UNIVERSITY OF GHANA, LEGON

LEGON CENTRE FOR INTERNATIONAL AFFAIRS AND DIPLOMACY (LECIAD)

CONTRIBUTIONS OF THE WEST AFRICA CENTRE FOR CROP IMPROVEMENT IN ENSURING FOOD SECURITY IN WEST AND CENTRAL AFRICA

BY

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(10937104)

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DECLARATION

I, Prisca Naakuo Djabang, hereby declare that this dissertation is a product of my original work under the supervision of Dr. Afua Boatemaa Yakohene. All materials used in this work have been cited and duly acknowledged. This work has not been submitted or published elsewhere for any other purpose.

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DATE: 18th September, 2023 **DATE: 18th September, 2023**

DEDICATION

This work is dedicated to my mother, Madam Agnes Abbey. My love, you are my hero.

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Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACCI	-	Africa Centre for Crop Improvement
AGRA	-	Alliance for a Green Revolution in Africa
APBA	-	African Plant Breeding Association
AQAS	-	Agency for Quality Assurance through Accreditation of Study Programs
ARC	-	Agricultural Research Corporation
ARI	-	Animal Research Institute
AU	-	African Union
AUM	-	Abdou Moumouni University
BHEARD	-	Borlaug Higher Education for Agricultural Research and Development
CAADP	-	Comprehensive African Agriculture Development Programme
CGIAR	-	Consultative Group for International Agricultural Research
CIAT	-	International Centre for Tropical Agriculture
CIFOR	-	Centre for International Forestry Research
CIMMYT	-	International Maize and Wheat Improvement Centre
CIP	-	International Potato Centre
CMB-SE	-	Directorate for Cattle Breeding and Livestock Stations
CRI	-	Crop Research Institute
CSIR	-	Council for Scientific and Industrial Research
DAAD	-	German Academic Exchange Service
DAR	-	Department of Agricultural Research

DLVD	-	Demand Led Variety Design
ECONET	-	Enhanced Communications Network Wireless Holdings Limited
ESA	-	East and Southern Africa
FAO	-	Food and Agriculture Organisation
FARA	-	Forum for Agricultural Research in Africa
FRI	-	Food Research Institute
FRIG	-	Forestry Research Institute of Ghana
GCP	-	Generation Challenge Programme
GDP	-	Gross Domestic Product
IARC	-	International Agricultural Research Centre
IBPGR	-	International Board for Plant Genetics Resources
ICARDA	-	International Centre for Agricultural Research in the Dry Areas
ICLARM	-	International Centre for Living Aquatic Resources Management
ICRA	-	Central African Agricultural Research institute
ICRAF	-	International Council for Research in Agroforestry
ICRISAT	-	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	-	International Food Policy Research Institute
IIMI	-	International Irrigation Management Institute
IITA	-	International Institute of Tropical Agriculture
ILCA	-	International Livestock Centre for Africa
ILRAD	-	International Laboratory for Research on Animal Diseases
ILRI	-	International Livestock Research Institute
IMF	-	International Monetary Fund

INERA	-	National Agricultural Study and Research Institute
INRAN	-	National Agricultural Research Institute of Niger
IPGRI	-	International Plant Genetic Resources Institute
IRAD	-	Institute of Agricultural Research for Development
IRRI	-	International Rice Research Institute
IWMI	-	International Water Management Institute
KAEHAI	-	Kofi Annan Enterprise Hub for Agricultural Innovation
KARI	-	Kenya Agricultural Research Institute
MDG	-	Millennium Development Goals
MAR	-	Ministry of Animal Resources
NARI	-	National Agricultural Research Institutions
NARS	-	National Agricultural Research Systems
NEPAD	-	New Partnership for Africa's Development
NERICA	-	New Rice for Africa
NGO	-	Non-governmental Organisation
NRC	-	National Redemption Council
OPRI	-	Oil Palm Research Institute
PFJ	-	Planting for Food and Job
PGRC	-	Plant Genetic Resources Centre
SAP	-	Structural Adjustment Programme
SARI	-	Savanna Agricultural Research Institute
SCARDA	-	Strengthening Capacity for Agricultural Research and Development in Africa
SDG	-	Sustainable Development Goals

SLARI	-	Sierra Leone Agricultural Research Institute
SRI	-	Soil Research Institute
UN	-	United Nations
UNDP	-	United Nations Development Programme
USAID	-	United States Agency for International Development
VW	-	Volkswagen
WAAP	-	West Africa Agricultural Productivity Program
WACCI	-	West Africa Centre for Crop Improvement
WARDA	-	West Africa Rice Development Association
WCA	-	West and Central Africa
WRI	-	Water Research Institute
WTO	-	World Trade Organisation

ABSTRACT

Every individual has the right to be food secure yet there is a constant increase in global hunger and malnutrition. Food insecurity leads to economic underdevelopment and poverty. Agricultural research has over the years played a substantive role in increasing food production and driving food security. However, in Africa, agricultural research, and its institutions, particularly those that are not state-owned and funded have not been given enough attention. The West Africa Centre for Crop Improvement (WACCI) is an example of such an institution. Despite its activities towards achieving food security, information on the Centre is limited. This study highlighted the contributions of WACCI in ensuring food security in West and Central Africa. This was a qualitative study and involved in-person and online interviews with purposively selected persons from WACCI, the Council for Scientific and Industrial Research (CSIR) and the Institute of Agricultural Research for Development (IRAD) which are the National Agricultural Research Institutions (NARIs) of Ghana and Cameroon respectively. The study also used additional information from secondary data sources in the analyses. The study showed that WACCI's contributions do not only include training research scientists but also organising workshops for farmers and extension officers as well as providing the platform for training the youth in agribusiness. In addition, the study discovered that funding towards agricultural research is averagely low on the continent which accounts for the slow progress made towards achieving zero hunger as captured under the Sustainable Development Goal (SDG) 2. Most African countries are unable to contribute 10% of their budgets towards agriculture as stipulated in the Comprehensive African Agricultural Development Programme (CAADP). It was also revealed a lack of resources and political responsibilities or a combination of both accounted for reasons why the CAADP has so far failed. The study recommended that a decrease in the percentage of contribution under the CAADP will go a long way to ensure a stable annual investment towards the agricultural sector and by extension agricultural research institutions. Additionally, centres like WACCI should be set up in the various sub-regions and in different agricultural research fields, to facilitate the work of the Centre and the NARIs.

CHAPTER ONE

INTRODUCTION

1.0 Background to the Research Problem

Food is scarce in supply around the world. "Some one billion people, nearly one-sixth of the world's population suffer from chronic hunger and some 25,000 people die each day from malnutrition" (Ejeta, 2009, p. 394). Daily statistics show that the number of people who go to bed hungry keeps increasing by the day. In 2022 alone, about 691 to783 million people around the globe faced hunger (Food and Agriculture Organisation, 2023). Discussions on food security place emphasis on improving agricultural productivity to meet the demands of the population.

The various schools on food security have linked food security to population growth. Neo-Malthusian theorists such as Ehrlich (2009) have linked an increase in food production to the rise in population growth rates. He believes that an increase in agricultural production is responsible for the surge in population. A stable increase in population growth will put a strain on the Earth's limited resources. Food security is believed to lead to economic growth. This is because hunger and malnutrition limit human capital development which is important for sustainable economic growth (Torero, 2014). When there is food insecurity, governments are forced to channel funds that could be used for other development policies and projects into increasing food security (Torero, 2014).

At the 2015 United Nations (UN) Conference in Rio de Janeiro, Brazil, the 17 Sustainable Development Goals were developed. Goal Two of the SDGs aims to "end hunger, achieve food

security and improved nutrition and promote sustainable agriculture" (United Nations, 2015, p. 19). Out of the eight targets captured under SDG2, Target 2a asks that member states "increase investments, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks to enhance agricultural productive capacity in developing countries, in particular, least developed countries" (United Nations, 2015, p. 19). Though the rest of the world has put drastic measures in place to achieve this goal, Africa, languishes behind and the target of becoming food secure by 2030 appears unobtainable. With the 2019 coronavirus pandemic that took the world by storm, the current Russia-Ukraine war in Europe, and climate change, Africa has become more food insecure than ever and continues to be the only place where the number of people hungry continues to increase exponentially (United Nations, 2022).

With more than half of its population engaged in the agricultural sector, one would expect Africa to be the most food secure. Yet, Africa does not produce enough food to feed its people. For several years now, Africa has had to rely on foreign assistance and imports to supplement the ever-growing demand for food. Africa spends USD 55 trillion on net food imports annually and this figure is estimated to be USD 110 trillion by 2030 (Nakweya, 2021).

Though data on Africa looks frightening and the situation appears unsurmountable, there have been several attempts by both researchers and policymakers to come up with viable solutions for Africa. The African Union (AU) since its inception in 2002, has formulated policies geared toward eradicating hunger on the continent and achieving food security. Notable among these are the Maputo Declaration in 2003 and the Malabo Declaration in 2014 which adopted the

Comprehensive African Agricultural Development Programme (CAAP) where African states were urged to contribute 10% of their budgets to the agricultural sectors (Donkor, Onakuse, Bogue, & Carmenad, 2017). However, most African states have been unable to honour these pledges. Therefore, these policies have not effectively tackled the issue of low agricultural productivity in the continent.

Practices from developed parts of the world like the United Kingdom, Germany, the United States, and France have proven that agriculture does not necessarily thrive when vast lands are cultivated but does with research include developing improved varieties of seeds, technological advancements, and best agricultural practices (Qaim M. , 2016). In the past, low agricultural production was attributed to insufficient acreage of land cultivated and an increase in agricultural production was linked to expanding agricultural land (Qaim, 2020). However, with the increase in population and the threat of environmental degradation, it was necessary to increase crop yield without converting much land to farms, especially, when concerns about deforestation sparked a conversation on climate change. It was, therefore, necessary for countries to establish agricultural research institutions that will solve two issues - boost agricultural yield and reduce the number of lands converted into farms to conserve vegetation and forests.

In the 1960s, the Green Revolution began which resulted in the emergence of Consultative Group for International Agricultural Research (CGIAR), a private agricultural research institution, that developed improved varieties of rice and wheat drastically reducing the percentage of global hunger in places that were confronted with food insecurity such as North and Latin America and Asia (Qaim M. , The Role of New Plant Breeding Technologies for Food Security and Sustainable

Agricultural Development, 2019). The CGIAR developed improved varieties of seeds that were resilient to diseases and could withstand harsh climatic conditions. In the long run, there was an increase in agricultural yield which resulted in a drop in food prices making food accessible to most, and a reduction in malnutrition and stunted growth which gradually led to reduced levels of poverty (Qaim M. , 2019). With new challenges confronting Africa daily such as climate change, the decline in arable land, and low-quality soils there has been a drive to transform Africa's agricultural sector to embrace research. However, such a push has not been as successful as one would hope. Africa can only meet the growing food demand if it successfully incorporates better research outcomes into agricultural production.

Agricultural research institutions have played a key role in reducing global hunger over the last hundred years (Qaim M. , 2019). Unfortunately, Africa missed out tremendously when these transformations in the agricultural sector were underway across the globe because newly independent African states were emerging at that time and most African countries were not prepared for any scientific revolution in the agricultural sector (Ejeta, 2009). In Africa, the number of people facing hunger has increased by 11 million people since 2021 (Food and Agriculture Organisation, 2023). Though Africa is ravaged by hunger, food insecurity is not an African problem but a global phenomenon. Globalization has shown that every country whether developed or not needs to be concerned with what happens across the globe (Hyden, 2005). Lack of food has resulted in unemployment and poverty which serve as a direct cause of conflict, terrorism, migration, and organized crime and these activities threaten the security of developed countries. Therefore, pressure has been mounted on Africa from countries in the West and international organizations such as the United Nations (UN) to address food insecurity.

In a bid to successfully implement the successful model of the developed countries, most African states have established agricultural research institutions managed at the national levels known as National Agricultural Research Institutions (NARI) which are responsible for developing improved varieties of seeds, providing agricultural extension services and training in the use of technology in agricultural production. These NARIs, however, have not been able to successfully push the transformation agenda that is needed to transition Africa from a food-insecure continent to a secure one. The NARIs underperformance could be due to the issue of an insufficient number of African agricultural scientists to undertake vital research projects on African plants and seeds that will transform the sector. In 2007, as part of finding African solutions to African problems, an agricultural research institution, the West Africa Centre for Crop Improvement (WACCI) was established with funding from private foreign institutions to train the next generation of African agricultural scientists for the continent to drive this transformation agenda (WACCI, 2020).

1.1 Statement of the Research Problem

In 2007, WACCI was established at the University of Ghana to train of plant breeders and seed scientists as well as provide workshops on extension services and agricultural value chains in Central and Western Africa to augment the work of the NARIs and drive transformation in the agricultural sector. The Centre is privately set up by individuals with support from the Alliance for a Green Revolution in Africa (AGRA) and other organisations such as the World Bank. AGRA was set up with support from the Rockefeller Foundation and the Bill and Melinda Gates Foundation, and functions under the CAADP. AGRA's main objective is to change the narrative of smallholder agriculture from a story of struggle to that of success by developing resilient food systems in Africa (Alliance for a Green Revolution in Africa, 2023). Though it was set up in

Ghana, WACCI trains plant breeders from West and Central Africa (WACCI, 2020). The Centre has produced its fair share of plant breeders who can be seen working in NARIs across the continent, developed over thirty improved varieties of seeds as well as provided training to private individuals and stakeholders (WACCI, 2020).

With the agricultural sector being a big contributor to the continent's Gross Domestic Product (GDP) and its highest employer, it is expedient to revamp the sector to maximize benefits. One way to achieve this is to encourage the setting up of private agricultural research institutions or provide technical and financial support to existing ones as the NARIs have proven unable to lead the kind of transformation the agricultural sector needs alone. Though WACCI has over the years provided NARIs with much-needed scientists and has contributed massively to ensuring food security in West and Central Africa, it has not received its due recognition nor adequate support from states and the African Union. With the right amount of support, WACCI has the potential to be the next agricultural research institution to drive a green revolution on the continent. It is against this backdrop that this study is being conducted. This study highlights WACCI's contributions in promoting food security in the West and Central African regions.

Research Questions

The study seeks to answer the following questions:

1) How vital are agricultural research and its institutions in achieving Sustainable Development Goal 2?

2) What contributions have WACCI made towards ensuring food security in Africa?

3) What is the level of national and continental financial support of WACCI?

4) What are the challenges WACCI faces?

1.3 Research Objectives

The study seeks:

1) To assess the importance of agricultural research institutions in achieving Sustainable Development Goals 2.

2) To ascertain the contributions WACCI has made toward ensuring food security in Africa.

3) To understand the level of national and continental financial support of WACCI

4) To identify the challenges WACCI faces.

1.4 Scope of Study

WACCI has been in existence since 2007 and has engaged in several activities over the years. The Centre is a training centre for both PhD and master's students in plant breeding and seed science technology. It has also engaged in other activities such as providing relevant workshops to private individuals and stakeholders as well as establishing its agricultural innovation hub with the target of attracting the youth into the sector. This study focuses on WACCI and all its activities from 2007 to 2022. This will provide a clearer picture of what WACCI has been able to achieve as well as highlight its impact on Africa's agricultural sector.

1.5 Rationale of Study

278 million people in Africa are suffering from chronic hunger which represents 20% of the world's population (Armstrong, 2022). Also, 55 million children under the age of five are stunted due to severe cases of malnutrition with low investments in agriculture being identified as a key cause of widespread hunger (Oxfam International, 2023).With hunger and malnutrition levels rising exponentially, Africa must embrace the best agricultural practices which can only be known

through research and technology. Research in agriculture is crucial, especially, if Africa wants to be food secure by 2030 as stated in the SDGs. Also, with intra- African trade set to increase with the establishment of the African Continental Free Trade Area, the agriculture sector will be key to boosting GDP and employment if proper changes are affected.

The research highlights the contributions of WACCI in ensuring food security in West and Central Africa. In doing so, among other things, it looks at successes chalked by the Centre as well as challenges it faces in executing its activities. Findings from the study will prove how vital the Centre is in the fight against food insecurity on the continent and increase state and continental involvement to accelerate the activities of the Centre.

1.6 Thesis Statement

The study states that food insecurity persists in Africa due to inadequate attention to agricultural research institutions such as WACCI.

1.7 Theoretical Framework

The theoretical framework underpinning this research is the techno ecological theory of food security.

1.7.1 Introduction

This section will look at the evolution of food security. It begins by looking at the traditional theory of security in International Relations and the various reasons why the theory of security needed to be enlarged to encompass new meanings of security such as the Human Security theory. It also takes a closer look at the food security as one of the seven categories of the human security theory

and highlights its pillars. Finally, it focuses on the techno-ecological theory of food security which is identified as the most suited for this study.

1.7.2 Human Security Theory

Security in International Relations (IR) has been understood from the perspective of the state and its military prowess. A state is said to be most secured when it has the greatest military power in the international system. Individuals were not considered important actors in the international system. If arguments from the Leviathan are anything to go by, individuals entrusted the state with the power to protect them from threats (Hobbes, 2006). However, these threats have only been viewed from a military perspective where states defend their borders from external attacks. (United Nations Development Fund, 1994).

Post-Cold War studies saw new discussions on the concept of security emerge (Tadjbakhsh, 2005). States did not only need to protect their people from other states but also needed to protect them from internal threats that were natural or artificial. Discussions on international security moved from the national level to the individual level where security focused on identifying threats that affect individuals, communities, and societies and how to prevent these threats to avoid disruptions in the international system (United Nations Trust Fund for Human Security, 2009). Human security is "about the security of individuals and communities in which they live, rather than the security of the state." (Kaldor, 2008, p. 1) Human security defined in simpler terms is freedom from wants (hunger, unemployment) and fears (crime, conflict) (United Nations Development Fund, 1994). Human security has been conceptualized in a broader term to include

every issue that affects an individual's existence (Freedom from Want) and narrower to include issues that really can become national or global issues if not addressed.

Human security also means freedom to live in dignity which means every individual has the right to live in a state that guarantees equal respect and helps them develop their capabilities which will help them realise their potentials. This can only be achieved when one is truly free from wants and fears (JICA, 2021)There are seven identified areas that threaten human lives and dignity. They are disease, hunger, unemployment, crime, social conflict, political repression, and environmental hazards (United Nations Development Fund, 1994). These threats are captured under "seven main categories: economic security, food security, health security, environmental security, personal security, community security, and political security" (United Nations Development Fund, 1994, p. 24).

1.7.3 The Concept of Food Security

Food security is said to be achieved when one has access to food which is safe and healthy in abundance. It means being able to produce your own food as well as having access to markets and the having money to buy food. 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 healthy life" (Food and Agriculture Organisation, 2009, p. 39).

1.7.4 Pillars of Food Security

The UN Food and Agriculture Organisation (FAO) developed the four pillars of food security which were set out at the World Summit of 1996. For food security to exist, food must be available, accessible, utilized, and stable (Volger & Annan, 2021).

Availability of food means that food should be easy to obtain. Food availability addresses issues that have to do with the supply of food through food production or food imports (Food and Agriculture Organisation, 2008). Also, food accessibility depends on individuals' ability to get food. It does not only depend on one having money but one's ability to get to the markets to purchase food (Darfour & Rosentrater, 2016). According to the UNDP Report, there are food security challenges not because food does not exist but rather because food is not affordable (United Nations Development Fund, 1994). States are addressing food accessibility issues by creating employment opportunities, increasing income levels as well as developing good infrastructure. Another way to make food cheap is by increasing food production which can be done when there are high-yielding seeds for crop production. Food utilization focuses on how food is used effectively and where food is consumed in its right amount and nutrients. Food utilization is solely about the individual and the focus is placed on the dietary practices of the consumer. What one eats and in what quantity is based on education and culture (Alonso, Cockx, & Swinnen, 2018). Food is said to be stable when food is available, accessible, and utilised always without disruptions such as extreme weather conditions, economic and social disruptions, and poor functioning global markets (Darfour & Rosentrater, 2016). Therefore, food security is said to be achieved when there is stability in food availability, accessibility, and utilization (Simelane & Worth, 2020).

1.7.5 Techno-Ecological Theory of Food Security

This theory focuses on the ability of humans to adapt technology to population demand in the global ecosystem (Iveren, 2021). Cohen (1995) claims that food security can be achieved when science and technology are incorporated into food production and distribution. It argues that "food security can be achieved if only human beings can adapt new technologies and strategies of land use and stratification" (Iveren, 2021, p. 5). Techno- ecologists like Simon also claim that an increase in population should not be seen as a threat to food security but rather an asset as human beings have the capacity to solve their problems using science and technology (Simon, 1981). The main elements of the techno-ecological theory are human ingenuity or actions and technology. The theory emphasizes how human interactions with technology can proffer long-lasting solutions to food insecurity (Megwalu, 2020). For example, the introduction of chemicals, fertilizers and improved crop varieties are developed through years of painstaking research activities. The emphasis on both human resource and science and technology in this theory makes it the best theoretical perspective on food security for this study. This work focuses on how agricultural research is vital to addressing food security challenges by looking at WACCI and its contributions so far in the field of research and food security.

1.7.6 Critique against the Techno-ecological Theory of Food Security

Food security centred on individual rights and states' rights to produce their food (Food and Agriculture Organisation, 2009). Also, food security moved from purely the supply of food to encompass access to food (Food and Agriculture Organisation, 2000). Though all these helped in shaping the concept and analysis of food security, it failed to look at the underlying power and social relations that characterize food systems and rather focuses on trade as a possible solution to

achieving food security (Patel, 2009). The concept of food security fails to recognize that people who produce food are not always treated fairly. This is something that dates back in history and a classical example of this power relations is seen in the Feudal system where those who worked the land and produced food were disregarded (Sakar, 2022). Patel (2009) argues that addressing the social and political underpinnings of food security will help address food security challenges.

For Neo-Malthusian theorists an increase in population is a threat to food security. The more people we have on earth, the less food secure we are going to be as the earth's capacity to sustain life will begin to diminish with an increase in population (Ehrlich & Ehrlich, 2009). According to the neo-Malthusian theory, although technological advancements can lead to increase in agricultural productivity, population growth will also increase due to such increase and will ultimately lead to the depletion of earth's resources (Ehrlich & Ehrlich, 2009). To the Neo-Malthusian theorists, there can be no guarantees of food security if population growth continues to increase unchecked. The dependency theory of food security, claim that food insecurity will always exist in less developed countries as developed countries economically exploit the less developed countries which depletes the capital needed to improve their agricultural sectors (Iveren, 2021). Like the Neo-Malthusian theory, the dependency theory does not regard the role of technology and research in achieving food security. According to these theories, the nature of human beings and the structure of the world makes food security impossible to achieve. To the dependency theorists, the less developed parts of the world like Africa, South America and some parts of Asia will always experience food security challenges as such situations are caused by the continuous exploitation of resources by developed countries (Iveren, 2021).

1.7.7 Relevance of the Techno-ecological Theory of Food Security

The techno-ecological theory of food security, unlike other theories of food security, concentrates on the relationship between science, technology, or research and human ingenuity, ability, or creativity (Cohen, 1995). To the theorists, food security cannot be improved in a vacuum or by wishing it. Food security can only be achieved through human beings' ability to conduct research in the field of agriculture to address challenges in the sector is vital (Megwalu, 2020). It is through research that chemicals such as insecticides, weedicides, fertilizers, and improved varieties of seeds have been developed to boost crop yield and productivity (Ahmed, 2022). This is what agricultural research institutions, particularly WACCI, are set up to do which makes the techno-ecological theory of food security the most relevant in this study.

1.8 Literature Review

1.81. Introduction

The study looks at the various literature concerning the research topic and the different views of authors on the subject under study. Under this section, the literature is divided according to various headings or subjects. Firstly, the issue of food security in Africa is highlighted and captures the picture painted in the various literature on the state of food security in Africa which includes the causes and challenges. Furthermore, the literature centres on agricultural research in Africa and the link between research and food security. The next section examines specific agricultural research organisations on the continent which are mostly international agricultural research organisations. There is limited literature on the NARIs and other agricultural research organisations such as WACCI. The literature also discusses barriers to agricultural research which is the next subject discussed. Most literature cited low level of investment in the agricultural sector

as a contributing factor to low levels of agricultural research activity in Africa. From the literature, when talking about agricultural research organisations, there is little or no mention of the NARI or other agricultural research organisations such as WACCI and their work. Also, low funding is identified as the major impediment to agricultural research organisation.

1.8.1 Food Security in Africa

Africa has been battling food security challenges ever since its independence. With a renewed interest in reviving the agricultural sector to achieve food security, research and policies have focused on causes of food insecurity where different thoughts have emerged. Darfour and Rosentrater (2016) mention that there are constraints in the agricultural sector of Ghana, and these contribute to food insecurity. According to them, these challenges include low-level technology development, natural resource management, and human resource management. However, they fail to mention that low agricultural research is a challenge in the agricultural sector. Also, he fails to look at how agricultural research can improve food production in Ghana. Sisha (2020), in his assessment of household levels of food insecurity in Ethiopia, reveals that food insecurity is associated with conflict, social insecurity, and climate shocks. Ahmed (2022) identifies that Africa encounters food security challenges due to low plant nutrients which translates into low agricultural productivity. He uses Ethiopia to further the argument that agricultural productivity can only improve by the usage of both improved varieties and inorganic fertilizers which are developed through research. However, he fails to identify the other factors which can improve agricultural productivity such as developing improved crop varieties, soil nutrient development, and improved climatic conditions.

Adeyeye (2017)attributes food insecurity to the low processing and storage culture that exists on the continent. Adeyeye notes that even if productivity is increased, it will still result in huge post-harvest losses if processing and storage capacities among farmers and consumers are not enhanced. Though he acknowledges the role of both national and international agricultural research organizations, particularly, the CGIR in developing sustainable food production systems across Africa, he fails to include agricultural research organizations that are either national nor international and their impact on food security in Africa. This literature is important as it highlights the role of agricultural research in achieving food security.

Several research conducted have been on the positive correlation between public spending on the agricultural sector and research to improve food security. Sers and Mugal (2019) notice that since 2003, countries that allocated 10% of their public budget to the agriculture and increased spending on agricultural research recorded improved food security. This demonstrates how crucial agricultural research is in addressing food insecurity in Africa and how the quality of the research depends on the amount of money pumped into it.

1.8.2 Agricultural research in Africa

Agricultural research in Africa is not a recent phenomenon. Individual countries have recognized its importance and have incorporated it into universities and national research institutions. Agricultural research delves into several aspects of agriculture which include developing improved seed varieties, technologies, and sustainable agricultural practices. Gassner et al (2019) argue that farm-level technologies are important in ensuring food security in sub-Saharan Africa. They also recognize that these technologies that will boost productivity can only be obtained through

agricultural research. Gassner et al agree that targeting smallholders as the beneficiary of farm-level technologies do not necessarily guarantee economic growth though it ensures food security. This is because smallholders in Africa do not have money to invest in agriculture as they have small farms which are not profitable. They suggest agricultural research should generate technologies that will be compatible with and available to these smallholders. Gassner et al, however, fail to mention what these farm-level technologies are. They also fail to acknowledge that reducing poverty using farm-level technologies will not happen instantly; there needs to be consistency over time to ensure economic growth. Also, there was no clear- cut solution on how to ensure that these technologies are cheap and accessible to farmers for a long time. Gassner et al also fail to look at how agricultural research will generate technologies that will enhance productivity in smallholder farming across the continent. They fail to also look at how governments can facilitate research to ensure that technologies that are developed are compatible and affordable. This literature is important because it reiterates the importance of agricultural research in achieving food security.

Flaherty and Luezaura (2019) reveal that before 2009, public agricultural research in Tanzania was donor funded. However, funds plummeted, and the government, realising the impact of research on agriculture, had to increase its budget for agricultural research which showed some improvement in agricultural research, though such improvement has been minimal. This literature supports the argument that agricultural research contributes to addressing food insecurity on the continent. Just as agricultural research is important, the organizations which conduct research are equally important in Africa's drive toward food security.

1.8.3 Agricultural Research Organisations in Africa

When it comes to agricultural research organisations in Africa much emphasis is placed on international agricultural research organisations and their roles or impact in Africa. These organisations include Africa Rice, and the International Maize and Wheat Improvement Center (CYMMIT). Rice which initially is not a staple of Africa, is gradually becoming one. As the consumption of rice is far above the quantity of rice produced on the continent countries would have to spend huge sums of money to import rice to meet the demand. Arouna et al (2017) talk about the importance of the agricultural research organization, Africa Rice, in generating improved rice varieties which have transformed economies in Africa. Africa Rice developed an improved variety of rice that is resistant to pests and diseases, and this has bolstered production in agriculture on the continent. Though highlighting the achievements in increasing rice production through developing improved rice varieties is good, they fail to address the achievements that have been chalked so far in the development of improved varieties of other crops which are equally consumed in higher quantities and considered staple African crops such as tomatoes, pepper, beans, maize, and cassava.

Ripoll et al (2017) speak about the importance of international research organizations to reshape their policies and structure toward youth. They argued that the youth is integral to attaining rural transformation in sub-Saharan Africa. The paper points out that people engaged in agriculture in sub-Saharan Africa are ageing and with challenges such as youth bulge and an increase in population, it is vital to target the youth in the transformation process of the sector. These organizations will introduce attractive packages and incentives to push more youth into the sector. Though talking about the involvement of international agricultural research organisations in

attracting the youth into the agriculture sector is commendable, the literature fails to look at how national structures can hinder these organisations. It also fails to look at how governments through their NARIs can develop and implement domestic policies which will attract the youth.

Hellin and Camacho (2017) talk about the role of agricultural research organizations like CYMMIT in Mexico. According to them, the collaboration between the government and CYMMIT led to innovation in wheat and maize production by developing improved varieties, sustainable agricultural practices, and land management approaches. Though agricultural research organizations have played their role, it is not without challenges and difficulties.

1.8.4 Barriers to Agricultural Research in Africa

This section highlights the key impediment to agriculture research in Africa which is low levels of investment. Chaminuka et al (2019) speak about the low investment of the South African government in agricultural research. They add that though governments across the continent committed to spending 10% of their budget on the agricultural sector and improvements have been witnessed, it still falls short of the 10%. According to them, there is a need to have a public investment in agricultural research as previous records from Asia have shown that agricultural research is necessary for the overall transformation of the sector. Chaminuka et al (2019) reveal that South Africa is at par with other countries like Nigeria, Kenya, and Ghana when it comes to public investment in agriculture. This literature is important as it reveals that African countries have not contributed enough to agricultural research, and this can account for the reasons why Africa is still food insecure.

1.9 Research Methodology

1.9.1 Research Design

Research design defines all methods and procedures used in data collection and analysis (Zikmund, 1988). This research used the qualitative research design in its analysis as the data gathered was purely non-numeric. In this study, the data gathered are based on individuals' opinions, and ideas of the state of food security in Africa and the importance of agricultural research institutions in solving the food security challenges in Africa (Hox & Boeije, 2005).

1.9.2 Inductive Research

This study is inductive as it enabled the researcher to generate themes and concepts from the collected raw data. It also allowed the researcher to develop connections between the research objectives and the findings gathered from the data (Thomas, 2006).

1.9.3 Case Study

The study is a case study as it involves a detailed study of an individual, a group of people or unit (Gustafasson, 2017). Using a case study allowed the researcher to study a particular event arising from a particular unit (Gustafasson, 2017). In this study, WACCI was used as case study to better understand how vital agricultural research organisations are in solving the food security challenges in Africa. It also revealed that though international research organisations are playing their part, other institutions such as WACCI are making headway which needs to be highlighted.

1.9.4 Sources of Data

Both primary and secondary sources of data were employed in the study.

1.9.4.1 Primary Data

Primary sources of data are data collected purposefully for specific research and use techniques that are tailored to that specific research (Hox & Boeije, 2005). Primary sources of data included interviews conducted with WACCI faculty, as well as with selected researchers from the Crop and Research Institute of Council for Scientific and Industrial Research (CSIR), Ghana and the Institute of Agricultural Research for Development (IRAD), Cameroon. CSIR and IRAD were chosen as they are the NARIs of both Ghana and Cameroon. Ghana was selected to represent West Africa as it is the home of WACCI and Cameroon was chosen to represent Central Africa since WACCI has had more engagements with Cameroon that the other countries in Central Africa. These two institutions were chosen to highlight the activities WACCI has in the western and central regions of Africa.

1.9.4.2 Secondary Data

Data collected for specific research and are being reused for another research are called secondary data sources (Hox & Boeije, 2005). Secondary sources of data used include reports on the SDGs from UN and AU, the twelve-year WACCI report and the CAADP report. Also, relevant sources from books, websites, and journal articles were used. The secondary data sources used were chosen in line of the research objectives of the study. The SDGs report from the provide insight into the continent's activities and progress in achieving SDG 2 by 2030. The twelve-year WACCI report sheds light on the Centre's work and its contributions towards attaining food security and the CAADP report highlights the levels of funding African governments pump into agricultural research annually. Other materials which talked about the research objectives were also included in the study.

1.9.5 Sample Population and Size

Population refers to a complete set of people with certain characteristics that are of interest to the study and the sample is a statistical representation of the population (Majid, 2018). The population included WACCI Faculty and staff from the NARIs in both West and Central Africa. NARIs were included in the study population as they have relevant information on WACCI's influence on agricultural research and help the researcher address the research objectives.

The sample size used in the study was five. Two researchers were selected each from WACCI and CSIR, Ghana and 1 researcher from IRAD, Cameroon. The researcher included CSIR in the sample because WACCI is in Ghana which makes its engagements with CSIR easier and more visible. The researcher also chose IRAD to provide relevant information on WACCI's activities and contributions in Central Africa. Five was chosen as this was cost-effective. Also, the primary source was supported by the WACCI 12-year report which contained a detailed account of the Centre's activities. Additionally, the directors of the crop division of both IRAD and CSIR were included in the sample size, and this meant detailed information was given about the activities between the Centre and the NARIs, and other NARIs in the regions under study.

1.9.6 Method of Sampling

"Sampling is the process of selecting a statistically representative sample of individuals from the population of interest" (Majid, 2018, p. 3). The sample cannot be chosen out of a vacuum. The appropriate sampling method should be employed to ensure that the information gathered from the sample reflects the population. Therefore, the researcher used purposive sampling. Purposive sampling is used because data was gathered from persons with relevant knowledge of the research

topic. This method is guided by the researcher's need for information and helps construct a meaningful sample (Hox & Boeije, 2005).

1.9.7 Data Collection

Data collection is a process used to gather information about the study (Cote, 2021). The study used a semi-structured interview guide through in-person and virtual interviews to collect data. The virtual interviews were done through phone calls and Zoom meetings. This type of interview is flexible as it contains key questions but allows for other questions to be posed for more information. It allows the researcher to have information which is important to the participants and the research but may not have been thought of by the researcher (Gill, Stewart, Treasure, & Chadwick, 2008). Additional information was also obtained from reports, websites, articles, and books.

1.9.8 Data Analysis

Data analysis focuses on how to analyse and present the data collected in a manner that answers the research objectives (Burnard, Stewart, Treasure, & Chadwick, 2008). As the study is qualitative and uses the inductive approach to research analysis, thematic analysis is used in analysing the data gathered. Thematic analysis entails identifying and analysing various patterns or themes that emerge from the data gathered (Braun & Clarke, 2006). The work used Braun and Clarke's six stages of thematic analysis which are - becoming familiar with the data, generating initial codes, searching for themes, reviewing themes, defining the themes, and then writing them (Braun & Clarke, 2006). The study identified the various themes or patterns that emerged by analysing the transcripts gathered from the interviews (Burnard, Stewart, Treasure, & Chadwick,

2008). This type of data analysis is flexible and allows the researcher to give a detailed account of sets of patterns that emerge from the data set (Braun & Clarke, 2006).

1.9.9 Ethical Considerations

Ethical considerations are principles that a researcher must abide by when collecting data (Bhandari, 2022). The ethical issues considered in the research are voluntary participation, consent, anonymity, and confidentiality (Bhandari, 2022). Permission and consent were obtained from participants. This allowed the participants to formulate coherent responses that were vital to the study and divulge information that may have been overlooked by the researcher but equally important to the study. During the interview process, permission was also sought to record the interview sessions. Confidentiality and anonymity were granted when requested. This was done to protect the participants and bolster their confidence for the participants to speak freely. Information presented from the study is not a reflection of any individual's thoughts but a cumulation of responses gathered from the interviews conducted in line with the objectives of the study.

1.10 Limitations of the Study

This study as compared to any other study is not without limitations. As the study employs the qualitative research method, issues of biases and subjectivity may arise. The study is limited in terms of sample size. Interviewing more researchers from the various NARIs in the regions will guarantee a higher level of confidence in the study. Another limitation of the study is time constraints as the study was conducted within a limited amount of time. Despite these limitations,

the study is still relevant as it provides useful insights which will add to already existing literature in the field.

1.11 Arrangement of Chapters

The study is organised into four chapters.

The first chapter consists of the introduction to the study. This provides a background to the research. It highlights the problem to be investigated, the research objectives, the research questions, and the rationale of the study. It also includes the theoretical framework of the study, a literature review on agricultural research and food security on the African continent, research methodology, sampling size, sources, collection, and analysis of data.

The second chapter looks at an overview of agricultural research in Africa. It highlights the emergence of agricultural research and institutions in the agricultural sector in various African countries and their contributions so far in tackling food security challenges on the continent.

Chapter Three analyses the various contributions of WACCI in ensuring food security in West and Central Africa. It highlights WACCI's achievements in fighting food insecurity on the continent which include developing improved varieties of seeds, training African plant breeders for other agricultural research institutions such as the NARIs and other private institutions on the continent, training stakeholders in agricultural value chains and its programme designed specifically for the youth to attract them to the agricultural sector. It will also address the various mechanisms that can be put in place to mitigate the challenges the Centre faces.

Chapter Four includes a summary of research findings, conclusions, and recommendations.

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CHAPTER TWO

OVERVIEW OF AGRICULTURAL RESEARCH IN AFRICA

2.0 Introduction

This chapter seeks to look at the evolution of agricultural research in Africa. It tracks the various trajectories agricultural research has taken under the three phases of African society. It begins with a historical account of agriculture from the pre-colonial era, moves to the state of agriculture in colonial Africa and finally provides insights on agriculture in contemporary African society. It shows agricultural research changed the dynamic of the agricultural sector in each era. It also looks at the different agricultural research institutions and policies that exist on the continent and their functions. The chapter concludes with an overview of WACCI which includes its organisational setup. This chapter addresses parts of the initial research question which seeks to bring to the fore the importance of agricultural research and its institutions to achieving SDG 2.

2. 1 Agriculture in the Three Eras

2.1.1 The Era of Farming, Fishing and Hunting in Pre-Colonial Africa

The perception that Africa had no civilisation before the arrival of the Europeans has been refuted by historians, archaeologists, and anthropologists. Studies show that before the arrival of the Europeans, Africa was at the peak of civilisation (wa Muiu & Martin, 2009). Though some parts of Africa had acephalous societies, food production was a common theme that run across the continent. Some societies were known for producing a lot of farmers in their location. For example, communities with vast portions of land had most of their population involved in either farming or hunting. Communities surrounded by the sea had some members being fishermen and others being farmers or hunters. There were also communities which dabbled mainly in the rearing of animals

such as the Fulani herdsmen (wa Muiu & Martin, 2009). Most of the tools used in food production were primitive. However, civilised parts of Africa such as the Nubian Empire and the Egyptian Empire had sophisticated tools and equipment as well as agricultural scientists who were responsible for ensuring that the land was arable, and the seeds were viable. In short, they were responsible for a bumper harvest and healthy crops (wa Muiu & Martin, 2009).

In pre-colonial Africa, the preoccupation of the people was to produce food in the right quantities to feed their families first. Hence agriculture in pre-colonial Africa was subsistence in nature (Inikori, 2013). Any extra produce obtained after feeding the family is then taken to the marketplace where they traded for other goods or items. Therefore, agriculture was accompanied by the barter trading system. Agriculture was so important that every community member needed to know how to provide food for themselves and trade some portions of what they produced for what they lacked. This ensured that everyone produced what they were best known for; therefore, there was both comparative advantage and specialisation in the agricultural sector of pre-colonial Africa.

2.1.2 Agriculture and Colonial Africa

Agriculture in colonial Africa did not go through many transformations. Agriculture was mostly subsistence. However, colonisation introduced exportation. This led to African societies engaging in agriculture on bigger scales to meet the export requirements of the Europeans (Beye, 2002). Also, the type of crops produced on the consistent underwent some form of transformation. Cash crops such as coffee, cotton, rubber, tea, and cocoa were introduced during the colonial period (Beye, 2002). The fishing industry also changed to meet the export demands. Chemicals for

fishing were introduced and concepts like fish farming were practised for the first time on the African continent during colonial rule (Beye, 2002).

With the idea of exportation came the mechanisation of the agricultural sector which introduced modern tools and equipment into the agricultural sector. Also, development projects in terms of infrastructure started springing up across different parts of the continent, especially in sub–Saharan Africa such as good roads and railways. For the first time in Africa's history, regional integration blocs such as customs unions were established by the Europeans to enhance trade among African countries due to the amount of exportation that was happening across the continent at the time.

2.1.3 Agriculture in Post-Colonial Africa

After most African states became independent by the 1960s, the face of the agricultural sector did not change much from the colonial era. African leaders of newly independent African states realised that there was a huge deficit in the number of people in the agricultural sector as most of the population was interested in white-collar jobs (Nyerere, 1977). The low number of people in the sector meant that African countries were going to experience a shortage of food and would have to spend large sums of money on food imports. African leaders, realising how important the agricultural sector is improving the livelihoods of the people, introduced policies and programmes geared towards transforming the agricultural sector into a viable one. In Tanzania, under the leadership of Julius Nyerere, policies were introduced to simultaneously solve food insecurity and curb excessive imports. He introduced policies like the Arusha Declaration which unfortunately did not yield the maximum benefits (Nyerere, 1977).

After Ghana's independence, Kwame Nkrumah embarked upon a development programme that will decrease Ghana's dependence on cocoa by diversifying the agricultural sector. In its initial phase the development plan targeted smallholder farmers. Storage facilities were built, and subsidies were given to smallholder farmers. Subsequently, large scale state farms were established (Lambert, 2019). The state farms were designed to decrease agricultural imports and increase agricultural exports of crops other than cocoa. These farms had employees and by 1965, the number of employees on the state farms were 18,000. Each employee received a formalised waged labour, but this project ended abruptly when Nkrumah was overthrown (Kunel, 2017). Colonel Kutu Acheampong, who was the leader of the National Redemption Council, introduced a similar policy in Ghana which he called 'Operation Feed Yourself' (Lemmenmeier, 2012). Nigeria also during its post-independence days introduced several agricultural policies and programmes all aimed at improving the agricultural sector. One of such policy is the Operation Feed the Nation which was launched in 1976. It worked similarly to Acheampong's policy as its aim was to encourage Nigerians to produce the food they consume. The government subsidised fertilizers, agrochemicals, land clearing and land preparation. The government also built storage facilities at strategic locations and tried to encourage everybody to farm (Ufedo, 2023).

Right after colonial rule, Cameroon, introduced five series of five-year development plans with agriculture occupying a major place in all these plans. The development plan was between 1960 to 1985. The initial five-year plan placed much concentration on peasant farming and how to gradually grow that sector. However, the subsequent five-year plans did not follow this initial trajectory and the government lost complete focus on protecting smallholder farmers such as the increase in indirect tax by marketing boards. Also, the development plans failed to achieve its full

potential as foreign aid donors were no longer willing to fund them (Bamou & Masters, 2007). The World Bank, International Monetary Fund and the World Trade Organisation championed the theory of comparative advantage which stressed the fact that Africa should only focus on producing what it is best known for which is raw materials and import items it cannot produce, or it does not have an advantage in producing (Siddiqui, 2018). Therefore, African countries became net exporters of raw materials and net importers of finished or processed goods and food. This has been largely attributed as one of the reasons for Africa being poor and hungry.

Since independence, African countries have continued to struggle with food insecurity. Every day, millions of Africans go to bed hungry or are not fed properly (United Nations, 2022). The agricultural sector has not improved much since the days before colonialism. Most African countries largely rely on traditional tools and equipment in the production of food and contemporary irrigation systems which are essential in farming systems are for the most part non-existent. African farmers largely require rainfall to irrigate their crops and with large parts of the continent suffering from drought, this has worsened the quantities of food Africa can produce yearly. The Millennium and Sustainable Development Goals were introduced to redirect African priorities into solving food insecurity. This led to a lot of interest in agricultural research and the development of institutions as these have been tested and worked in places like South America and Asia (Ripoll, et al., 2017). It is believed that agricultural research and its institutions could help Africa overcome its food security issues and ultimately drive development. Agricultural research revealed that food production can be increased with science and technology and not by necessarily involving lots of people in the agricultural sector.

2.2 The Genesis of Agricultural Research Institutions in Africa

Agricultural research began very early in Africa. Research focused mostly on commercial crops and the establishment of botanical gardens. These gardens were set up and managed by colonial powers such as the United Kingdom, France, and Germany. Three botanical gardens were set up by the Germans in Edea, Akonolinga and Victoria of Cameroon and in Ghana, the Aburi Botanical Gardens was constructed by the British (Beye, 2002). "Research at that time focused mainly on screening exotic materials, such as oil palm, cocoa and rubber, for economic uses in the colony" (Beye, 2002, p. 12). However, after Second World War, there was a need to create more formal agricultural research centres in the colonies which led to the establishment of regional research structures to cater for several local territories. This kind of approach was adopted by both the British and the French as they found such an arrangement cost-effective and very easy to run. These regional agricultural research centres include the West African Cocoa Research Institute and the West African Timber Borer Research Unit both situated in Ghana (Beye, 2002). Kenya and Madagascar, for example, also had local research stations such as the Kabete Station and the Maravoay Station respectively. These research stations were later absorbed into the NARS (Beye, 2002).

Very early on, the Heads of State on the African continent realised that agriculture was crucial to their development. The agricultural sector contributed massively to their GDP and was also a sector that raked in a lot of foreign exchange for the country through the export of these agricultural products, particularly, cash crops. Ghana, for instance, is one of the two largest exporters of cocoa. Agricultural research has always existed in contemporary Africa and the research institutions established by the colonial powers were now under the control of African governments after

independence. Ghana, for instance, gained control of the West African Cocoa Research Institute that was established for the West Africa region. Universities across Africa have departments dedicated solely to agricultural research. Also, agricultural ministries had sections for agricultural research. Due to how little Africa is recognised in the international system during the 1960s to 1980s, much international influence was absent from the continent and the scale of agricultural research conducted on the continent was limited since governments were the sole sponsors of research in Africa. As a result, agricultural research was not able to yield the maximum result or improve the agricultural sectors of African states as governments did not have enough funds to conduct large-scale research in the agricultural sectors or in situations where the funds were available, governments had other priorities that took precedence over agriculture. Universities had few students or youth interested in agricultural research and the type of research conducted targeted crops which were not indigenous such as wheat and barley.

Also, the equipment and tools needed for effective research were not readily available. Public departments responsible for agricultural research were short-staffed, not remunerated enough and lacked the funds to carry out good research (IFPRI, 2016). There was no periodic training of staff on new ideas in agricultural research. These made agricultural research urban-centred which proved futile in the long run as studies have shown that agriculture is more vibrant in the rural areas than in the cities and towns. Therefore, there existed a gap between the agricultural researchers and farmers (IFPRI, 2016). Currently, such gaps still exist despite numerous efforts by governments to breach the gap.

Apart from national agricultural research institutions, other research institutions started springing up on the continent, especially in the 1980s when the Structural Adjustment Programmes (SAPs) put a limit on government roles in agricultural research to allow for more public-private cooperation (Sumberg, 2005). Therefore, there existed three types of agricultural research centres in Africa (Sumberg, 2005). There are the national agricultural research systems (NARS) which constituted departments, centres and institutions that were either public or private in structure. Additionally, there are international agricultural research centres established on the continent which were mostly private and funded by international agricultural research institutions such as the CGIAR. More also, there exists agricultural research agencies which are research institutions in developed countries (Sumberg, 2005).

2.3 Some Challenges Facing Agricultural Research Institutions in Africa

Perhaps, the biggest challenge facing agricultural research institutions is the issue of funding. Funding or resource mobilisation hinders the work of research institutions on the continent. The NARIs are ineffective because most governments do not invest in agricultural research (Chaminuka, Beintema, Flaherty, & Liebenberg, 2019). This is because African states have low resource mobilisation systems and in addition to those a huge part of their revenue is channelled into servicing sovereign debts, paying salaries and corruption. Therefore, agriculture is relegated to the background and not given as much attention as it ought to be given. Low funds in NARIs mean that the amount of research conducted every year dwindles. Also, these institutions are unable to employ more researchers or unable to have regular training sessions for their employees. Higher institutions do not also receive enough public funds to carry out their research activities and this makes them ineffective in terms of complementing the activities of the NARIs. African

states are unable to meet the target of CAADP of 10% due to funding issues and the work of FARA is also ineffective due to low levels of funds (AUDA-NEPAD, 2021).

Another challenge has to do with low levels of private partnership (Lynam, Beintema, & Annor-Frempong, 2011). Most of the agricultural research institutions on the continent are controlled by states. Few public-private partnerships exist on the African continent. The notable ones are the CGIAR partnerships we have on the continent. However, this is not enough to solve Africa's problems in the agricultural sector. Also, some private investors would like to partner with universities or research centres and not with the NARIs as they believe that the universities or research centres will have better accountability and transparency systems. Though such a partnership is beneficial, Africa has a better shot at addressing poverty and food insecurity when there is a greater partnership between the public and private sectors (Lynam, Beintema, & Annor-Frempong, 2011).

Technology continues to be a challenge to agricultural research institutions. Agriculture research can only be effective when it is accompanied by technology and Africa is deficient in this area (Hall & Dorai, 2020). Africa needs state-of-the-art research facilities with the most modern equipment and technology to help researchers make breakthroughs in the agricultural sector (Suri & Udry, 2022). For example, the creation of varieties cannot be done in a vacuum, such research must be conducted with the help of biotechnology and some trials need to be done in greenhouses. Most NARIs and research centres do not have these technologies; therefore, much research cannot be done when the right technology is absent (Agricultural Science and Technology Indicators, 2018).

Many agricultural research institutions do not have enough research scientists. One big reason that accounts for the shortage of research scientists is brain drain (Cha'ngom, 2020). Most agricultural research scientists go outside the continent to receive training and they seldom return to their home countries (NASAC, 2009). They are retained by international agricultural research centres and research departments or centres of universities. Also, most of the training received by agricultural research scientists is not on indigenous African crops which also accounts for why these scientists would prefer to work outside rather than come and work on the continent (WACCI, 2020). Also, lack of funding and technology are factors that also push agricultural research scientists from working on the continent (NASAC, 2009). The youth for a long time has not found the agricultural sector attractive. Therefore, it is difficult for institutions of higher learning to have a lot of students in the agricultural department or centre.

2.4 Agricultural Research Frameworks in Africa

2.4.1 The Comprehensive Africa Agriculture Development Programme (CAADP)

The AU developed a continental framework and policy on agriculture called the Comprehensive Africa Agriculture Development Programme (CAADP). This was done in 2003 by the Food and Agricultural Organisation (FAO) in collaboration with the New Partnership for Africa's Development (NEPAD) Secretariat (AU-NEPAD, 2003). CAADP was declared an integral part of NEPAD at the 2003 AU Summit in Maputo, Mozambique. It has subsequently been adopted into Agenda 2063 where African states agree to allocate an annual budget of at least 10% to agriculture and rural development (Ebi & Amaraihu, 2018).

CAADP has four priority areas or pillars for improving food security and increasing agricultural investment. They are:

1. Extending the area under sustainable land management and reliable water control systems,
2. improving rural infrastructure and trade-related capacities for market access,
3. increasing food supply, reducing hunger, and improving responses to food emergency crises and
4. improving agricultural research, technology, dissemination, and adoption (AU-NEPAD, 2003).

Each of these four pillars has frameworks which are companion documents to the CAADP Framework. These are the Framework for Sustainable Land and Water Management (FSLWM), the Framework for the Improvement of Rural Infrastructure and Trade-Related Capacities for Market Access (FIMA), the Framework for African Food Security (FAFS) and the Framework for African Agricultural Productivity (FAAP) respectively. These four pillars have been identified as key investment areas which will boost agricultural productivity (NEPAD, 2009). These pillars have been set in line with the overall objective and target of CAADP which are to allocate 10% of state budgets to agriculture and to obtain a 6% annual agricultural growth rates (AUDA-NEPAD, 2021). So far, most African countries have lagged or are unable to achieve the targets. According to the 3rd Biennial Report of CAADP, only four (Burundi, Dr Congo, Ethiopia, and Mali) out of fifty-one countries captured in the report have achieved the10% target (AUDA-NEPAD, 2021).

Within the wider framework of CAADP, African states signed the Malabo Declaration (African Union Commission, 2014). This spell out the directions states must follow to achieve agricultural sector transformation to be achieved within 2015–2025-year period (PLAAS, 2020). The Declaration has seven commitments which have incorporated the four pillars of CAADP. The first commitment asks member states to recommit to the principles and values of the CAADP process

(AUDA-NEPAD, 2021). Only three member states (Rwanda, Tanzania, and Zimbabwe) out of fifty-one are on track to achieving this commitment (AUDA-NEPAD, 2021). Commitment Two focuses on enhancing Investment Finance in the Agricultural Sector which is measured by the number of states that allocate 10% of state budgets to agriculture and four countries have been able to achieve this so far: Egypt, Eswatini, Seychelles, and Zambia (AUDA-NEPAD, 2021). The third commitment is on ending hunger by 2025 and Kenya is the only country reported to be on track to achieving this target (AUDA-NEPAD, 2021). Commitment Four is on reducing poverty levels by half through agriculture by 2025. Only two countries are reported to be on track to achieving this target (Ghana and Morocco) (AUDA-NEPAD, 2021).

Commitment Five is on boosting agricultural trade and services within Africa (AUDA-NEPAD, 2021). The score for this target in 2021 was 2.44 against the target of 5.0. Again, Botswana, Nigeria, Senegal, and Sierra Leone are the four countries reported to be on track. Commitment Six focuses on enhancing resilience to climate variability and 29% of the member states captured in the report are on track to achieving this target. They are Lesotho, Burundi, Zimbabwe, Namibia, Ghana, Malawi, Egypt, Ethiopia, Seychelles, Cabo Verde, Mali, Morocco, The Gambia, Rwanda, and Cameroon (AUDA-NEPAD, 2021). The seventh commitment talks about promoting mutual accountability for actions and results and eleven countries are on track-track to achieve this target. Countries must therefore include the goals in their National Agriculture Investment Plans and regularly carry out peer review processes (PLAAS, 2020). The countries are Tanzania, Ghana, Rwanda, South Africa, Ethiopia, Mauritania, Mali, Morocco, Tunisia, Botswana, and Senegal. (AUDA-NEPAD, 2021). The Table below captures all seven commitments of the Malabo Declaration and the progress made by member states.

Table 2.1 Member States Performance on Malabo Declaration Commitments

Commitment	Commitment Name	Benchmark	Member States on-track
1	Recommitment to the Principles and Values of the CAADP Process	10.00	Rwanda (10.00), Zimbabwe (10.00), Tanzania (10.00)
2	Enhancing Investment Financing in Agriculture	7.5	Seychelles (8.87), Egypt (8,56), Eswatini (8.54), and Zambia (8.07)
3	Ending Hunger by 2025	6.32	Kenya (6.40)
4	Halving Poverty through Agriculture by 2025	5.81	Ghana (8.24), Morocco (7.52), Rwanda (6.95), Egypt (6.20), Mali (6.11), Nigeria (5.96), Burkina Faso (5.90), and Tunisia (5.88)
5	Boosting Intra-African Trade in Agriculture Commodities and Services	5.0	Senegal (7.70), Nigeria (6.52), Sierra Leone (6.13), and Botswana (5.06)
6	Enhancing Resilience to Climate Variability	8.0	Morocco (10.00), Mali (10.00), Rwanda (9.70). Ghana (9.69), Gambia (9.64), Lesotho (9.62), Carbo Verde (9.47), Ethiopia (8.90), Zimbabwe (8.76), Egypt (8.60), Burundi (8.44), Cameroon (8.43), Namibia (8.33). Seychelles (8-33), and Malawi (8.09)
7	Enhancing Mutual Accountability for Actions and Results	8.33	Mali (9.95), Ethiopia (9.93), Rwanda (9.87), Morocco (9.80), Mauritania (9.40), Tanzania (9.39), Tunisia (9.35), Senegal (9.25), Ghana (9.07), Botswana (8.66) and South Africa (8.42)

Source: AU-NEPAD Report, 2021

2.4.2 The Forum for Agricultural Research in Africa (FARA)

It is a branch within the African Union Commission that deal with issues related to agriculture science, technology, and innovation. It was established in 2001 and its headquarters is in Accra, Ghana. FARA is a coordinating body which collaborates with various stakeholders including NARIs (FARA, 2018). It coordinates with various stakeholders across the various countries on the continent on agriculture projects or initiatives such as the Programme for Agricultural Intensification in Africa (PAINT), Universities, Business and Research in Agricultural Innovation (UniBRAIN) and the Sub-Saharan Africa Challenge Programme (SSA CP) (FARA, 2018). Its key achievements include helping the agriculture research and development systems achieve greater cohesion and integration with the CAADP framework. It also coordinated a comprehensive and holistic approach to capacity strengthening dubbed Strengthening Capacity for Agricultural Research and Development in Africa (SCARDA) (FARA, 2018). This provided an effective model and tools to build the research capacity of NARS (Adekunle, Obi, & Ajayi, 2013).

Twelve institutions from sub-Saharan sub-regional organisations were selected to participate in the SCARDA programme. Activities under the programme included "MSc-level training for staff from the twelve institutions, research management courses and short professional skills up-grading courses such as proposal writing workshops" (Adekunle, Obi, & Ajayi, 2013, p. 58) . In addition, there was a mentorship scheme where newly trained participants of the various programmes were mentored. There were also management plans formulated by the trainers and the various institutions to improve performance at the various institutions (Forum for Agricultural Research in Africa, 2010). Table 2.2 shows the various institutions that participated in the SCARDA programme.

Table 2.2 Sub-regional Organisations and their institutions in the SCARDA Programme

Sub-regional organisations	Number of Institutions	Names of Institutions
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)	3	Institut des Sciences Agronomiques du Rwanda (ISAR, Rwanda), Institut des Sciences Agronomique de Burundi (ISABU, Burundi), and Agricultural Research Corporation (ARC, Sudan)
Conseil oust et centre Africain pour la recherche et le dévelopement Agricole/ West and Central African Council for Agricultural Research and Development (CORAF/WECARD)	4	Crops Research Institute (CRI, Ghana), Centre de Researches Agronomique de Loundima (CRAL, Congo), Institut d'Economie Rurale (IER, Mali), and National Agricultural Research Institute, (NARI, Gambia)
Southern African Development Community/ Food, Agriculture and Natural Resources Directorate (SADC/FANR)	5	Botswana College of Agriculture (BCA, Botswana), University of Zambia (UNZA, Zambia), Department of Agricultural Research (DAR, Botswana), National University of Lesotho (NUL, Lesotho), and Natural Resources Development College (NRDC, Zambia)

Source: (Forum for Agricultural Research in Africa, 2010)

2.5 Structure of Agricultural Research Institutions on the Continent

2.5.1 International Agricultural Research Institutions- Consultative Group for International Agricultural Research (CGIAR)

In 1971, the Consultative Group for International Agricultural Research **(**CGIAR) was created to oversee agricultural research on a global level. It is therefore very different from the NARS which has a domestic or national focus. It is an intergovernmental organisation that collaborates with national and regional research institutes, civil societies, academia, development organisations and the private sector. The CGIAR functions as a secretariat that coordinates the activities of international research centres to reduce poverty and attain food security (CGIAR, 2022).

The history of CGIAR can be dates to the Green Revolution which was an era of massive transformation in the agricultural sectors of countries in Asia and Latin America. Improved varieties of maize and rice were developed which led to a boost in maize and rice production (Qaim M. , The Role of New Plant Breeding Technologies for Food Security and Sustainable Agricultural Development, 2019). The Mexican government and the Rockefeller Foundation established the International Rice Research Institute (IRRI) in 1960 and the International Maize and Wheat Improvement Centre (CIMMYT) in 1963 (Bjornlund, Bjornlund, & Rooyen, 2022). These two research centres undertook intensive and large-scale research in these three kinds of cereal; rice, maize, and wheat where they developed improved seed varieties which were disease-resistant and high-yielding This translated into an high yields of these staple crops within a short time frame (Young, 2013). The Rockefeller Foundation proposed that a worldwide network of agricultural research centres should be established under one secretariat. After much international

support from the World Bank, FAO, and the United Nations Development Fund (UNDP), the CGIAR was established on May 19, 1971 (CGIAR, 2022).

The CGIAR is made up of the CGIAR Fund, the CGIAR Consortium of International Agricultural Research Centres which currently has fifteen research centres under its umbrella, the CGIAR Independent Science and Partnership Council (ISPC) and partners (CGIAR, 2022). Table 2.3 shows all fifteen centres of the CGIAR, together with the dates they were established and their headquarters. It shows that four of its centres have their headquarters in Africa such as the Africa Rice Centre in Benin, International Livestock Research Institute and World Agroforestry Centre in Kenya, and the International Institute of Tropical Agriculture (IITA) in Nigeria.

Table 2.3 CGIAR Research Centres

	Research Centre	Location	Year of establishment
1	Africa Rice Centre (West Africa Rice Development Association, WARDA)	Cotonou, Benin	1971
2	Biodiversity International (International Plant Genetics Resources Institute, IPGRI)	Rome, Italy	1974
3	Centre for International Forestry Research (CIFOR)	Bogor, Indonesia	1993
4	International Centre for Tropical Agriculture (CIAT)	Cali, Columbia	1969
5	International Centre for Agricultural Research in the Dry Areas (ICARDA)	Aleppo, Syrian Arab Republic	1975
6	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Patancheru, India	1972
7	International Food Policy Research Institute (IFPRI)	Washington DC	1979
8	International Institute of Tropical Agriculture (IITA)	Ibadan, Nigeria	1967
9	International Livestock Research Institute (ILRI)	Nairobi, Kenya	1973

10	International Maize and Wheat Improvement Centre (CIMMYT)	Mexico City, Mexico	1963
11	International Potato Centre (CIP)	Lima, Peru	1971
12	International Rice Research Institute (IRRI)	Los Banos, Philippines	1960
13	International Water Management Institute (IWMI)	Colombo, Sri Lanka	1984
14	World Agroforestry Centre (International, Centre for Research in Agroforestry (ICRAF)	Nairobi, Kenya	1991
15	World Fish Centre (formerly International Centre for Living Aquatic Resources and Management (ICLARN)	Penang, Malaysia	1977

Source: CGIAR website

In Sub-Saharan Africa, the CGIAR is visibly present on the continent. Its activities have been divided across two main regions - The East and Southern Africa (ESA) Region and the West and Central Africa (WCA) Region. The CGIAR works in nineteen countries in the ESA region and eighteen countries in the WCA region (CGIAR, 2022). The presence of CGIAR in Africa has made tremendous strides in agricultural research and subsequently in addressing food security issues on the continent. The CGIAR has developed high-yielding varieties of staple crops such as cassava, maize, and cowpea. It has also developed the New Rice for Africa (NERICA) which is increasing rice yield in farms (CGIAR, 2011).

The CGIAR has also established state-of-the-art science facilities in the East and Southern Africa regions which offer a source of training and capacity development. These facilities include a lab testing greenhouse gas emissions of livestock and a thirteen-thousand-hectare ranch where research is conducted on livestock, wildlife ecosystems, climate change, and zoonotic diseases

(CGIAR, 2022). Also, its centres such as Africa Rice and IITA work on joint research projects with private agricultural research institutions such as WACCI (WACCI, 2020).

Though the work of CGIAR is very beneficial to Africa, it cannot work in isolation. For the work of CGIAR to be effective, there must be a massive collaboration between CGIAR and the NARS. The CGIAR can provide research capacities such as knowledge and facilities and the NARS can provide personnel for education and training as well as the platform to reach a larger target or audience of people actively employed in the agricultural sector. Also, the work of the CGIAR is limited in the sense that its presence is not in all African countries and does not conduct research on all indigenous crops. Research is conducted on specific crops, and it is also based on available funding for that research.

2.5.2 National Agricultural Research Systems

"NARS is defined, in a given country, as encompassing all institutions public or private devoting full time or partially their activities to agricultural research and committed to a national research agenda" (Beye, 2002, p. 13). NARS can either be:

i.) NARIs,

ii.) higher education institutions

iii.) departments in ministries or development agencies and

iv.) the private sector and Non-governmental Organisations (NGOs) (Beye, 2002).

The most popular or widely known type of agricultural research institution that exists in African countries is the NARI. They are a state-owned and funded research institution that is set up to

conduct research in key agricultural sector areas. Agricultural research is predominantly conducted by NARIs (Beintenma & Stads, 2014). The NARIs in sub-Saharan Africa are either:

1) research departments in ministries such as Botswana's Department of Agricultural Research (DAR), Ministry of Agricultural Development and Food Security
2) government institute with a semi-autonomy and can determine key internal policies such as the Kenya Agricultural Research Institute (KARI)
3) a group of agencies focusing on key subsectors, such as the Agricultural Research Corporation (AARRC) in Sudan, which focuses on livestock (Beintenma & Stads, 2014) and
4) as research councils which are semi-autonomous bodies such as the Ghana's CSIR (Taylor, 1991).

NARS has proven to be vital in developing the agricultural research capacities of developing countries. NARS has been very integral in addressing food shortages on a national level as well as on a regional level. NARS, especially, the institutions of higher education have continued to train and develop talents or researchers that will be absorbed by the NARIs.

The work of agricultural research scientists becomes irrelevant if farmers cannot adopt measures that have been developed through research. In a continent like Africa which has more smallholder farmers in the agricultural sector, these farmers must be included in all agricultural research activities. Therefore, the NARIs are the only institutions that can produce a lot of agricultural research extension officers who link up the farmers and the researchers. These extension officers educate farmers on new farming methods such as the type of fertilizer to use and how to use it and the right type of seeds to plant. They also educate on the proper irrigation methods to use. They

also take notice of any new pests and diseases that have surfaced on farms and report them to various institutions for further research (Ali, Hamad, Abdallah, & Elagab, 2020).

2.5.2.1 NARS in West and Central Africa

All seventeen countries in West Africa have NARS with most of them having NARIs as their predominant agricultural research agencies. They also have agricultural research facilities in higher education institutes though the number is low compared to NARIs. Except for Cote d'Ivoire whose funding comes mostly from private producers through Fonds Interprofessionnel pour la Recherche et le Conseil Agricoles (FIRCA). All NARIs are predominantly funded by governments (Domgo, Doumbia, & Stads, 2017).

Since 1954, Nigeria has had regional and national agricultural research institutes. The government also established acts that governed the activities and mandates of these research institutes. Nigeria has twenty state-owned research institutes and twenty-four universities with agricultural research departments (Fasinmirin & Barga, 2009). The National Agricultural Research Institute of Niger (INRAN) is a Nigerien NARI administered by the Ministry of Agricultural Development (Kadi M, 2011). It is a semi-autonomous body which conducts research on environmental issues, forestry, crops, fisheries, agroecological animal sciences, and agronomy. The Directorate for Cattle Breeding and Livestock Stations (CMB-SE) is another NARI under the Ministry of Animal Resources (MRA) (Kadi M, 2011). Research is mostly conducted on cattle selection and breeding, and livestock genetic improvement. Niger also has four institutions of higher education conducting research in agriculture in the Abdou Moumouni University (AUM) (Kadi M, 2011) (Stads, Kabaley, & Gandah, Agricultural Science and Technology Indicators: Niger, 2004).

There are eight semi-autonomous research institutes in Ghana under the CSIR. They include the "Crops Research Institute (CRI), Animal Research Institute (ARI), Water Research Institute (WRI), Soil Research Institute (SRI), Savanna Agricultural Research Institute (SARI), Plant Genetic Resources Centre (PGRC), Oil Palm Research Institute (OPRI), Forestry Research Institute of Ghana (FRIG), and Food Research Institute (FRI)" (Asuming-Bremoon, Sarpong D, & Asante, 2006, p. 13). The University of Ghana has departments which conduct agricultural research. For example, the College of Basic and Applied Science has departments and centres which conduct agricultural research. The School of Agriculture has three research centres: Soil and Irrigation Research Centre, Forest and Horticultural Crops Research Centre, and the Livestock and Poultry Research Centre. Other agricultural research centres include the West Africa Centre for Crop Improvement and the Biotechnology Centre (University of Ghana, 2022). Other universities such as Kwame Nkrumah University of Science and Technology (KNUST), University of Development Studies (UDS), and University of Cape Coast also have agricultural research departments and centres.

Central Africa consists of nine countries with most of them having NARS (IFPRI, 2016). NARIs are present in many countries, and they are the principal agricultural research agencies which are mostly or predominantly funded by the government. IRAD in Cameroon is its principal NARI which is responsible for research in all agricultural sectors (Agricultural Science and Technology Indicators, 2018). IRAD is within the Ministry of Scientific and Technological Research which has oversight on the activities of the institution (Beye, 2002). IRAD has five research centres and five broad research areas which include farming systems, economics and rural sociology (socio-

economics, food technology, agroforestry, intensification and diversification), annual crops (banana/plantains, cotton, sugar cane, cereals, vegetables, legumes and roots and tubers), forest and environment (forest, wood, biodiversity, soils, water and environment), animal production and fisheries (cattle, monogastric, small ruminants, animal health, aquaculture fisheries and marine ecosystem), and perennial crops (fruits, cocoa, coffee, oil palm and rubber)and (IRAD, 2021).

The Central African Agricultural Research institute (ICRA) of the Central African Republic is the country's largest agricultural research agency which is under the Ministry of Agriculture and Rural Development. Its research interests are crops and forestry (IFPRI, 2021). The National Agricultural Study and Research Institute (INERA) of the Democratic Republic of Congo is also the country's principal NARI which falls under the Ministry of Higher Education and Scientific Research and focuses research on crops, livestock, forestry, and fisheries (Stads & Lubanga, 2013).

All the NARIs across both West and Central Africa have institutional weaknesses. Research shows that most of the agricultural research scientists in NARIs do not have a PhD (IFPRI, 2016). This puts a strain on their research capacity and capabilities. Therefore, governments must invest money in training their scientists which would build their capacity and improve the quality of research outputs. Countries which do not have training centres or low-quality training centres can sponsor their scientists to undergo training elsewhere and one such training facility on the African continent is the WACCI.

2.5.3 West Africa Centre for Crop Improvement (WACCI)

WACCI is one of two centres in the University of Ghana under the World Bank Project Africa Centre for Excellence (WACCI, 2020). It is a semi-autonomous body just like most departments

and centres at the universities. It receives most of its funds from external partners such as the World Bank and the German Academic Exchange Service (DAAD) which is responsible for giving out scholarships to most of WACCI's students to carry out agriculture-related research. WACCI also partners with external institutions such as the CGIAR, AGRA and other partner universities such as Cornell University, and Africa Centre for Crop Improvement (ACI) (WACCI, 2020). WACCI also works with the CSIR. WACCI is peculiar in the sense that though it is set up within the framework of NARS, its objectives and targets are regional in scope. Therefore, it functions as both a national agricultural research institution and a regional agricultural research centre.

WACCI over the years of its existence has fed NARIs in West and Central Africa with research scientists, particularly plant breeders. WACCI also trains employees of NARIs who want to receive additional training or who want to build their research capacities. As most of its funding is from external sources, WACCI has a large research capacity when compared to other institutions of higher learning who depend hugely on the government to fund their research activities. WACCI has increased the number of agricultural scientists with PhD across the West and Central African regions, especially in Ghana. WACCI has produced 81 PhD students who are working in NARIs such as CSIR, IRAD, and INRAN in Niger who have developed and released over fifty-nine improved crop varieties (WACCI, 2020). Other alumni are also employed in the agricultural departments of universities such as Ho Technical University and the Ladoke Akintola University of Technology. Some alumni are working with international agricultural research institutions such as ICRISAT, IITA, and the Environmental Institute for Agricultural Research (INERA). They have developed high-yielding varieties which are being used by farmers in the West and Central African regions. They have developed rice, sweet potato, tomato, and taro varieties in Ghana and Burkina Faso, maize in Mali and Nigeria, cowpea in Burkina Faso and Nigeria, millet in Niger, and

groundnut in Mali and cassava in Ghana and Nigeria. The Centre has also released three high-yielding maize hybrids as well as developed tomato varieties (WACCI, 2020).

WACCI has seasoned and trained faculty members who are actively engaged in research in addition to supervising students' projects. WACCI has partnered with various agricultural research institutions and agencies such as the Gates Foundation and Borlaug Higher Education for Agricultural Research and Development (BHEARD) on agricultural research projects. The Centre has also organised workshops in partnership with institutions such as the Syngenta Foundation for Sustainable Development. These workshops include the 2015 Demand Led Variety Design (DLVD) Workshop where a training manual on DLVD was developed. Researchers from institutions such as the University of KwaZulu Natal in South Africa, Cornell University, and the University of Illinois, come to the Centre as visiting lecturers to talk to students and share current research knowledge and findings in the field of agricultural research (WACCI, 2020).

2.5.3.1 Organisational Structure of WACCI

WACCI has a robust management team. It has an advisory board, a management committee as well as an associate faculty.

2.5.3.1.1The Advisory Board

The advisory board is there to guide the Centre in its activities and steer it towards current global trends and development perspectives to enhance its sustainability. It consists of seven members including the founding director of WACCI, Professor Eric Danquah. The board is made up of seasoned research scientists drawn from across the globe (WACCI, 2020).

2.5.3.1.2 The Management Committee

The management committee ensures that the goals set out for the Centre are being achieved and the associate faculty collaborates with units within or outside the Centre on academic matters (WACCI, 2020) The Committee has nine staff members and five non-staff members with two of the non-staff members being student representatives of both PhD and MPhil students (WACCI, 2020).

2.5.3.1.3Administration

The administrative block of WACCI also works behind the scenes to ensure the Centre is running smoothly. The Centre has two administrative units; it has a farm administration which oversees matters related to its farm activities and an office administration which runs the Centre itself. The Administration is responsible for overseeing the welfare of students.

WACCI relies predominantly on funding and most of its students get full scholarships to study there. Students partake in modules delivered by research scientists from all over the world and get the opportunity to carry out their research in their home agricultural research institutions. Currently, WACCI has a state-of-the-art infrastructure for agricultural research. The Centre boasts a research farm, a seed science lab, a tissue culture lab, a cold room, a growth room, a fully automated greenhouse, lecture rooms, bioinformatics lab. conference auditorium, board room and library. These facilities make it easier for students to conduct their trials and run analyses. These facilities are not only used by WACCI faculty and students but also by students from various agricultural departments (WACCI, 2020).

2.5.3.2 Partnership

2.5.3.2.1 Education

WACCI has several partners that help in achieving its objectives and goals. WACCI has educational partners from across the globe which comes in handy for students in their training and research. The three biggest educational partners are Cornell University, Purdue University, and the University of Illinois. These partners have over the years provided WACCI with scholarships and research projects. Students also have access to the vast resources at these universities such as access to libraries and lecturers (WACCI, 2020).

2.5.3.2.2 Non-Profit Organisations

WACCI has worked or collaborated with many non-profit organisations over the past fifteen years. These include AGRA, Generation Challenge Programme (GCP), Volkswagen (VW) Foundation, Kirkhouse Trust, ICRISAT and Enhanced Communications Network Wireless Holdings Limited (ECONET) Foundation. These non-profit organisations have provided WACCI with research grants and scholarships as well as also organised a series of workshops (WACCI, 2020).

2.5.3.2.3 Government

WACCI also works with various international organisations and national governments, and they have equally supported WACCI by providing scholarships and grants. Some of these institutions include West Africa Agricultural Productivity Program (WAAP), EU Intra African, Caribbean and Pacific (ACP) Mobility, DAAD, BHEARD and the United States Agency for International Development (USAID) (WACCI, 2020).

2.5.3.3 Programme Component

WACCI's programme is divided into three different sections. There are coursework, seminars, and modules. Both the PhD and MPhil programmes have elements of coursework which are divided into either core courses or optional/elective courses. The PhD is a four-year programme which is culminated with a year-long thesis in the home country of the students. The MPhil programmes are two-year programmes with a thesis component. Also, students are mandated to attend two seminars in the second year where the first seminar covers the research proposal, and the second seminar deals with discussions of research results (WACCI, 2020).

Over the years, WACCI has organized a series of modules for students. WACCI has had a variety of visiting scientists sharing knowledge with students on the various topics captured under the modules. Some of the modules covered over the past fifteen years include leadership training, Molecular Marker Analysis, Seed Business Management, Data Analysis, Statistics, Project Management and Breeding skills, and breeding programmes (WACCI, 2020).

2. 7 Conclusion

This chapter discusses the evolution of agriculture in Africa. It also gives a historical account of agricultural research and its institutions on the continent. It shows that agriculture has transitioned during the three eras. It moved from a pure subsistence sector during the pre-colonial period to a combination of both subsistence and commercial sectors in contemporary Africa. It highlights the various agricultural research architecture that exists on the continent, including the CAADP. The CAADP stipulates that every African state contributes 10% of their national budget towards the agricultural sector. Unfortunately, most African countries have been unable to meet this annual target which poses a challenge to states to boost agricultural research.

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CHAPTER THREE

CONTRIBUTIONS OF WACCI IN ENSURING FOOD SECURITY IN WEST AND CENTRAL AFRICA

3.0 Introduction

This chapter seeks to highlight the contributions of WACCI since its inception in 2007. The study is premised on the thesis that "*food insecurity persists in Africa due to inadequate attention to agricultural research institutions such as WACCI."* Using the techno-ecological theory of food security, data collected are analysed along the theory. It highlights the two main elements of the theory which are technology/research/science and human ingenuity or resource which essentially are the bedrock of agricultural research institutions. It shows the various contributions of WACCI as an agricultural research institution in achieving food security. This chapter analyses data collected from both primary and secondary sources of data. The primary data source was gathered from interviews and the secondary sources of data used include reports on the SDGs from UN and AU, the twelve-year WACCI report and the CAADP report. The analysis is in line with the thesis by answering the research questions posed at the beginning of the study outlined below:

1) How vital are agricultural research and its institutions in achieving Sustainable Development Goal 2?

2) What contributions have WACCI made towards ensuring food security in Africa?

3) What accounts for the low level of national and continental financial support of WACCI?

4) What are the challenges WACCI faces?

The analysis has been grouped based on these thematic areas.

3.1 The Role of Agricultural Research institutions in Achieving Food Security in Africa

3.1.1 The Big Question

The 2019 Africa SDG Index and Dashboard reveal the progress made by African countries in achieving the SDGs (The Sustainable Development Goal Centre for Africa and Sustainable Development Solutions Network, 2019). The SDGs overall have seventeen goals. The table below lists all seventeen goals of the SDGs.

Table 3.1 List of All 17 Goals of the SDGs

SDG Numbers	Meaning of Goals	SDG Numbers	Meaning of Goals
1	No poverty	10	Reduced Inequalities
2	Zero hunger	11	Sustainable cities and communities
3	Good health and well-being	12	Responsible Consumption and Production
4	Quality education	13	Climate Action
5	Gender equality	14	Life below water
6	Clean water and sanitation	15	Life on land
7	Affordable and clean energy	16	Peace, justice, and strong institutions
8	Decent work and economic growth	17	Partnerships for the goals
9	Industry, innovation, and infrastructure		

Source: The Sustainable Development Goal Centre for Africa and Sustainable Development Solutions Network, 2019.

The table captured below from the SDG report from the AU shows the summary of progress of 54 African countries on the SDG goals.

Table 3.2 Summary of trends towards SDGs across all African countries for 15 of 17 goals

	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goal 9	Goal 11	Goal 13	Goal 14	Goal 15	Goal 16	Goal 17
↑	7	0	0	1	2	6	1	2	1	1	47	0	10	1	7
→	7	20	26	11	26	8	13	20	20	4	0	16	20	8	14
↗	27	27	27	37	25	38	35	8	31	25	1	15	16	30	25
↓	9	2	0	4	0	2	3	1	1	4	5	0	8	3	5
–	4	5	1	1	1	0	2	23	1	20	1	23	0	12	3

↓Decreasing → Stagnating ↗Moderately improving ↑ On track or maintaining SDG achievement —Information Unavailable

Source: The Sustainable Development Goal Centre for Africa and Sustainable Development Solutions Network, 2019

On goal 2, Zero Hunger, the overall progress is stagnant. The report shows that no country is on track to achieving SDG 2. Though half are making some improvements the other half are also either stagnant or decreasing in performance which does not look encouraging overall. Recent global trends such as Covid 19 pandemic and the Russian-Ukraine wars will further lead to a decrease in the efforts made so far (Armstrong, 2022).

At the beginning of the interview, all participants were asked to comment on the current state of Africa in achieving its 2030 deadline on food security. All five respondents agreed that there was no straight answer to that question. Two of the respondents added that the Covid-19 pandemic and the effects of the Russia-Ukraine war have derailed the progress made by some African countries. The pandemic threatened the already fragile food systems in Africa with small-scale farmers being the most affected by the crisis which meant bad news for Africa as most of its farmers are small-scale farmers (United Nations, 2020). States had to divert resources into feeding their population and stocking up on medical supplies.

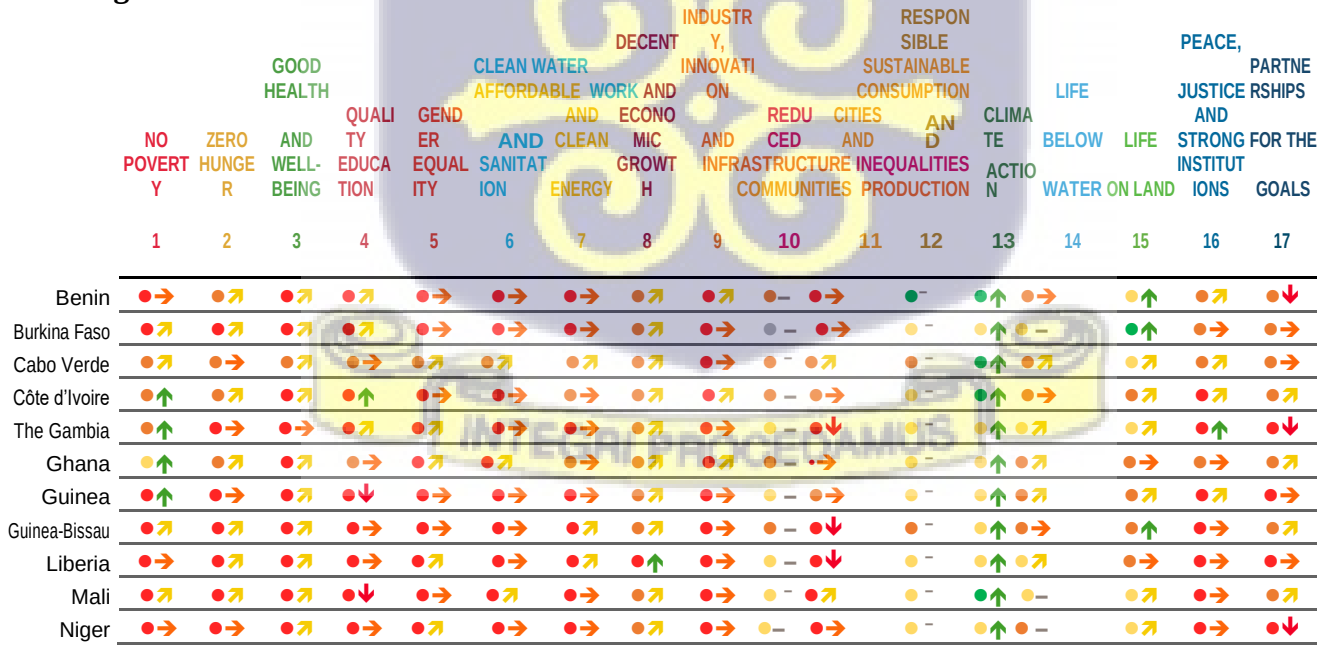
Also, the various security measures put in place such as the lockdowns hampered people's movements and made it difficult to access food.

> *What I know is that many African governments are doing their best to achieve this goal by the deadline. From what I can see government are working; however, there are new challenges every day. When you look at these past years, all the unexpected challenges we have had such as the Covid-19 pandemic, the Russia- Ukraine war, and the Fall Armyworm make it difficult to achieve this target. (Researcher 2, IRAD).*

> *When COVID came, it exposed the weaknesses in our food systems. Also, the Russia-Ukraine war also disrupted our food systems as we most often than not depend on inputs from these countries. Climate change is also restraining our ability to achieve these targets. (Researcher 4, WACCI)*

Figure 3.1 and Figure 3.2 are the 2020 Africa SDG report on West and Central Africa which shows how the various countries performed in the various goals. The average performance of the countries in all the goals is poor.

Figure 3.1 West Africa's Performance in the SDGs



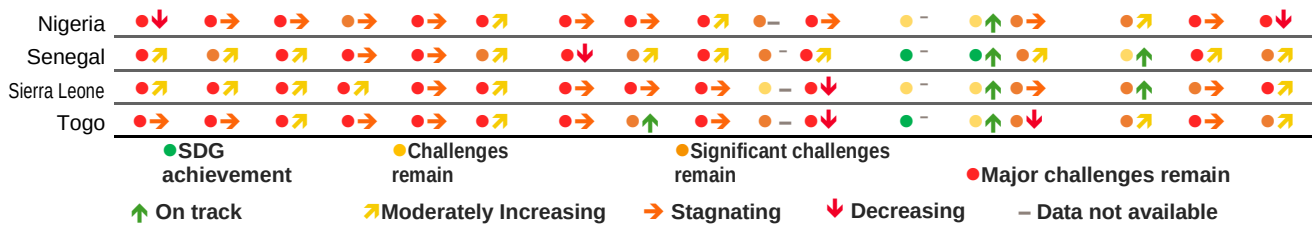
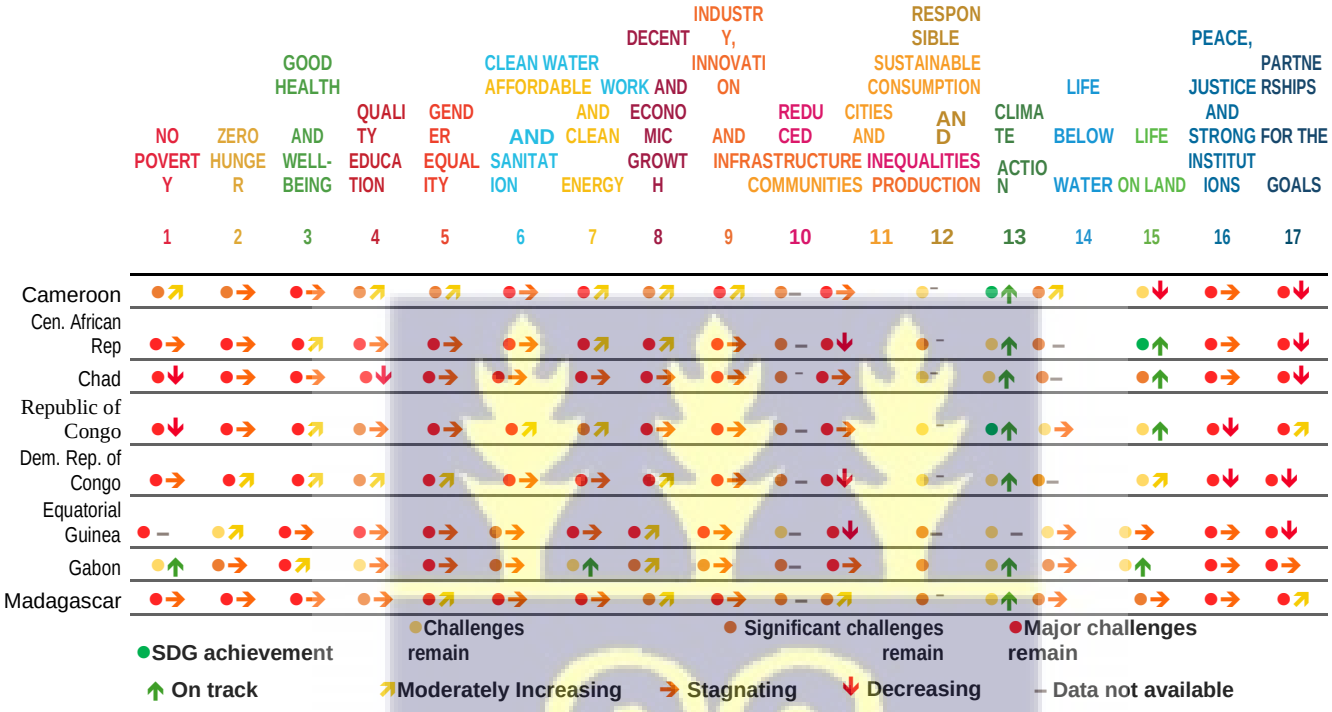


Figure 3.2 Central Africa's Performance in the SDGs



Source: Africa SDG Index and Dashboards Report 2020

Under goal 2, most of the countries in West Africa are making slight improvements despite having serious challenges, mostly attributed to the outbreak of Covid-19. Funds which are supposedly earmarked for agricultural sector are transferred to finance the fight against Covid 19 (Otekunrin, 2021). Comparing both regions, the Central Region is the worst performing region in SDG 2 as most of the countries are stagnant while most countries in west Africa are improving their performances.

In addition, conflict is a major cause of food insecurity. The 2019 Global Report on Food Crises identified Chad, South Sudan, the Central African Republic, the Democratic Republic of Congo, and Somalia as countries with acute hunger due to the frequent outbreaks of conflict in these areas and three out of the five are countries in Central Africa (Food Security Information Network, 2019). Also, "the Ukraine crisis has triggered food shortages for the world's poorest people" (United Nations, 2022, p. 9). This is because both Russia and Ukraine combined export 30%, 20% and 80% wheat, maize, and sunflower seed products respectively (United Nations, 2022). Conflicts make the political environment unsafe for people to work or thrive, thus people might not go to work or school. Migration rises and the government of the day channels resources meant for development projects into curbing conflicts (Teslac & Teslac, 2022).

Other causes for the poor performance of SDG 2 in both west and Central Africa include pre- and post- harvest losses due to ravaging pests and diseases, social exclusion, unemployment, poverty, corruption, and terrorism (Otekunrin, 2021). These are issues that are deeply rooted in the African institutions, and they prevent the realisation of all SDGs, including goal 2. Perhaps, emphasis should be placed on addressing these problems as the hope of achieving SD2 remain bleak.

On the issue of what Africa needs to do to be on-track to achieving food security, the respondents suggested some solutions.

> *We have some technology that can help but we need to continue to develop new technologies that can propel us to meet the target by the 2030 deadline. (Researcher 3, CSIR-SRI).*

> *Irrigation is important to achieving food security by 2030. The major problem for agriculture in Africa is water. When farmers are unable to get enough water, it becomes very difficult to farm year-round. We also need to mechanise our farms. We need tractors*

that can plough, do fertilizer application, harvest, and mill everything. (Researcher 1, WACCI).

Financial resources are number one in agriculture. You need money to mechanise and have an intensive farming system which is the only kind of farming system we need to have. (Researcher 1, WACCI).

Capacity building in the agricultural research domain is important. Governments should support agricultural research and by giving more funding to research, we can improve the capacity of researchers and that is also one aspect which is missing in our continent. In Cameroon, for example, we do not have so many researchers. There is a lack of scientists within several domains, including plant breeding. In IRAD, there are less than five breeders, and we work on several crop programmes, such as rice, potato, yam, maize, and tomato. (Researcher 2, IRAD).

The participants agreed that Africa needed a complete overhaul of its activities and systems to meet the 2030 deadline. They outlined some measures that African governments need to put in place which included technology, financial resource, and most important agricultural research. All these measures, however, cannot flourish without a stable and peaceful political environment which seems to have alluded a lot of African countries, especially, those in West and Central Africa. All respondents agree that agricultural research institutions are vital to achieving SDG 2. The targets and indicators under SDG2 emphasize research and technology which supports the arguments that agricultural research institutions are important.

3.1.2 Importance of Agricultural Research Institutions

Agriculture has over the years contributed to the success of economies and its benefits are heavily seen in agrarian economies (Yao, 2000). Most countries in Africa are agrarian yet they are not

tapping fully into the potential benefits of agriculture. Tapping into the agricultural sector will involve major investments in research and development. Investing in research leads to economic growth and an overall increase in agricultural performance (Pray & Fugilie) and currently, 95% of the global private agricultural research and development comes from companies in developed countries (Pray & Fugilie). This data accounts for some of the reasons why developed countries are far ahead in agricultural productivity.

3.1.2.1 Identification of Gaps and knowledge production

Agricultural research is important as it helps identify the research gaps and provide answers or solutions to solving them.

> *You cannot rule out the role of agriculture research out in terms of food security because it is the research that will come out with all the interventions that are needed, and all the gaps that are currently confronting agriculture. And as these gaps are unravelled, then the solutions are also developed and if these solutions are developed and applied appropriately, then it means that we are contributing towards sustaining or ensuring food security*. (*Researcher* 3, CSIR-CRI).

Gaps are not only identified through research, but knowledge is also accrued through research. Knowledge, which comes from gathering information, is necessary for progress. Research enhances knowledge and improves our understanding of the various food production systems (FAO). A researcher at WACCI talks about how through research, they were able to identify which tomato variety worked better in each ecological zones in Ghana.

> *We were evaluating about 40 varieties of tomatoes which were already in the system to know which one is more productive in which region within the country as we have various ecological zones. Before this research, we did not know which tomato variety worked better in the various ecological zones. Research institutions are very important in this case to be*

able to assist farmers to select the right planting material or variety. They are also very important because they develop new varieties of crops (Researcher 1, WACCI).

3.1.2.2 Results in Efficiency in Food Production

Agricultural research results in the development of new technologies, techniques and inputs that drive efficiency in the agricultural sector.

It is the science that makes food production more efficient and helps improve food productivity. For example, farmers can cultivate old varieties or what we call landraces or heritage varieties, and they will not get a lot of yield out of it because the productivity is very low; therefore, they put in a lot of effort and yield per acre is maybe 1/4 of what you get from improved varieties. That is how science and research contribute to agriculture. Sometimes it is not obvious because we go to the market and the food is there and we assume food will be there with or without science. But it is the science that has kept food production going with the development of new varieties, superior varieties and the technologies associated with it such as nutrient management and weed management. One of the most important things in agriculture is weed management. Originally, in many farms, it used to be manual weeding but these days one cannot find the labour when you have money, but science has brought in a lot of selective herbicides. People have done experiments and told the farmers how to use it and when to use it. Nutrient management, herbicide management, insecticide management, water management and technologies in irrigation contribute to productivity in farmers' fields. (Researcher 5, CSIR-CRI).

Food security is all about efficiency in food production which can only manifest when research is added to agricultural production. For example, research developed insecticides, herbicides and new crop varieties which have resulted in an increase in farm production without any increase in the total mass of land farmed. It is also through research that the greenhouse concept was developed where people could still farm without cultivating their lands.

3.1.2.3 Research as Synonymous with Development

Research drives development as it comes up with innovations and technologies that lead to change and efficiency. Most countries, companies and organisations with a development-forward orientation dedicate funds or investments to research. Some companies like pharmaceuticals and technology companies spend huge sums of money on research and product development.

> *No development can take place without research. Research is the pivot at which all developments take place. You get innovations through research so if a country fails to invest in research for development, the country will fail to develop. And of course, agriculture research is not an exception. If we fail to invest in agricultural research, what innovations are we going to get? It will still be business as usual. We are already struggling with our current agricultural practices; hence, we need to research to bring out innovations. We need to develop seeds; a superior variety of crops for farmers to use and how can we get that without research? Research is critical, without it we will fail. (Researcher 4, WACCI).*

3.1.2.4 Increase in Crop Production

Africa has often been described as a continent with abundant arable land yet spends billions of dollars annually to import food outside the continent. Even though Africa has a lot of lands and can feed its entire population, its inability to currently do so is the result of low levels of agricultural research. Agricultural research is needed to boost crop production which will reduce importation.

> *Governments should support agricultural research Institutions so that the results of this research and the technology developed will be able to increase food production which will reduce food importation and poverty. When food production increases, prices of food will decrease, and this will make food more available to the population* (researcher 2, IRAD).

3.2 Contributions of WACCI to Ensuring Food Security in Africa

"The goal of WACCI is to improve food security in Africa. The approach is to equip plant breeders with the knowledge and skills to develop superior varieties of indigenous crops, using both conventional and modern technologies" (WACCI, 2020, p. 3). WACCI's set-up and activities over the past 15 years of its existence have played a tremendous role in achieving this goal. This section uses data gathered from the participants in addition with the twelve-year WACCI report.

3.2.1 Rationale for WACCI

WACCI came at a time when it was highly necessary to have well-trained and highly qualified agricultural scientists to work in our NARIs and train the next generation of agricultural research scientists. Most African countries had agricultural research institutions such as the NARIs and the universities, but none had a plant breeding institution which is a very important branch of agricultural science and vital in developing local superior seed varieties.

> *One thing that we have failed over the years to recognize is the contribution of people who work to develop superior varieties of crops. Realizing this gap is why WACCI was established, and it was established to develop a critical mass of scientists the region will need to achieve its food security needs. Some years back we could not develop seeds. (Researcher 4, WACCI).*

> *At the time WACCI came on board, the first generation of breeders was either retiring or had received international appointments. Hence, WACCI came in to fill a great gap and to bring up people who are well-trained to especially release new crop varieties. Agriculture is built around the release of crop varieties as it is based on this that all the other disciplines develop their technology. (Researcher 5, CSIR-CRI).*

3.2.2 Activities of WACCI

3.2.2.1 Training

Most national agricultural research institutions in Africa have one problem in common, which is the insignificant number of agricultural research scientists with PhD and studies conducted by the ASTI affirm this fact. Perhaps, the most important activity of WACCI is the level of training it gives to its students. WACCI was established to feed agricultural research institutions across the continent with highly trained and qualified African agricultural research scientists, particularly, in plant breeding. Plant breeding is an essential ingredient in what is known as Climate Smart Agriculture which involves developing innovations that can adapt and eventually become resilient against climate changes (Atukunda, Eide, Kardel, Iversen, & Westerberg, 2021). Climate Smart Agriculture is seen as the right thing for sub-Saharan Africa due to its changing and challenging weather and climatic conditions. (Atukunda, Eide, Kardel, Iversen, & Westerberg, 2021). WACCI has trained over 90 PhD students in plant breeding. These alumni are found in the various national agricultural research institutions in Africa leading breeding programmes as well as heading these institutions. Some alumni are also in the universities training new generations of students in plant breeding and supervising students' research. Crop varieties developed by WACCI alumni are being used by farmers across the continent. WACCI also has over 164 publications by graduates and students in peer-reviewed journals.

The first female maize breeder, Dr Priscilla Ribeiro, at the CSIR-CRI was trained at the Centre. She has developed five maize varieties which have been approved and recommended for release by the National Varietal Release and Registration Committee (NVRRC) (CSIR, 2023).

> *WACCI is very selective in choosing its students. The training at WACCI is not only theoretical. There is an emphasis on practical training. WACCI invites so many highly*

competent scientists from all over the world such as researchers from the University of Cornell. Wherever there is a competent scientist or lecturer, WACCI will invite the person to come and share knowledge with the students. Students are also sent to laboratories for practical sessions, and this was during the time WACCI did not have such laboratories. (Researcher 2, IRAD).

WACCI currently has two MPhil programmes in plant breeding and seed science and technology. With MPhil in seed science and technology, students are trained in seed technology and are equipped with the skills in this field by working with a research company or a private seed company for a three-month experiential attachment (WACCI, 2014).

As it stands today, WACCI has trained students who are developing varieties that are becoming game-changers in their home country (Researcher 4, WACCI).

For PhD, students are to identify a topic of great importance in their own country and to conduct research that will contribute towards the development of the agricultural sector of their countries and not just any ordinary research for research's sake. (Researcher 2, IRAD).

WACCI has trained a lot of PhD and Master students who can be found spread across various countries in Africa. The training is also on multi-crops such as maize, rice, cassava, and vegetables as well which are very important for food security. The people trained at WACCI are the ones now manning the research institutions and are developing new crop varieties some of which have been released and are used by the farmers, some are also in the pipeline of development, and as the years go by, they will come out and then complement what is already in existence. (Researcher 3 CSIR-CRI).

WACCI mainly contributes to the breeding of crop varieties. I have led the breeding of so many crop varieties after WACCI. I have contributed to the release of about 15 rice varieties many of which are being used by farmers. My colleagues are also working on

maize, cassava, and other crops. Many WACCI alumni have risen to administrative positions and are also managing, managing research, and training other young scientists. (Researcher 5, CSIR-CRI).

3.2.2.2 Research

WACCI faculty is made up of brilliant agricultural research scientists who not only train students but also undertake research projects. The Centre on its own has released several crop varieties in maize and tomato which are currently being used in farms. The Centre released 3 high yielding (9 to 11 t/ha) and climate-resilient maize varieties in Ghana. (WACCI, 2020) Some of this research is conducted with partnerships from BHEARD and Gates Foundation.

And the Centre is also apart from training involved in research activities. The Centre has released, for instance, the maize variety, which is one of the highest-yielding hybrid maize varieties in the country and I do not think those are mere achievements. (Researcher 4, WACCI).

3.2.2.3 Organising Workshops

WACCI is notable for always involving farmers in the use of their crop varieties. The Centre hold workshops for farmers and agricultural extension officers where they are trained on the use of the various crop varieties developed. Discussions are held on some farm practices such as planting and irrigation. The Centre over the years has organised maize and tomato value chain workshops, food security seminars and demand-led variety design workshops both for students and industry. It is at such a similar conference that the African Plant Breeding Association was established (WACCI, 2020).

We build capacity at the farmer level as well. We train farmers and agriculture extension officers so that when these varieties get into the hands of farmers, they will know how to handle these varieties. We build capacity for farmers through good agronomic practices.

We bring innovations that we think are relevant to farmers to their doorstep. We involve them even in breeding so that the adoption rate will be high when the varieties are released. (Researcher 4, WACCI).

3.2.2.4 African Plant Breeding Association

Most African countries do not have a national plant breeding association which makes it difficult to coordinate their activities and makes the impact on plant breeding not that effective. In 2019, a conference was held at WACCI where the idea was to bring together all plant breeders in Africa under one roof to discuss issues in plant breeding and how plant breeding is important in Africa's quest for food security (CGIAR, 2019). The conference brought together scientists and various stakeholders from different parts of the world. The conference lasted for four days with a four-day workshop on how to solve challenges in agriculture by developing problem-solving skills organised by ICRISAT (CGIAR, 2019). The success of the conference led to the demand for a permanent African secretariat on plant breeding: hence, the APBA. The Association will organise such conferences every year and help coordinate the activities of national plant breeding associations. This meant that countries without national plant breeding associations would have to set up one and the Ghana National Plant Breeding Association was established after the conference (WACCI, 2020).

WACCI cannot work in silos and knowing that collaboration is key, WACCI has brought together plant breeders in Africa under one umbrella. The founding President of the Association is the Director of WACCI. The Association aims to bring these scientists working together to tackle a common challenge and achieve a common goal for the continent. (Researcher 4, WACCI).

3.2.2.5 Empowering the Youth in Agriculture

WACCI believes strongly in the vision of Kofi Annan that the youth is the future of agriculture and believes in innovations. In this vein, WACCI in collaboration with both local and international partnerships established the Kofi Annan Enterprise Hub for Agricultural Innovation (KAEHAI) where the central focus of its activities is youth in agribusiness. It identifies the potential agribusinesses of young graduates, provides training, and workshops to these people and provides a great platform for opportunities and networking. Under KAEHAI, WACCI has also started a lunch series where conversations on agriculture and the role of various stakeholders are held (WACCI, 2020).

3.2.2.6 Collaboration with NARIs

WACCI also coordinates with various national agricultural research institutions such as CSIR-CRI and IRAD to undertake research projects and to help students with their research.

> *WACCI does a lot of work with us. We supervise a lot of WACCI students in conducting their research. We also do joint projects with the Centre one of such is a joint AU project which was mainly about training farmers to improve their productivity. (Researcher 5, CSIR-CRI).*

> *WACCI really cannot train people just for training's sake. WACCI works with all the national agricultural research institutions both in Ghana and the rest of the continent to build human capacity for them. The national agricultural research institutions are involved in the training as some of the researchers from these institutions become supervisors of some of our students and the students go back and work on problems about their local environment. (Researcher 4, WACCI).*

> *Some projects are currently being jointly executed between WACCI and CSIR in seed production. Some of the students at WACCI also come to CSIR to undertake their thesis*

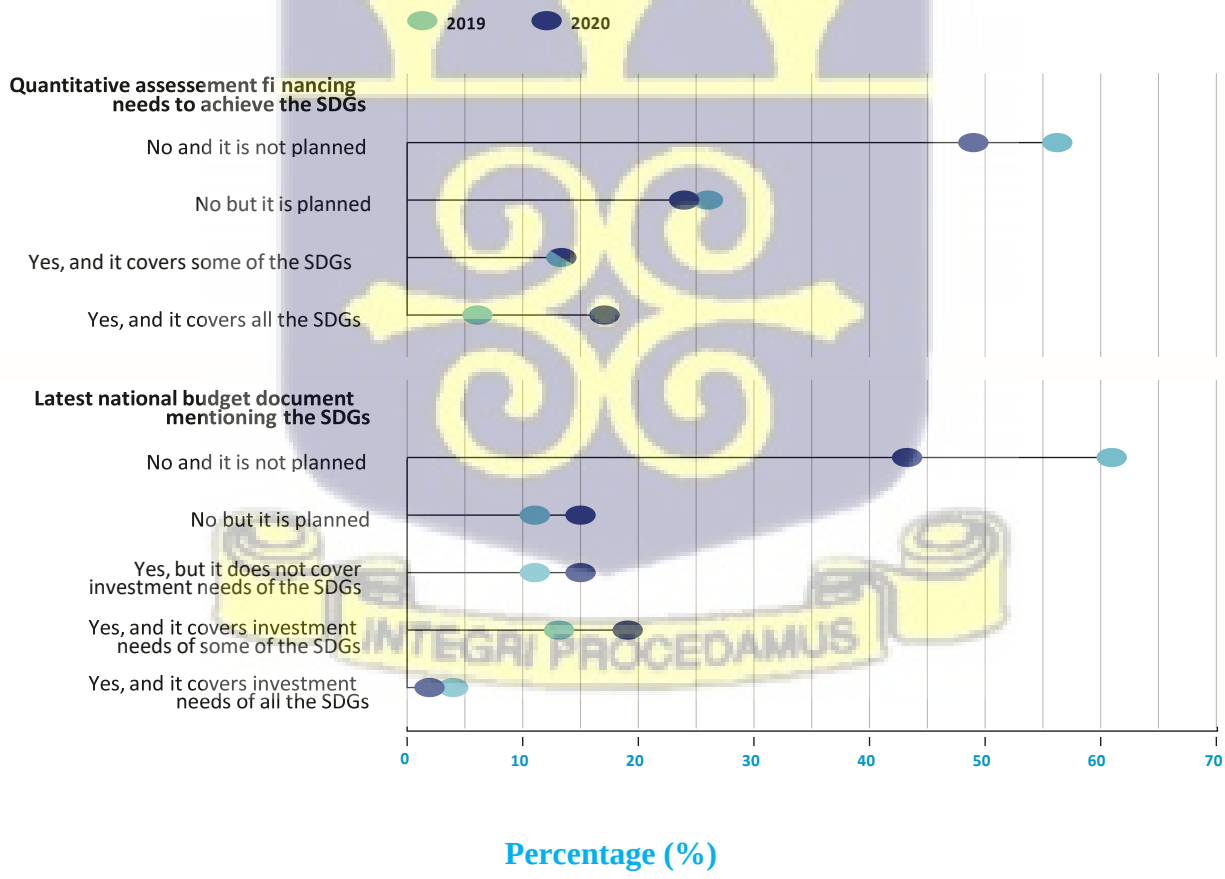
research and some of the staff are in-country supervisors for students. (Researcher 3, CSIR-CRI).

3.3 Level of Continental and National Support

3.3.1 National Budgets on the SDGs

The 3rd CAADP Biennial Review Report, 2021 is used in this section to give a clear view on how much funds African governments channel into agriculture research. The Figure below shows the percentage distribution of countries which have done a quantitative assessment as well as allocated funds to the SDGs in their national budgets. For quantitative assessment, less than 20% have done an assessment which is an improvement on the 2019 figures, yet it is still not impressive.

Figure 3.3 Percentage Distribution of African Countries with both Quantitative Assessment and SDG Funds Allocation in their National Budgets



Source: 3rd CAADP Biennial Review Report

In 2020, less than 5% have their budgets covering the investment needs of all the SDGs. Though on the international stage, African countries have pledged their support to achieve the SDGs, the figure shows how reluctant the various countries are to commit funds to the SDGs and this translates to the less national support we see in SDG 2, food security (SDG Centre for Africa and Development Solutions Network, 2020). A wide range of reasons can be attributed to why majority do not have their national budgets covering the SDGs which include low revenue mobilisation and high expenditure needs. Most African countries do not have a robust system for resource mobilisation and at the end of the day, governments would have to disburse the few resources available to meet its huge expenses. Therefore, when it gets to allocating money to the SDGs which is mostly not a priority to the government, there is little or no money to invest in such areas. African countries lose huge sums of money annually to corruption when such monies can be put to better use.

The 3rd CAADP Biennial Review Report captured in 2021 shows that only four countries out of fifty-one have achieved the target of contributing 10% of their national expenditure to the agricultural sector (AUDA-NEPAD, 2021). Two countries are in East Africa and one each is in the western and central regions. This figure is not encouraging which could be because allocating 10% of the national budget to agriculture is too much of a price to pay for most African countries. Therefore, the CAADP should be reviewed to ensure that every country is at the same level when it comes to agricultural growth and productivity.

3.3.2 WACCI Funding

WACCI like most national agricultural research institutions have not received a lot of financial support from either the national governments or the continental international organisations. The 12-year report reveals that most of WACCI's funds come from its international donors and partners outside the continent with its initial donor being AGRA. AGRA was established by the Bill and Melinda Gates Foundation to lead Africa into 'the Green Revolution' period as it happened in Asia and South America. Using the data presented in the Twelve- year WACCI Report, the table below talks about the total amount of funds received by the Centre at the end of 2019.

Table 3. 2 Funds Received by WACCI from 2007-2019

Donor	Funds Received (USD)
AGRA, Kenya	11,449793
Generation Challenge Programme (GCP), Mexico	667,054
VW Foundation, Germany	90,960
Kirkhouse Trust	110,019
WA Agricultural Productivity Programme	1, 297,455
Purdue University, USA	304,995
Cornell University, USA	624,500
EU Intra ACP Mobility, RUFORUM, Uganda	293,814
ICRISAT, India	50,000
Syngenta Foundation, Switzerland	160,380
AGRA SSTP, Kenya	74,977
DAAD, Germany	1,888,560
World Bank Africa Centre for Excellence project, USA	6,600,056
USAID, USA	298,131
UQ, Demand-Led Variety Design, Australia	228,350
BHEARD, USA	59,129
Econet, UK and South Africa	250,000

Syngenta Seeds BV, The Netherlands	124,850
SLARI, Sierra Leone	15,000
University of Illinois, USA	25,688
AGRA Maize Hybrid Kenya	249,991
African Union- European Union Research Grant	611,832
University of New Hampshire, USA	63,456
Australian High Commission, Ghana	42,972
National Root Crop Research Institute, Nigeria	118,386
African Agricultural Technology Fund, Kenya	52,245
Massachusetts Institute of Technology, USA	7,750
Total	**25,760342**

Source: Twelve-year WAACI Report

From the table, it is quite clear that most funds were received from foreign partners. Only three of the funds came from NARIs and the AU. Two from the NARIs: SLARI in Sierra Leone and National Root Crop Research Institute in Nigeria. The other one is from the WA Agricultural Productivity Programme which is run under the AU. The combined funds from these three are USD 1,430,841 which is less than 1/15 of the total funds received over a period of 12 years. If achieving food security is a priority for African governments and its international organisations like the AU, why have there been limited funds directed towards agricultural research institutions such as WACCI which has proven over the years that research in plant breeding can go a long way in solving Africa's food security problems? The participants gave various reasons for the low national and continental financial support of agricultural research which includes low resource levels and political reasons.

3.3.3 Reasons for Low National and Continental Support

3.3.3.1 Resource/ Financial Deficits

Some of the participants argued that foreign governments and international organisations have made and continue to make huge investments in agricultural research on the continent because they have the financial capacity to do so. Therefore, financial support is injected into agricultural research to help solve hunger on the African continent and to also prevent migration issues.

> *Ideally, African governments should be championing investment in research in the development of the agricultural sector. Of course, there have been some investments of some sort but not enough. In our part of the world, investment in research is not one of the priorities of governments. We tend to depend on donors and developmental partners to get research funding. Governments are playing their role but there is always room for improvement. For institutions that are doing well, governments should put them under continuous support to ensure that they keep on working or functioning properly. (Researcher 4, WAACI).*

> *Advanced countries know the benefits of research and they have the money to invest in research. They also have more money to spare than our African governments. Therefore, when Africans are starving and always knocking at their doors for food aid, they feel the moral obligation to support African countries so that they can produce on their own to sustain their population. To also prevent Africans from migrating there, they give aid to Africa so Africa can develop and produce their food (Researcher 3, CSIR-CRI).*

African governments on the other hand do not have the financial strength to invest in research. Governments are always faced with budget deficits and debt crises which means that it is always little money left to invest in agricultural research. Agricultural research also demands huge financial injections and most often than not African governments are unwilling or incapable of allotting such huge money to research, particularly, agricultural research.

The usual problem for African governments is a lack of money which does not only affect agricultural research but other parts of the agricultural value chain. After distributing its resources much is not left for agricultural research. Governments will rather focus on producing food for people to eat using what is there which is not sufficient. It is the thinking of most African governments that if farmers are producing and people have food to eat that should be enough. They do not consider the research part of it, so the research budget is always like constrained. (Researcher 3, CSIR-CRI).

3.3.3.2 Political Reasons

The political climate in Africa makes it difficult for governments to invest in research in general. Research is a long-time investment, and the results are not seen immediately. "Research takes a long time to affect production, and then it affects production for a long time" (Alston, 2010, p. 10). The initial part of the statement by Alston is the only part African leaders dwell upon and this makes research unattractive to African governments because they want to achieve results as fast as possible. Hence, African governments would invest in providing social amenities such as roads, schools, and hospitals as these are tangible proof that they are working. They also invest in food production rather than agricultural research and this is seen clearly in Ghana's Planting for Food and Jobs Policy (PFJ).

The PFJ is a policy which aims to achieve food security, reduce poverty, and create employment opportunities (MoFA, 2022). The PFJ focuses on seed subsidies and encourages farmers to buy seeds from local producers (Pauw, 2022). Though this is good, the policy does not include research, especially, in seed production. The policy should be accompanied by research to attain a greater impact.

Research usually takes a long time to generate results. Most African governments have four years in power, and they do not think that they will get any credit to campaign for the

next election when they invest in research which can probably take a period of 5 to 7 years to generate results so they tend to invest in things that would get them quick results; things that people can see to say that they are working. We can set up a national coffer, irrespective of which government comes into power where contributions will go into that, and no government will take credit for that. It will function like the national research fund which the government of Ghana has established but has no significant funds so far. (Researcher 4, WACCI).

It is a general thing that goes beyond WACCI. Research, science, and technology have not been prioritised at the continental and national levels. There are many issues in society, so money is channelled into areas which will bring immediate results. However, that should not be the case. Governments should also segment their resources properly so that if 1% of GDP is what goes towards research, that should be distributed properly among the institutions (Researcher 5, CSIR-CRI).

3.3.3.3 Awareness

WACCI has not been given due recognition for its activities and contributions towards addressing the food security concerns on the continent and this is a huge reason why it is not receiving enough national support and funds. Funds received by WACCI over the years have been from organisations and institutions which are aware of WACCI's role and the importance of agricultural research institutions. National government's failure to financially support WACCI makes it impossible to expand and extend its reach of influence to attract more private investors and support.

3.4 Challenges

However, like any institution, WACCI is confronted with its own set of challenges and if these challenges are addressed properly, the Centre's capacity will be strengthened. The challenges can be looked at on two levels: internal and external.

3.4.1 Internal Challenges

3.4.1.1 Management and Coordination challenges

> *Some projects are lumped together due to similarities in projects. However, this increases the workload of the researchers and most often than not, the junior researchers are not informed when such changes occur. There are also communication challenges at WACCI. The chain of communication is not properly set up and the junior staff are always the last ones to know of any changes or new developments. When it comes to transportation as well, those who go around to conduct research are not given any means of transport to facilitate their research and this puts a strain on their work and exposes them to a higher risk of being involved in road accidents. (Researcher 1, WACCI).*

3.4.1.2 Farm Challenges

As climate change has become a big problem for many countries and not just African countries, Africa must include technologies in food production. One of the adverse effects of climate change can be seen in agricultural production (UN-OHRLLS, 2009) as the rainfall patterns have been completely disrupted because of climate change. Climate Change to a greater extent cannot be controlled by the African government but by international organisations such as the UN as studies have shown that the biggest contributors (contributing about 50% of global greenhouse emissions) to climate change are the developed countries (Popovich & Plumer, 2021). However, what they can control is how much water goes onto farms and irrigation ensures that crops are watered year-round with or without rainfall.

Irrigation is a big challenge at WACCI research farms. The University of Ghana, where the farms are allocated does not have irrigation systems set up so crops on the farms are either being watered annually or rain-fed. This makes it difficult especially in seasons where the annual rainfall record

is low. In this vein, WACCI has put measures in place to create an irrigation system at their farms, but the success of this project will depend largely on donors.

3.4.2 External Challenges

3.4.2.1 Funding

Funding is another critical challenge for WACCI. Agricultural research institutions are there to mostly conduct research and agricultural research requires huge investments which unfortunately WACCI is not receiving from national governments and continental institutions.

> *Imagine that at the reading of the next budget, the government of Ghana allocates an amount of money towards training and capacity building of crop improvement at WACCI. You can imagine the huge impact that will have on the Centre. However, we are always at the mercy of one donor or the other. When one grant is finished, you are thinking about where the next grant is going to come from. (Researcher 4, WACCI).*

3.5 WACCI Receives Endorsement

WACCI has been endorsed as a model for replication in South-East Asia and sub-Saharan Africa by the Chicago Council on Global Affairs AQAS. Most participants ended the interview with the hope that institutions like WACCI will be set up in various parts of the continent as the benefits of WACCI are enormous and beneficial to the continent.

> *I hope there will be more institutions like WACCI in the continent in different disciplines and not just agriculture so that we can train a high calibre of people who can change the continent (Researcher 5, CSIR-CRI).*

> *I am sure that if several programmes like WACCI are established in several countries, there will be more breeders. There will be more increase in crop production, not only in quantity but in quality as well. (Researcher 2, IRAD).*

3.6 Conclusion

The data gathered and analysed have shown that WACCI has contributed a lot to achieving food security on the African continent. The participants shared that funding research is not something that African governments are particularly interested in doing. They pointed out that contributing as low as 1% of governments' GDP annually to research will go a long way to yielding results in terms of reaching the 2030 food security targets.

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CHAPTER FOUR

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

4.0 Introduction

Food security has become a vital aspect of human security. Global hunger and malnutrition levels keep rising at alarming rates, threatening international security. Over the years, the international community has put some guidelines in place to reduce food insecurity levels with the current measure being the sustainable development goals. Goal Two, which talks about zero hunger, highlights the importance of research and technology. To achieve this target by the 2030 deadline, African governments should prioritise agricultural research by investing in research and agricultural research institutions. Unfortunately, many funds are not being channelled into agricultural research, making food security an impossible target to achieve.

The study sought to highlight WACCI's contributions to ensuring food security in West and Central Africa premised on the thesis that food insecurity persists in Africa due to inadequate attention in agricultural research institutions such as WACCI. To begin, the study stressed WACCI's activities that drive food security and then used qualitative analysis through interviews to find out how important agricultural research and research institutions are in achieving food security and how WACCI's activities drive food security; find out why national and continental support of agricultural research is low; highlight some challenges of WACCI.

This chapter highlights the major findings gathered at the end of the study, presents a conclusion and provides recommendations which will increase national and continental support of agricultural research and research institutions in Africa.

4.1 Summary of Findings

4.1.1 Africa's Performance on SDG 2

The 2019 and 2020 reports put out by the Africa SDG Index and Dashboard Reports reveal that Africa's performance of SDG 2 has not improved. The report highlights that countries in Central Africa are the worst performers of all the regions. The report also shows that though Africa has pledged to commit to achieving the SDG goals, most of them have no place for the SDGs on their annual budgets.

Some of the respondents attribute the Covid-19 pandemic, Russia-Ukraine War and climate change issues as serious concerns that impede Africa's progress to achieving food security. For internal challenges, all respondents highlight that investments in agricultural research and technology are low which accounts for food security challenges on the continent.

4.1.2 Importance of Agricultural Research in Achieving SDG 2

All respondents agreed that the role of agricultural research in food security cannot be overemphasised. Generally, agricultural research, according to the respondents leads to efficiency in food productivity. Efficiency will reduce food imports as there will be an increase in food production which will lead to food security. Efficiency is achieved because of new crop varieties, innovations and techniques that are developed through agricultural research.

Agricultural research reveals the gaps that exist and provide knowledge. All research shares the basic purpose of identifying the gaps that exist and bringing knowledge. Some respondents shared how through agricultural research, farmers now know when and in which ecological zones to plant

the various tomato varieties that already existed in the Ghanaian markets. This knowledge ensured that farmers were using the right varieties which ensured an increase in farm yield.

Another important aspect of agricultural research is the fact that research ultimately leads to development. Every society can only develop through research as research brings about innovations and new ways of doing things which leads to efficiency and an increase in productivity. Therefore, investing in agricultural research means investing in the development of the agricultural sector and consequently the development of the economy.

4.1.3 Contributions of WACCI to Ensuring Food Security

All respondents highlighted the various activities of WACCI which contributes to the quest of achieving food security in the Western and Central African regions.

WACCI's training is seen as essential in achieving food security. The respondents mentioned that before its existence the two regions did not have an agricultural research institution that specialised in plant breeding. Also, the training that WACCI gives to students ensures that at the end of the day, students carry out research that is of great importance to their home counties. The state-of-the-art facility available at the Centre also makes research easy for students to undertake. Alumni from WACCI are heading various national agricultural research institutions and have also developed high-yielding crop varieties that are being used by farmers.

Some of the respondents also revealed that WACCI faculty members also conduct their research which has led the Centre to reveal high-yielding crop varieties in maize, tomato, and cowpea.

WACCI in addition to releasing its crop varieties, hold workshops with farmers, agricultural extension officers and agricultural research scientists to demonstrate how these varieties work.

The APBA which was established by the Centre is also contributing towards attaining food security on the continent. The APBA, as a platform, brings together agricultural research scientists, particularly plant breeders in Africa to share ideas on research in plant breeding and hold discussions on how to drive the food security goal through plant breeding.

The Centre is interested in the youth and the future of the agricultural sector. Therefore, the Centre organises workshops for young people with agribusinesses. The Centre invites successful people in the world of agribusiness to provide these people with skills, tools, and equipment to enable them to thrive.

4.1.4 Factors that Account for Low National and Continental Support of Agricultural Research Institutions

All respondents emphasised the need for national governments and international organisations on the continent to support agricultural research. They acknowledged that currently, the support is low, and they cite low levels of financial resources and politics as the reason for low support.

The respondents highlighted low levels of financial resources as Africa's biggest challenge. Africa does not have the money and resources to invest in things that are not of a priority and agricultural research is such. African governments always have budget deficits and must borrow huge sums of money to support their budget. Social interventions or the provision of social amenities are of high

importance to governments; therefore, the money is always used for buildings, roads, schools, and hospitals. These are good projects; however, there must also be money allocated to agricultural research which is equally important.

The respondents cited that the reason why most African governments do not invest in agricultural research is that the results of agricultural research are slow to yield results. Sometimes, research can take four or more years to achieve good results and African governments do not have the luxury of time to wait that long for results. They want to be able to point out visible projects to the citizens as proof that they are working and that is why most governments would rather invest in social amenities than in agricultural research.

4.1.5 Challenges Facing WACCI

The challenges facing the Centre are grouped into two, internal and external challenges.

For internal challenges, the respondents mentioned that there are challenges at the research farms. One such challenge is water. Crops need water to grow and trials at WACCI are either done through the rainfed method or by irrigation. Issues of climate change make it difficult to carry out research using rainfall as rainfall patterns have completely changed. The WACCI farms, however, do not have any irrigation systems at the farms and the crops are watered by hand. This makes it tedious for the researchers and hours are spent watering crops when the time could have been used more productively.

Also, management and coordination issues pose a challenge to the Centre. Communication channels at the Centre are not clear or direct and sometimes information gets lost or is not given

to the right person at the right time. This slows down activities and leads to a waste of resources which can also be used better elsewhere.

The biggest challenge WACCI faces are external and that is sustained funding. Research is an expensive investment, and the Centre is always at the mercy of donors for their next source of funding which is not always guaranteed as the activities and interests of these donors can change at any time. However, if national governments allocate a certain percentage of their budget to WACCI, then the Centre will only focus on research and not worry about funding.

4.2 Conclusions

The role of agricultural research institutions cannot be overemphasised. Agricultural research institutions such as the NARIs and other centres like WACCI have contributed to the African agricultural sector. However, their activities or roles have been diminished and relegated to the background. African leaders on the international front have pledged to support and promote the SDGs to achieve sustainable development. The SDGs have also been incorporated into Africa's Agenda 2063; however, the levels of financial support given by national governments and international organisations like the AU to agricultural research institutions such as WACCI are minimum. Though investments in agricultural research have not been a priority for many governments, it is not too late to invest in agricultural research and investing in this will increase Africa's chance of achieving food security by the 2030 deadline.

To achieve a prosperous Africa, governments must put into action all the various goals. This does not require only one country but all African countries to play their roles in achieving this. The CAADP mandates all African governments to contribute 10% of their national budgets to

agriculture; however, most countries have failed to achieve that. Investments in the agricultural sector have fallen drastically. If the 10% is too high for governments, perhaps it is time to reduce this so that every country will be able to contribute something to the agricultural sector.

4.3 Recommendations

The study makes the following recommendations to increase agricultural research in Africa's food security efforts.

I. The CAADP should be considered for amendment. African governments are failing to realise 10% of their budgets. The figure should be reduced from 10% to a percentage that can work for all African countries. This will ensure that if not all countries, then most countries will be able to allocate such an amount to the agricultural sector. Out of the 3%, 2% should be solely for agricultural research. This will go into the NARS and increase research activity in the countries. This will also ensure that agricultural research centres like WACCI have a steady source of funding, and this will lead to an increase in WACCI's capacity.

II. Agricultural research centres like WACCI should be built in various regions. WAACI is built mainly for students in West and Central Africa and there is another plant breeding institution in South Africa, ACCI, which was built before WACCI to cater for the needs of the whole continent. However, due to climatic and ecological differences, it was prudent to build another one for the western and central African regions. West and Central Africa also share different ecological conditions; therefore, it will be best to set up plant breeding institutions for the five regions in Africa. This will just enhance plant breeding research

and result in an increase in plant breeders and an increase in the crops that will be researched.

III. Major investments should also go into developing the technological capacities of states. Technology plays an essential role in boosting agricultural productivity. The NARS should be outfitted with the latest agricultural technologies and equipment.

IV. Africa battles with worse climate conditions which have adverse effects on the agricultural sector. The amount of rainfall recorded by states keeps falling as such states should prioritise developing irrigation systems for farmers. This will increase crop production as farming will no longer be determined by rainfall patterns.

V. Additionally, governments should put efforts into addressing civil wars and military coups that have started increasing on the Continent. This can be achieved by strengthening democratic institutions such as the Judiciary, Electoral Commission and Legislature. A stable political environment is a prerequisite for development.

4.4 Suggestions for Future Studies

The study proposes that in-depth analysis of the low financial support of agricultural research institutions from the government and international organisations' perspectives should be considered for future studies. The result will lead to the development of long-lasting solutions that will increase the financial support of agricultural research institutions.

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APPENDIX

UNIVERSITY OF GHANA

LEGON CENTRE FOR INTERNATIONAL AFFAIRS AND DIPLOMACY

INTERVIEW GUIDE

RESEARCH TOPIC:

CONTRIBUTIONS OF THE WEST AFRICA CENTRE FOR CROP IMPROVEMENT IN ENSURING FOOD SECURITY IN WEST AND CENTRAL AFRICA

NAME OF STUDENT: PRISCA NAAKUO DJABANG

MA INTERNATIONAL AFFAIRS

2021/2022 ACADEMIC YEAR

Questionnaire for WACCI/ CSIR/IRAD

The purpose of this interview is to help me collect data for my research. CSIR and IRAD have been selected to represent the National Agricultural Research Centres for the West and Central African Regions respectively. Both institutions have had engagements with WACCI over the past years and your ideas/experience/knowledge on food security and agricultural research will be invaluable to the outcome of my study. This interview is between 20-30 minutes. The study at the end will affirm the thesis of the or otherwise, that food insecurity persists in Africa due to inadequate attention to agricultural research institutions such as WACCI.

Thank you for your participation.

Questions

1. How can Africa achieve SDG 2 by the 2030 deadline?
2. How vital are agricultural research institutions in achieving SDG 2?
3. What contributions has WACCI made towards ensuring food security in Africa?
4. What makes WACCI better when compared to other institutions of Higher education in agricultural research?
5. Why is there less focus on institutions of higher learning as compared to NARIs in NARS?
6. Should the WACCI programme be duplicated across Africa?
7. Is state support of WACCI at the level you want it to be, especially, in terms of accepting your products?
8. What is the level of coordination between WACCI and NARIs?
9. How beneficial has WACCI been to NARIs?
10. How does WACCI complement the work of NARIs?
11. What are the challenges WACCI faces?