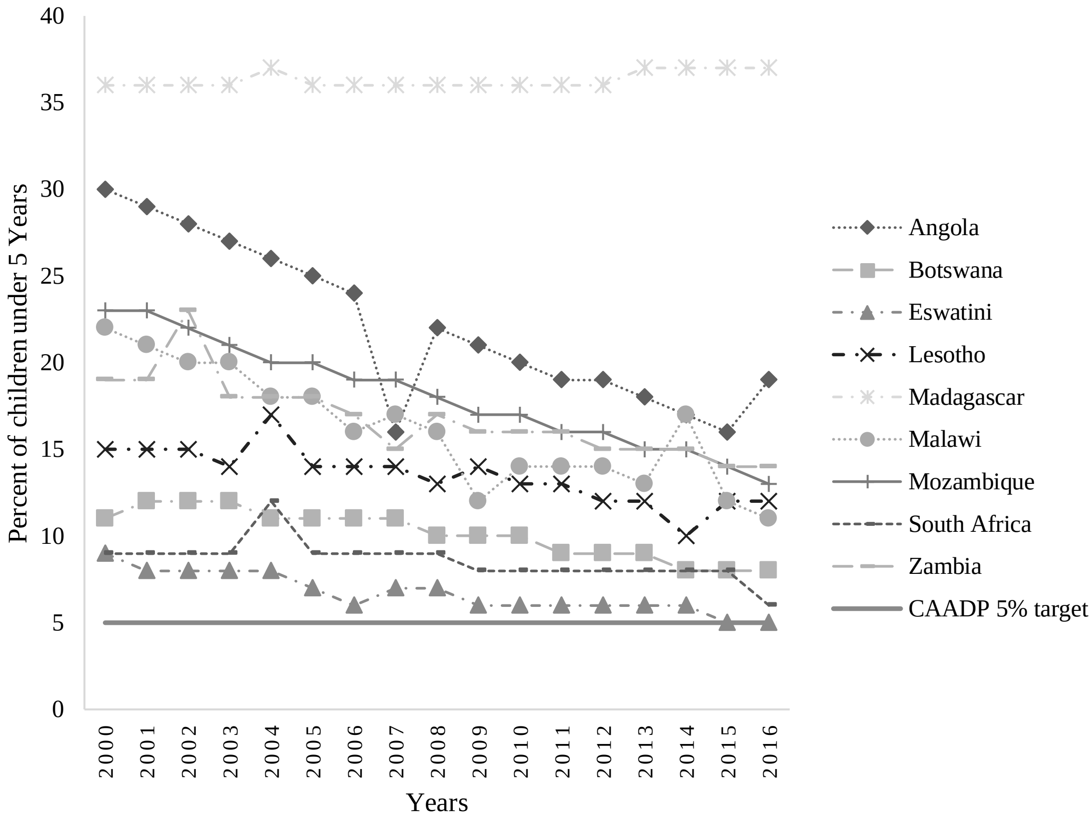

Figure 3-7: The prevalence of underweight

Source: Author's own compilation using data from Regional Strategic Analysis Knowledge Support System (2018).

In line with the Malabo Declaration target for underweight, Angola, Lesotho, Madagascar, Mozambique, Malawi and Zambia were far from reaching the five per cent target set for 2025 under CAADP (African Union Commission and NEPAD, 2017). The prevalence of underweight in these countries was above 10 per cent by the year 2016 (Figure 3-7). It is evident from these results that more needs to be done to achieve the Malabo Declaration target. All in all, countries, strategies and plans are to speed up and scale up actions to achieve the target by 2025.

3.4.6 Trends in the prevalence of wasting in SADC

The prevalence of wasting is the proportion of children under the age of five, whose mass for height is below two standard deviations of the World Health Organisation child growth standard (World Health Organisation, 2010). The indicator monitors children's nutritional status and relates to illness as well as the loss of body mass or the failure to gain weight in children under the age of five years (Bloss et al., 2004; World Health Organisation, 2010). Wasting disrupts the proper functioning of the immune system and can cause increased vulnerability to infectious diseases and the risk of death (World Health Organisation, 2010).

Angola, Botswana, Eswatini, Lesotho, Malawi, Mozambique and South Africa experienced a decrease in the prevalence of wasting between 2000 and 2016 (figure 3-8). The trend likely was as a result of an increased focus on nutrition in the national and regional development agenda where food security and nutrition have been prioritised as shown through the SADC Regional Indicative Strategic Development Plan and Food and Nutrition Security Strategy 2015-2025 (SADC, 2003; SADC, 2014). Lesotho’s progress was remarkable, reducing the prevalence of wasting from seven per cent in 2000 to one per cent in the year 2016. The reduction in child undernutrition has been associated with improvements in economic growth and the health sector in the country (FAO et al., 2019b). However, in the same period, Madagascar experienced an increase in the prevalence of wasting. In the year 2000, the country had a prevalence of wasting of 13 per cent, which increased to 19 per cent in 2016. The situation may have worsened due to economic and environmental instability and a lack of knowledge of sound nutritional practices in the country (Asgary et al., 2015).

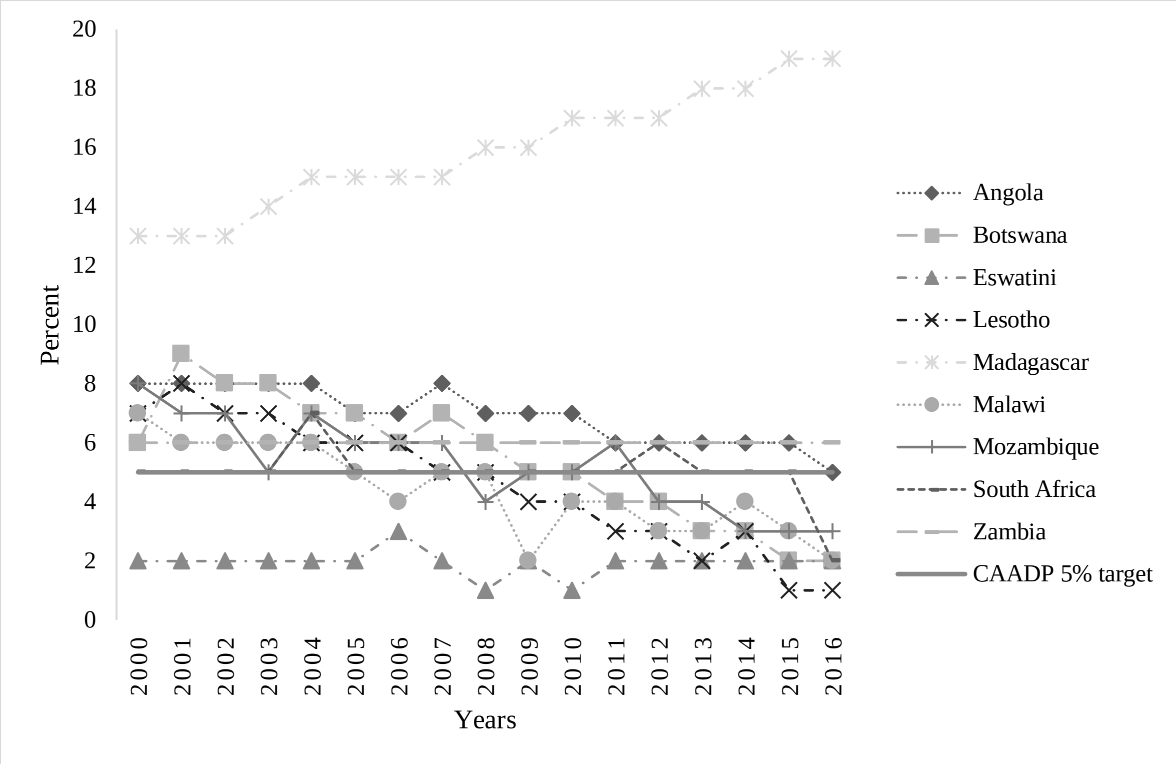

Figure 3-8: The prevalence of wasting

Source: Author's own compilation using data from Regional Strategic Analysis Knowledge Support System (2018).

According to the Malabo Declaration, African countries are required to achieve less than a five per cent prevalence of wasting by the year 2025 (African Union Commission and NEPAD, 2017). Five of the countries achieved the Malabo Declaration target for the prevalence of wasting apart from Madagascar and Zambia by 2016. Countries that have reached the required targets need to maintain these levels. Those that are still above the target need to align their policies in such a way as to enable a reduction in the prevalence of wasting to five per cent by the year 2025.

3.4.7 Trends in the prevalence of obesity in the adult population in SADC

Obesity is measured using the Body Mass Index (BMI), which is an index of mass for height (World Health Organisation, 2010). A person is considered obese if their BMI is greater than 30 kg/m^2 (World Health Organisation, 2010). The prevalence of obesity is the percentage of the population aged 18 and older whose BMI is equal to or greater than 30 kg/m^2.

Unlike the other food security indicators that have shown mixed trends among the nine countries, the prevalence of obesity has since 2000 been increasing in all nine countries, as shown in Figure 3-9. The increase in obesity over the years has been linked to growing economies, and the expansion of fast food industries (Agyemang et al., 2015; Steyn and Mchiza, 2014). As countries develop economically, people begin to experience nutrition transitions. People tend to change from peasant diets, which are predominantly plant-based, to diets of more meat and processed foods, contributing to increased levels of obesity (Fox et al., 2019). In some cases, obesity has been associated with urbanisation, low education and social demographic status (Tulp et al., 2018). People with lower knowledge and education about healthier lifestyles might be more prone to obesity (Tulp et al., 2018; Steyn and Mchiza, 2014). South Africa had the highest prevalence of obesity among the nine countries, increasing from 18.1 per cent in 2000 to 27 per cent in 2016 (Figure 3-9). South Africa happens to be the most developed country in the SADC region, making it more prone to a high incidence of obesity.

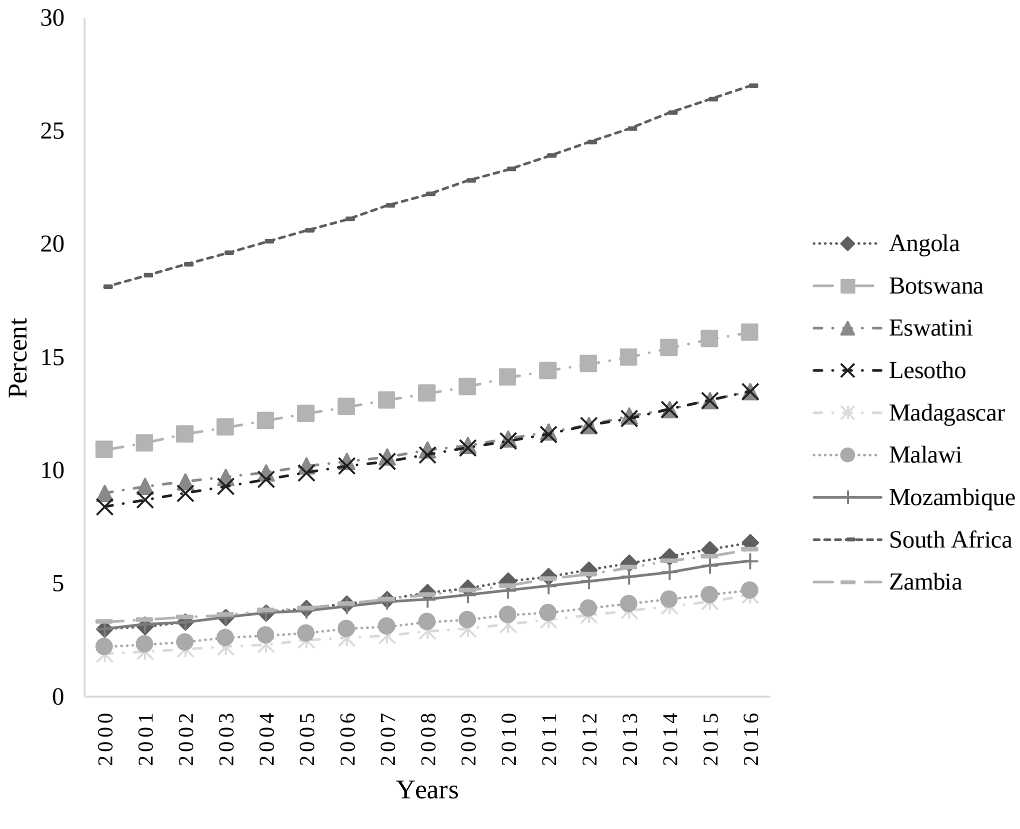

Figure 3-9: The prevalence of obesity in adults

Source: Author's own compilation using data from the Food and Agricultural Organisation (2019).

By contrast, Malawi and Madagascar had a low prevalence of obesity compared to other countries. In Madagascar, 1.9 per cent of the population was obese in 2000, increasing to 4.5

per cent in 2016. Even though the level is low in Madagascar, the trend still shows an increase in obesity over time. The trend is likely to continue if measures to curb obesity are not put in place.

3.4.8 Progress of SADC countries towards achieving the CAADP 2025 goals

The study further assessed the marginal rate of change in food security and nutrition outcomes in the SADC countries between 2000 and 2016. The rate of change showed the general progress made towards the achievement of the Malabo Declaration goals in the nine SADC countries.

Table 3-2 highlights the marginal rate of change in food security and nutrition indicators between 2000 and 2016. There has been an overall decline in the prevalence of undernourishment, stunting, underweight and wasting with a negative marginal rate of change in most of the countries, except in Madagascar and South Africa, in terms of the prevalence of undernourishment and no change in Zambia and Eswatini for wasting.

The rates of changes were different for different indicators and countries (Table 3-2). The decrease in the prevalence of underweight was highest in Malawi and Angola (-0.69 per cent per year for both countries). For wasting the most considerable change occurred in Lesotho and Madagascar (-0.38 per cent per year). The results showed that the greatest change in undernourishment (-2.98 per cent per year) and stunting (-0.88 percent per year) occurred in Angola and Madagascar, respectively. Such variations were likely to be as a result of country-specific programmes that may have been implemented to tackle food security and nutrition. In general, the results showed that some countries were making progress towards the reduction of food insecurity and malnutrition. Still, the changes have not been significant enough to meet the Malabo Declaration goals for food security and nutrition by 2025 (African Union Commission, 2014).

Table 3-2: Progress in achieving Malabo Declaration food security and nutrition targets

Country	CAADP 2025 Target	2000	2016	The marginal rate of change between 2000 and 2016 (percent per year)
Undernourishment				
Angola	5%	71.5%	23.9%	-2.98%
Botswana		35.7%	28.5%	-0.45%
Eswatini		19.2%	20.7%	-0.09%
Lesotho		13.6%	12.8%	-0.05%
Madagascar		34.4%	43.1%	0.54%
Malawi		27.1%	26.3%	-0.05%
Mozambique		40.3%	30.5%	-0.61%
South Africa		5%	6.1%	0.07%
Zambia		47.4%	44.5%	-0.18%
Stunting				
Angola	10%	51.0%	38.0%	-0.81%
Botswana		29.0%	28.0%	-0.06%
Eswatini		37.0%	27.0%	-0.63%
Lesotho		53.0%	38.0%	-0.93%
Madagascar		54.0%	46.0%	-0.50%
Malawi		55.0%	42.0%	-0.81%
Mozambique		51.0%	37.0%	-0.88%
South Africa		30.0%	27.0%	-0.19%
Zambia		50.0%	42.0%	-0.5%
Underweight				
Angola	5%	30.0%	19.0%	-0.69%
Botswana		11.0%	8.0%	-0.19%
Eswatini		9.0%	5.0%	-0.25%
Lesotho		15.0%	12.0%	-0.19%
Madagascar		36.0%	37.0%	-0.06%
Malawi		22.0%	11.0%	-0.69%

Country	CAADP 2025 Target	2000	2016	The marginal rate of change between 2000 and 2016 (percent per year)
Mozambique		23.0%	13.0%	-0.63%
South Africa		9.0%	6.0%	-0.19%
Zambia		19.0%	14.0%	-0.31%
Wasting				
Angola	5%	8.0%	5.0%	-0.19%
Botswana		6.0%	2.0%	-0.25%
Eswatini		2.0%	2.0%	0%
Lesotho		7.0%	1.0%	-0.38%
Madagascar		13.0%	19.0%	-0.38%
Malawi		7.0%	2.0%	-0.31%
Mozambique		8.0%	3.0%	-0.31%
South Africa		5.0%	2.0%	-0.19%
Zambia		6.0%	6.0%	0%

Note:

Highlighted in light grey = increase change in direction

Highlighted in white = decrease change in direction

Highlighted in dark grey = no change in direction

African countries have committed to increasing spending on agriculture to address food insecurity and malnutrition. This chapter has highlighted how public expenditure on agriculture and the rates of food security and nutrition indicators have changed between the year 2000 and 2016 in nine SADC countries. The results have shown that some countries have made progress while others are lagging behind in meeting the CAADP targets. However, it remains unknown whether the changes in investment might have had an influence on the differences in food security and nutrition outcomes over the years in the SADC region. Therefore, the study proceeded to establish whether there was an association between public spending on agriculture and food security and nutrition outcomes among the nine countries.

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

Food insecurity and malnutrition continue to pose a challenge in the SADC region, as reported in chapter three. The study in chapter three established that some countries were experiencing improvements in food security and nutrition outcome indicators. However, other countries were stagnant or worsening regarding the same indicators. No empirical study has been done to establish the influence that public investment in agriculture has on food security and nutrition outcomes in the SADC region. This chapter set out to show the effect of public expenditure on agriculture on food security and nutrition in SADC countries between 2000 and 2016. This chapter, as chapter three, focuses on nine SADC countries with the necessary data.

4.1 Variables used in evaluating the impact of government expenditure on agriculture on food security and nutrition in SADC

The study used the four dependent variables to evaluate whether public agriculture expenditure was significantly related to changes in food security and nutrition in the SADC region. These variables were average dietary energy supply adequacy; the prevalence of undernourishment; the prevalence of stunting; and per capita food production variability (Table 4-1). The data for these variables were sourced from the Food and Agricultural Organisation (2019) and The World Bank (2016).

The prevalence of undernourishment and stunting were selected as these are included in the Malabo Declaration's Biennial Review monitoring process (African Union Commission and NEPAD, 2017) and Sustainable Development Goal two (FAO et al., 2019a). The explanatory variables included in the fixed effects and generalised least squares model were government agriculture expenditure as a share of total expenditure; GDP per capita; inflation; trade openness; the level of democracy (Polity2); agriculture production; and population growth. The explanatory variables were used as controls in the study.

Inflation constituted the rise in general levels or prices. The inflation rate has been commonly measured using an indicator known as the Consumer Price Index (CPI) which measures the change in the price of goods and services purchased by households as a percentage (McConnell et al., 2018). Agricultural production was the use of cultivated plants and the rearing of animals to produce products that are used to enhance human life (Harris and Fuller, 2014). Agriculture production was measured using the agricultural gross production value (constant 2004-2006 1000 I$). The use of constant prices is used to show how quantities of products change over time (FAO, 2018b).

GDP per capita measured the economic output per person of a country. This is one of the core indicators used to measure the economic performance of a country (McConnell et al., 2018). The indicator has been used to measure the average standards or economic well-being at a broader level. Population growth was the average annual rate of change of population size during a specified period (Sibly and Hone, 2002). The indicator was measured as a percentage and showed how rapidly the size of the population is changing.

The polity indicator was an annual measure of democracy and autocracy (Marshall et al., 2002). The polity indicator was measured using a scale that ranges from -10 to 10, where higher values indicate greater democracy and lower values indicate autocratic governments according to the Polity IV database under the Polity IV project (Clark et al., 2012; Marshall et al., 2002). Trade openness was a measure of the degree in which countries were involved in global trade. It was measured as the sum of exports and imports of goods and services as a share of GDP (OECD, 2011). These variables are summarised in Table 4-1.

Table 4-1: Variables used in the study

Variable	Definition	Expected sign per food security indicator	Source of data
Dependent Variables			
Average dietary energy supply adequacy	The dietary energy supply as a percentage of the average dietary energy requirement in each country (%)		Food and Agricultural Organisation (2019)
Prevalence of stunting	Height for age as a percentage of children who are under five and short for their age (%)		Regional Strategic Analysis Knowledge Support System (2018)
Prevalence of undernourishment	The proportion of people consuming less than the minimum dietary energy requirement (%)		The World Bank (2016)
Per capita food production variability	This measures net food production variability expressed in US dollars		Food and Agricultural Organisation (2019)
Independent Variables			

Variable	Definition	Expected sign per food security indicator	Source of data
Public agricultural expenditure as a share of total government expenditure	Percentage of agriculture expenditure in total public expenditure (%)	Average dietary energy supply adequacy (+), the prevalence of stunting (-), the prevalence of undernourishment (-) and per capita food production variability (-).	Regional Strategic Analysis Knowledge Support System (2018)
Gross domestic product per capita	Gross domestic product per capita million constant 2010 prices	Average dietary energy supply adequacy (+), the prevalence of stunting (-), the prevalence of undernourishment (-) and per capita food production variability (-).	The World Bank (2016)
Inflation	Consumer Prices (Annual %)	Average dietary energy supply adequacy (-), prevalence of stunting (+), prevalence of undernourishment (+) and per capita food production variability (+).	The World Bank (2016)
Polity2	Political regime (scale)	Average dietary energy supply adequacy (+), the prevalence of stunting (-), the prevalence of undernourishment (-) and per capita food production variability (-).	Center for Systemic Peace (2018)
Trade openness	The sum of exports and imports of goods and services as a share of GDP (%)	Average dietary energy supply adequacy (+), the prevalence of stunting (-), the prevalence of	The World Bank (2016)

Variable	Definition	Expected sign per food security indicator	Source of data
		undernourishment (-) and per capita food production variability (-).	
Population growth	The annual growth rate of the population (%)	Average dietary energy supply adequacy (-), prevalence of stunting (+), prevalence of undernourishment (+) and per capita food production variability (+).	The World Bank (2016)
Agricultural production	Value of agriculture production measured by the gross value of agriculture production (constant 2004-2006 International US$)	Average dietary energy supply adequacy (+), the prevalence of stunting (-), the prevalence of undernourishment (-) and per capita food production variability (-).	Food and Agricultural Organisation (2018)

Note: All the variables in the table contained data from the year 2000 to 2016

4.2 Descriptive analysis of the variables used in the fixed effects and generalised least squares models

The mean average dietary energy supply adequacy was 102.39 per cent in the nine SADC countries (Table 4-2). In the period between 2000 and 2016, the nine SADC countries have been able to meet the calorie requirements for their population. These results reveal that in the nine SADC countries, there were enough calories, but in most cases, it might not have been a true reflection of the individual countries and households in these nations (Coates, 2013). In cases where social inequalities persist between countries, there are always problems related to the supply of food and access to food in the deficit countries (Berners-Lee et al., 2018; Garnett, 2013). These inequalities cause some countries to have an excess food supply and others to struggle with food deficits.

The average prevalence of undernourishment among the nine countries from the year 2000 to 2016 was 28.53 per cent. The prevalence of undernourishment meant that 28.53 per cent of the population's food intake was insufficient to meet daily energy requirements during those years. The level of undernourishment in Southern Africa has been associated with the countries being exposed to high poverty levels and the increased impact of climate change in the region (Misselhorn, 2005).

The mean per capita food variability for the nine SADC countries between the year 2000 to 2016 was 8.19 per cent, demonstrating a high instability in net food production. The results show that there have been higher deviations of food production from the expected output per capita for all the nine countries combined. These deviations are likely to be attributed to changes in the factors of production (agricultural farm inputs) where climate change has also played a role in disrupting production in the region (Misselhorn, 2005; FAO and ECA, 2018).

The countries were on average spending 5.33 per cent of their total budget on agriculture between the years 2000 to 2016. The expenditure level was low compared to the Malabo Declaration target of 10 per cent (African Union Commission, 2014). The results indicated that the nine countries in the SADC region continued to struggle to reach their commitment as far as investment in agriculture was concerned. The results also concur with the review report on progress towards Malabo Declaration commitments. The report shows that Southern Africa is not on track in enhancing investment in agricultural finance (Matchaya et al., 2018).

Table 4-2: Descriptive statistics

Variable	Mean	Standard deviation	Min	Max	Observations
Average dietary energy supply adequacy (%)	102.39	11.63	73	125	153
Prevalence of undernourishment (%)	28.53	14.99	4.3	71.5	153
Prevalence of stunting (%)	40	8.56	25	55	153
Per capita food production variability (thousand international dollars per capita)	8.19	5.05	1.4	25.4	153
Government agricultural expenditure as a share of total government expenditure (%)	5.33	5.02	0.52	28.88	153
Gross Domestic Product per capita (United States of America dollars)	2692.46	2502.09	261.69	7864.25	153
Inflation (%)	14.05	30.42	-1.7	325	153
Polity2 (Scale -10 to 10)	3.92	5.59	-9	9	153
Trade Openness (%)	87.03	30.13	38.58	170.41	153
Population Growth (%)	2.08	1.11	-0.62	3.71	153
Gross agricultural production value (Thousand international dollars)	2880755	3564364	157799.7	1.41e+07	153

A panel data model, which controlled for unit-specific as well as time-specific effects, was used. Panel data looks at different observations across time. The Chow poolability and

Hausman tests were used to determine the most appropriate model among these three approaches. The details about the tests are covered in the following sections.

4.3 Chow test for poolability

In dealing with panel data, the question arises as to whether or not the data needs to be pooled (Baltagi, 2008). Pooling in panel data analysis means that the data of different units (for example, countries) are combined and analysed together without assuming differences between the units (Wooldridge, 2015). In the context of this study, pooling would mean that there were no differences in the nine countries, yet in chapter three, it is evident that the countries are different. Pooling assumes that the parameter estimates (intercept and slope) are the same for all the units in the data (Wooldridge, 2015; Asteriou and Hall, 2015). The need to pool data or not arises because the panel analysis deals with data collected across observations in different periods of time. A confirmatory poolability test developed by Gregory Chow in 1960 (Chow, 1960) was used. The primary purpose of the test is to establish whether the parameters in the model run vary over cross-section units (Baltagi, 2008).

If the test results favoured pooling the data, then the ordinary least square would have been used to analyse the panel data. The Chow poolability test compared a restricted and unrestricted model. The restricted model uses a pooled regression which assumes that the parameter estimates are the same across countries. The unrestricted model was a regression equation which assumed that the parameter estimates differ across countries (Baltagi, 2008). Equation one represents the restricted model of the test.

Equation 1:

$$y = Z\delta + u$$

Where Z is a vector of variables in the model and δ is a vector of parameter estimates for the model.

The unrestricted model denotes the regression equation for each group (equation two)

Equation 2:

$$y_i = Z_i\delta_i + u_i$$

Where Z_i is a vector of variables in the unrestricted model and δ_i a vector of parameters estimates for the unrestricted model. In the poolability test, the study tested the H_o: $\delta_i = \delta$ for all *i*. The poolability test followed an F-statistic distribution given by equation three below, as presented by Baltagi (2008):

Equation 3:

$$\frac{(e'e - (e_1'e_1 + e_2'e_2 + \cdots + e_N'e_N))/(N-1)(K-1)}{(e_1'e_1 + e_2'e_2 + \cdots + e_N'e_N)/N(T-K-1)}$$

Where $e'e$ is the residual sum of squares for pooled regression, $e_i'e_i$ is the residual sum of squares for the individual group regressions, T is the number of periods, K is the number of regressors and N is the number of individual groups.

In a case where the null hypothesis is accepted, the data can be pooled for analysis without controlling for differences in observations (countries) and periods. When the data is poolable, the Ordinary Least Squares estimation method may be used to analyse the panel data. In contrast, rejecting the null hypothesis suggests that the panel data cannot be combined for analysis. Therefore, an estimation method that controls for the differences in the observations and periods must be used.

The test results in Table 4-3 showed that for all the models, poolability was not possible since all the countries had different parameter estimates. The test results rejected the null hypothesis that parameter estimates for the restricted and unrestricted model were the same across countries in all the four models, as shown in Table 4-3. The null hypothesis was rejected because the chi-square values for the average dietary energy supply adequacy (72.37), undernourishment (103.31), prevalence of stunting (11.24) and per capita food production variability (6.89) were greater than the critical values at all levels of significance (Table 4-3). Therefore, there was a need to use estimation methods other than the typical Ordinary Least Squares. In light of these findings, the study further carried out a test to determine the alternative estimation method, which would be suitable for the data.

Table 4-3: Poolability test results for panel data

Dependent Variable	Null Hypothesis	χ^2	Conclusion
Average Dietary Energy Supply Adequacy	Parameter estimates for the restricted and unrestricted model were the same across countries	72.373	Parameter estimates for the restricted and unrestricted model were different across countries
Undernourishment	Parameter estimates for the restricted and unrestricted model were the same across countries	103.313	Parameter estimates for the restricted and unrestricted model were different across countries
Prevalence of stunting	Parameter estimates for the restricted and unrestricted model were the same across countries	11.244	Parameter estimates for the restricted and unrestricted model were different across countries
Per capita food production variability	Parameter estimates for the restricted and unrestricted model were the same across countries	6.890	Parameter estimates for the restricted and unrestricted model were different across countries

Critical values for F (48,81) at 1% - 1.512, 5% - 1.795, 10% - 1.380

4.4 Hausman test for fixed-effects and random effects selection

Next, the data were subjected to the Hausman test to check whether a fixed-effects or random-effects method would be appropriate for the panel data analysis. The test measured the difference between the fixed-effect estimator and the random effects estimator. The test was carried out under the null assumption that random effects estimators are consistent and efficient (Asteriou and Hall, 2015). The Hausman test assumed no correlation between the explanatory variables (per capita gross domestic product, inflation, polity2, trade openness, population growth and agriculture production) and the unobserved specific effects (in the error term). The unobserved specific effects are individual characteristics that are unique to observations but cannot be measured and included in the model as part of the explanatory variables (Baltagi, 2010). These specific effects with respect to this study consisted of but were not limited to, geopolitics and institutional structures of countries. If there were no correlation between the explanatory variables and the unobserved specific effects, then the random effect would have been an appropriate model. On the contrary, if there were a correlation, the fixed effects model would have been suitable. The Hausman test used the following test statistics as defined by Asteriou and Hall (2015) in equation four.

Equation 4:

$$H = \left(\hat{\beta}^{FE} - \hat{\beta}^{RE}\right)' [Var\left(\hat{\beta}^{FE}\right) - Var\left(\hat{\beta}^{RE}\right)]^{-1} (\hat{\beta}^{FE} - \hat{\beta}^{RE})$$

In equation four, $\hat{\beta}^{FE}$ is a coefficient estimate of the fixed-effect model while $\hat{\beta}^{RE}$ was a coefficient estimate of the random effect model (Asteriou and Hall, 2015).

The Hausman test followed a Chi-square distribution. The p-values from the test results were all less than 0.05 percent, as highlighted in Table 4-4. In this case, the null hypothesis of no correlation between the independent variables and the error term in the study was rejected. The results indicated that the fixed effect model was appropriate for the analysis.

Table 4-4: Hausman test results

Dependent Variable	**H_0**	**Chi-Squared**	**P-value**	**Conclusion**
Average Dietary Energy Supply Adequacy	No correlation between independent variables and the error term	73.44	0.0000	Use fixed effects
Undernourishment	No correlation between independent variables and the error term	24.54	0.0004	Use fixed effects
Prevalence of stunting	No correlation between independent variables and the error term	4549.33	0.0000	Use fixed effects
Per capita food production variability	No correlation between independent variables and the error term	33.47	0.0000	Use fixed effects

In summary, the Chow poolability test results indicated that pooling was not ideal for the dataset. In contrast, the Hausman test showed that a fixed-effects model was appropriate for the data. The study then used the fixed effects model to evaluate the effect of government expenditure on agriculture on food security and nutrition.

4.5 Fixed-effects model estimation

A fixed-effects model is an estimation method that controls for unobserved country-specific effects such as geopolitics and institutional structures (Baltagi, 2008; Baltagi, 2010). The model captures all country-specific effects that do not vary over time (Asteriou and Hall, 2015). When the unobserved, specific effects are not controlled for the model, estimates become biased (Baltagi, 2010). Biased estimates mean that the model was not able to produce estimates that are close to the true value of the parameter being estimated. The results that are obtained from the sample estimates are not a true reflection of the population. Heteroskedasticity, serial correlation and cross-section dependence are common in fixed-effects models. Heteroskedasticity is a state whereby the variance of the error term conditional on the explanatory variables is not constant (Wooldridge, 2015). When heteroskedasticity is ignored, it results in having estimates that are not efficient. Serial correlation (autocorrelation) is the condition wherein the error terms from different periods are related (Wooldridge, 2015). When serial correlation is ignored when running a model, it leads to inefficient estimates and biased standard errors (Drukker, 2003). Cross-section dependence occurs when the cross-section units in the panel data depend on one another. The dependency usually is caused by either unobserved common shocks, agro-climatic conditions or single currency use (De Hoyos and Sarafidis, 2006). Ignoring cross-sectional dependence can lead to having biased and inefficient estimates and, in some cases, the model can suffer from inconsistency (De Hoyos and Sarafidis, 2006). Therefore, diagnostic tests are necessary to check for the presence of the issues highlighted.

Food security is multidimensional and, as such, there is no single indicator that has been agreed-upon for its measurement (Maxwell et al., 2013). In such a scenario, different indicators are used to capture the various dimensions of food security (Maxwell et al., 2013). The study used four food security indicators considering the nature of food security measurement. The indicators represented the four food security dimensions which include availability, accessibility, utilisation and stability. In the study, the panel data analysis consisted of four estimation models that were estimated independently from one another. Equation five presents the generic regression function of the food security and nutrition outcomes adapted from Slimane et al. (2016).

Equation 5:

$$Y_{it} = \beta_0 + \beta_1 agr\_exp_{it} + \beta_2 K_{it} + \gamma FE_i + \delta FE_t + \varepsilon_{it}$$

- Y_{it} denoted food security and nutrition outcome variables for a country in a specific year (average dietary energy supply adequacy, prevalence of undernourishment, prevalence of stunting and per capita food production variability).
- agri_exp denoted public agriculture expenditure as a share of total expenditure.
- K denoted a vector of other macro explanatory variables for the food security indicators (per capita gross domestic product, inflation, polity2, trade openness, population growth and agricultural production).
- FE_i denoted the country fixed effects.
- FEt denoted the time fixed effects.
- εit denoted the error term.
- β_1, β_2, γ and δ were the parameters that were estimated.

After running the four fixed-effects models (in the appendix), diagnostic tests were carried out to ensure that the model was in line with econometric assumptions. To ensure that the estimates were not biased or inefficient, the study tested the four models for cross-section dependence, autocorrelation and heteroskedasticity.

4.5.1 Test for cross-section dependence in the fixed effects model

Panel data models assumed that the error terms were cross-sectionally independent (Pesaran, 2004). When the assumption does not hold, cross-section dependence arises. Cross-section dependence can result from special or spillover effects or as a result of common unobserved factors among the cross-section units that are relegated into the error term (De Hoyos and Sarafidis, 2006; Baltagi and Hashem Pesaran, 2007). Spillover effects happen when events in one cross-section unit, for example, a country affecting another in the panel data. Ignoring cross-sectional dependence can lead to having biased and inefficient estimates and, in some cases, the model can suffer from inconsistency (De Hoyos and Sarafidis, 2006).

In the study, the Lagrange Multiplier (LM) test for cross-section dependence (Breusch and Pagan (1980) was used. The LM test was applied as the panel data had more periods than the cross-section dimension (De Hoyos and Sarafidis, 2006). The test was done to ensure that the estimates were efficient and unbiased. In the event where there was cross-section dependence in the model, an estimation method that controls for cross-section dependence was used. The null hypothesis for this test stated that the residuals across entities are not correlated (no cross-section dependence). The LM test of cross-section dependence follows a Chi-square distribution, meaning that the test used a Chi-square test statistic (Breusch and Pagan, 1980).

The results in table 4-5 revealed that there was cross-sectional dependence in the average dietary energy supply adequacy, a prevalence of undernourishment and per capita food production variability. In the case of undernourishment, average dietary energy supply adequacy and per capita food production variability, there was a need to use an estimation method that controlled for cross-section dependence. For stunting, the study showed that there was no cross-sectional dependence. After testing for cross-section dependence, the models were then tested for autocorrelation.

Table 4-5: Cross-section dependence test results

Dependent Variable	**Null Hypothesis**	χ^2	**p-value**	**Conclusion**
Average dietary energy supply adequacy	Cross-sectional independence	103.538	0.0000	No Cross-sectional independence
Prevalence of undernourishment	Cross-sectional independence	99.472	0.0000	No Cross-sectional independence
Prevalence of stunting	Cross-sectional independence	44.477	0.1505	Cross-sectional independence

Dependent Variable	Null Hypothesis	χ^2	p-value	Conclusion
Per capita food production variability	Cross-sectional independence	131.020	0.0000	No Cross-sectional independence

4.5.2 Test for autocorrelation in the fixed-effects model

A first-order autocorrelation (serial correlation) test was also carried out for the four fixed-effects models as stipulated by Baltagi (2008). The test measured the relationship between errors in different periods (Wooldridge, 2015). The classical error component disturbances assumed that panels were serially uncorrelated (Born and Breitung, 2016; Baltagi, 2008). However, the assumption would not hold water in cases where unobserved shocks from one panel affected the outcome of a variable in subsequent years. It was important not to overlook serial correlation in the panel data to avoid having consistent but inefficient parameter estimates as well as biased standard errors (Baltagi, 2008; Drukker, 2003).

The null hypothesis for the diagnostic test was that there is no first-order autocorrelation. The null hypothesis showed that the previous year's error term did not influence the current error term. The serial correlation test followed an F-distribution (Baltagi, 2008). The results in table 4-6 showed that the three models (average dietary energy supply adequacy, undernourishment and per capita food production variability) had serial correlation except for the stunting model. The results meant that there was a need to use an estimation method that would control for serial correlation in the average dietary energy supply adequacy, undernourishment and per capita food production variability models only.

Table 4-6: Serial correlation test results

Dependent Variable	H_0	F-Statistic	P-Value	Conclusion
Average dietary energy supply adequacy	No serial correlation	58.813	0.0001	Serial correlation present
Undernourishment	No serial correlation	226.762	0.0000	Serial correlation present
Prevalence of stunting	No serial correlation	0.885	0.3745	No serial correlation present
Per capita food production variability	No serial correlation	45.983	0.0001	Serial correlation present

4.5.3 Test for heteroskedasticity in the fixed-effects model

In the fixed-effects models it was assumed that the error term was homoscedastic (equal variance across the cross-section units) (Feng et al., 2020; Baltagi, 2008). In a case where the assumption did not hold, heteroskedasticity would arise. In the presence of heteroskedasticity, the parameter estimates that were not efficient, and the standard errors would be biased (Feng et al., 2020). In the presence of heteroskedasticity, robust standard errors were used to obtain unbiased standard errors which gave more precise estimates (Hoechle, 2007).

Consequently, the fixed-effect models were tested for heteroscedasticity using a modified Wald test for Group-wise heteroskedasticity (Baum, 2001). The null hypothesis for the test for heteroskedasticity in the fixed-effects model was that the error variance is constant in all countries in the study. The null hypothesis for the heteroskedasticity test can be stated as

$$H_0: \sigma_i^2 = \sigma^2 \; for \; all \; i \ldots . N_g$$

where N_g was the number of countries, σ_i^2 was the error variance for each country. The Wald test statistic followed a Chi-Square(N_g) distribution (Baum, 2001).

The results for the heteroskedasticity test were quite different from the previous test results for serial correlation and cross-section dependence. The previous two tests showed that the stunting model presented no problems, while in the heteroskedasticity test, the stunting model was not homoskedastic. The test results in Table 4-7 showed that all models suffered from heteroskedasticity since all the p-values were less than 0.05. There was a need to use robust standard errors in the fixed-effects models to correct for heteroskedasticity. However, the correction was only done for the stunting model, while for the other three models, an alternative estimation method was used to solve all the problems identified collectively.

Table 4-7: Heteroskedasticity test results

Dependent Variable	H_0	Chi-square	P-Value	Conclusion
Average dietary energy supply adequacy	No heteroskedasticity	1496.99	0.0000	Heteroskedasticity present
Undernourishment	No heteroskedasticity	1411.71	0.0000	Heteroskedasticity present
Prevalence of stunting	No heteroskedasticity	110.40	0.0000	Heteroskedasticity present
Per capita food production variability	No heteroskedasticity	18.04	0.0347	Heteroskedasticity present

From the three diagnostic tests (cross-section dependence, autocorrelation and heteroskedasticity in the fixed-effects models) the models for average dietary energy supply adequacy, the prevalence of undernourishment and per capita food production variability suffered from cross-section dependence, autocorrelation and heteroskedasticity. These problems created a need to find an estimation method that controls for all these problems in the three models. In order to deal with these problems, a fixed effect generalised least squares model was used. The stunting model only suffered the presence of heteroskedasticity. Robust standard errors were used to solve the problem of heteroskedasticity in the stunting model.

4.6 Results for the fixed-effect generalised least squares model (controlling for cross-section dependence, autocorrelation and heteroskedasticity)

This section presents the results of three regression equations using the generalised least squares estimator for panel data for the average dietary energy supply adequacy, undernourishment and per capita food production variability. A fixed-effect generalised least square estimation method was used as this method controlled for cross-section dependence, autocorrelation and heteroskedasticity (Hoechle, 2007). This approach is applied for panel data where the number of cross-sectional units (countries) is less than the periods (years), which was the case for study data. All results in this section are presented with *ceteris paribus* concept (Bierens and Swanson, 2000).

4.6.1 Fixed effect generalised least squares results for average dietary energy supply adequacy model

Table 4-8 presents the results of the average dietary energy supply adequacy model. In this model, the signs on the parameter estimates were in line with expectations except for GDP per capita, which had a negative sign, as highlighted in Table 4-1. In the average dietary energy supply adequacy equation, all the variables were found to be significant, demonstrating that they had a role in determining average dietary supply adequacy in the countries.

The coefficients of GDP per capita, inflation and population growth were all negatively and significantly related to average dietary supply adequacy. The negative coefficients suggested that high population growth and macro-economic instability reduced the average dietary energy supply adequacy (Tayal, 2019; Ogunniyi et al., 2020). Coefficients of government agricultural expenditure, polity, trade openness, and gross production value were positively and significantly related to average energy dietary supply adequacy.

A one per cent increase in the share of government agriculture expenditure in the total public expenditure would increase the average dietary energy adequacy by 0.27 per cent, *ceteris paribus*. An increase in government expenditure on agriculture has the potential to increase production, which could contribute to an increase in dietary energy supply adequacy. The results were in line with the idea that agriculture has the ability to influence food security and nutrition as per the CAADP Commitment in Africa (African Union Commission, 2014).

The negative relationship between GDP per capita and average dietary energy supply adequacy was entirely unexpected. An increase in national income was expected to have a positive outcome on the dietary energy supply in a country (Dithmer and Abdulai, 2017). The results showed that a one per cent increase in gross domestic product per capita would reduce the average dietary energy supply adequacy by 1.20 per cent *ceteris paribus*. This might have been the case because increased incomes only contribute to food security and nutrition when the money is used to purchase goods and services that promote food nutrition. These study results were contrary to the findings of Kaur and Kaur (2016), Dithmer and Abdulai (2017) and Fusco et al., (2020), who found that GDP per capita was associated with a favourable impact on food security.

A one per cent increase in inflation would reduce the average dietary energy supply adequacy by 0.07 per cent *ceteris paribus* in the nine SADC countries. Inflation reduces economic access to food which might affect the average dietary energy supply adequacy. The results in a study by Kaur and Kaur (2016) also revealed that inflation negatively affected food security and nutrition. Inflation is used as a proxy of macro-economic stability, and higher inflation represents macro-economic policies that are not in favour of the nation's economic progress.

Polity had the expected sign, and it was statistically significant. A unit increase in the polity scale would increase the average dietary energy supply adequacy by 0.23 per cent holding other factors constant. The results show that democratic governments respond well to food security concerns of the population through redistributive policies (Mihalache-O'Keef and Li, 2011; Sen, 2001). However, the results were contrary to the findings of Hitzhusen and Jeanty (2006) and Slimane et al. (2016) who showed that polity was not highly significant in determining food security.

Table 4-8: Estimation results for Average Dietary Energy Supply Adequacy

Variable	Coefficients (Standard Errors)
Government agriculture expenditure as a share of total government expenditure	0.27^{**} (0.10)
Logged Gross Domestic Product per capita	-1.20^{**} (0.50)
Inflation	-0.07^{***} (0.02)
polity2	0.23^{***} (0.09)
Trade openness	0.08^{***} (0.02)
Population growth	-10.72^{***} (0.63)
Logged agricultural gross production value	7.71^{***} (0.51)
Constant	15.61 (8.99)
Wald Chi-Square	549.01^{***}
Observations	146
Countries	9

*Note: * significant at 10%, ** significant at 5%; *** significant at 1%*

The coefficient on trade openness showed that a unit change in trade openness would increase the adequacy energy dietary supply adequacy by 0.08 per cent holding all factors constant. Trade policies that promote trade openness tend to increase volumes of trade, creating an opportunity to increase the average dietary energy supply adequacy of a country. The result was similar to the findings of two studies (Dithmer and Abdulai, 2017; Nisa et al., 2017), where trade had a positive and significant effect on food security.

Population growth adversely affected food security as a unit change in population growth would result in a 10.71 per cent decrease in the average dietary energy supply adequacy holding all factors equal. An increase in population can hinder food accessibility might contribute to the reduction of the daily energy supply. The results were in line with findings by Rena (2005) and Hitzhusen and Jeanty (2006) at the national level and Feleke et al. (2005) at the household level.

The *a priori* expectation of the impact of agricultural production on average dietary energy supply adequacy was positive, showing that agricultural production changes were associated with favourable effects on food security. Agricultural production usually leads to an increase in food availability which can contribute to a rise in the country's dietary energy supply. The study results highlighted that a one per cent change in the gross production value would result in a 0.07 per cent increase in the average dietary energy supply adequacy *ceteris paribus*. The results were in line with Slimane et al. (2016), who showed that agricultural production had a positive and significant effect on food security.

4.6.2 Fixed-effect generalised least squares results for the prevalence of undernourishment model

The coefficients of the explanatory variables of the undernourishment regression equation were in line with expectations apart from the coefficient on GDP per capita (Table 4-9). In terms of significance, the rest of the explanatory variables were statistically significant apart from GDP per capita and polity2. The results showed that the share of government expenditure in agriculture as the share of total government expenditure, inflation, openness to trade, population growth and gross production value significantly influenced the prevalence of undernourishment.

The results in Table 4-9 showed that the share of government expenditure in agriculture on the total public spending, trade openness, and gross production value were negatively and significantly related to the prevalence of undernourishment. The study showed that these variables aid in improving the food security situation by reducing the prevalence of undernourishment. Inflation and population growth were positively and significantly related to the prevalence of undernourishment. The study showed that these inflation and population growth adversely affected the prevalence of undernourishment.

A one per cent increase in the share of government agriculture expenditure was associated with a 0.22 per cent decline in the prevalence of undernourishment. Countries relying on agriculture for food and income were likely to benefit in terms of reducing undernourishment through agriculture investments. Developing the agriculture sector through investments is associated with increased income for the net food seller and lower food prices for the net food buyer, thereby reducing the levels of undernourishment (Hawkes and Ruel, 2008; Zezza et al., 2009).

A one per cent increase in inflation would result in a 0.12 per cent increase in the prevalence of undernourishment *ceteris paribus*. Increase in prices has the potential of limiting food access which might lead to increased prevalence of undernourishment. The results from the study were in agreement with results found in a study by Kaur and Kaur (2016), which showed that inflation increased the prevalence of undernourishment in Sub-Saharan countries. The findings of this study and Kaur and Kaur (2016) showed that where there is no macro-economic stability in a country, the prevalence of undernourishment is likely to increase, as highlighted by Warr (2014).

Table 4-9: Estimation results for the prevalence of undernourishment

Variable	Coefficients (Standard Errors)
Government agriculture expenditure as a share of total government expenditure	-0.22* (0.13)
Logged Gross Domestic Product per capita	0.20 (0.62)
Inflation	0.12*** (0.02)
polity2	-0.13 (0.11)
Trade openness	-0.06** (0.03)
Population growth	14.02*** (0.78)
Logged agricultural gross production value	-7.13*** (0.63)
Constant	103.56 (11.11)
Wald Chi-Square	608.03***
Observations	146
Countries	9

*Note: * significant at 10%, ** significant at 5%; *** significant at 1%*

Openness to trade was also associated with a reduction in the prevalence of undernourishment. A one per cent increase in trade openness would reduce the prevalence of undernourishment by 0.06 per cent. Opening to trade provides a way to obtain food deficits from other parts of the world, holding all other factors constant. Currently, the world produces enough food, yet many more people still go hungry (Berners-Lee et al., 2018; FAO et al., 2019a). Under these circumstances, trading becomes a means of bridging the food deficit gap by moving food from abundant food areas to those that have less food. However, the findings of Mary (2019) showed that trade openness increased the prevalence of undernourishment in 52 developing countries. Most developing countries tend to apply protectionist policies such as food trade restrictions to reduce hunger. The same study by Mary (2019) highlighted that a one percentage point increase in the prevalence of hunger would result in a 0.9 per cent decrease in food trade openness.

Population growth in the nine SADC countries negatively affected the prevalence of undernourishment. A one percentage point increase in the population would increase the prevalence of undernourishment by 14.02 percent *ceteris paribus*. An increase in population tends to increase the demand for food, and in a case where food production does not grow at the rate of the population, food insecurity increases (Fróna et al., 2019; Luan et al., 2013).

A unit increase in the agricultural gross production value would reduce undernourishment by 0.07 per cent, holding all factors constant. Increased agricultural production can improve food availability in a country, thereby contributing to the reduction of undernourishment (Hawkes and Ruel, 2008). Currently, countries are facing the challenge of climate change that has caused droughts and floods, which disrupts food production (FAO and ECA, 2018).

4.6.3 Fixed-effect generalised least squares results for per capita food production variability model

In the study, most of the explanatory variables did not explain the changes in per capita food production variability. Only two variables were statistically significant at a ten per cent level of significance (p-value less than 0.1), and these were government agriculture expenditure as a share of total government expenditure and polity 2. Table 4-10 shows that a one percentage point increase in government agriculture expenditure as a share of total government expenditure would increase per capita food production variability by 0.02 per cent. The finding of the study was rather surprising because normally it would be expected that an increase in government spending on agriculture would decrease the per capita food production variability *ceteris paribus*. This could have been as a result of the low explanatory power of the model.

Table 4-10:Estimation results for per capita food production variability

Variable	Coefficient (Standard Error)
Government agriculture expenditure as a share of total government expenditure	0.02* (0.01)
Logged Gross Domestic Product per capita	0.10 (0.06)
Inflation	-0.002 (0.002)
polity2	0.02* (0.01)
Trade openness	0.002 (0.003)
Population growth	0.06 (0.08)
Logged agricultural gross production value	0.07 (0.06)
Constant	-0.26 (1.08)
Wald Chi-Square	12.76*
Observations	146
Countries	9

*Note: * significant at 10%, ** significant at 5%; *** significant at 1%*

The study further showed that a unit increase in the polity2 scale would lead to a 0.02 per cent increase in the per capita food production variability. The results for polity2 showed that the more democratic a country was, the more the country would experience a change in the normal food production levels. The countries, therefore, face instability in terms of food security due to high fluctuations in yearly food production, which might lead to frequent changes in food prices. These results are contrary to literature where it was stipulated that the more democratic a country is, the more likely they are to address concerns with regard to food security and nutrition (Mihalache-O'Keef and Li, 2011; Sen, 2001). The difference might have been as a result of a lack of a strong political will where those elected into power did not have a strong determination to address food security issues in the countries to achieve the desired outcomes (Zidouemba, 2017).

4.7 Correcting for heteroskedasticity in the stunting model

The final regression equation run was for the prevalence of stunting. The fixed-effects model for stunting was corrected for heteroskedasticity using robust standard errors (Hoechle, 2007).

The results (Table 4-11) showed that gross domestic product per capita, inflation, trade openness and gross production value had a significant impact on the prevalence of stunting. In contrast, government agriculture expenditure as a share of total government expenditure, polity2 and population growth did not have a significant effect on the prevalence of stunting.

Table 4-11: Estimation results for the prevalence of stunting using robust standard errors

Variable	Coefficients (Standard Errors)
Government agriculture expenditure as a share of total government expenditure	-0.09 (0.05)
Logged Gross Domestic Product per capita	-12.82*** (3.76)
Inflation	0.009* (0.004)
polity2	0.30 (0.18)
Trade openness	0.02* (0.009)
Population growth	0.77 (1.40)
Logged agricultural gross production value	-5.43** (2.28)
Constant	207.51 (17.32)
F-Statistic	7539.80***
Observations	146
Countries	9

*Note: * significant at 10%, ** significant at 5%; *** significant at 1%*

The results showed that a unit change in the GDP per capita was associated with a 0.13 per cent reduction in the prevalence of stunting *ceteris paribus*. Increased national income can contribute to higher investments in health, nutrition, water and sanitation and social protection which is likely to translate into better child nutrition outcomes at a country level. It is important to realise that an increase in national income may only be effective in reducing child malnutrition if the income is directly channelled by governments towards the provision of better diets for children, improving sanitation, women's empowerment and reducing poverty and inequality in the countries (McGovern et al., 2017). The results of this study were in agreement with those of Smith and Haddad (2015) who found that a one per cent increase in GDP per capita was associated with a 0.17 per cent decrease in the prevalence of stunting. Also, Yaya et al. (2020) found that there was a positive association between per capita GDP and stunting in Sub-Saharan Africa. However, Yaya et al. (2020) noted that the association between per capita GDP and stunting was strong in the case of children in the richest quantile.

A one percentage point increase in inflation could result in a 0.009 per cent increase in the prevalence of stunting *ceteris paribus*. This could be associated with reduced purchasing power (McConnell et al., 2018) which affects economic access to food and other services that contribute to the reduction of stunting. Also, the small change (0.009 per cent) would have been as a result of the nature of the stunting indicator which depicts a chronic condition making it less sensitive to changes in price shocks when compared to other malnutrition measures (Arndt et al., 2016). Similar to this study's result, Kaur and Kaur (2016) found a significant relationship between stunting and inflation in Sub-Saharan Africa.

Trade openness was positively related to the prevalence of stunting. The results showed that a one percentage point in the sum of import and export of goods and services as a share of the GDP would increase the prevalence of stunting by 0.02 percent holding other factors constant. This could have been a result of the negative effect of trade resulting from volatile market prices which might reduce access to food when prices increase. The study results agreed with findings by Mary (2018), who found out that agricultural trade openness increases the prevalence of stunting in developing countries. On the contrary, Anderson (2016) highlighted that trade openness improves the food security outcomes of a country in a case where trade enables increased food availability in areas where there is a deficit and also increased incomes of the traders.

Lastly, a unit increase in the gross agricultural production value was associated with a 0.05 per cent decrease in the prevalence of stunting in children in the SADC countries holding all other factors constant. This result could have been due to the fact that agricultural production contributes to increased food availability and access, providing households with macro-nutrients and micro-nutrients (Hawkes and Ruel, 2008; Fan et al., 2019b). These results were in line with findings by Slimane et al. (2016), who found a positive contribution of agricultural production to food security and nutrition in 55 developing countries.

CHAPTER 5 : CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to evaluate the impact of public expenditure on agriculture on food security and nutrition in SADC countries. The study accomplished this by addressing two specific objectives. First, a trend analysis of public agriculture expenditure, food security and nutrition was conducted. Second, the study evaluated the impact that public agriculture expenditure had on food security and nutrition in the nine SADC countries from the years 2000 to 2016.

The study tested two hypotheses:

(i) SADC countries did not reach their 2003 Maputo Declaration targets for government agriculture expenditure, food security and nutrition between the years 2000 and 2016;

(ii) government agriculture expenditure was not significantly related to food security and nutrition indicators in the SADC countries between the years 2000 and 2016.

The findings in concurred with the null hypothesis that the nine SADC countries as a whole did not reach their 2003 Maputo Declaration targets for government expenditure on agriculture. Ideally, the countries were expected to be spending a minimum of ten per cent of the total spending on agriculture. However, the average spending on agriculture was less than what the countries committed to in the Maputo and Malabo Declarations. There was mixed progress in the progress in public agriculture spending among the nine countries. Malawi, Zambia, Mozambique and Madagascar were able to reach the required expenditure level in any given year while the rest did not meet the target. The countries that spent more than ten per cent of their expenditure on agriculture did not maintain this level of spending consistently over a number of years. The inconsistency could have been as a result of the countries prioritising other sectors above the agriculture sector.

The study rejected the hypothesis that the nine SADC countries made no progress towards the attainment of the CAADP food security and nutrition indicator targets. Some countries were able to meet the Maputo Declaration targets while others were not. As for the prevalence of undernourishment, stunting and underweight, there were high variations in the progress towards the attainment of the CAADP targets, and by the year 2016, most countries had not reached these targets. However, in terms of the prevalence of wasting, the countries were able to meet the CAADP targets by 2016 except for Madagascar. Furthermore, the findings showed that even though the targets had not been met by 2016; several countries were making progress in improving food security and nutrition outcomes between 2000 and 2016.

The study also rejected the hypothesis that government expenditure on agriculture did not significantly influence undernourishment, the average dietary energy supply adequacy and per capita food production variability in the nine SADC countries. However, the study concurred with the hypothesis that government agriculture expenditure does not significantly influence the level of stunting. The results showed that the prevalence of undernourishment dropped with increased public agriculture expenditure and the dietary energy supply adequacy and per capita food production variability improved in the nine SADC countries.

5.1 Conclusions

The study found that most of the countries among the nine SADC countries did not make adequate progress towards meeting their commitment to increasing agriculture spending between the years 2000 and 2016. Only Malawi, Zambia, Mozambique and Madagascar were doing well in the area of agriculture spending, which was depicted by their increased expenditure on agriculture as a share of the total government budget. Zambia, Mozambique and Madagascar did not meet the target every year. The reason for the poor performance could have been as a result of uneven progress among the nine SADC countries. Malawi, Zambia, Mozambique and Madagascar were among the first countries to sign the CAADP compact and start their CAADP process, and these countries have been able to reach the ten per cent target in any given year. Also, this could be because some countries do not depend on agriculture as much for their primary national income source. The countries (Malawi, Zambia, Mozambique and Madagascar) that fulfilled the promise among the nine SADC countries were those that rely heavily on agriculture.

The study also showed that agriculture spending could have been one of the factors that contributed to the positive changes in the average dietary energy supply adequacy over the period of study in the nine SADC countries. For per capita food production variability, the study highlighted that spending in agriculture could have been one of the factors contributing to the increase in production variability among the nine SADC countries. In as much as the trend analysis showed an improvement in the prevalence of stunting between the years 2000 and 2016, the empirical results showed that there was no sufficient evidence to relate progress in stunting to changes in government agriculture spending.

The study concluded that the nine SADC countries had improved food security and malnutrition over the period studied. Most countries experienced a decline in the prevalence of undernourishment, stunting, wasting and overweight. However, progress has been slow for some indicators. For example, all countries reached their targets for the prevalence of wasting by 2016, while they are still off target for achieving the targets for stunting, undernourishment and wasting.

Although government agriculture expenditure was positively related to progress with regard to increasing the average dietary energy supply adequacy and reducing the prevalence of undernourishment, per capita food production variability dropped as agricultural expenditure increased. However, progress towards the goals was inadequate, reflecting that even where there were increases in agricultural spending, this may not be adequate to drive changes in food security and nutrition. The slow progress could have been as a result of funds spent on areas that did not produce adequate change or inadequacy of funds. Most of these countries were spending less than US $50 billion between the years 2000 and 2016 in the agriculture sector despite some of them reaching the ten per cent Maputo target. For example, in Malawi, despite the country reaching the Malabo target of spending at least ten per cent of the national budget on agriculture in any given year, the country continued to struggle with high levels of food insecurity and malnutrition. Malawi's agricultural spending focused on the farm input subsidy, which promoted an increase in maize production. However, it is known that an increase in maize production not necessarily means improved household food security and nutrition. Programme design also influences the impact of agricultural expenditure on nutrition. The SADC countries may need to review and perhaps revisit the design of their sector interventions, ensuring a more nutrition-sensitive approach to speed up their progress towards the food security and nutrition-related CAADP targets.

5.2 Recommendations

The nine SADC countries need a sustained increase in government expenditure on agriculture. They can do this by prioritising the agriculture sector in their yearly government budgets and controlling current spending in other sectors. However, increasing expenditure alone is not sufficient to foster agricultural-led growth. These countries will need to improve the quality of their spending on agriculture by using empirical evidence that exists to inform decision making on how best to use the funds allocated to agriculture. For example, spending on rural roads, research and development and irrigation have the potential of improving the agriculture sector. Making use of the empirical evidence to support decision making will ensure that countries use the funds allocated to the agriculture sector efficiently, and they are likely to meet their Maputo targets.

Second, countries need to capitalise on agriculture's ability to improve food security and nutrition. Agriculture may be capitalised by developing the sector through increased expenditure and making it more nutrition-sensitive when it comes to food production. The nine SADC countries need to promote an increase in agricultural production of a diverse crop that will supply both macro-nutrients and micro-nutrients, which are required for the healthy and active lives of their citizens. They also need to increase the development and use of biofortified food crops. Furthermore, they can capitalise agriculture by empowering women who contribute to a larger percentage of agriculture labour and also tend to be primary caregivers in their homes. The countries can empower the women by giving them an opportunity to have productive assets such as land and to have decision-making powers over those assets. The ability of women to produce in the agricultural setting and to earn their income can positively shift the food security narrative of the nine SADC countries. Women have been known to be better at making decisions that can improve food security and the nutrition status in their households. In so doing, the nine SADC countries will be able to reduce food insecurity and malnutrition at the same time and will be able to reach their Maputo targets on food security and nutrition.

In as much as increasing food production can benefit the SADC countries, the countries are also supposed to ensure that the producers and consumers of food products are protected. They can do this by developing agricultural policies, for example, by setting limits on market prices of food products to ensure that the producer and consumer benefit from the improved production.

5.3 Contribution of the study to global knowledge

This study contributes to the impact of public investment studies by focusing on food security and nutrition. Also, the study has provided empirical evidence of the impact of government agriculture expenditure on food security and nutrition indicators in the nine SADC countries, since there has been no study of this kind since the establishment of CAADP. The empirical results will give the nine SADC countries evidence that will support them in policy formulation or change to ensure that they meet their CAADP food security and nutrition goals by 2025.

5.4 Recommendations for improvement of the study

The study focused on four food security and nutrition indicators. The study could have been improved by adding more indicators that are currently being used to monitor food security and nutrition under CAADP. More indicators would have enabled the study to have insights on how the other indicators would be impacted by government spending on agriculture.

The study could be improved by considering biophysical factors that affect food security and nutrition in the SADC region. More explanatory can also provide insight into how they affect food security and nutrition in the region.

The study could have also been improved by considering the use of a dynamic model. The dynamic models capture both short and long-term effects. Establishing the long-term impact analysis would have highlighted how the present government spending on agriculture could impact food security and nutrition indicators years later after this spending.

5.5 Recommendations for further research

First, further research is required to produce country-specific studies. These studies could focus on investigating the context and dynamics of each country on the impact of government agriculture spending on food security and nutrition. Focusing on individual nations can ensure that countries obtain results that are specific to their context and recommendations that are country-specific.

In addition, studies that focus on the impact of components of government agriculture expenditure on food security and nutrition should be carried out. For example, studies can focus on how spending on agricultural extension, research and development, rural infrastructure and irrigation impacts food security and nutrition. By examining different components of government agricultural expenditure, it could be helpful to know which expenditure produces the highest returns. In so doing, the government could take advantage of such spending to improve food security and nutrition by increasing spending on the component that brings the highest returns.

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APPENDIX A: Regression results for fixed effects estimation

	Average dietary energy supply adequacy	**Prevalence of undernourishment**	**Prevalence of stunting**	**Per capita food production variability**
Government agriculture expenditure as a share of total government expenditure	0.01 (0.08)	0.09 (0.01)	-0.09 (0.06)	-0.02 (0.01)
Gross Domestic Product per capita	0.70 (3.05)	-0.46 (3.82)	-12.81*** (2.23)	-0.66 (0.57)
Inflation	-0.05*** (0.01)	0.08*** (0.01)	0.009 (0.008)	-0.0004 (0.002)
Polity2	-0.18 (0.27)	0.53 (0.34)	0.30 (0.20)	0.10** (0.05)
Trade openness	0.03 (0.02)	0.01 (0.02)	0.02 (0.01)	0.004 (0.003)
Population growth	-2.90** (1.39)	4.47** (1.74)	0.77 (1.01)	-0.34 (0.26)
Agricultural gross production value	12.23*** (2.17)	-15.14*** (2.72)	-5.43*** (1.59)	1.17*** (0.40)
Constant	-72.02*** (18.88)	233.74*** (23.63)	207.51*** (13.78)	-9.77*** (3.50)
Observations	146	146	146	146
Countries	9	9	9	9
Within R^2	0.62	0.64	0.71	0.14
R-Adjusted	0.58	0.60	0.68	0.04