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Multi-stakeholder approaches to food security and adaptive governance for sustainable agriculture in Sub-Saharan Africa

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ABSTRACT

In Africa, the great challenge posed by climate change, population growth, and economic instability to food and agricultural sustainability represent a complex landscape which necessitates a multi-stakeholder approach and adaptive governance strategies in order to set up a sustainable and resilient food system. To direct attention to this problem, this paper examines systematically the common point of economic development, plant breeding, policy practices and agricultural reinvestment. The agricultural landscape is modified by the climate change effect, requiring advanced plant breeding techniques to create crop varieties capable of resisting or be resilient to extreme weather events, pests and diseases. These efforts are pivotal for preserving and improving food security in Africa. Simultaneously, there is an urgent demand to grow African economies and at the same time assure food availability and accessibility for African fast growing population. However, economic trends, best practices and future policies are crucial to adapt the future of African agriculture. The reinforcement of current policies and by increasing the reinvestment in the agricultural sector, African countries can create good environments for food security and sustainable economic growth. This requires multiple stakeholders like government agencies, research institutions, private sector entities and local communities. Importantly, adaptive governance structures are essential for addressing African agriculture dynamic challenges. The governance structures must be flexible enough to satisfy the market fluctuations, respond to the changing climatic conditions and technological advancements while remaining rooted in the local contexts and traditional knowledge. The multi-stakeholder approach purposely supports collaboration and knowledge sharing within agricultural sector actors. By creating platforms encompassing plant breeders, economists, policymakers, farmers, and other relevant stakeholders, we can develop global solutions to face the interconnected challenges of agricultural sustainability and food security in Africa.

Key words: Africa, agricultural education, agricultural policies, agricultural productivity, climate change, food systems, food security, plant breeding, policy makers

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RÉSUMÉ

En Afrique, le grand défi posé par le changement climatique, la croissance démographique et l'instabilité économique à la durabilité alimentaire et agricole représente un paysage complexe qui nécessite une approche multipartite et des stratégies de gouvernance adaptatives afin de mettre en place un système alimentaire durable et résilient. Pour attirer l'attention sur ce problème, le présent sujet examine systématiquement le point commun du développement économique, de la sélection végétale, des politiques agricoles et du réinvestissement agricole. Le paysage agricole est modifié par l'effet du changement climatique, ce qui nécessite des techniques de sélection végétale avancées pour créer de nouvelles variétés de cultures capables de résister ou d'être résilientes aux impacts climatiques extrêmes, aux ravageurs et aux maladies. Ces efforts sont essentiels pour préserver et améliorer la sécurité alimentaire en Afrique. Simultanément, il y a une demande urgente de croissance des économies africaines et en même temps d'assurer la disponibilité et l'accessibilité de la nourriture pour la population africaine en croissance rapide. Cependant, les tendances économiques, les meilleures pratiques et les politiques futures sont cruciales pour adapter l'avenir de l'agriculture africaine. En renforçant les politiques actuelles et en encourageant le réinvestissement dans le secteur agricole, les pays africains peuvent créer un environnement favorable à la sécurité alimentaire et à une croissance économique durable. Cette méthode implique de multiples parties prenantes telles que les agences gouvernementales, les instituts de recherche, les entités du secteur privé et les communautés locales. Il est important que des structures de gouvernance adaptatives soient essentielles pour relever les défis dynamiques de l'agriculture africaine. Ces structures de gouvernance doivent être suffisamment souples et flexibles pour répondre aux fluctuations du marché, à l'évolution des conditions climatiques et aux avancées technologiques, tout en restant ancrées dans les contextes locaux et les connaissances traditionnelles. L'approche multipartite ici développée vise à soutenir la collaboration et le partage des connaissances entre les acteurs du secteur agricole en Afrique. En créant une plateforme regroupant des sélectionneurs de plantes, des économistes, des décideurs politiques, des agriculteurs et d'autres parties prenantes, nous pouvons développer des solutions globales pour faire face aux défis interconnectés de la durabilité de l'agriculture et de la sécurité alimentaire en Afrique. Cette étude examine les défis multidimensionnels, soulevés par divers panélistes lors de la deuxième conférence triennale de RUFORUM (Forum régional des universités pour le renforcement des capacités en agriculture), afin de garantir une politique solide de sécurité alimentaire durable en Afrique. Cette deuxième conférence triennale de RUFORUM, qui s'est tenue en Namibie, a servi de plateforme pour discuter des stratégies prospectives, partager les meilleures pratiques et tirer parti des partenariats qui permettront de progresser dans la mise en place d'un système alimentaire durable en Afrique.

Mots clés : Afrique, éducation agricole, politique agricole, productivité agricole, systèmes alimentaires, sécurité alimentaire

INTRODUCTION

In Africa, food insecurity is one of the most important challenges in the continent faces. There are multiple obstacles to ensuring sustainable agricultural development and for setting up adequate nutrition for its expanding population. The Food and Agriculture Organization (FAO, 2008) defines food security as a situation where "all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life". The population in Africa is expanding rapidly and is projected to reach 2.5 billion by 2050 (Prosekov *et al.*, 2018; UN DESA, 2019; Bjornlund *et al.*, 2022). This growing population poses considerable challenge to the food system and natural resources and further still the continent is particularly vulnerable to climate change

impacts (UN DESA, 2019; Hossain *et al.*, 2019; Wudil *et al.*, 2022). According to the Intergovernmental Panel on Climate Change (IPCC) reports, Africa will face changing precipitation patterns, more frequent droughts and floods and extreme temperature (IPCC, 2014). These changes affect significantly agricultural productivity and especially the food availability. Further, the World Bank (2020) stated that subsistence farming techniques with low productivity, are largely used in Africa and employ 60% of the available workforce. Hence, in Africa, around 40% of the population lives below the poverty line (World Bank, 2022). This creates wide spread food insecurity and poverty as the access to agricultural inputs and food is highly limited. The Global Hunger Index 2021 stated in their report that globally, 8 out of 10 countries with unfavourable food systems are in Africa (Wudil *et al.*, 2022). These poor food systems are often associated with inadequate storage facilities thus causing considerable post-harvest losses (Juma, 2015). The African Post-Harvest Losses Information System estimates that 30-40% of food produced in Africa is lost before it reaches the consumer (Juma, 2015; APHLIS, 2020).

Overall, African agriculture productivity growth is threatened by the lack of access to agricultural input like improved seeds, fertilizers and modern agricultural technologies and unsustainable farming practices. A report by UNCCD, the UN Convention to Combat Desertification stated that 65% of agriculture landscape in Africa is degraded, affecting 485 million people (UNCCD, 2019). All these factors show not only the complex aspect of the persistent challenges of food insecurity and agricultural policy in Africa but also highlight that these factors are deeply rooted, interconnected and multifaceted. In 2020, about 281.6 million people were undernourished in Africa (FAO *et al.*, 2021). Additionally, the issues above were exacerbated by the COVID-19 pandemic and its socio-economic impacts with the number of people facing acute food insecurity rising to 258 million in 58 countries in 2022 (Adam *et al.*, 2020; Moseley and Battersby, 2020; WFP, 2022). Facing these complex and interconnected-challenges require a global multi-stakeholder approach, involving among others, developing new and livestock climate resilient farming systems and putting in place techniques and policies supporting sustained investment in agriculture. Furthermore, the approach must be robust enough to create a sustainable solution to the African food system while being flexible and dynamic to respond to the changing nature of agriculture food systems in Africa.

African universities are at the forefront of education in agricultural and other sectors, training next generation researchers and other practitioners. For example, among them, Makerere University Regional Centre for Crop Improvement (MaRCCI) in Uganda, Crop Improvement Program at University of KwaZulu, Natal in South Africa, and West Africa Centre for Crop Improvement (WACCI) in Ghana. These institutes cover various aspects of agriculture including agronomy and plant breeding, providing programs from undergraduate to doctoral levels. Importantly, these institutions contribute to developing human capital by conducting research and creating innovations in the agricultural sector. Approximately, 127 agriculture-focused universities were recorded across Africa in 2020 (African Development Bank, 2021). And between 2010 and 2020, enrolment in agricultural programs in African universities increased by 32% (UNESCO Institute for Statistics, 2021). These institutions conduct critical research to address agricultural challenges in Africa and particularly they focus on development of improved crop varieties, sustainable farming practices and innovative technologies for enhancing productivity as well as resilience in agriculture systems. From 2000 to 2016 African agricultural research spent $1.7 to $3.9 billion, showing an increase spending in agricultural research within this period (Beintema and Stads, 2017; Sers and Mughal, 2019). All these efforts aim at improving yield, pests and disease resistance, and climate resilience in African agriculture. These institutions disseminate technologies and knowledge to farmers and other practitioners through outreach, extension services, training

programs and partnerships with local communities and other stakeholders. These institutions also contribute to reducing dependence on external expertise and reinforce local capacity in agriculture and development. Frequently, the results of the research conducted by these institutions are used to inform agricultural policies at national and regional levels and thereby contributing to informed decision-making.

Several factors contributed to the increasing food insecurity and wide-spread poverty in Africa, among them, the rapid population growth, unsustainable farming practices resulting in declining soil fertility, climate change, and overall economic instability challenges. Therefore, a comprehensive multistakeholder approach is crucial to successfully tackle these multifaceted and interrelated challenges. Various stakeholders like farmers, NGOs, government agencies, and private sector entities have diverse perspectives and interests in agriculture development. Adaptive governance can help balance stakeholders' interests by creating more flexible policies. Multistakeholder processes can lead to efficient and effective sustainable solutions, applicable to complex development challenges (Dodds and Benson, 2013). This approach facilitates innovative-knowledge sharing in agricultural practices. Adaptive governance approaches are needed for responding to the sustainable development challenges which requires in the context of climate change, responsive management strategies (Folke *et al.*, 2005). With this approach, Africa agricultural sector can overcome policy fragmentation and facilitate more coherent and robust agricultural policies.

The World Bank has stated that spending in Africa agricultural research is only 0.39% of agricultural GDP compared to 3.25% in high-income countries (Wachira, 2022; World Bank, 2022). According to the Mo Ibrahim Foundation (2019) only 13 out of 54 African countries have fully implemented the Comprehensive Africa Agriculture Development Programme (CAADP). Multistakeholder partnerships could facilitate resources mobilizations in agricultural sector for food security and could also leverage networks to address complex development challenges (Pattberg and Widerberg, 2016). For the policy implementation transparency in agricultural sector, the Ibrahim Index of African Governance 2019 shows that only 8 out of 54 African countries scored above 60 (out of 100) in the "Rural Sector" category, including successful measures of agricultural policy implementation. By addressing food security challenges in Africa, using multi-stakeholder approval, this review seeks to provide broad overview in analyzing how plant breeding, economic growth, policy practices and implementation, agricultural education and agricultural reinvestment in Africa are interrelated in the context of food security and sustainable agriculture development.

Conceptual framework. To address the African agriculture interrelated challenges, the multistakeholder approach promotes diverse actor collaboration, interdisciplinary knowledge sharing, and flexible management within actors. This approach recognizes that any single actor or intervention alone cannot successfully address the interconnected complex agriculture challenges in Africa, and hence multistakeholder engagement is essential for tackling African agriculture challenges.
(Figure 1). This approach prioritizes collaborative partnerships, knowledge sharing, expertise exchanges and flexible management. The conceptual framework showcases the food system issues in Africa and their complex natures, while promoting the consensus facilitation for food security reinforcing and sustainable economic growth. In the present framework, diverse relevant actors support the process through adaptive governance structure highlighting learning-by-doing and participatory policy-making processes (Folke *et al.*, 2005; Reed *et al.*, 2009). Various knowledge bodies especially scientific, traditional and local are integrated and combined to develop observations or evidence-based and context-specific solutions. It considers the value of rural and local agricultural practices and their potential to sustainable food systems

enhancements (Tengö *et al.*, 2014). Additionally, this integration promotes knowledge sharing, skill enhancement, capacity-building and engagement of stakeholders in decision-making and a sustainable agricultural practices implementation (Shackleton *et al.*, 2009). Furthermore, policy coherence and transparent decision implementation across African agricultural sectors provide an opportunity to set a supportive structure for agricultural development sustainability and food security. This robust structure is capable of creating sustainable intensification of agricultural productivity in Africa through continuous learning and evaluation over time to develop strategies and interventions (Pretty *et al.*, 2011; Guijt, 2014; Candel and Biesbroek 2016).

Functional agriculture system and plant breeding for resilient climate change. Plant breeding is important for climate change adaptation, particularly in African agriculture. Faced by the continuously significant threats posed by climate change to food security especially, plant breeders are working to create new crop varieties that are high yielding, climate-resilient and with desirable agronomic traits capable of withstanding various stresses including environmental. With the increased severe drought conditions observed in many parts of Africa, plant breeding techniques could help to enhance food security by essentially developing new crop varieties not only capable of adapting and to maintain productivity under higher temperatures, but also capable of withstanding prolonged periods of water scarcity (Ribaut *et al.*, 2009). Also, climate change is always altering the distribution and intensity of pests and diseases, consequently, it is important to create varieties capable to better utilize the nutrients available in the soil and to develop crops varieties with enhanced pests and disease resistance (Hirel *et al.*, 2007; Bebber *et al.*, 2013). Breeding programs are intended to establish new crop varieties with shorter growth cycle, with desirable and farmers preferred traits, able to adapt the changing rainfall patterns (Rosegrant *et al.*, 2014). Various techniques and breeding strategies are utilized to develop crops with shorter maturation periods and desired traits including high-yielding, nutritional value, pests and disease resistance. These techniques and breeding strategies encompasses conventional breeding methods, participatory plant breeding involving local farmers, marker-assisted selection, genetic engineering and genomics selection based on genome editing tools such as TALENs, ZFNs, CRISPR-Cas9 (Kpoviessi *et al.*, 2024). The modern breeding techniques and the traditional knowledge integration has been successfully used in developing locally adapted and climate resilient varieties (Ceccarelli *et al.*, 2015).

Role of other actors in facilitating adopted practices. Multiple initiatives are underway in Africa to support plant breeding for climate change resilience. Partnership with agribusiness sector could improve markets access and technology transfer and thereby enhance supply chain. Private sector involvement is essential to foster innovation and investment in agriculture, and this is important for driving sustainable agricultural practices and especially food security across Africa (Post *et al.*, 2021; Agarwal *et al.*, 2023; Pickson *et al.*, 2024).

Gaps between local communities and government organizations are often bridged by NGOs which provide resources and training to local communities. NGOs significantly contribute to the agricultural practices enhancement and local farmers' empowerment, by delivering agricultural extensions services, thus assuring food availability (Danso-Abbeam *et al.*, 2018). Local communities' involvement in decision-making builds trust and ensures that resulting policies are relevant to their conditions and needs. Traditionally, rural farmers possess useful, context-specific, and indigenous knowledge adapted to the rural area specific context which is invaluable for sustainable practices. Hence, local knowledge practices should inform and be the basis of the adaptation strategies in agriculture systems governance to improve climate change resilience (Kolawole *et al.*, 2014; Fisher *et al.*, 2015)

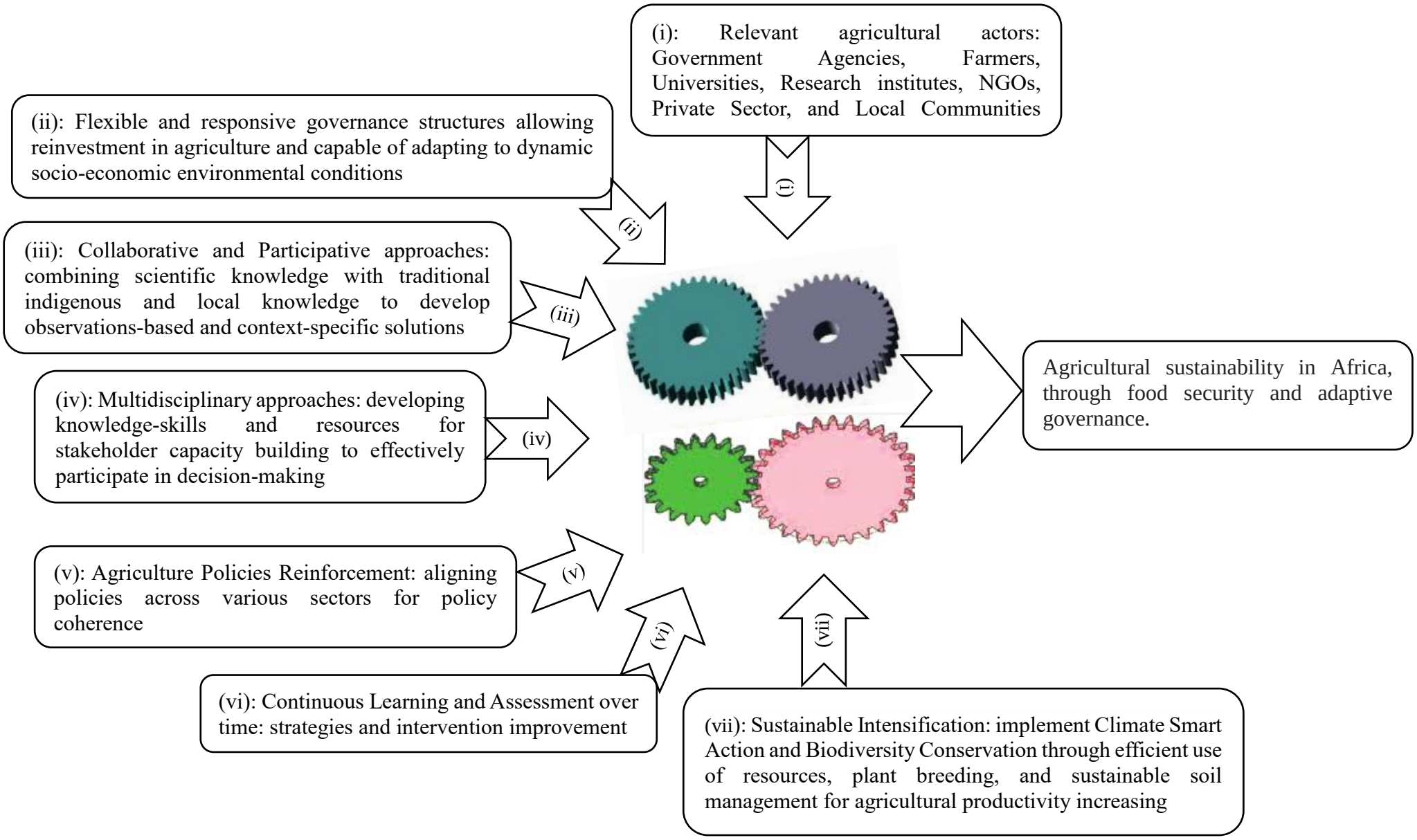

Figure 1: Conceptual Framework for the multi-stakeholder approach for agricultural sustainability in Africa

National agencies and local government entities play a central role in policy creation, implementations and regulations supporting agriculture development. Effective government support through robust infrastructure and investments in technology and research could enhance food security in Africa. Governments' development agendas could integrate agricultural policies for adapting Agrifood systems to the climate resilient strategies (Smith and Frankenberger, 2018).

Agriculture research institutions are important in providing observations-based data and innovative solutions to enhance agricultural productivity, particularly in the process of breeding crops and livestock for desirable farmers preferred traits including pest and disease resistance, nutritional quality and climate resilience. Collaborative research among institutions like universities and research organizations can facilitate knowledge sharing and promote partnership with other stakeholders while fostering adaptive governance to address the multifaceted challenges of food security in Africa (Adenle *et al*., 2019).

It is important to have flexible governance frameworks for African agriculture systems so as to be able to adapt to new information and changing circumstances, particularly related to climate change impacts. Transformative change and paradigm shifts are essential to apply resilience principles to sustainable agriculture, showcasing that a flexible approach is important for responding to the dynamic changes in socio-economic conditions and agricultural systems in changing climate (Rhodes *at al.*, 2022; Shumi *et al*., 2024). Therefore, connectivity among actors and stakeholders' collaboration are essential and fundamental to adaptive governance especially on the promotion of knowledge co-production and sharing and ensuring integration of diverse perspectives in policy-making process. Importantly, inclusive decision-making engaging diverse stakeholders builds trust and enhances governance legitimacy and effectiveness while facilitating collaborative management (Brondizio *et al.*, 2009; Ayivor *et al*., 2020). These could work not only for immediate food security but also build resilience principles for future challenges such as market fluctuations and climate variability. These will establish resilience oriented governance fundamental for agricultural sustainability in the face of increasing environmental challenges (Takeuchi *et al*., 2016; Wakweya, 2023).

Economic growth sustainability and agrifood systems strengthening. Effective agricultural development bolstered by sustainable economic growth is possible through the implementation of interrelated strategies by multiple actors. Among others, research institutions are fundamental in the development of innovative technologies and practices by conducting research on pests, diseases and development of drought-resistant crops and sustainable farming practices. The research Institutes are capable of enhancing agricultural productivity while minimizing environmental impact. These institutions also provide farmers with latest technological practices information and data on climate patterns for adaptation, thereby promoting knowledge sharing and facilitating partnerships between scientists, farmers, and policy-makers (Spindell Berck *et al.* 2018). Diverse stakeholders contribute to the agriculture sustainability through investment in infrastructure (e.g., irrigation systems, roads) and supportive policies, while delivering training programs for farmers on sustainable practices and micro-financing process. These stakeholders also help to invest in agricultural technologies (biotech, precision farming amongst others) and work closely with farmers to develop sustainable supply chains for main agricultural value chains (Eweje *et al.*, 2021; Maryono *et al.*, 2024).

Sustainable economic growth in agriculture systems could be attained through agroecological approaches integrating efficient use of resources, minimizing chemical inputs, promoting biodiversity conservation while prioritizing circular economic approach by emphasizing waste reduction for sustainable food production (Vladimír, 2021). These strategies if implemented could strengthen the

food systems by building resilient food production in Africa. These, for examples, could include investments in infrastructure and technology for smallholders and in so doing improving their market access, and ensuring fair prices for their products. These strategies could help farmers in post-harvest management by reducing crop losses and expanding their access to credit and insurance services while mitigating environmental risks (Pawlak and Kołodziejczak, 2020; Sharma *et al*., 2024).

Actual policies in African agricultural systems for food security implementation. In recent decades, African agricultural policies have progressed significantly with increased focus on food security, sustainable development and climate adaptation. Launched in 2003 under the African Union's New Partnership for Africa's Development (NEPAD), the Comprehensive Africa Agriculture Development Programme (CAADP) has been fundamental for agriculture policy across Africa continent, providing crucial policy direction for African agriculture development (AU, 2003; AU, 2014). Policies promoting climate smart-agriculture including resilient farming practices, breeding and deployment of drought-resistant crops, pests and disease-resistant crops, and improved water management have been adopted across the continent (Lipper *et al.*, 2014). To facilitate market access and crops value chain development, policies encompassing infrastructure development, reducing trade barriers and agro-processing capabilities enhancements have been developed and adopted (Jayne *et al*., 2014). Many other policies focusing on research funding enhancements for research institutions and knowledge dissemination among smallholder farmers have been implemented (Byamugisha, 2013; Beintema and Stads, 2017).

Successful policy implementation targeting agricultural development has been recorded across Africa. Among them, agricultural support. African countries have been encouraged to allocate at least 10% of their national budgets to agriculture under the Maputo Declaration 2003 and Malabo Declaration 2014 (Pernechele *et al.*, 2021). This aims at contributing to poverty reduction in several African countries. In Ghana, agricultural GDP growth of 4.5% per year between 1991 and 2005 led to a 24% reduction in poverty (Diao *et al.*, 2010). Other countries have recorded significant yield increases for staple crops. For example, Ethiopia's maize yields doubled between 2005 and 2015 due to use of improved inputs and extension services provided in the sectors following policy implementation (Bachewe *et al.*, 2018). The regional economic communities' formation in Africa, has facilitated trade and policy harmonization at regional level (Badiane and Makombe, 2015). Nevertheless, the development of African agricultural policies still faces some challenges. Despite the commitments to reinvest in agriculture, many African countries still struggle to comply with the investments targets in agricultural sector, highlighting the implementation gaps of agricultural policies in Africa (Pernechele *et al.*, 2021). The increasing severity of droughts, and the outbreaks of pests and diseases represent a critical challenge for food security (Kotir, 2011). Frequent land degradation including soil erosion, deforestation, and unsustainable farming practices pose significant threats for long-term agricultural productivity in Africa (Nkonya *et al.*, 2016). Poor infrastructure and trade barriers environment continue to weaken smallholder farmers bargaining power and limit their capacity to access markets (Barrett, 2008). Issues related to policy coherence particularly the lack of coordination between different sectors (e.g., agriculture, environment, trade) often lead to mistrust and conflicting policies and their implementations (Nilsson *et al.*, 2012). Overall, youth attraction to African agricultural sector remains a challenge, showing a low young people engagement which curtains long-term food security sustainability (Sumberg *et al.*, 2012).

Current policy practices, and those in development and implementation, are essentially focusing on multi-stakeholder engagement in agricultural sector. This approach encompasses gathering under one

umbrella government agencies, smallholder farmers, local community organizations, private sector actors, civil society organizations, and research institutions to collaboratively address emerging challenges in agricultural sector (von Braun, 2009; Vink *et al.*, 2013; Candel, 2014). These crucial policies approaches, which aim to provide participates and promote inclusivity could be strengthened to ensure that marginalized groups, including smallholder farmers and women participate effectively in policy-making processes. To enhance food security in the current climate change conditions, and effectively adapt to climate challenges, many African countries have adopted policies promoting climate-smart agriculture practices. These policies include measures to improve crops for their resistance to emerging pests and diseases, improving soil health as well as water management (Lipper *et al.*, 2014; Lopez- Makate *et al*., 2017; Ridaura *et al.*, 2018). Policies will evolve over time to integrate the latest climate science research and local knowledge stemmed from climate-smart agriculture context, with a focus on observations-based decision-making and context-specific solution delivery capable of being scaled up across various agro-ecological zones.

The Comprehensive Africa Agriculture Development Programme (CAADP) initiative showcase effective regional co-operation engagement in agricultural policy (NEPAD, 2003). This, among others, could promote the strengthening of the regional policy frameworks and facilitate national policy harmonization for cross-border trade and resource management and sharing. Some African countries demonstrate trends towards digital policies, by supporting adoption of digital technology in agricultural sector, which includes the use of mobile apps for market information and weather forecasting (Tsan *et al*., 2019; Abdulai *et al*., 2023). Future digital policies should focus on reducing digital divide by ensuring equitable digital tools access for stakeholders in agricultural sector. For agriculture financial sustainability, emerging policies seek to increase public and private investments including green bonds and blended financial mechanism for agriculture sustainability (Havemann *et al*., 2020). Further innovative policies for agriculture financing capable of unlocking capital for smallholder farmers especially those in remote area and promoting agriculture sustainability practices at grassroots levels could be considered or harnessed as financial opportunities in agricultural sector.

Flexible investment strategies in changing climate conditions and stakeholders' approach for resource mobilization. Recently, the importance and the need for increasing investment in African agricultural sector have been raised to enable achieving sustainable food security, economic growth and sustainable development in Africa. However, the investment trends in agricultural sector are driven by many factors. Through the CAADP initiative, some African countries have recommitted to agriculture development by committing to allocate 10% of their national budgets to agriculture sector, with an emphasis on private sector actors' involvement in African agriculture, ranging from small-scale farmers to large multinational corporations (Poulton and Kanyinga, 2014; Jayne *et al*., 2019). Global initiatives like the Alliance for a Green Revolution in Africa (AGRA) have supported African agricultural development by mobilizing significant resources (Toenniessen *et al*., 2008). These encompass, investments for research and development in agriculture and the adoption of digital technologies for productivity-driven improvements (Shimeles *et al*., 2018). The investments for climate change adaptation in African countries have essentially focused on climate-smart agriculture and resilience-building in changing climate, and are particularly targeting entire agricultural value chains (Nyasimi *et al.*, 2014; Reardon *et al.*, 2019).

Agriculture is a pillar of Africa economy, and it represented in 2022 around 17 percent of Sub-Saharan Africa's GDP, with significant variations across countries, observed from 2020 to 2022. For example, Sierra Leone registered the highest contribution to the GDP of the

agriculture, forestry, and fishing sector in Africa, with over 60 percent. Niger and Ethiopia followed, with agriculture sector's accounting for approximately 42 percent and 38 percent of the GDP, respectively. Contrastingly, South Africa, Botswana, Djibouti, Equatorial Guinea, and Libya were the African countries with the lowest percentage of the GDP generated by the agricultural sector (Statista, 2024). The implementation of the Malabo and Kampala declarations on accelerated agricultural growth and transformation for shared prosperity and improved livelihoods, also seek for 10 percent of public expenditures investment in agriculture.

The trend in Figure 2 on the percentage of public expenditure in agriculture, highlights that overall Africa has not met CAADP's agricultural spending target of 10 percent of total public expenditure's investments in agriculture, with 2.66% the average percent of public expenditures from 2018 to 2023 for all African countries (Resakss, 2024). On the other hand, maintaining agricultural GDP at a minimum of 6 percent per year has also not been met as shown in the Figure 3 with 3.04 %, the average yearly growth rate recorded from 2018 to 2023 for all African countries (Resakss, 2024.

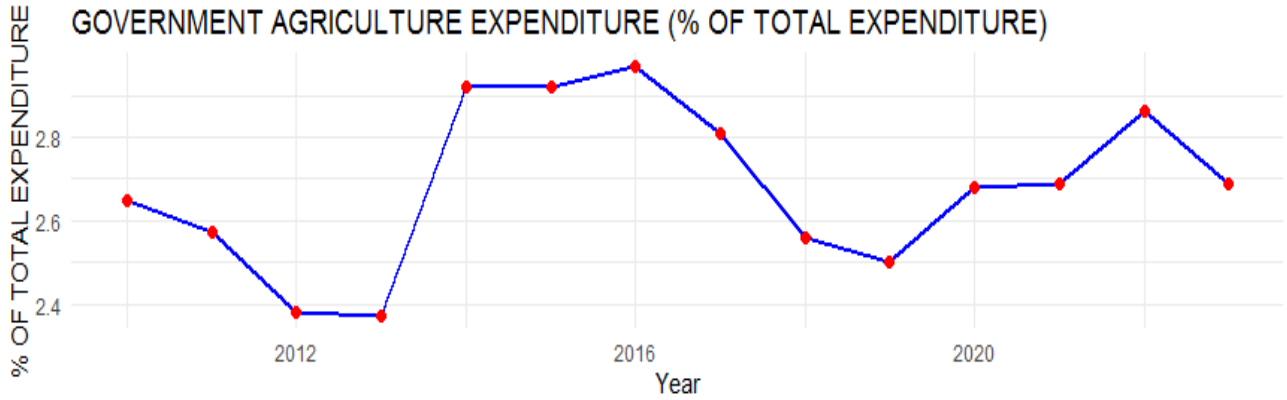

Figure 2: Government Agriculture Expenditure (% of total expenditure) (Resakss, 2024)

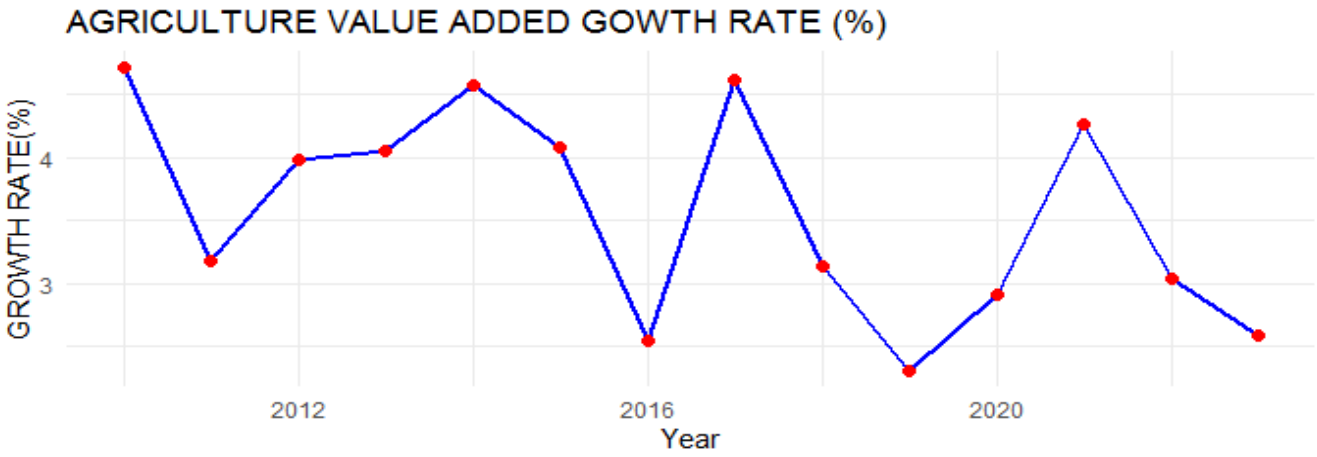

Figure 3: Agriculture Value Added Gowth Rate (%) Per Year (Resakss, 2024)

However, in the changing climate conditions in Africa, adaptive investment strategies require a multifaceted approach that has to be implemented for effective agriculture development. These encompasses increasing investments in agriculture, developing climate-resilient crops, promoting cultivation of pests and diseases resistance crops, promoting sustainable agricultural practices and implementing supportive and flexible policies, amongst others. By adopting these strategies, African countries can improve their climate-resilience ability while

ensuring food security and sustainable economic growth. Specifically, investing in climate-resilient crop varieties development is essential for food security sustainability. This could be achieved by developing drought-tolerant and heat-resistant crop varieties, and breeding crops with improved water-use efficiency and enhanced pest and disease resistance. According to the World Bank (2020), Climate-smart agriculture can help transforming Africa's agricultural systems, improving productivity and resilience while reducing greenhouse gas emissions. Overall, for sustainable economic growth in Africa, agricultural sector needs to develop and harness climate-smart agriculture practices, adopt efficient irrigation systems and diversification of crops and income sources, based on policies promoting agricultural transformation and resilience to climate shocks (AfDB, 2022). The key practices for adaptive investments in African agricultural sector should focus on increasing public and private sector investments in agricultural research and development, implementation risk management practices such as weather-indexed insurance while adopting precision agriculture and digital technologies. The FAO (2021) has stated that agricultural reinvestment with a focus on climate adaptation can significantly improve rural livelihoods and promote food security in Africa. Such reinvestment seeks to strengthen agricultural policies by aligning national agricultural policies with climate change adaptation strategies, taking into account climate science research and farmers and local communities' observations and knowledge. This requires increasing budget allocations for agricultural development and also facilitating regional co-operation for trade and global sustainable development for food security.

Capacity building through adaptive learning systems for sustainable agriculture. There is a growing trend of plant breeding for crop improvement and food security for agrifood systems enhancements in the climate change context. Some African universities and research institutions are developing training programs for the next generation of plant breeders and agricultural scientists. Amongst others, the Makerere University Regional Centre for Crop Improvement (MaRCCI) in Uganda, the West Africa center for Crop Improvement (WACCI) at the University of Ghana and the Crop Improvement center at University of Kwazunatal in South Africa. These institutions and CGIAR have been at the forefront of training plant breeders to develop climate-resilient crop varieties in Africa. The training programs in these institutions have a focus on sustainable agriculture and its role in economic development across African countries. The Agenda 2063 of the African Union outlines the importance of agriculture-driven economic growth and food security (African Union, 2015). In response, African agricultural education and research institutions are now incorporating elements of adaptive governance and multi stakeholder engagement in their programs to foster sustainable farming practices and agribusiness management. The agricultural institutions like the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) network is promoting policy-relevant agricultural research and agricultural education across African universities (Adipala *et al.*, 2017). These have strengthened recognition and the need for a multi-stakeholder approach for agricultural research education and technology delivery in Africa (see Box 1).

Despite some progress several challenges impair agricultural education in Africa. African universities and other research institutions struggle with inadequate funding for agricultural research, capital development and ensuring improved practices are adopted by end users. Some of the key challenges include poor research and training infrastructure (Beintema and Stads, 2017). The agricultural education in Africa is also impacted by the under representation of women in agriculture research and leadership (Chakeredza *et al.*, 2008; Beintema and Stads, 2017; Houweling *et al.*, 2018). However, some, positive advancements have been recorded networking initiatives like under the Forum for Agricultural Research in Africa (FARA) and RUFORUM promote collaboration across Africa, bringing together and brokering co-operation amongst universities, private sector and other agricultural stakeholders, to enhance policy alignment, develop practical training programs and enhancing research relevance for promoting

observations-based and context-specific decision-making for agricultural sustainability (Adipala *et al*., 2017). Further, the growing recognition of digital innovations such as E-learning and digital technologies for agricultural sector would enhance agricultural education and research to spur agricultural innovation and enhance sustainable productivity (Tata and McNamara, 2018).

Union, the CAADP initiative, represents a successful example of a multi-stakeholder approach offering a multilateral solution for a network initiative, the Plant Breeding Academy (APBA), established in 2018 is a collaborative effort to foster co-operation between universities, research institutions and private sector to develop African plant breeders' capacity (APBA, 2021). This APBA network focuses on developing climate-resilient and pests and disease-resistant crop varieties, and training the next generation of agriculture scientists in plant breeding and crop. improvement to better tackle food security issues in Africa. Importantly, launched by the African sustainable development in Africa (AU, 2021). The CAADP gathers governments' bodies, civil society, private sector, and local communities' organizations to promote public investment in agriculture and to improve agricultural productivity. The CAADP program has led to capacity-building initiatives across Africa, targeting crops value chains development and sustainable farming practices (CAADP, 2023). Another initiative is the African Capacity Building Foundation (ACBF) which particularly focuses on addressing economic issues and promoting best farming practices through stakeholders' engagement (ACBF, 2021). The ACBF fosters collaborations between governments' agencies, academic institutions, and local communities' organizations to develop institutional and human capacities related to private and public sector management and economic policy analysis.

Box1: Multistakeholder Engagement for Technology Development and Dissemination: The Case of the Baobab CARP in Benin

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The Baobab CARP initiative in Benin, formally known as the BAOCHAIN Project, was a five-year Community Action Research Programme Plus (CARP+) project implemented from February 2018 to March 2023. Funded by the MasterCard Foundation and RUFORUM. The project exemplifies a successful multi-stakeholder research-for-action platform combining participatory research, capacity building, and technology dissemination to promote the baobab value chain in Benin. Led by the University of Abomey-Calavi through its Laboratory of Applied Ecology, the project brought together three university laboratories, two Technical and Vocational Education Training (TVET) colleges, five non-university research institutions, and four private sector partners. This diverse network enabled the co-development and dissemination of eight market-driven technological packages including grafting techniques for early fruiting and processing innovations such as baobab nectar and seasoned leaf powder. The project was structured into six work packages (WPs): (1) value chain diagnosis (2) actor organization and platform formation (3) capacity building (4) establishment of pilot incubators (5) adoption and impact assessment, and (6) national scaling and advocacy. A central outcome was the creation of a national stakeholder platform to align interests, facilitate dialogue, and drive sector-wide development. Capacity building was a major pillar, with 35 students (2 PhD, 5 MSc, 8 BSc, and 20 TVET) trained, alongside 491 community actors and 30 young entrepreneurs. These beneficiaries contributed directly to developing technologies, forming startups, and promoting baobab-derived innovations. Notably, several project alumni received international recognition and fellowships (e.g., Tony Elumelu Foundation, Kofi Annan Foundation). The Baobab CARP's approach highlights the power of inclusive collaboration linking academia, vocational education, private enterprise, and rural communities to create sustainable agricultural innovation. The engagement of TVET institutions particularly accelerated grassroots adoption, demonstrating the value of bridging educational and development sectors. This experience reinforces that multistakeholder innovation platforms are effective vehicles for deploying locally adapted technologies and scaling impact in nutrition, biodiversity, and livelihoods.

The ACBF initiatives particularly involve policy dialogues and knowledge-sharing platforms for best practices dissemination across the continent. On the other hand, Alliance for the Green Revolution in Africa (AGRA) fosters collaborations among stakeholders to strengthen food security and adaptive governance (AGRA, 2021). As such AGRA fosters partnerships with governments' bodies, academic and research institutions, farmers' organizations, and the private sector to promote sustainable farming practices for agrifood systems improvement and strengthening market linkages. The capacity-building initiatives described above also focus on enhancing local farmers resilience to climate change, strengthening agricultural crops value chains and improving access to markets, while reinforcing smallholders' farmers bargaining power.

Another key initiative promoting capacity-building in African agricultural sector is African Agricultural Technology Foundation (AATF), a public-private partnership facilitating access to agricultural technologies for smallholder farmers, especially those in remote area (AATF, 2021). As such AATF's engagement includes training farmers on new technological advancements and supporting local seed companies for improved crop varieties establishment. The Forum for Agricultural Research in Africa (FARA) initiative, on the other hand, works to support coordination of agriculture research in Africa by bringing together national, regional, and international stakeholders (FARA, 2021). FARA capacity building initiatives target agricultural research system reinforcement and knowledge sharing among scientists and with other stakeholders including policymakers. The African Women in Agricultural Research and Development (AWARD) initiative is women led initiative seeking to strengthen research and leadership skills of African women in agricultural sector. Through mentorship, fellowships, and networking opportunities AWARD is involved in multilateral partnerships with universities, research institutions, and the private sector (AWARD, 2021). Additionally, Grow Africa initiative is a platform leveraging partnership gathering governments' agencies, private sector, and local farmers' organizations to trigger agriculture investments in Africa (Grow Africa, 2021). Grow Africa's efforts focus on developing agricultural value chains and creating a favourable environment for agribusiness. These diverse multi-stakeholder initiatives showcase the collaborative efforts and co-operation engagements being made for sustainable development in Africa, particularly to address the complex and interrelated challenges of agrifood systems, climate change adaptation, and sustainable economic growth in Africa. Importantly, these initiatives (bodies) strive to leverage collective expertise and resources in agricultural sector to build capacity across this sector in Africa.

Overall, a multi-stakeholder approach is crucial to establish adaptive perspectives for addressing agrifood systems challenges in Africa. Stakeholders' commitment is essential for ensuring adaptive, inclusive and participatory learning systems in agricultural sector. Governance structures can leverage this diversify and multilateral initiatives to elaborate context-specific adaptive policies for enhancing sustainable development that is responsive to local conditions and needs (Widerberg *et al.*, 2023). Evolving and continuously improving practices and policies are vital to respond to the changing conditions in order to set up a robust system for addressing new emerging challenges. These systems should draw upon multiple stakeholders' input incorporating experiences of multiple actors including farmers, researchers, and others. Such an approach builds trust among stakeholders and fosters innovations in agricultural practices.

Effective multi-stakeholder initiatives in African agriculture. Specific actions have been implemented by various stakeholders' initiatives to support sustainable development in Africa. These encompass crucial research development projects focusing on developing climate-resilient crop varieties to ensure food security in Africa. One notable example is the implementation of the Drought Tolerant Maize for Africa (DTMA) project, a collaborative research development project between CIMMYT, IITA, national agricultural research systems, and seed companies across 13 African countries

(CIMMYT, 2012). This initiative has contributed to developing and disseminating drought-tolerant maize varieties. The DTMA project has significantly contribute to maize yields improvement and food security enhancements for smallholder farmers in arid regions of Africa.

Plant breeding and crop improvement are pivotal in creating crop varieties that can withstand challenges of changing climatic conditions. Techniques like marker-assisted selection, genetic engineering and genomics selection based on genome editing tools such as TALENs, ZFNs, CRISPR-Cas9 and especially participatory plant breeding involving farmers directly in the selection process, ensure that new varieties meet local community needs and conditions (Kpoviessi *et al*., 2024). This process can enhance agrifood systems and thereby food security by improving crop yields and nutritional values, and supporting communities to address climate adversities (Vincent, 2023). By integrating traditional knowledge with modern and scientific agricultural techniques, scientists, farmers and other practitioners can contribute to improving soil health, increase biodiversity, and adapt to climate changes (Altieri and Nicholls, 2017). Government policies supporting cooperative farming practices and facilitating markets access also play a significant role in promoting economic stability among rural farmers (FAO, 2018). Policy frameworks support these trends by promoting investment in research, infrastructure, and education to facilitate knowledge exchange (World Bank, 2021).

The Alliance for A Green Revolution in Africa (AGRA) works with governments' bodies, private sector partners, and local farmers to promote sustainable agricultural practices by improving access to inputs, and developing market linkages. Their efforts have been crucial as they have contributed to increased crop yields and improved livelihoods for millions of farmers across 11 African countries (AGRA, 2021). At continent level CAADP initiative has successfully brought together governments agencies, and development partners to promote agriculturally based economic growth. The CAADP has played a pivotal role in designing agricultural policies and shaping investment priorities across Africa, with a focus on sustainable development, market development, and agrifood systems enhancements (Badiane *et al.*, 2021). The African Agricultural Technology Foundation (AATF) initiative for example, has developed and disseminated new technologies in agricultural sector tailored to African farmers' conditions and needs while facilitating public-private partnerships, among actors. The Water Efficient Maize for Africa (WEMA) project has been crucial in contributing to the agrifood system improvement food security enhancement and ensuring climate resilience (Acbio, 2015).

In Africa, diverse successful stakeholders' organizations have demonstrated and showcased their critical role and their power of collaborative approaches in providing solutions to the complex and interrelated challenges of African agricultural sector. By collaboratively gathering their various resources and expertise, they have contributed to the agrifood systems enhancement and improved agricultural sustainability across Africa. The African Orphan Crops Consortium (AOCC) is one of the successful examples. By developing underutilized and nutrient-rich African crops, this consortium works to improve nutrition and food security in Africa. The AOCC consortium has brought together international organizations, private companies, and academic and research institutions across the continent to sequence, assemble and annotate the genomes of about 101 traditional African food crops (Hendre *et al.*, 2019). The Scaling Seeds and Technologies Partnership (SSTP) is another valuable initiative for African sustainable development. These technological partnerships are implemented by AGRA in collaboration with USAID. The technological partnerships work to produce and distribute the high-quality seeds while promoting adoption of the improved agricultural technologies in several African countries (AGRA, 2019). Another successful multi-stakeholder initiative is the Platform for African-European Partnership in Agricultural Research for Development (PAEPARD), facilitating collaboration between African and European partners in agricultural research and development. This collaborative partnership has been pivotal in research projects shaping according to the needs and conditions of

stakeholders and addressing the critical African agriculture challenges (PAEPARD, 2018).

Case studies of successful multi-stakeholder approaches for community action initiatives in African agriculture. The Community Action Research Platform (CARP) approach in agriculture and agrifood system development in Africa: CARP is a collaborative multi-stakeholder approach developed by RUFORUM. The Community Action Research Platform (CARP) was designed to address farmers' challenges and promote uptake of improved agriculture practices. The CARP approach sought to showcase the potential of stakeholders' collaboration involving smallholder farmer communities' organizations, universities, research institutes, NGOs and private sector.

In Eastern Africa, one CARP was implemented in Kenya focused on cassava value chains in Coastal Kenya, a second on potato value chains in Southwestern Uganda and a third on fish value chain in Malawi. Through stakeholders' participation and collaborative efforts, the CARP initiatives have empowered rural communities' organizations and reduced poverty while enhancing potato, cassava and fish value chains. In coastal Kenya, the research examined how the cassava value chains can be leveraged to improve local farmers' livelihoods and reduce poverty among rural communities. The case study in Ugandan investigated the role and implication of farmer communities' organizations in potato value chains development, highlighting the challenges and opportunities for potato smallholder farmers and supporting sustainable economic growth across East Africa (Egeru *et al*., 2023).

In West Africa the CARP in Benin supported scaling up and adding value to the African baobab and food products (Box 1). Through a collaborative initiative involving farmer communities' organizations, smallholder farmers, universities, research institutes, NGOs, and the private sector, the Benin CARP aimed to enlarge and develop the baobab value chains by adding value to baobab products and food products in order to improve food and nutritional security in the region and beyond. This research project established flexible strategies to optimize production, processing, and marketing of baobab products and baobab-derived foods while emphasizing food safety standards and nutritional values. Based on multiple stakeholders' expertise, the Benin CARP project sought to elaborate sustainable practices, benefit for local communities and smallholders' farmers in baobab value chains while meeting market demands. Indeed, the Benin CARP initiative has showcased the potential for collaborative research project for improving indigenous food systems and value chains The Benin CARP research project also provided insights into realistic and effective scaling up methods for traditional and indigenous food products by integrating them into food and nutrition business sectors. This provides valuable lessons for future similar research projects across Africa (Egeru *et al*., 2023).

The CARP research initiative in Southern Africa investigated two cases of climate-resilient agriculture as its main goal, specifically targeting climate-smart agriculture initiatives in Zimbabwe and Namibia. Through stakeholders' collaborative efforts including smallholders' farmers, farmers' communities, universities, research institutions, NGOs, and private sector, these CARP research projects initiatives have focused on agricultural resilience enhancements and livelihoods improvement in changing climate conditions in the studied regions. In Zimbabwe, the CARP research initiative has examined university-community partnership targeting dry and land crop yields improvement and their value addition enhancement though adaptive and context-specific climate-smart agriculture practices. Specifically, the Zimbabwe CARP research initiative was implemented to address the context-specific challenges of agrifood systems and economic development in African arid regions. The Namibian CARP research initiative explored innovative-based approaches for climate adaptation. Particularly, these climate adaptation approaches have been centered on developing value chains from encroacher bushes in the Otjozondjupa Region.

The Namibian CARP research initiative has been implemented to turn an environmental problem represented by bushed area into a sustainable economic opportunity while enhancing local community livelihoods and resilience to climate change. Ultimately, these Southern African CARP research projects have provided insightful and context-specific strategies for adaptive climate-resilient implementation in agricultural sector and fostering community-based solutions to local environmental challenges (Egeru *et al.*, 2023).

Box 2 presents a Case of multi-stakeholder engagement in Cassava improvement being implemented by the National Research Organization in Uganda. It has also supported development and release of Cassava varieties with farmers preferred traits and processing qualities. Box 3 presents an illuminating example of a multi-stakeholder approach, Innovation Platform that has led to great improvement in performance of the agricultural sector in Rwanda.

Box 2. Participatory Plant Breeding: Case of Cassava improvement in Uganda

Rationale: Concept wise, participatory plant breeding (PPB) is the process of creating new crop varieties in this case cassava in collaboration with important stakeholders, including farmers, breeders, processors, and consumers—many cassava farmers are also consumers! The goal of this breeding strategy is to guarantee that recently launched varieties fulfill and/or surpass consumer expectations. In practice PPB frequently enhances traditional breeding methods, especially when consumer preferences are unclear or challenging to identify.

Approach: By design cassava breeding is a highly structured process that entails three core and interrelated processes namely crossing, evaluation and selection. The entry point for PPB at crossing stage is put into context when choosing cassava progenitors. Often prioritized progenitors (i.e., at least 20) must exhibit trait thresholds acceptable to customers; some progenitors may however, be deficient in few essential traits. On the other hand, during evaluations, entry points for PPB is during the late-stage testing, when the number of test candidates have been remarkably reduced. Late-stage testing was, and is still being done on research experimental stations and/or on-farmer's fields to evaluate clones under diverse real-world situations. This often involves testing 10 to 25 best bet clones under contrasting environmental conditions to identify the truly outstanding clones. The "citizens in science" approach has also been utilized. Last-stage testing often focuses on validating priority agronomic, resilience and quality traits using benchmark and/or standard varieties as references. In the end, any break-through varieties should exceed performance of the benchmark varieties in some priority traits.

Achievements: The success and impact of a breeding programme is hinged on number of officially released varieties and/or the acreage of cultivation of a released variety. Accordingly, cassava has witnessed phased variety releases. In the early and late 1990s, varieties released largely responded to the cassava mosaic disease epidemic, while in the 2000s, varieties released largely addressed shortfalls in quality traits of previously released varieties and the outbreak of cassava brown streak disease. In total up to 21 varieties have been officially released. Each variety release process involved PPB.

Impact and Key lessons learnt: As of this writing, acreage of cassava in Uganda is ~1 million hectares, with 60-70% farmers cultivating officially released varieties depending on the region. Most of the production is concentrated in eastern, northern, and West Nile regions and thus cassava is now considered as one of the strategic crop under Uganda's National Development Plan IV. One key lesson learnt is the need for regular updating customer preferences through conducting of market intelligence surveys. Documented customer information offers valuable feedback to the breeding programme in its pursuit to develop new demand-driven cassava varieties. Thus, engagement of a diversity of key actors is critical for variety development, uptake and commercialisation

Source: Dr. Robert Kawuki, Cassava Breeder at National Crops Resources Research Institute (NaCRRI), Namulonge, Uganda

Box 3. Agricultural Innovation Platform approach and its implementation in Rwanda

Rationale: In spite of the many efforts made by the Government and several institutions in Rwanda, the adoption level of agricultural technology by farmers and other stakeholders had been very low for a long time. In addition, research findings had remained on the shelves of ISAR and MINAGRI. It was hypothesized that inadequate co-operation between the key players in the agricultural sector limits the uptake of new knowledge and technologies for various commodity value-chain development. Hence, the Innovation Platforms (IPs) approach was deemed necessary and important for Rwanda's agricultural development. It is in this regard that the Rwanda Agricultural policy (2010 reviewed in 2017) has mainstreamed the importance of different stakeholders working collaboratively to identify mechanisms to rapidly improve and sustain agricultural development through innovation, investment and poverty reduction strategies. This approach brings The Innovation platform (IP) brings together diverse stakeholders including **local leaders, farmers, cooperatives, seeds multipliers, input suppliers, processors, traders, credits service representatives, researchers and extension officers**. They meet at regular intervals to discuss and implement value-chain interlinked activities. Since 2008, Research into Use Project of DFID called "RIU project" has initiated four local agricultural Innovations Platforms (IPs) to promote technology diffusion in Rwanda. These IPs was formed around prioritized agricultural commodities, in different districts of Rwanda, namely Gatsibo for cassava, Gicumbi for Irish potato, Nyagatare for maize and Karongi for farmers' associations. Later, other IPs was initiated through collaborative efforts of various stakeholders around various commodities: PASNVAMINAGRI (2009): 11 IPs; ASARECA (2010-2015): 11 IPs, RAB (2013): 5 IPs, VICRES-RAB: 2 IPs, SIMLESA-RAB (2012): 2 IPs; Humid Tropics-CIAT-RAB (2014): 2 IPs; CIAT-Beans (2017): 3 IPs and IITA-RAB (2018): 2 IPs.

How were they implemented?

Rwanda Agricultural Innovation Platforms are generally value-chain locally based (see below stakeholders, Figure 1). As shown by Figure 1, the bigger is the circle, the bigger is the role in the development of the IP. Hence, local leaders play a big role in the case of Rwanda. They are followed by marketers, Mci (Microfinance Institutions) and processors. In fact, markets, access to credit and processing units constitute the main drivers for the IPs development.

Source: Leonidas Dusengemungu, RAB/Senior Socio-Economist Researcher /Head of Agricultural Innovation Platforms in Rwanda

Figure 4: Example of Maize-Legumes value-chain based IP stakeholders in Nyagatare District of Rwanda

Steps undertaken for IP establishment in Rwanda

1. Step 1. Meeting with **local leaders** to introduce the IP approach, get their buy-in and select the cooperatives/informal associations/Twigire-Muhinzi groups.
2. Step 2. Meeting with functioning **Farmers cooperatives**/informal associations/Leaders to introduce the IP concept and benefits and identify all stakeholders.
3. Step 3. Meeting with **Farmer cooperative stakeholders** for IP concept, problem assessment, possible solutions and action plans including clear roles and responsibilities, communication strategy and M&E procedures. The IP is established.
4. Step 4. Setting rules, regulations and **memorandum of understanding (MoUs)** for managing partnerships and eventual conflicts.
5. Step 5. Launching of the **cooperative led IP which is the official initiation of the IP** to secure stakeholders' commitment to the platform and any internal or external support. **Agreement on activities** to be shared: roles and responsibilities
6. Step 6: **Implementation of IP activities** (Supporting platform's activities by providing improved seeds, fertilizers, agricultural techniques, ensuring credits and markets, etc. including scaling out, among others).
7. Step 7: Undertaking **M&E to monitor achievements**, learn and improve.
8. Step 8: **Reviewing the law** to ensure partnerships are within cooperative regulation of Rwanda because the IPs are not legally recognized up to now

If dispatched well, each district in Rwanda would have benefited from the IP approach. There have been Challenges and opportunities which need to be identified. Also, recommendations could be made for further steps.

What were the impacts?

Increased access to and use of improved and good quality seeds (e.g. Quality Protein Maize (QPM) varieties were introduced through the platform. Increased yield of the maize crop from 0.5 tonnes per hectare before RIU interventions to about 6 tonnes per hectare. Same applies to potato crop. Increased knowledge and skills in using improved agricultural production technologies: The maize platform adopted a Farmer Field School approach to farmers learning (e.g. trainings and internal study tours and in Uganda were related to selection of good planting material/seeds, spacing and planting, disease and pest management, and fertiliser application). The social networks of all the stakeholders involved were widened and this further strengthened their mutual trust, interaction among farmers resulted in seed exchanges and field visits among farmers to share knowledge and experiences. Creation of new business deals for platform members: The maize platform has given birth to maize investment group "Nyagatare Maize Investment Group" (NYAMIG) as the business arm of the innovation platform. NYAMIG is made up of about 30 farmers' associations. Access to new maize markets: New markets for maize were accessed by farmers in Kigali (the capital of Rwanda) and other urban centres. World Food Programme is currently buying the maize flour distributed to refugee camps in the country. The amount of cash in farmers' pockets and the change in the household livelihood motivate not only the producers but also all their neighbours. In 2010, one maize farmer in Nyagatare District, proudly asserted during a training session that: "From the past two maize seasons, I was able to buy two motorcycles, build a new house and I am planning to acquire a computer for my children to use."

Dusengemungu Leonidas, 08/06/2025

Lessons learned and best practices in sustainable agriculture development in Africa. Some past successful practices should be actively pursued to guide future actions and behaviors while implementing new initiatives in agricultural sector in Africa. Some interrelated and multifaceted approaches are important in addressing agrifood systems challenges and for enhancing agricultural sustainability. These approaches may combine innovative plant breeding, sustainable farming practices, inclusive governance and flexible policy structures. By learning from the previous experiences and practices implemented, African countries can work towards achieving food security through agrifood system enhancements and sustainable economic growth. Some of the lessons learned and the successful best practices implemented are summarized below:

- Commitment of various stakeholders such as local farmers' organizations, private sector, academic and research institutions, and policymakers are crucial for context-specific decision-making leading to effective and sustainable development solutions. These actors could collaboratively design adaptive governance frameworks allowing continuous learning over time in the changing climate conditions (Candel, 2014; Termeer *et al*., 2016).
- Robust innovative systems in agricultural sector through stakeholders' partnerships capable of accelerating technological and new farming practices adoption (Spielman *et al*., 2011; Mapiye and Dzama, 2024). The Innovation Platform approach that has been widely adopted in Rwanda should be promoted elsewhere.
- Pests, diseases and climate-resilient crop varieties development is crucial for agrifood systems enhancements in Africa particularly in the extremely changing weather patterns (Atlin *et al*., 2017; Pixley *et al*., 2023; Kpoviessi *et al*., 2024).
- Multi-actor participatory plant breeding, especially involving local farmers and taking into account their indigenous knowledge leads to adoption of newly created varieties adapted to local communities' content (Ceccarelli, 2015; Mamo and Singh, 2016; Kpoviessi *et al*., 2024).
- Plant genetic resource conservation for crop improvement is essential for crop genetic diversity preservation for climate-adaptive traits development (Jarvis *et al*., 2015; Byrne 2023).
- Flexible and supportive policies structures and frameworks encompassing measures for input subsidies and price stabilization is needed to encourage farmers to adopt new technologies (Jayne and Rashid, 2013; Kumbhakar *et al*., 2023).
- Infrastructure enhancement is key, and includes aspects such as improvement in roads, irrigation systems and storage facilities for post-harvest losses reduction and market access improvement (Shiferaw *et al*., 2011; Balasubramanya and Lele, 2022).
- Local and regional trade development for sustainable economic growth across the continent is needed (Badiane *et al.*, 2014; Simola *et al.*, 2022).
- Local communities' organizations and smallholders' farmers' market access improvement is critical. This requires strengthening farmers bargaining power while boosting agricultural productivity and markets growth (Godfray *et al.*, 2010; Touch *et al*., 2024).
- The need to strengthen Crops value chains and agribusiness livestock opportunity development for youth employment and job creation especially in rural area is urgent (Jayne *et al*., 2010; Rafael, 2023).

Barriers limiting multi-stakeholders approaches implementation in Africa

- The complex interrelated aspect amongst plant breeding (and other approaches), agrifood systems, food security, and climate change makes it difficult to align with diverse stakeholders' interests and interventions. For instance, climate impact is not similar across regions, requiring context-specific and localized solutions that may not always be applicable at

continental level (Adhikari *et al.*, 2015; Abbass *et al.*, 2022).

- Most of the time, there is a lack of up-to-date and reliable data on agricultural systems, climate change impacts and other sustainable development factors in Africa, hindering observations-based decision-making (Ziervogel *et al.*, 2014; Apraku *et al.*, 2021).

- Short term instead of long-term economic gains may sometimes be prioritized to the long-term sustainable agricultural solutions due to the significant economic challenges facing many African countries. This can create a disagreement amongst stakeholders advocating for the short term and immediate economic strategies and those targeting sustainable food security for long-term economic strategies (Collier and Dercon, 2014; Ville *et al.*, 2017).

- Weak coordination capacity in African agricultural institutions, limit implementation of stakeholders approaches in many African countries. These encompass for example weak administration structure, limited human resources and technical expertise, which grossly impede collaboration amongst diverse stakeholders (Agyeman *et al.*, 2019; Akenroye *et al.*, 2021).

- Overlapping structures for agricultural governance in agricultural sector at local, national and regional levels. These can complicate and delay the implementation of locally adapted governance approaches (Termeer *et al.*, 2010; Nikkanen *et al.*, 2024).

- Misbalancing of power between stakeholders and other participants for sustainable approaches implementation. Powerful actors like government bodies or international agencies may establish dominance and control the whole decision-making processes. This could marginalize small stakeholders like women, smallholder farmers, youth and local communities' organizations (Domingo *et al.*, 2015; Pouw and Gupta, 2017).

- Unequal access to digital technologies, social media and other communications tools, hinder effective collaboration among stakeholders. These may particularly exclude important voices representing rural communities and smallholder farmers (Tsan *et al.*, 2019; Morrison-Smith and Ruiz, 2020).

- Cultural diversity of African continent may pose challenges to desired approaches in implementation, particularly social barriers, language barriers, and persistent traditional barriers, leading to misunderstandings among actors. The newly established adaptive governance approach implementation may not align with some traditional practices and cultural norms. These could result in resistance from local communities (Adger *et al.*, 2009; Mwongera *et al.*, 2017)

- Lack of sustainable funding mechanisms restrict stakeholders abilities to cope while making implementation processes difficult to implement along the agreed-upon engagements and strategies (Otsuka and Larson, 2013; Eikelenboom and Long, 2023).

- Lack of transparency and the existence of corruption can build mistrust among stakeholders and prevent collaborative problem-solving, which is essential for successful stakeholders' engagement in implementation (Bizikova *et al.*, 2015; Boateng *et al.*, 2024).

Integrated approaches for agriculture systems and food security enhancements. The multifaceted challenges posed by changing climate in Africa also create opportunities for innovations in plant breeding and crop improvement. For example, the development of new crop varieties, especially for climate-resilience is crucial for agrifood enhancements

particularly to maintain and improve food security. These opportunities encompass, amongst others, the development of drought-tolerant and heat-resistant crop varieties. Also the development of new crops varieties with improved nutrient content could address malnutrition, while harnessing the genetic diversity to create pests and disease-resistant crop varieties. Breeding for agrifood systems enhancements and robust food security in the face of changing climate impacts require the deployment of modern techniques of breeding such as genomic selection to boost development of climate-resilient cultivars (Atlin *et al.*, 2017). Furthermore, for sustainable economic development and robust agrifood systems in Africa, stakeholders should prioritize sustainable intensification to increase yields without compromising the environment, invest in agro-processing to reduce post-harvest losses and create job opportunities, and establish efficient food distribution systems and facilitate market linkages.

Some African continent strategies like "Feed Africa" strategy of the African Development Bank, emphasize that African agriculture transformation into a robust and competitive agribusiness sector would create jobs, improve lives and secure environment (AfDB, 2016). Cutting-edge policy practices could drive African agricultural transformation. This transformation is possible through evidence-based or context-specific agricultural policies particularly supporting investment in agriculture, research for development, and addressing weak linkages such as limited business skills of smallholder farmers, women and youth. These could facilitate innovation uptake and promote integration and regional trade while enhancing food availability and accessibility. The Food and Agriculture Organization (FAO, 2020) for example stated that achieving food security and nutrition objectives for a sustainable economic growth, requires policy coherence across sectors. However, it is important to foster partnership among stakeholders such as government bodies, private sector, NGOs, academic and research institutions, and smallholder farmers to implement adaptive governance models, flexible enough and capable of responding to the changing climatic conditions. Such processes could build trust stakeholders and empower local communities' organizations and smallholder farmers in decision-making processes. By involving a broader range of actors through different agricultural perspectives, the multi-stakeholder governance has the potential to enhance the effectiveness and legitimacy of agrifood systems and food security policies (Candel, 2014). At the same time, harnessing all these potentialities and opportunities requires that Africa continent establish comprehensive strategies for agrifood system enhancements and sustainable food security. This is indeed elucidated in the Comprehensive African Agricultural Development Program (CAADP). This kind of integrated strategy is capable of addressing the complex nature and multifaceted challenges of agrifood systems and food security in Africa while harnessing emerging opportunities especially digital technologies to improve the process implementation. As stated by the Malabo Montpellier Panel (2018), achieving sustainable food security in Africa require integrated approaches combining innovative technologies, policy reform, and effective stakeholders collaboration.

CONCLUSION and RECOMMENDATIONS

The multidimensional challenge of sustainable development especially of ensuring sustainable and resilient agrifood system requires a multi-faceted and multi-stakeholder approach. Based on a systematic analysis of existing relevant literature and synthesis of key findings related to the sustainable development, while also identifying gaps and providing recommendations for future research and policy, the present review unveiled stakeholders approaches for sustainable agricultural development in Africa. African sustainable development implementation is complex and presents both challenges and opportunities under especially changing climatic conditions and social political environment. Therefore, the involvement of multiple stakeholders and adaptive governance structures are essential for elaborating and implementing effective policies for a long-term sustainable agriculture in Africa. Importantly, for long-term

sustainable development in Africa, efforts should focus on:

- ❖ Human capital development through capacity building enhancements and promotion of knowledge transfer and sharing in agricultural sector. These could focus not only on the investment in agricultural education, to strengthen future agricultural scientist knowledge-skills, but also strengthen agricultural advisory services for an effective dissemination of new technologies and best farming practices to farmers.
- ❖ Promotion of sustainable agricultural practices, essentially based on eco-smart friendly farming methods such as climate-agriculture, conservation agriculture and agroforestry to optimize resources use and increase productivity while ensuring environmental health and natural resources.
- ❖ Strengthen agriculture value chains through public-private partnerships facilitation for agricultural supply chains development and investment in rural infrastructure such as storage facilities, transportation networks, rural roads, and processing centres for reducing post-harvesting losses and strengthening small holder farmers market access as well as their bargaining power development.
- ❖ Promotion of innovative financing mechanisms, including agricultural financial services development. These include access facilitation to credit and insurance also there is need to attract more capital into African agricultural sector.
- ❖ Investment in innovative research and development for climate-resilient agriculture. These should prioritize funding for plant-breeding programs and other research programs to create climate-resilient and pests and disease-resistant crop varieties. Collaborative research programs involving research institutions, universities, and farmers, to tailor the new practices to farmer needs and local conditions is critical.
- ❖ Promotion of good policies by reinvestment in agricultural sector. This would sustain various axes of agricultural sector public expenditure, and reinvestment of significant part of GDP to agricultural sector/
- ❖ Establishment of flexible policy frameworks capable to quickly respond to climate impacts and also facilitating context-specific decision-making processes involving smallholder farmers and local communities' organizations especially in policy formulation, alongside the powerful organizations such as government bodies and international corporations.
- ❖ Leverage multi-stakeholders' expertise by encouraging local, regional and international partnerships and knowledge sharing for best practices dissemination. Also, foster collaborations by creating regular dialogues platforms involving government agencies, academics and research institutions, private sector entities, NGOs, and smallholders' farmers and local communities' organizations.
- ❖ Promotion of digital agriculture. There is a need to encourage wide adaptation of ICT tools in agricultural sector for weather forecasting, agricultural practices, pests and disease management, and market information. This also requires investment in digital infrastructure to improve the social media use in farming activities and connectivity access to farmers especially in remote areas.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abbass, K., Qasim, M.Z., Song, H., Murshed, M. and Mahmood, H. 2022. A review of the global climate change impacts¸adaptation, and sustainable mitigation measures. *Environ Sci Pollut Res* 29 : 42539–42559. https://doi.org/10.1007/s11356-022-19718-6.

Abdulai, A. R., Tetteh Q. P., Duncan, E. and Fraser, E. 2023. Is agricultural digitization a reality among smallholder farmers in Africa? Unpacking farmers' lived realities of engagement with digital tools and services in rural Northern Ghana. *Agric Food Secur* 12: 11. https://doi.org/10.1186/s40066-023-00416-6.

Acbio (African Centre for biodiversity). 2015. The Water Efficient Maize for Africa (WEMA) project—profiteering not philanthropy! Discussion document. 61.

Adam, C., Henstridge, M. and Lee, S. 2020. After the lockdown: Macroeconomic adjustment to the COVID-19 pandemic in sub-Saharan Africa. *Oxf. Rev. Econ. Policy.* 36:S338–S358. https://doi.org/10.1093/oxrep/graa023

Adenle, A. A., Wedig, K. and Azadi, H. 2019. Sustainable agriculture and food security in Africa: The role of innovative technologies and international organizations. *Technology in Society* 58: 101143. https://doi.org/10.1016/j.techsoc.2019.05.007

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J. and Wreford, A. 2009. Are there social limits to adaptation to climate change? *Climatic Change* 93 (3): 335-354. https://doi.org/10.1007/s10584-008-9520-z.

Adhikari, U., Nejadhashemi, A. P. and Woznicki, S. A. 2015. Climate change and eastern Africa: a review of impact on major crops. *Food and Energy Security* 4 (2): 110-132.

Adipala, E., Blackie, M. and Wachira, F. 2017. Strengthening capacity for agricultural research and innovation in Africa. pp. 216-236. In: The Business of Plant Breeding. CABI.

Africa Agriculture Status Report. 2013. Focus on staple crops. Nairobi Kenya. Alliance for a Green Revolution in Africa (AGRA).

African Agricultural Technology Foundation. 2021. https://www.aatf-africa.org/ (Available 16/11/2024).

African Capacity Building Foundation. 2021. https://www.acbf-pact.org/ (Available 16/11/2024).

African Development Bank 2016. Feed Africa: Strategy for Agricultural Transformation in Africa 2016-2025. AfDB, Abidjan,Côte d'Ivoire.

African Development Bank. 2021. African Economic Outlook 2021. AfDB, Abidjan,Côte d'Ivoire.

African Development Bank. 2022. African Economic Outlook 2022: Supporting Climate Resilience and a Just Energy Transition in Africa. African Development Bank Group, Abidjan, Côte d'Ivoire.

African Plant Breeding Academy. 2021. University of California, Davis. https://pba.ucdavis.edu/PBA_Africa/

African Post-Harvest Losses Information System (APHLIS). 2020. Tracking food losses in Africa. https://www.aphlis.net/en/news/49/tracking-food-losses-in-africa

African Union (AU). 2003. Maputo Declaration on Agriculture and Food Security in Africa. Assembly of the African Union Second Ordinary Session .2003. Maputo, Mozambique, Assembly/AU/Decl. 7(ii). Addis Ababa, Ethiopia: African Union (AU).

African Union (AU). 2014. Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. 23rd Ordinary Session of the AU heads of state and Government, Malabo, Equatorial Guinea, Declaration 5. Addis Ababa, Ethiopia: African Union (AU).

African Union. 2019. Agenda 2063: The Africa We Want. African Union Commission. Addis Ababa

African Union. 2021. Comprehensive Africa Agriculture Development Programme (CAADP). https://au.int/en/caadp (Available 16/11/2024).

African Women in Agricultural Research and Development.2021. https://awardfellowships.org/ (Available 16/11/2024).

Agarwal, V., Malhotra, S. and Dagar, V. 2023. Coping with public-private partnership issues: A path forward to sustainable agriculture. *Socioeconomic Planning Sciences* 89: 101703.

AGRA. 2019. Scaling Seeds and Technologies Partnership: Final Report. Alliance for a Green Revolution in Africa. Nairobi, Kenya

AGRA. 2021. Annual Report 2020. Alliance for a Green Revolution in Africa. Nairobi, Kenya

Agyeman, Y. B., Aboagye, O. K. and Ashong, M. 2019. Institutional capacity and policy for sustainable agricultural transformation in Ghana. *Journal of Integrative Environmental Sciences* 16 (1): 1-22.

Akenroye, T. O., Abubakre, A., Elbaz, J., Vishnu, C. R., Beka Be Nguema, J. N., Rana, G. and Falode, O. 2021. Modeling the barriers to multistakeholder collaboration for COVID-19 pandemic response: Evidence from Sub-Saharan Africa. *International Public Management Journal* 25 (2): 192–216. https://doi.org/10.1080/10967494.2021.1970061.

Altieri, M. A. and Nicholls, C. I. 2017. Agroecology: A Brief History of the Movement, its Principles, and its Role in Sustainable Agriculture. *Renewable Agriculture and Food Systems* 32 (1): 17-29.

APHLIS – The African Postharvest Losses Information System. 2020. https://www.aphlis.net/en/data/tables/dry-weight-losses/XAF/all-crops/2022?metric=fin

Apraku, A., Morton, J. F. and Gyampoh, B. A. 2021. Climate change and small-scale agriculture in Africa: Does indigenous knowledge matter? Insights from Kenya and South Africa. *Scientific African* 12. e00821. https://doi.org/10.1016/j.sciaf.2021.e00821

Atlin, G. N., Cairns, J. E and Das, B. 2017. Rapid breeding and varietal replacement are critical to adaptation of cropping systems in the developing world to climate change. *Global Food Security* 12: 31-37.

Ayivor, J.S., Nyametso, J.K. and Ayivor, S. 2020. Protected area governance and its influence on local perceptions, attitudes and collaboration. *Land.* 9 (9): 310. https://doi.org/10.3390/land9090310

Bachewe, F. N., Berhane, G., Minten, B. and Taffesse, A. S. 2018. Agricultural transformation in Africa? Assessing the evidence in Ethiopia. *World Development* 105: 286-298.

Badiane, O. and Makombe, T. 2015. Beyond a middle income Africa: Transforming African economies for sustained growth with rising employment and incomes. ReSAKSS Annual Trends and Outlook Report 2014. International Food Policy Research Institute (IFPRI).

Badiane, O., Benin, S. and Makombe, T. 2021. Successes and Challenges of CAADP in Accelerating Agricultural Transformation in Africa. pp. 3-25. In: African Agricultural Development: Lessons and Challenges. Palgrave Macmillan.

Badiane, O., Makombe, T. and Bahiigwa, G. 2014. Promoting agricultural trade to enhance resilience in Africa. ReSAKSS Annual Trends and Outlook Report 2013. International Food Policy Research Institute.

Balasubramanya, S. and Lele, U. 2022**.** Policy Note: Expanding Irrigation in Sub-Saharan Africa. *Water Econ. Policy* 8*:* 2171003.

Barrett, C. B. 2008. Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy* 33 (4): 299-317.

Bebber, D., Ramotowski, M. and Gurr, S. 2013. Crop pests and pathogens move polewards in a warming world. *Nature Clim Change* 3: 985–988. https://doi.org/10.1038/nclimate1990

Beintema, N. M. and Stads, G.-J. 2017. A comprehensive overview of investments and human resource capacity in African agricultural research. ASTI Synthesis Reports 131402. International Food Policy Research Institute (IFPRI).

Bizikova, L., Echeverría, D. and Hammill, A. 2015. Participatory scenario development and future visioning in adaptation planning: lessons from experience Part I. International Institute for Sustainable Development.

Bjornlund, V., Bjornlund, H. and van Rooyen, A. 2022. Why food insecurity persists in sub-Saharan Africa: A review of existing evidence. *Food Security* 14 (4): 845–864. https://doi.org/10.1007/s12571-022-01256-1

Boateng, A., Wang, Y., Ntim, C. G. and Elmagrhi, M. 2024. Institutions and corruption relationship: Evidence from African countries. *Journal of International Management* 30 (3). https://doi.org/10.1016/j.intman.2024.101136

Brondizio, E.S., Ostrom, E. and Young, O.R. 2009. Connectivity and the governance of multilevel social-ecological systems: the role of social capital. *Annual Review of Environment and Resources* 34 (1):253–278. https://doi.org/10.1146/annurev.environ.020708.100707

Byamugisha, F. F. K. 2013. Securing Africa's Land for Shared Prosperity: A Program to ScaleUp Reforms and Investments. World Bank Publications - Books, The World Bank Group, number 13837.

Byrne, P.F. 2023. Plant breeding for climate change: Opportunities for adaptation and mitigation. In: Volk, G. M., Moreau, T.L. and Byrne, P.F.

(Eds.) Conserving and Using Climate-Ready Plant Collections. Fort Collins, Colorado: Colorado State University. Available from: https://colostate.pressbooks.pub/climatereadyplantcollections/chapter/plant-breeding-for-climate-change/.

CAADP. 2023. The Biennial Review Report of the African Union Commission on the Implementation of the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. The 3rd Report to the February 2022 Assembly.120 pp.

Candel, J. J. 2014. Food security governance: a systematic literature review. *Food Security* 6 (4): 585-601.

Candel, J.J.L. and Biesbroek, R. 2016. Toward a processual understanding of policy integration. *Policy Sciences* 49 (3): 211-231.

Ceccarelli, S. 2015. Efficiency of plant breeding. *Crop Science* 55 (1): 87-97.

Chakeredza, S., Temu, A. B., Saka, J. D. K., Munthali, D. C., Muir-Leresche, K., Akinnifesi, F. K., Ajayi, O.C. and Sileshi, G. 2008. Tailoring tertiary agricultural education for sustainable development in Sub-Saharan Africa: Opportunities and challenges. *Scientific Research and Essays* 8: 326-332.

CIMMTY.2012.https://www.cimmyt.org/projects/drought-tolerant-maize-for-africa-dtma/ (Available 16/11/2024).

Collier, P. and Dercon, S. 2014. African agriculture in 50 years: smallholders in a rapidly changing world? *World Development* 63:92-101.

Danielsen, F., Burgess, N.D. and Balmford, A. 2005. Monitoring matters: examining the potential of locally-based approaches. *Biodiversity Conservation*. 14 (11): 2507–2542. https://doi.org/10.1007/s10531-005-8375-0.

Danso-Abbeam, G., Ehiakpor, D.S. and Aidoo, R. 2018. Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. *Agriculture & Food Security* 7: 74. https://doi.org/10.1186/s40066-018-0225-x.

Diao, X., Hazell, P. and Thurlow, J. 2010. The Role of Agriculture in African Development. *World Development* 38 (10): 1375-1383.

Dodds, F. and Benson, E. 2013, Multi- Stakeholder Dialogue. In: Stakeholder Forum for a Sustainable Future. Johannesburg: Civicus.

Domingo, P., Holmes, R., O'Neil, T., Jones, N., Bird, K., Larson, A., Presler-Marshall, E. and Valters, C. 2015. Women's voice and leadership in decision-making: Assessing the evidence. Overseas Development Institute report. 130pp.

Egeru, A., Lindow, M. and Muir Leresche, K. (Eds.). 2023. University Engagement with Farming Communities in Africa: Community Action Research Platforms. Routledge. https://doi.org/10.4324/9781003387497.

Eikelenboom, M. and Long, T.B. 2023. Breaking the Cycle of Marginalization: How to Involve Local Communities in Multi-stakeholder Initiatives? *J Bus Ethics* 186: 31–62. https://doi.org/10.1007/s10551-022-05252-5.

Eweje, G., Sajjad, A., Nath, S. D. and Kobayashi, K. 2021. Multi-stakeholder partnerships: A catalyst to achieve sustainable development goals. *Marketing Intelligence Planning* 39 (2): 186-212.

Food and Agriculture Organization (FAO). 2008. Food Security Information for Action: Practical Guides. EC - FAO Food Security Programme, Rome.

Food and Agriculture Organization (FAO). 2018. Promoting Financial Inclusion through Cooperatives: A Guide for Financial Development Practitioners. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO). 2020.The State of Food Security and Nutrition in the World 2020. FAO,Rome

Food and Agriculture Organization (FAO). 2021. The State of Food and Agriculture 2021: Making agri-food systems more resilient to shocks and stresses. FAO,Rome

Food and Agriculture Organization (FAO), ECA, AUC. 2021. Africa – Regional Overview of Food Security and Nutrition 2021: Statistics and trends. FAO, Accra. https://doi.org/10.4060/cb7496en 2021. https://openknowledge.fao.org/server/api/core/bitstreams/10c06ace-5541-4242-9aa6-2781861cf9ff/content#:~:text=The%20most%20recent%20estimates%20show,period%20of%20improving%20food%20security

Fisher, M., Abate, T., Lunduka, R., Asnake, W. and Madulu, R. 2015. Drought-tolerant maize for farmer adaptation to drought in sub-Saharan Africa: Determinants of adoption in eastern and southern Africa. *Clim. Change* 133: 283-299. https://doi.org/10.1007/s10584-015-1459-2.

Folke, C., Hahn, T., Olsson, P. and Norberg, J. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and*

Resources 30: 441-473. doi: 10.1146/annurev.energy.30.050504.144511.

Forum for Agricultural Research in Africa (FARA). 2021. https://faraafrica.org/ (Available 16/11/2024).

Godfray, H. C., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M. and Toulmin, C. 2010. Food security: the challenge of feeding 9 billion people. *Science* 327 (5967): 812–818. https://doi.org/10.1126/science.1185383.

Grow Africa (GA).2021. https://www.nepad.org/programme/grow-africa (Available 16/11/2024).

Guijt, I. 2014. Participatory Approaches, Methodological Briefs: Impact Evaluation 5, UNICEF Office of Research, Florence.

Havemann, T., Negra, C. and Werneck, F. 2020. Blended finance for agriculture: exploring the constraints and possibilities of combining financial instruments for sustainable transitions. *Agriculture and Human Values* 37: 1281-1292.

Hendre, P.S., Muthemba, S., Kariba, R. Muchugi, A., Fu, Y., Chang, Y., Song, B., Liu, H., Liu, M., Liao, X., Sahu, S. K., Wang, S., Li, L., Lu, H., Peng, S., Cheng, S., Xu, X., Yang, H., Wang, J., Liu, X., Simons, A., Shapiro, H.-Y., Mumm, R.H., Deynze, A. V. and Jamnadass, R. 2019. African Orphan Crops Consortium (AOCC): status of developing genomic resources for African orphan crops. *Planta* 250: 989–1003. https://doi.org/10.1007/s00425-019-03156-9.

Herens, M. C., Pittore, K. H. and Oosterveer, P. J. M. 2022. Transforming food systems: Multi-stakeholder platforms driven by consumer concerns and public demands. *Global Food Security*. 32:100592. https://doi.org/10.1016/j.gfs.2021.100592.

Hirel, B., Le Gouis, J., Ney, B. and Gallais, A. 2007. The challenge of improving nitrogen use efficiency in crop plants: towards a more central role for genetic variability and quantitative genetics within integrated approaches. *Journal of Experimental Botany* 58 (9): 2369–2387. https://doi.org/10.1093/jxb/erm097.

Hossain, M.S., Arshad, M., Qian, L., Zhao, M., Mehmood, Y. and Kächele, H. 2019. Economic impact of climate change on crop farming in Bangladesh: An application of Ricardian method. *Ecol. Econ.* 164:106354. doi: 10.1016/j.ecolecon.2019.106354.

Houweling, E. V., Christie, M. E. and Rahim, A. A. 2018. Women's access and experience in higher education agricultural programs in Africa, Gender and Education DOI:10.1080/09540253.2018.1495832.

Intergovernmental Panel on Climate Change (IPCC) Reports. 2014. Climate change. https://www.globalchange.gov/reports/ipcc-climate-change-2014-synthesis-report#:~:text=IPCC.-Climate%20Change%202014%3A%20Synthesis%20Report,Report%20in%202007%20(AR4).

Jarvis, A., Ramirez-Villegas, J., Campo, B. V. H. and Navarro-Racines, C. 2015. Is cassava the answer to African climate change adaptation? *Tropical Plant Biology* 8(1): 68-85.

Jayne, T.S. and Rashid, S. 2013. Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. *Agric. Econom*. 44 (6): 547-562.

Jayne, T. S., Chamberlin, J. and Headey, D. D. 2014. Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. *Food Policy* 48: 1-17.

Jayne, T. S., Muyanga, M., Wineman, A., Ghebru, H., Stevens, C., Stickler, M., Chapoto, A., Anseeuw, W., Westhuizen, D. V. D. and Nyange, D. 2019. Are medium-scale farms driving agricultural transformation in sub-Saharan Africa? *Agricultural Economics* 50: 75-95. https://doi.org/10.1111/agec.12535.

Jayne, T.S., Mather, D. and Mghenyi, E. 2010. Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa. *World Developmen*t 38 (10): 1384-1398 ISSN 0305-750X https://doi.org/10.1016/j.worlddev.2010.06.002.

Juma, F.K. 2015. Effects of Mining on Food Security to Farming Communities Surrounding Nyamongo Gold Mine in Tarime District, Tanzania. Ph.D. Thesis. Sokoine University of Agriculture, Morogoro, Tanzania.

Kolawole, O., Wolski, N.B. and Mmopelwa, G. 2014. Ethno-meteorology and scientific weather forecasting: small farmers and scientists' perspectives on climate variability in the Okavango Delta, Botswana. *Climate Risk Manage*. 4 (5): 4358. https://doi.org/10.1016/j.crm.2014.08.002.

Kotir, J.H. 2011. Climate change and variability in Sub-Saharan Africa: a review of current and future trends and impacts on agriculture and food security. *Environ Dev Sustain* 13: 587–605. https://doi.org/10.1007/s10668-010-9278-0.

Kpoviessi, A.D., Badji, A., Edema, R. and Adipala, E. 2024. Enhancing crop protection and yield through crop improvement for climate change resilience: A comprehensive review. *African Journal of Rural Development* 9 (1):1-15.

Kumbhakar, S. C., Li, M. and Lien, G. 2023. Do subsidies matter in productivity and profitability changes? *Economic Modelling*. 123.106264. https://doi.org/10.1016/j.econmod.2023.106264.

Lécuyer, L., Alard, D., Calla, S., Coolsaet, B., Fickel, T., Heinsoo, K., Henle, K., Herzon, I., Hodgson, I., Quétier, F., McCracken, D., McMahon, B. J., Melts, I., Sands, D., Skrimizea, E., Watt, A., White, R. and Young, J. 2021. Chapter One - Conflicts between agriculture and biodiversity conservation in Europe: Looking to the future by learning from the past. Volume 65. pp 3-56. In: Bohan, D.A., Dumbrell, A.J., Adam J. Vanbergen, A.J. (Eds). Advances in Ecological Research. Academic Press. ISSN 0065-2504. ISBN 9780323915038. https://doi.org/10.1016/bs.aecr.2021.10.005.

Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottle, R., Jackson, L., Jarvis, A., Kossam, F., Mann, W., McCarthy, N., Meybeck, A., Neufeldt, H., Remington, T., Sen, P.T., Sessa, R., Shula, R., Tibu, A. and Torquebiau, E.F. 2014. Climate-smart agriculture for food security. *Nature Climate Change* 4:1068–1072. https://doi.org/10.1038/nclimate2437.

Lopez-Ridaura, S., Frelat, R., van Wijk, M. T., Valbuena, D., Krupnik, T. J. and Jat, M. L. 2018. Climate smart agriculture, farm household typologies and food security: an ex-ante assessment from Eastern India *Agric. Syst*. 159 57–68.

Makate, C., Makate, M. and Mango, N. 2017. Sustainable agriculture practices and livelihoods in propoor smallholder farming systems in southern Africa. *African Journal of Science, Technology, Innovation and Development*. 9. 269–279.

Malabo Montpellier Panel. 2018. Mechanized: Transforming Africa's Agriculture Value Chains.

Mamo, T. and Singh, A. 2016. Participatory Plant Breeding and Participatory Variety Selection. In Crop Improvement, interactive e-learning courseware. Plant Breeding E-Learning in Africa. Retrieved from https://pbea.agron.iastate.edu.

Mapiye, O. and Dzama, K. 2024. Strengthening research-extension-farmer-input linkage system for sustainable smallholder livestock farming in Africa: progress and prospects. *Trop Anim Health Prod* 56: 363. https://doi.org/10.1007/s11250-024-04210-9.

Maryono, M., Killoes, A. M., Adhikari, R. and Aziz,A. A. 2024. Agriculture development through multi-stakeholder partnerships in developing countries: A systematic literature review, *Agricultural Systems* 213: 103792ISSN 0308- 521X. https://doi.org/10.1016/j.agsy.2023.103792.

Mo Ibrahim Foundation. 2019. Ibrahim Index of African Governance.

Morrison-Smith, S. and Ruiz, J. 2020. Challenges and barriers in virtual teams: a literature review. *SN Appl. Sci.* 2: 1096. https://doi.org/10.1007/s42452-020-2801-5.

Moseley, W.G. and Battersby, J. 2020. The vulnerability and resilience of African food systems, food security, and nutrition in the context of the COVID-19 pandemic. *Afr. Stud. Rev.* 63:449–461. doi: 10.1017/asr.2020.72.

Mwongera, C., Shikuku, K. M., Twyman, J., Läderach, P., Ampaire, E., Asten, P. V., Twomlow, S. and Winowiecki, L. A. 2017. Climate smart agriculture rapid appraisal (CSA-RA): A tool for prioritizing context-specific climate smart agriculture technologies, *Agricultural Systems* 151:192-203. https://doi.org/10.1016/j.agsy.2016.05.009.

NEPAD. 2003. Comprehensive Africa Agriculture Development Programme. New Partnership for Africa's Development (NEPAD).

Nikkanen, M., Räsänen, A. and Juhola, S. 2024. Adaptive governance of disaster preparedness? The case of regional networks in Finland. *International Journal of Disaster Risk Reduction*. Volume 108. https://doi.org/10.1016/j.ijdrr.2024.104549.

Nilsson, M., Zamparutti, T., Petersen, J.E., Nykvist, B., Rudberg, P. and McGuinn, J. 2012. Understanding Policy Coherence: Analytical

Framework and Examples of Sector–Environment Policy Interactions in the EU. *Env. Pol. Gov*. 22: 395-423. https://doi.org/10.1002/eet.1589.

Nkonya, E., Mirzabaev, A. and von Braun, J. 2016. Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development. Springer Cham. XVIII 686. https://doi.org/10.1007/978-3-319-19168-3.

Nyasimi, M., Amwata, D., Hove, L., Kinyangi, J. and Wamukoya, G. 2014. Evidence of Impact: Climate-Smart Agriculture in Africa. CCAFS Working Paper no. 86. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://hdl.handle.net/10568/51374.

Otsuka, K. and Larson, D. F. 2013. Erratum to: An African Green Revolution. In: Finding Ways to Boost Productivity on Small Farms. Springer Netherlands. Isbn: 978-94-007-5760-8. 1590-1611 pp. https://doi.org/10.1007/978-94-007-5760-814.

Pattberg, P. and Widerberg, O. 2016. Transnational multistakeholder partnerships for sustainable development: Conditions for success. *Ambio* 45 (1):42-51.

Pawlak, K. and Kołodziejczak, M. 2020**.** The Role of Agriculture in ensuring food security in developing Countries: Considerations in the context of the problem of Sustainable Food Production. *Sustainability* 12*:* 5488. https://doi.org/10.3390/su12135488.

Pernechele, V., Fontes, F., Baborska, R., Nana, J., Pan, X. and Tuyishime, C. 2021. Public expenditure on food and agriculture in sub-Saharan Africa: Trends, challenges, and priorities, Food and Agriculture Organization., Rome

Pickson, R.B., Gui, P., Jian, L.andBoateng, E. 2024. The role of private sector investment in agriculture:Acatalyst for sustainable development in Asia. *Sustainable Development* 116. https://doi.org/10.1002/sd.3105.

Pixley, K. V., Cairns, J. E., Lopez-Ridaura, S., Ojiewo, C. O., Dawud, M. A., Drabo, I., Mindaye, T., Nebie, B., Asea, G., Das, B., Daudi, H., Desmae, H., Batieno, B. J., Boukar, O., Mukankusi, C. T. M., Nkalubo, S. T., Hearne, S. J., Dhugga, K. S., Gandhi, H., Snapp, S. and Zepeda-Villarreal, E. A. 2023. Redesigning crop varieties to win the race between climate change and food security. *Molecular Plant*. 16 (10.)

Platform for Africa-Europe Partnership in Agricultural Research for Development (PAEPARD). 2018. Strengthening Capacity for Agricultural Research for Development: Collaboration for Results. 13pp.

Post, L., Schmitz, A., Issa, T. and Oehmke, J. 2021. Enabling the environment for private sector investment: Impact on food security and poverty. *Journal of Agricultural Food Industrial Organization* 19 (1): 25–37.

Poulton, C. and Kanyinga, K. 2014. The Politics of Revitalising Agriculture in Kenya. *Development Policy Review* 32 (s2): s151-s172.

Pouw, N. and Gupta, J. 2017. Inclusive development: a multi-disciplinary approach. *Current Opinion in Environmental Sustainability* 24*:* 104-108. https://doi.org/10.1016/j.cosust.2016.11.013.

Pretty, J., Toulmin, C. and Williams, S. 2011.Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability* 9 (1):5–24. https://doi.org/10.3763/ijas.2010.0583.

Prosekov, A.Y. and Ivanova, S.A. 2018. Food security: The challenge of the present. *Geoforum.* 91:73–77. doi: 10.1016/j.geoforum.2018.02.030.

Rafael, B. 2023. The Importance of Agricultural Development Projects: A Focus on Sustenance and Employment Creation in Kenya, Malawi, Namibia, Rwanda, and Uganda. *Journal of Agricultural Chemistry and Environment* 12:152-170. https://doi.org/10.4236/jacen.2023.122013.

Reardon, T., Echeverria, R., Berdegué, J., Minten, B., Liverpool-Tasie, S., Tschirley, D. and Zilberman, D. 2019. Rapid transformation of food systems in developing regions: Highlighting the role of agricultural research innovations. *Agricultural Systems* 172: 47-59.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C. H. and Stringer, L. C. 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management* 90 (5): 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001.

RESAKSS.2024.https://www.resakss.org/node/3 (available November 9, 2024).

Rhodes, J. R., Armsworth, P. R., Iacona, G., Shah, P., Gordon, A., Wilson, K. A., Runting, R. K. and Bryan, B. A. 2022. Flexible conservation decisions for climate adaptation. *One Earth* 5 (6): 622-634 https://doi.org/10.1016/j.oneear.2022.05.010.

Ribaut, J.M., Betran, J., Monneveux, P. and Setter, T. 2009.Drought Tolerance in Maize. In: Bennetzen, J. and Hake, S. (Eds.), Handbook of Maize: Its Biology. Springer, New York 311-344. http://dx.doi.org/10.1007/978-0-387-79418-1_16

Rosegrant, M. W., Jawoo Koo, Cenacchi, N., Ringler, C., Robertson, R., Fisher, M., Cox, C., Garrett, K., Perez, N. D. and Sabbagh, P. 2014. Food security in a world of natural resource scarcity: the role of agricultural technologies. IFPRI (International Food Policy Research Institute), Washington, USA. https://doi.org/10.2499/9780896298477.

Sers, C.F and Mughal, M. 2019. From Maputo to Malabo: Public agricultural spending and food security in Africa. *Appl. Econ.* 51:5045–5062. https://doi.org/10.1080/00036846.2019.1606411.

Shackleton, C.M., Pasquini, M.W. and Drescher, A.W. (Eds.). 2009. African Indigenous Vegetables in Urban Agriculture (1st ed.). Routledge. https://doi.org/10.4324/9781849770019.

Sharma, S., Inubushi, K. and Mukherjee, S. 2024. Roles of Agricultural Sciences for Achieving Sustainable Development in India: Perspectives and Challenges. In: Sobti, R.C. (Ed.) Role of Science and Technology for Sustainable Future. Springer, Singapore. https://doi.org/10.1007/978-981-97-0710-2_11.

Shiferaw, B., Prasanna, B.M., Hellin, J. and Bänziger, M. 2011. Crops that feed the world: Past successes and future challenges to the role played by maize in global food security. *Food Sec.* 3: 307–327. https://doi.org/10.1007/s12571-011-0140-5.

Shimeles, A., Verdier-Chouchane, A. and Boly, A. 2018. Building a resilient and sustainable agriculture in Sub-Saharan Africa. Springer International Publishing.

Shumi, G., Loos, J. and Fischer, J. 2024. Applying social-ecological system resilience principles to the context of woody vegetation management in smallholder farming landscapes of the Global South. *Ecosystems and People* 20 (1). https://doi.org/10.1080/26395916.2024.2339222.

Simola, A., Boysen, O., Ferrari, E., Nechifor, V. and Boulanger, P. 2022. Economic integration and food security – The case of the AfCFTA. *Global Food Security* (35): 100651. https://doi.org/10.1016/j.gfs.2022.100651.

Smith, L. C. and Frankenberger, T. R. 2018. Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. *World Development* 102: 358–376.

Spielman, D. J., Davis, K., Negash, M. and Ayele, G. 2011. Rural Innovation Systems and Networks: Findings from a Study of Ethiopian Smallholders. *Agr. Hum. Value*. 28:195–212.

Spindell Berck, C., Berck, P. and Di Falco, S. (Eds.). 2018. Agricultural Adaptation to Climate Change in Africa: Food Security in a Changing Environment *Routledge*. https://doi.org/10.4324/9781315149776.

Statista.2024.https://www.statista.com/statistics/1265139/agriculture-as-a-share-of-gdp-in-africa-by-country/ (available November 9, 2024).

Sumberg, J., Anyidoho, N.A., Leavy, J., te Lintelo, D.J.H. and Wellard, K. 2012, Introduction: The Young People and Agriculture 'Problem' in Africa. *IDS Bulletin* 43:1-8. https://doi.org/10.1111/j.17595436.2012.00374.x.

Takeuchi, K., Ichikawa, K. and Elmqvist, T. 2016. Satoyama landscape as social-ecological system: historical changes and future perspective. *Curr Opin Environ Sustain*. 19:30–39.doi: 10.1016/j.cosust.2015.11.001.

Tata, J. S. and McNamara, P. E. 2018. Impact of ICT on agricultural extension services delivery: evidence from the Catholic Relief Services SMART skills and Farmbook project in Kenya. *The Journal of Agricultural Education and Extension* 24 (1): 89-110.

Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P. and Spierenburg, M. 2014. Connecting diverse knowledge systems for enhanced ecosystem governance: the multiple evidence base approach. *Ambio* 43 (5): 579–591. https://doi.org/10.1007/s13280-014-0501-3.

Termeer, C. J. A. M., Dewulf, A. and van Lieshout, M. 2010. Disentangling scale approaches in governance research: comparing monocentric, multilevel, and adaptive

governance. *Ecology and Society* 15 (4): 29. https://edepot.wur.nl/159062

Termeer, C. J. A. M., Dewulf, A. and Biesbroek, G. R. 2016. Transformational change: governance interventions for climate change adaptation from a continuous change perspective. *Journal of Environmental Planning and Management* 60 (4): 558–576. https://doi.org/10.1080/09640568.2016.1168288.

Toenniessen, G., Adesina, A. and DeVries, J. 2008. Building an alliance for a green revolution in Africa. *Annals of the New York Academy of Sciences* 1136 (1): 233-242.

Touch, V., Tan, D. K. Y., Cook, B. R., Liu, D. L., Cross, R., Tran, T. A., Utomo, A., Yous, S., Grunbuhel, C. and Cowie, A. 2024. Smallholder farmers' challenges and opportunities: Implications for agricultural production, environment and food security. *Journal of Environmental Management.* 370.122536. https://doi.org/10.1016/j.jenvman.2024.122536.

Tsan, M., Totapally, S., Hailu, M. and Addom, B. K. 2019. The Digitalisation of African Agriculture Report 2018–2019. Wageningen. The Netherlands: CTA/Dalberg Advisers. https://hdl.handle.net/10568/101498.

UNESCO Institute for Statistics. 2021. Education Statistics Database. UNESCO

United Nations Convention to Combat Desertification (UNCCD). 2019. Addressing the land degradation migration nexus: the role of the United Nations convention to combat desertification. © 2019 International Organization for Migration (IOM). P. 60.

United Nations Department of Economic and Social Affairs (UNDESA).. 2019 https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html.

Uychiaoco, A.J., Arceo, H.O., Green, S.J., De La Cruz, M.T., Gaite, P.A. and Aliño, P.M. 2005. Monitoring and evaluation of reef protected areas by local fishers in the Philippines: tightening the adaptive management cycle. *Biodivers Conserv*. 14 (11):2775–2794. doi: 10.1007/s10531-005-8414-x.

Ville, A. S. S., Hickey, G. M. and Phillip, L. E. 2017. How do stakeholder interactions influence national food security policy in the Caribbean? The case of Saint Lucia. Food Policy. Pages 53- 64. https://doi.org/10.1016/j.foodpol.2017.01.002

Vincent, K. 2023. Development geography II: Community-based adaptation and locally-led adaptation. *Progress in Human Geography* 47 (4): 604-612. https://doi.org/10.1177/03091325231166076

Vink, M. J., Dewulf, A. R. P. J. and Termeer, C. J. A. M. 2013. The role of knowledge and power in climate change adaptation governance: a systematic literature review. *Ecology and Society* 18 (4): 46.

Vladimír, Š. K. 2021. Sustainable management of agricultural resources (agricultural crops and animals) pp. 99-145: In: Chaudhery Mustansar Hussain and Juan F. Velasco-Muñoz (Eds.). *Sustainable Resource Management* ISBN 9780128243428. https://doi.org/10.1016/B978-0-12-824342-8.00010-9.

von Braun, J. 2009. Addressing the food crisis: governance, market functioning, and investment in public goods. *Food Security* 1(1): 9–15.

Wachira, K. 2022. University world news Africa edition: Countries spend less than 1% of GDP on research, Proceedings of the IAU 2022, 16th General Conference, University College Dublin, Dubilin, Ireland. 25–28 October 2022, London, UK: University World News, 2022. [(Accessed on 16 September 2024)]. University World News Africa Edition Available online: https://www.universityworldnews.com/post.php?story=20210616151534847.

Wakweya, R. B. 2023. Challenges and prospects of adopting climate-smart agricultural practices and technologies: Implications for food security, *Journal of Agriculture and Food Research* 14: 100698 https://doi.org/10.1016/j.jafr.2023.100698.

WFP. 2022. https://www.wfp.org/news/global-report-food-crises-number-people-facing-acute-food-insecurity-rose-258-million-58.

Widerberg, O., Fast, C., Rosas, M.K. and Pattberg, P. 2023. Multi-stakeholder partnerships for the SDGs: is the "next generation" fit for purpose? *Int Environ Agreements* 23: 165–171. https://doi.org/10.1007/s10784-023-09606-w.

World Bank. 2019. World Development Indicators. https://databank.worldbank.org/source/world-development-indicators.

World Bank. 2020. Forthcoming. World Development Report 2020: Trading for Development in

the Age of Global Value Chains. Washington, DC: World Bank.

World Bank. 2021. Agriculture and Food Security in Africa: Building Resilience and Adaptation. World Bank Group.

World Bank. 2022. World Bank Research and Development Expenditure (% of GDP)—Sub-Saharan Africa by Countries from 1980–2021. [(Accessed on 16 September 2024)]. Available online: https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=ZG

Wudil, A. H., Usman, M., Rosak-Szyrocka, J., Pilař, L. and Boye, M. 2022. Reversing Years for Global Food Security: A Review of the Food Security Situation in Sub-Saharan Africa (SSA). *International Journal of Environmental Research and Public Health* 19 (22): 14836. https://doi.org/10.3390/ijerph192214836

Ziervogel, G., New, M., Archer van Garderen, E., Midgley, G., Taylor, A., Hamann, R., Stuart-Hill, S., Myers, J. and Warburton, M. 2014, Climate change impacts and adaptation in South Africa. *WIREs Clim Change* 5: 605-620. https://doi.org/10.1002/wcc.295.