Technical Report

Current Agro-based Transformation and its Future in East and Southern Africa.

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Abbreviations

Acronyms	Definitions
AATM	Africa Agriculture Trade Monitor
AfCTA	African Continental Free Trade Area
AR6	IPCC's Sixth Assessment Report
ARM	Agricultural risk management
AU	African Union
AUC	African Union Commission
BR	Biennial Review
CAADP	Comprehensive African Agriculture Development Programme
CIMP	Coupled Model Intercomparison Project
DSSAT	Decision Support System for Agrotechnology Transfer
ESA	East and Southern Africa
ESI	Export Similarity Index
EU	European Union
FACE	Free-Air CO_2 Enrichment
FANRPAN	Food Agriculture and Natural Resources Policy Analysis Network
FISPs	Farm input subsidy programs
FPUs	Food production units
GCMs	General Circulation Models
GDP	Gross domestic product
GFDL	Geophysical Fluid Dynamics Laboratory
GHG	Greenhouse gas
ICT	Information Communication Technology
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Intergovernmental Panel on Climate Change
ISIMP	Inter-Sectoral Impact Model Intercomparison Project
IWMI	International Water Management Institute
M&E	Monitoring and Evaluation
MFAT	New Zealand Ministry of Foreign Affairs and Trade
NAIP	National Agricultural Investment Plans
NARS	National Agriculture Research Systems
NPP	Net primary production
QSI	Production Similarity Index
RCA	Revealed Comparative Advantage
RCP	Representative Concentration Pathway
ReSAKSS	Regional Strategic Analysis and Knowledge Support Systems
S4I	Scaling for Impact
SADC	Southern Africa Development Community
SMEs	Small and medium-sized enterprises
SSP	Shared Socioeconomic Pathways
TEI	Trade Expansion Index
TFA	Trade Facilitation Agreement

TOI	Trade Overlap Index
USD	United States dollar
WBES	World Bank Enterprise Survey
WTO	World Trade Organization

Foreword

Transforming livelihoods and driving economic growth in Eastern and Southern Africa (ESA) demands a clear understanding of the region's agricultural landscape and its future potential.

The interactions between climate risks, socio-economic shifts, and agricultural development are pivotal—they shape food security, economic opportunities, and policy choices.

How we prepare for and respond to these risks matters profoundly, particularly in ESA, where climate-related threats endanger over **US $45 billion** in agricultural production, and food systems face growing pressure from population growth and resource constraints.

At the heart of this challenge lies maize—a cultural and economic cornerstone that provides income, employment, and vital nutrition across the region. However, maize remains highly vulnerable to climate shocks, with potential yield declines of up to 15% in ESA if no adaptive measures are implemented.

The consequences for food security and economic stability are significant. Persistent challenges such as low productivity, high post-harvest losses, pest outbreaks, limited market access, and recurrent droughts underscore the urgent need for action.

For the past three years, the CGIAR **Ukama Ustawi** Initiative worked with over 150 partners to explore science-based pathways for sustainable intensification and diversification of maize-based farming systems.

Yet a key question remains: have these efforts delivered meaningful progress? This report examines that question, offering lessons from Ukama Ustawi while looking ahead under the **CGIAR Scaling for Impact (S4I)** Program, which now leads CGIAR's scaling efforts across ESA.

Achieving a resilient, diversified agricultural future in ESA will require coordinated action by governments, the private sector, civil society, producers, and consumers, supported by inclusive policies and enabling environments.

This **State of the Region Report** presents an evidence-based analysis of the region's agrifood systems, combining climate impact modelling, participatory scenario planning, and current status assessments. It aims to inform smarter investments and policy choices that lead to lasting transformation.

We invite you to explore this report—developed with contributions from partners including IWMI, FANRPAN, AKADEMIYA2063, and IFPRI—and to join us in advancing inclusive, evidence-based strategies that can secure a resilient, sustainable, and equitable future for Eastern and Southern Africa

Dr. Inga Jacobs – Mata
Interim Deputy Director for the CGIAR Scaling for Impact (S4I) Science Program

Executive Summary

The **Technical Report: Current Agro-based transformation and its future in East and Southern Africa** investigates critical issues surrounding agricultural transformation in the Eastern and Southern Africa (ESA) region, with a particular focus on maize-based farming systems.

It provides an overview of key themes including agricultural performance, trade, climate change, and future agricultural scenarios, concentrating on 12 countries that were part of the CGIAR's **Ukama Ustawi** Regional Initiative: Eswatini, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Rwanda, Tanzania, Uganda, South Africa, Zambia, and Zimbabwe.

In many of these countries, agriculture remains a central pillar for both livelihoods and national economies. For instance, agriculture accounts for around 30% of Ethiopia's GDP, 29% in Madagascar, and 26% in Malawi.

Even in countries where agriculture's contribution to GDP is below 10%, such as Zambia and South Africa, the sector remains critical—any downturn in agricultural performance can trigger significant social and economic repercussions. For example, drought in Zambia in 2024 prompted the government to allocate USD 1 billion for relief measures to cushion the effects of poor harvests on livelihoods.

These challenges are compounded by the widespread dependence on maize-based systems across the region, heightening vulnerability to climate shocks. To improve agricultural performance, it is essential to strengthen the enabling environment—spanning macroeconomic stability, business conditions, policies, and institutions—to attract investment and foster robust growth. Similarly, enhancing regional trade is vital for driving agricultural transformation and building climate resilience.

Despite the importance of these factors, few studies offer an integrated analysis of the current agricultural landscape, enabling environments, trade dynamics, climate change impacts, and future scenarios in ESA.

This report addresses that gap by providing a comprehensive assessment of agricultural trends, trade patterns, climate risks, and plausible development pathways for the region. The analysis draws on secondary data, literature reviews, trend and correlation analysis, and climate scenario modeling.

Key Findings

Enabling environment needs strengthening: Many countries in the region face policy, macroeconomic, and infrastructure gaps. High inflation, volatile exchange rates, and prohibitive interest rates limit agricultural investment. Trade facilitation and input market development are critical for successful diversification beyond maize-based systems.

Agricultural technology use remains low: Uptake of technologies such as irrigation, mechanization, and digital tools is limited. Poor internet and energy access further constrain technology adoption and agricultural growth.

Insufficient agricultural finance hinders transformation: Despite Maputo and Malabo commitments, most countries—except Malawi, Zambia, and Rwanda—have not met the 10% agricultural financing target set by the African Union (AU).

Productivity falls short of AU targets: Low productivity persists due to climate change, limited finance, and restricted input access. Maize and other staple crops remain highly vulnerable, raising food security concerns.

Trade faces infrastructure and policy bottlenecks: Inadequate infrastructure, restrictive policies, and institutional weaknesses constrain regional trade and limit progress toward agricultural diversification.

Climate variability will persist: Northern East Africa (Djibouti, Eritrea, Ethiopia, Uganda, Somalia) is projected to become wetter, while much of Southern Africa is expected to become warmer, impacting yields of key crops.

Certain crops will face climate pressure: Maize, wheat, and potatoes may see declining rainfed yields, while soybeans and sorghum could benefit in some areas. Vegetables, potatoes, wheat, teff, and barley are likely to experience yield declines under future climate scenarios. Maize is especially vulnerable, increasing import dependency across the region.

Stable governance attracts investment. Countries with stronger political and institutional stability show higher levels of domestic and foreign agricultural investment.

Macroeconomic stability supports growth. Lower inflation, stable exchange and interest rates, and effective accountability mechanisms such as CAADP Joint Sector Reviews are linked to better sector performance.

Investment in inputs and infrastructure drives productivity. Greater mechanization, irrigation, energy access, digital connectivity, and soil health improvements correlate with higher yields and value added.

Scaling up drought-tolerant crops is essential: Given water constraints and the high cost of irrigation, drought-resistant varieties will be crucial for managing climate risks such as erratic rainfall and El Niño events.

Labour productivity remains low: Low agricultural labour productivity is linked to limited skills development. Investments in farmer training and skills development—supported by increased public agricultural expenditure—are needed to enhance productivity.

Building on these findings, the report makes the following **recommendations.** The technical and managerial capacities of farmers and agribusinesses—alongside promoting the adoption of modern technologies such as mechanization, irrigation, and digital tools—is essential to enhance productivity and sustainability. Regional cooperation to share best practices and innovations should also be prioritized.

In addition, developing strong partnerships for agricultural financing and increasing funding for agricultural research and development (R&D)—aiming toward the **1% of agricultural GDP** target recommended by the African Union Commission (AUC)—will be crucial for long-term transformation.

Given persistent trade barriers, countries should invest in trade facilitation measures to boost intra-regional and bilateral trade. This includes removing unnecessary tariff and non-tariff barriers such as road harassment, border delays, arbitrary trade bans, and poor infrastructure. Investments in agro-processing are equally important to extend the shelf life of commodities and increase the value added to agricultural products.

Governments should also strengthen regional trade agreements by reducing non-tariff barriers, streamlining customs procedures, and promoting fair competition. Harmonizing agricultural standards across countries will further facilitate cross-border trade and foster greater market integration.

Furthermore, governments and financial institutions should collaborate to design tailored financial products that address the unique needs of agricultural enterprises, particularly those in rural areas.

At the same time, regional strategies should focus on promoting value-added agricultural production to boost export earnings and reduce reliance on primary commodity exports.

Chapter 1: Introduction

Greenwell Collins Matchaya and Mahlatse Nkosi

As climate change continues to exert pressure on East and Southern African economies, it is increasingly important for policymakers to deepen their understanding of the structure of their economies, the resilience options available, and the general trends shaping key sectors. Such knowledge is crucial for developing effective preventive and corrective policy frameworks, as well as guiding their implementation.

Economically, East and Southern African countries are highly diverse and heterogeneous, yet they also share many similarities. These differences offer opportunities for collaborative transformation, while their common challenges—particularly in agriculture—further justify coordinated regional approaches.

The region includes a mix of low-income, lower-middle-income, and middle-income countries, creating opportunities for intra-regional trade, technology transfer, and knowledge exchange. While services, mining, and manufacturing are important, agriculture remains the dominant source of employment in many countries. Botswana, Eswatini, Lesotho, Mauritius, Namibia, Seychelles, and South Africa have recorded more advanced economic progress, while others continue to face high levels of poverty.

Agriculture is a major contributor to GDP in Southern Africa, accounting for between 3% and 40% of GDP depending on the country (Gardiner & Mabogunje, 2023). It also remains a key employer, especially in rural areas, where most households depend on farming for their livelihoods (Ayim et al., 2022). This underscores the agricultural sector's critical role in regional development.

However, the region is highly vulnerable to climate change and other external shocks. Recent crises, including El Niño-induced droughts, the COVID-19 pandemic, and the Russia-Ukraine conflict, have exposed the region's limited resilience.

These events have led to sharp declines in agricultural yields, food price spikes, and widespread livelihood disruptions. Droughts in particular have triggered severe food insecurity, causing starvation in some areas and hurting both producers and consumers through volatile prices.

The agricultural landscape in East and Southern Africa is changing, shaped by climate variability, rapid urbanization, technological progress, shifting trade policies, and broader macroeconomic trends. Expansionary monetary policies in response to the COVID-19 pandemic, along with the inflationary pressures from global crises, have further affected food systems and markets.

In this context, diversifying agricultural production is essential for strengthening resilience and driving growth. Yet maize continues to dominate the region's crop sector, despite its vulnerability to climate shocks. Limited diversification has left both farmers and consumers increasingly exposed to risks.

Urbanization is also reshaping food demand in the region. As more people move to cities, food systems are adapting to changing diets and rising incomes, with greater emphasis on processed foods and longer supply chains. This shift highlights the need for better rural-urban linkages and improved market access (Tschirley et al., 2013). In parallel, the growing use of digital technologies is helping bridge gaps between input providers, producers, consumers, and markets. Mobile applications and digital platforms are enhancing information flow and knowledge-sharing, enabling smallholder farmers to access timely, reliable agricultural advice (Ayim et al., 2022).

These trends underscore the region's agricultural potential but also highlight the need for accelerated efforts to achieve growth, diversification, and stronger market integration for smallholder farmers.

Ukama Ustawi (UU) supported water security and climate-resilient agricultural livelihoods in East and Southern Africa (ESA), enabling millions of vulnerable smallholders to transition from maize-dominated farming systems to more intensified, diversified, and de-risked systems.

The initiative fostered enterprise development, mobilized private investment—particularly targeting women, youth, and other disadvantaged groups—and promoted landscape-scale environmental health. These efforts are now continuing under the **CGIAR Scaling for Impact (S4I) Science Program** through science-based innovation, capacity strengthening, policy engagement, and strategic communications.

A key milestone of these efforts has been the establishment of the **Regional East and Southern Africa Scaling Hub**, based in Nairobi, Kenya. This hub focuses on adaptive scaling research and developing fit-for-purpose, bundled innovation delivery models tailored to the region's specific contexts.

Scalable solutions, including digital platforms co-developed with national agricultural research systems (NARS), governments, and private-sector partners, are being deployed to provide agro-advisory services and de-risk agricultural activities.

These platforms feed into multi-stakeholder dialogues that actively engage the private sector and help cultivate a pipeline of small and medium-sized enterprises (SMEs). These SMEs benefit from incubation and acceleration services, coupled with access to inclusive financial mechanisms, to drive sustainable and climate-resilient growth.

Empowerment of marginalized groups—especially women, youth, and migrants—is integrated through targeted capacity-building activities such as change agent identification, internships, mentorship programs, and support for cooperatives and networks.

These efforts are supported by integrated land, water, and energy management systems, alongside collaborative governance frameworks. Through shared regional visions, targets, and plans for food and water security, these initiatives are also expected to influence regional trade patterns and human mobility dynamics positively.

Against this backdrop, this report examines current agricultural performance trends in East and Southern Africa, with a particular focus on crop sector dynamics, the extent of diversification, and the impacts of climate change. It also explores climate trends, regional agricultural trade dynamics, and related constraints, before presenting possible agricultural development scenarios under future climate conditions. Each of these themes is addressed in the chapters that follow.

Chapter 2 summarizes the current status of agricultural transformation in ESA, focusing on the enabling environment (policies, macroeconomic conditions, and infrastructure), agricultural performance, and the linkages between agricultural inputs and sectoral/national outcomes.

Chapter 3 analyses regional trade and agricultural diversification, highlighting the role of trade in driving diversification, existing constraints, and regional trade potential.

Chapter 4 presents the regional climate outlook and its likely impacts on agriculture, identifying priority value chains either vulnerable to or likely to benefit from future climate regimes.

Chapter 5 discusses plausible agricultural development scenarios under projected climate conditions.

The report concludes with a summary of key findings and provides recommendations for policy actions and stakeholder engagement across the region.

The next chapter presents the status of agricultural performance in Eastern and Southern Africa, providing a data-driven baseline on productivity, policy, and investment trends.

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Chapter 2: The Status of Agricultural Performance in the Eastern and Southern Africa region

Greenwell Collins Matchaya

2.1 Introduction

This chapter provides a baseline assessment of agricultural performance in East and Southern Africa. It adopts a multidimensional perspective, recognizing that agricultural performance reflects not only productivity and output but also the policy, institutional, infrastructural, and technological conditions that shape sector outcomes.

Accordingly, indicators related to policy effectiveness, investment levels, input access, and innovation are treated here as core dimensions of performance, rather than as separate enabling-environment factors.

The East and Southern Africa regions are highly diverse, with countries at different stages of economic development. South Africa, Namibia, Botswana, Eswatini, Lesotho, Mauritius, and Kenya are classified as middle-income economies, while the remainder are low-income.

Despite these differences, agriculture remains a central driver of GDP, employment, and poverty reduction throughout the region. Yet agricultural transformation has slowed and, in some cases, has been outpaced by population growth.

Contributing factors include policy and institutional weaknesses, limited implementation capacity, inadequate transformative investment, low technology adoption, and insufficient use of evidence to guide policy decisions (AUC 2023).

While data, information, and knowledge are potential enablers of competitiveness and transformation, regional data and knowledge systems remain weak, constraining evidence-based planning and monitoring. The indicators presented in this chapter therefore provide a reference baseline against which future performance - of both national programs and CGIAR-supported initiatives - can be assessed.

Analytical Framing of Agricultural Performance

The assessment organizes the analysis across four interrelated dimensions. The first focuses on the policy and institutional environment, the enabling conditions that influence sector coordination, governance, and investment.

The second examines productivity and output trends, capturing growth in value added, yield improvements, and labor efficiency.

The third explores infrastructure and market systems, including physical, financial, and trade linkages that determine how efficiently agricultural inputs and outputs move through value chains.

The fourth considers innovation and human capital, encompassing technology adoption, digitalization, extension, and education. Together, these dimensions provide a holistic view of progress and constraints shaping agricultural performance across the region.

The remainder of the chapter is structured as follows:

Section 2.2 reviews the policy and institutional environment, including countries' adoption of agricultural transformation frameworks, governance quality, and macroeconomic indicators such as interest rates, exchange-rate volatility, and inflation.

Section 2.3 discusses primary factors of production—land and population (as a proxy for agricultural labor).

Section 2.4 analyzes infrastructure and market systems, focusing on energy use, internet penetration, and agricultural machinery intensity.

Section 2.5 presents development results, including income and income growth, followed by indicators of crop and livestock productivity and selected cross-indicator linkages that help explain performance patterns.

The chapter concludes with key findings and recommendations, while highlighting areas where further analysis is required to establish causality and deepen understanding.

2.2 Enabling Environment

Policy environment

A key policy framework for agricultural transformation in Africa is the Comprehensive Africa Agricultural Development Program (CAADP) which emerged after the Maputo Declaration in 2003 (AUC 2003) and reaffirmed in the Malabo Declaration of African Heads of State in 2014 in Malabo, Guinea in 2014 (AUC 2014).

The adoption of this framework and its key principles is considered critical for agricultural transformation. Many of the countries in the region have rallied behind the framework, with many of them developing CAADP/Malabo consistent National Agricultural Investment Plans (NAIP) and participating in the CAADP Biennial Review processes as seen in ***Table 1***, which stands as evidence that the leadership of these nations are ready to play their part in leading transformation.

However, there are still some weaknesses even in this area in that only three of these countries (Malawi, Rwanda and Zambia) appear to be achieving the targets of investing 10% of their resources in the agriculture sector, ***Figure 9***. Many of these countries should increase the share of national budgets allocated to agriculture.

Table 1: Enabling environment in the 12 ESA countries (2018 - 2023)

	Participation in Biennial Review (BR)	**Joint Sector Review assessments**	**Governance Effectiveness**	**Interest rates**	**Exchange Rate volatility**	**Inflation**
Eswatini	Yes	Yes	40,14	9,39	10,87	5,37
Ethiopia	Yes	Yes	38,61	11,75	33,08	30,32
Kenya	Yes	Yes	50,59	12,74	11,20	7,15
Madagascar	Yes	No	24,34	51,99	11,64	7,95
Malawi	Yes	Yes	33,85	29,08	35,00	19,69
Mozambique	Yes	Yes	35,15	21,27	3,85	7,94
Rwanda	Yes	Yes	69,47	16,52	12,04	12,36
South Africa	Yes	No	64,14	9,38	10,86	5,91
Tanzania	Yes	Yes	39,53	17,21	3,80	3,95
Uganda	Yes	Yes	40,61	20,56	2,73	4,92
Zambia	Yes	Yes	35,39	10,48	28,62	14,63
Zimbabwe	Yes	Yes	14,49	58,69	144,20	101,00
Data Sources	AUC 2024	ReSAKSS	World Bank 2024	World Bank 2024	World Bank 2024	World Bank 2024

Table 1 shows that all countries in focus have participated in the recent cycles of the African Union Biennial Review (BR) processes. Only South Africa and Madagascar have Joint Sector review assessments yet to be introduced, Thisprovides some evidence that many of the countries are willing to adopt innovations for data systems strengthening.

It should be said though that governance needs strengthening with many of the countries scoring less than 50% of the governance effectiveness maximum score of 100%. Kenya (50.59%), Rwanda (69.47%) and South Africa (64.14%) have better governance systems relative to the rest of the ESA countries based on this indicator implying that support for better governance is needed in the other countries to give development interventions a better chance of success.

2.3 Performance on CAADP Biennial Reviews

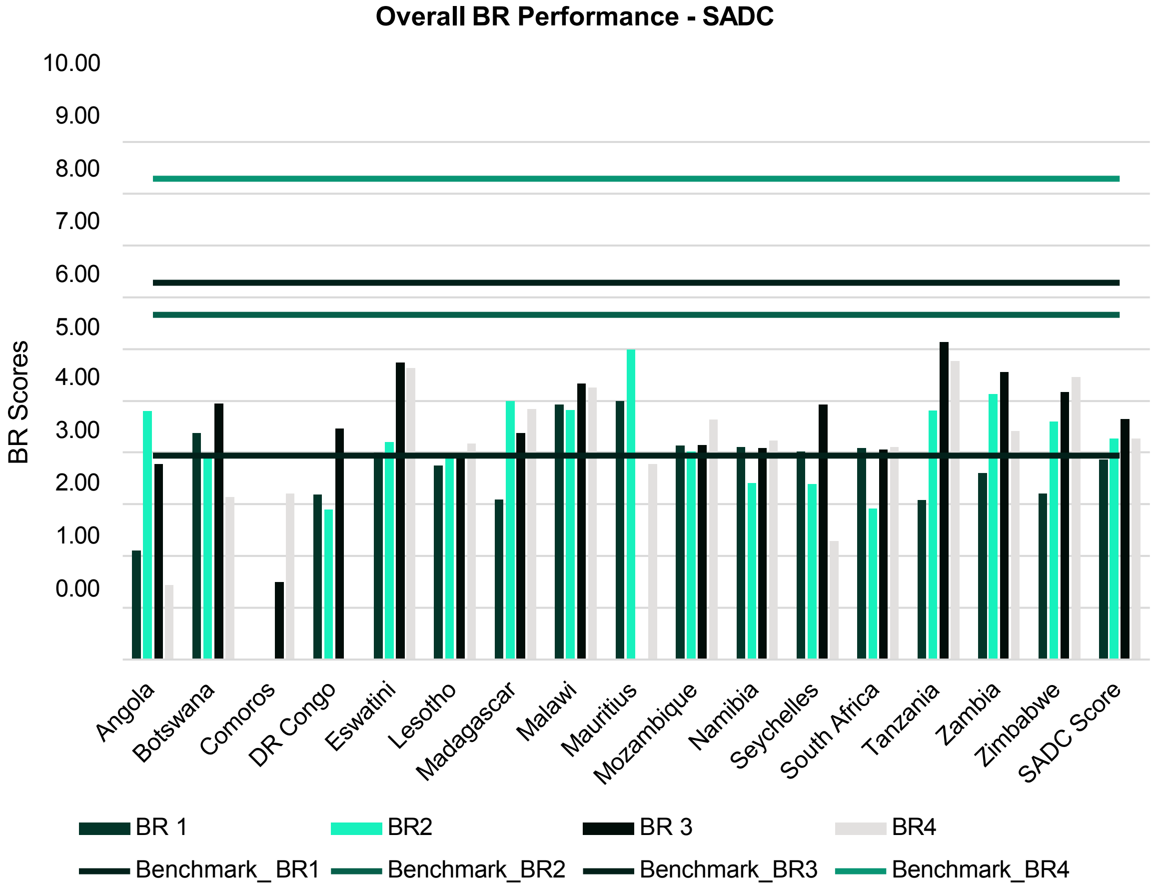


Figure 1: Overall Comprehensive Africa Agriculture Development Programme Biennial Review (BR) performance by SADC member states over the three

Source: (AUC, 2023)

All Southern African Development Community (SADC) member states need to intensify the implementation of their National Agricultural Investment Plans (NAIPs) if they and the region as a whole, are to meet the Malabo Declaration aspirations by 2025 or shortly thereafter.

While several countries achieved the minimum benchmark score of 3.94 in the initial Biennial Review (BR1, completed in 2017), their performance declined in subsequent reviews (BR2 in 2019, BR3 in 2021, and BR4 in 2023), with none reaching the updated milestones required to stay “on track.”

This pattern partly reflects the design of the benchmarking model, in which the benchmark represents the milestone value a country must reach in a given review cycle to remain on course toward achieving a score of 10.00 by the final target year (2025). Thus, benchmarks are not static—they rise over time in proportion to expected progress. If benchmarks were to remain unchanged, a country could appear “on track” in 2025 without having demonstrated real advancement.

The BR4 cycle identified several persistent challenges constraining progress despite these recalibrated benchmarks, including:

2.4 Key challenges from the Malabo BRs

The Biennial Review (BR) process has revealed persistent structural, institutional, and investment challenges constraining agricultural transformation across Eastern and Southern Africa (ESA).

The Third (2021) and Fourth (2023) Biennial Review Reports of the African Union Commission (AUC) highlight that, despite incremental progress in some countries, most ESA member states remain off-track toward achieving the Malabo Declaration's 2025 targets. Across both reporting cycles, the data reveal a worrying convergence of low agricultural growth, weak investment, and limited resilience to shocks.

For instance, less than five percent of youth in Eswatini and Ethiopia were engaged in new employment opportunities within agricultural value chains, underscoring the persistent gap in creating decent jobs for young people. In Eswatini, Madagascar, and Kenya, agricultural GDP growth stagnated below 1.9% in the evaluation year, far short of the 6% annual growth target, while agricultural public expenditure consistently lagged behind the 10% commitment set under the Maputo and Malabo Declarations

The Fourth Biennial Review (2023) further noted that no country in Africa was on track to meet the 9.29 benchmark, with the best-performing countries, Rwanda (8.07), Morocco (6.99), and Egypt (6.83), still falling below the target. Several ESA countries, including Malawi, Mozambique, Zambia, Zimbabwe, Madagascar, and Uganda, recorded slow or negative progress on poverty reduction, signalling that agricultural growth has not translated into broad-based welfare gains.

In the same vein, trade facilitation and regional integration commitments showed widespread underperformance, with non-tariff barriers, weak logistics, and inadequate border infrastructure constraining intra-African agricultural trade.

Resilience building remains a critical weakness. Countries such as Madagascar (9.4%) and Zimbabwe (15.7%) reported very low shares of farm, pastoral, and fisher households resilient to climate- and weather-related shocks — reflecting inadequate adaptation investments and slow uptake of climate-smart practices.

Moreover, the Fourth BR attributed much of the stagnation to compound crises, including the lingering effects of COVID-19, the Russia–Ukraine war, extreme weather events, and input price volatility, all of which have reversed earlier development gains.

At the institutional level, weak monitoring and evaluation (M&E) systems, fragmented data architectures, and inconsistent policy coordination remain major barriers to evidence-based decision-making. The 2021 BR had already called for stronger national coordination platforms, harmonized data protocols, and improved integration between National Agricultural Investment Plans (NAIPs) and Biennial Review processes.

Yet by 2023, progress in institutionalizing these systems remained uneven. Collectively, these findings suggest that the challenge is not merely poor performance against indicators, but a deeper misalignment between policy ambition, investment effort, and implementation capacity.

For the ESA region to accelerate agri-food system transformation, countries will need to:

- Strengthen domestic financing for agriculture and ensure its effective targeting.
- Integrate resilience and youth employment objectives into core agricultural strategies.
- Modernize trade and market systems under the AfCTA framework; and
- Institutionalize robust, data-driven mutual accountability mechanisms.

Only by addressing these interlinked constraints investment, productivity, resilience, and accountability, can ESA countries move decisively toward achieving the aspirations of the Malabo Declaration by 2025 and sustain progress under the post-Malabo CAADP framework.

Macro-economic environment

A conducive macro-economic environment is important for agricultural transformation. Investors in the agricultural sector benefit from low inflation and a stable exchange rate as well as affordable cost of finance.

More than half of the ESA countries have average inflation rates that are under 10% which is generally viewed as good for investment decisions. However, with inflation rates above 10% as in the case of Ethiopia (30.32%), Malawi (19.69%), Rwanda (12.04%), Zambia (14.63%) and Zimbabwe (101.00%) more needs to be done in order to stabilize their prices and make it more attractive for investors to invest their resources in the respective countries.

Subsequently exchange rates in Zimbabwe, Zambia, Malawi and Ethiopia exhibited huge volatility in recent years, which again creates uncertainty for investors and deterring investment away to economies with stable exchange rate regimes.

Not only should such unstable exchange rate regimes be resolved, countries in the region, especially, Madagascar (51.99%), Malawi (29.08%), Zimbabwe (58.69%), and Uganda (20.56%) should strive to reduce the cost of borrowing for investors to make it easier for agri-food systems entrepreneurs to engage in business in the sector.

The selected 12 countries in the East and Southern Africa region inhabited around half a billion people in 2024 and at a net growth rate of around 2.3 as calculated from the data (*2*), the region will inhabit around 1 billion people by 2060 .

Primary factors of production

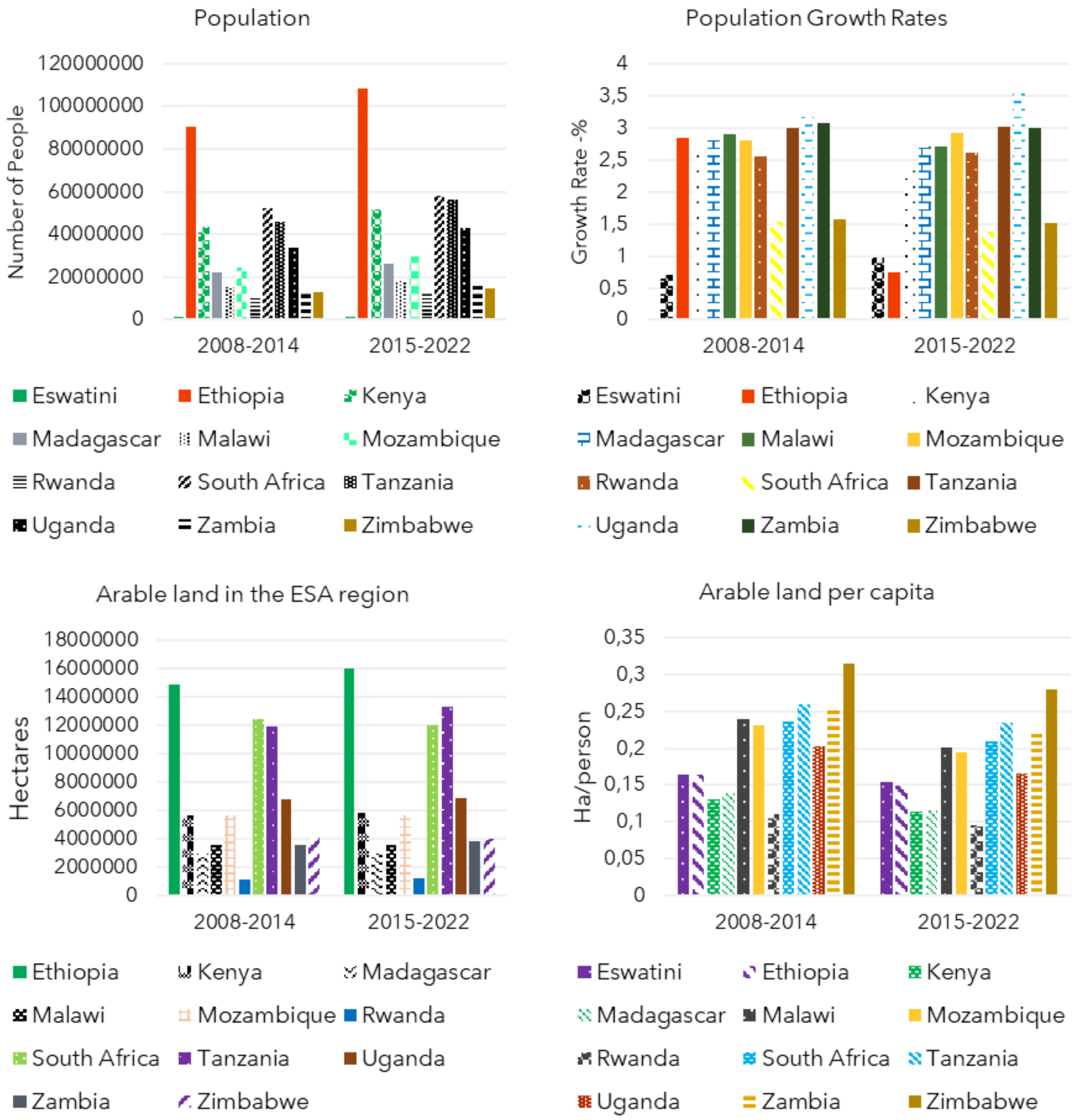


Figure 2: Population, Population Growth rates, arable land and arable land per capita in the ESA

Source: Authors with World Bank data

Many of these people will live in Ethiopia, Tanzania, Uganda and Kenya. The growth rate of the population suggests that the region has the potential to serve as a big market for the supply and demand of commodities of diverse kinds in future (owing to copious labour and consumers).

Nevertheless, should the development of the region be insufficient to generate the jobs needed for the future, such a rapid increase in population could also spell doom as it would generate a pool of jobless youth who will suffer from insecurity, and other forms of deprivation. It is therefore important for programs such as S4I be used to spur growth in food production, and broad-based transformation of the agricultural sector especially because at present, many of the region's people live in rural areas where they derive a living through agriculture.

The two graphs on the bottom panel of ***2,*** show arable land in absolute terms and in per capita terms.

Most of the region's 76 million hectares of arable land rest with Ethiopia, Tanzania and South Africa, respectively, but per capita land holdings are highest in Zimbabwe, Tanzania, Zambia, South Africa, and Malawi owing to low populations in those countries.

Average arable land holdings per capita are generally under 0.2 per hectare although in practice, available land per farming population is larger because a significant proportion of the population earns a living off farming as well, and in countries such as South Africa, land is available to only few farmers which makes per capita holdings high.

In any case, the low per capita holding in the region signals that agricultural productivity improvement through better soil health management will be key in future if the region is to meet the food and agricultural services needs of the one billion plus population of that time.

Requisite Infrastructure

Agricultural transformation and successful diversification away from maize-based systems will also require reliable energy sources for agro-processing, storage, production as well as mechanization. It will also require the utilization of digital technology for efficiency which in turn require access to reliable internet.

Similarly, farm operations that are labor-intensive are often less efficient, and therefore mechanization of farms will be determinantal to future agri-food systems transformation in line with the focus of the future Kampala Declaration on agri-food systems transformation.

Figure 3 shows that the population in the East and Southern Africa region has limited access to electricity, especially in rural areas, with the majority of the countries reporting less than 10% of the rural population with access to electricity in the pre-Malabo period.

Although the Malabo period (2015 – 2022) has seen changes in the share of rural populations with access to electricity, more than 80% of the rural populations still have no access to electricity in many of these countries. The exception is South Africa where 78% have access, and Eswatini (68%) followed by Kenya (49%). Thus, investing in energy systems including solar, wind, nuclear and hydro energy systems depending on the country, would prove useful for meaningful agri-food systems transformation.

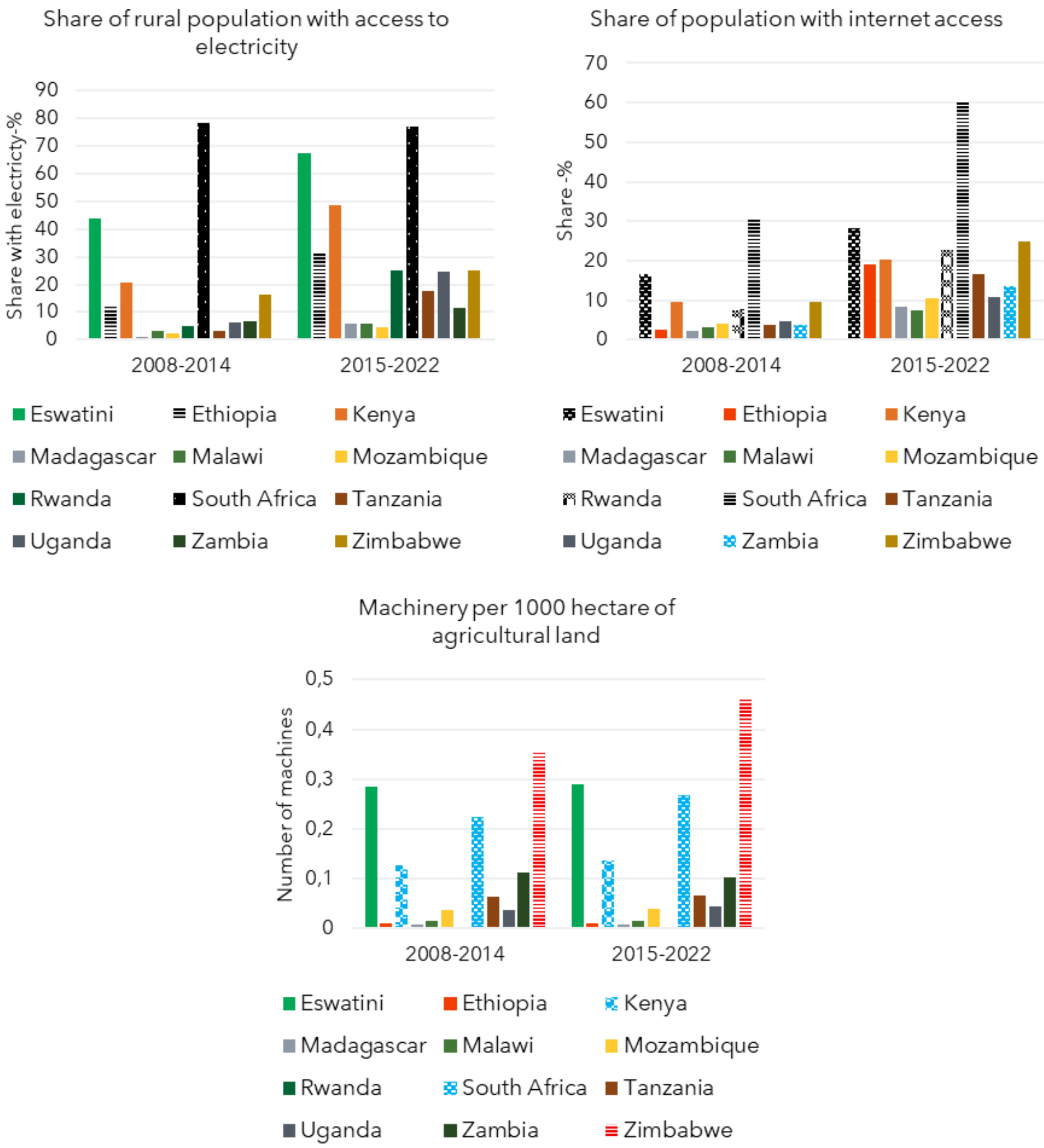


Figure 3: Access to electricity, mechanization, internet and land availability

Source: World Bank Data (World Bank 2024)

The bottom panel of ***Figure 3*** also shows that the usage of machines per hectare in the region is low and stood at 0.4 machines per 1000 hectares. Such low mechanization means that the region has low capital per labour which depresses total factor productivity. Going forward, mechanization should intensify in the region in order to spur productivity.

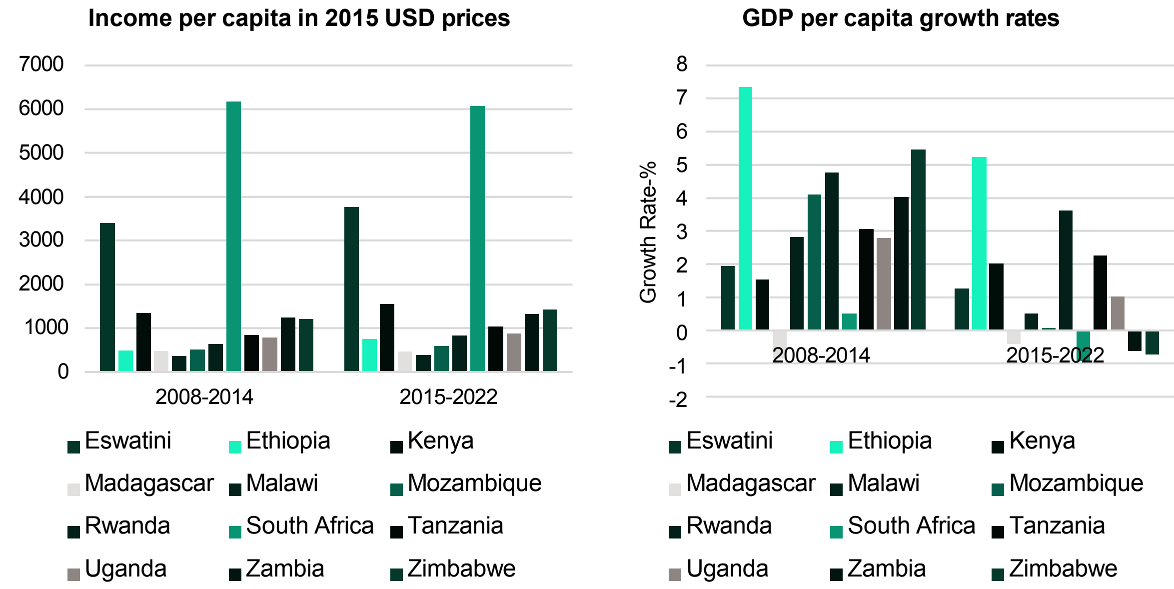
Development Results

The East and Southern Africa region is characterized by general low incomes per capita (less than USD1500 for 9 of the 12 countries) with the exception of South Africa, Eswatini and Kenya whose incomes per capita surpass USD 1500 (***Figure 4***). Thus, the majority of the region's population is categorized as poor, underscoring the importance of better programs that seek to transform the agricultural sectors of the region as a means towards improving people's incomes and livelihoods.

Figure 4 depicts the income growth rates which are not high, in the Malabo era, growth has been undermined by events of the era which included the Covid-19 pandemic, the Russia Ukraine crisis and to some extent the droughts that have persisted in the region.

The average growth rates for incomes have been below 4% per annum with countries such as South Africa, Zambia, Zimbabwe, Madagascar and Malawi being negative or just above the 0.5%.

These growth rates are smaller than the AU targets of 6% per annum and more should be done to increase them. A growth rate of 3% per annum would imply the region's lower than USD 1500 incomes per capita would require 65 years to reach an upper middle-income status of USD 10,000 which is a long time, as such more intervention is required to spur income growth in the region.



Source: World Bank Data

Figure 4: Income per capita and GDP per capita growth rates in ESA

Agricultural Performance

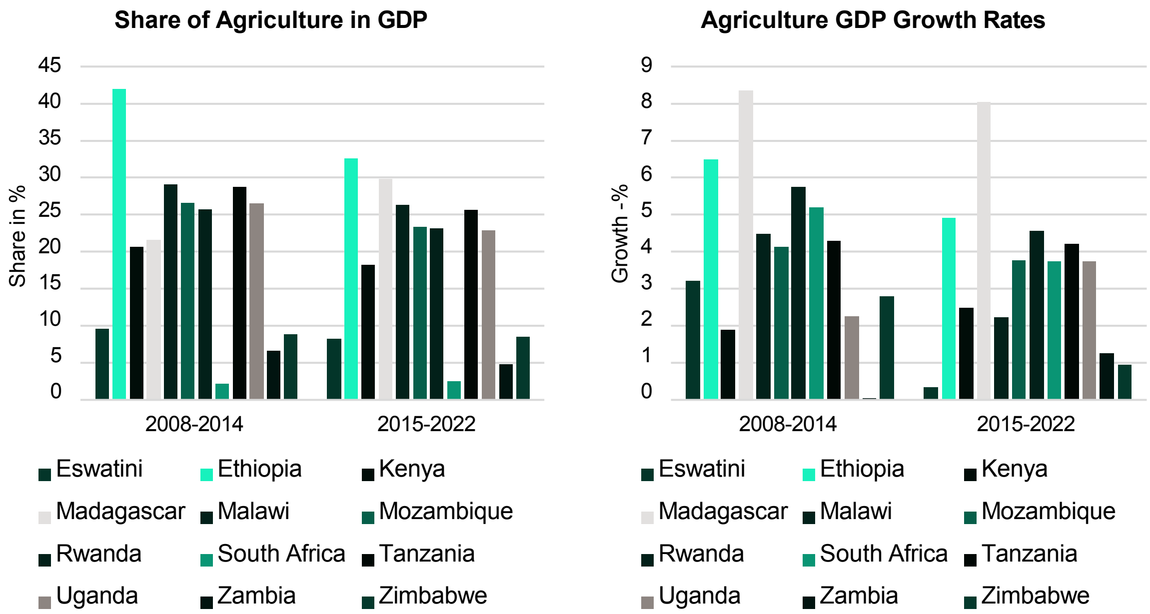
Part of the stagnation of the region emanates from the nature of performance in the agricultural sector considering that for some countries it accounts for a larger share of the economies as measured by agriculture GDP.

Figure 5 shows that the share of agriculture in the total GDP is as high as 20% for many of the countries, with only Eswatini, South Africa, Zambia and Zimbabwe registering much lower shares of agriculture in total GDP.

The high shares of agriculture GDP as a share of total GDP is an indication of the importance of agriculture in the ESA economies, where agriculture GDP shares are low for example in Zambia and South Africa, large shares of the population in those countries depend on agriculture directly.

It is evident also that the share of agriculture in GDP have remained largely constant across the two time periods under consideration, but agriculture GDP growth rates have stagnated below 4% per annum and are lower in the 2015 – 2022 period.

The fact that many of the countries have agriculture GDP growth rates that trail the 6% target set by the AU within CAADP, calls for more efforts to transform agriculture.



Source: Authors with World Bank Data

<u>Figure 5</u>: Share of Agricultural GDP and Agriculture Growth rates

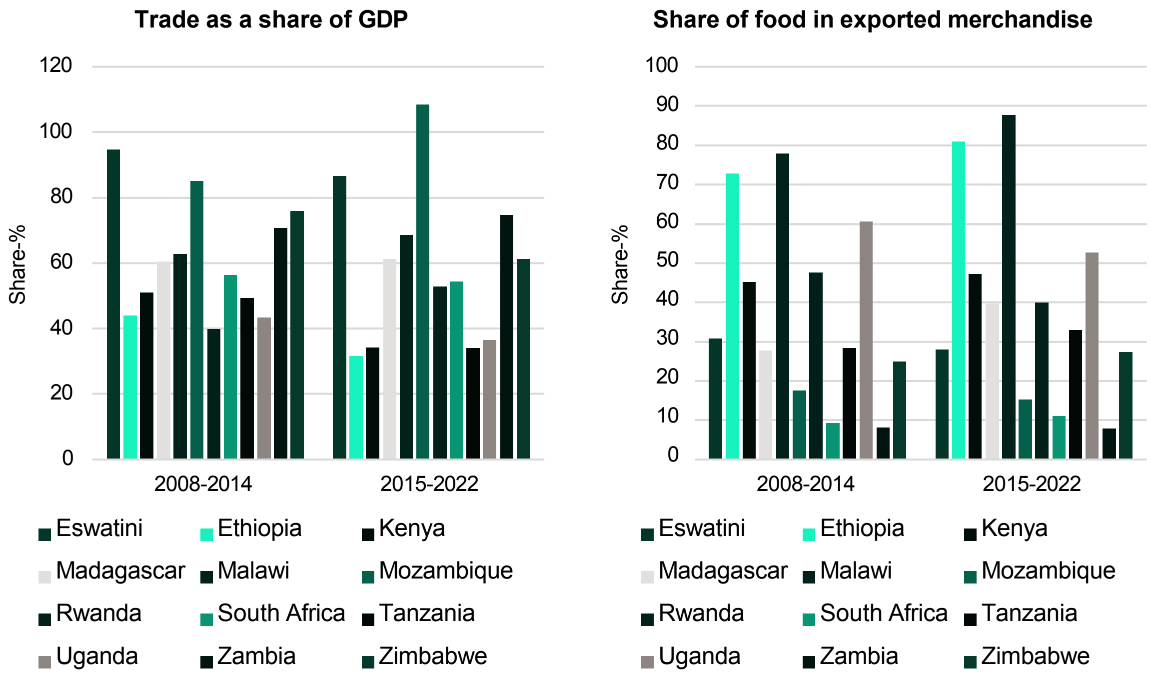
<u>Figure 6</u> shows the Eastern and Southern Africa (ESA) region remains relatively open to trade, with total trade (exports plus imports) accounting for about 50 percent of GDP in most countries. Exceptions include Eswatini and Mozambique, where trade exceeds 90 percent of GDP (Figure 6). This indicates that trade plays a central role in many economies across the region.

However, the relationship between trade openness and economic growth is not straightforward. While increased trade can enhance competitiveness, productivity, and access to technology, the extent of these benefits depends on the structure of trade, the diversity of exports, and the capacity of domestic industries to respond effectively to market opportunities (World Bank, 2022; UNECA, 2023).

Food trade forms an important component of total trade in several ESA countries, accounting for more than 30 percent in some cases. In contrast, in Zambia, South Africa, and Mozambique, food trade represents less than 16 percent of total trade, reflecting the dominance of non-agricultural exports or limited participation in regional food markets. Strengthening food trade therefore remains essential for both economic diversification and regional food security.

Efforts to improve trade performance must address a broader range of challenges than tariff reductions alone. The region faces several non-tariff and structural barriers, including weak transport and logistics infrastructure, high transaction costs, cumbersome customs procedures, inconsistent sanitary and phytosanitary standards, and poorly developed regional value chains (COMESA, 2021; AfDB, 2023).

These barriers continue to limit the potential benefits of the African Continental Free Trade Area (AfCFTA) and the SADC trade protocols. Addressing them through coordinated policy action, improved trade facilitation, harmonized standards, and investment in regional transport corridors could significantly increase the efficiency and inclusiveness of agricultural trade within ESA.



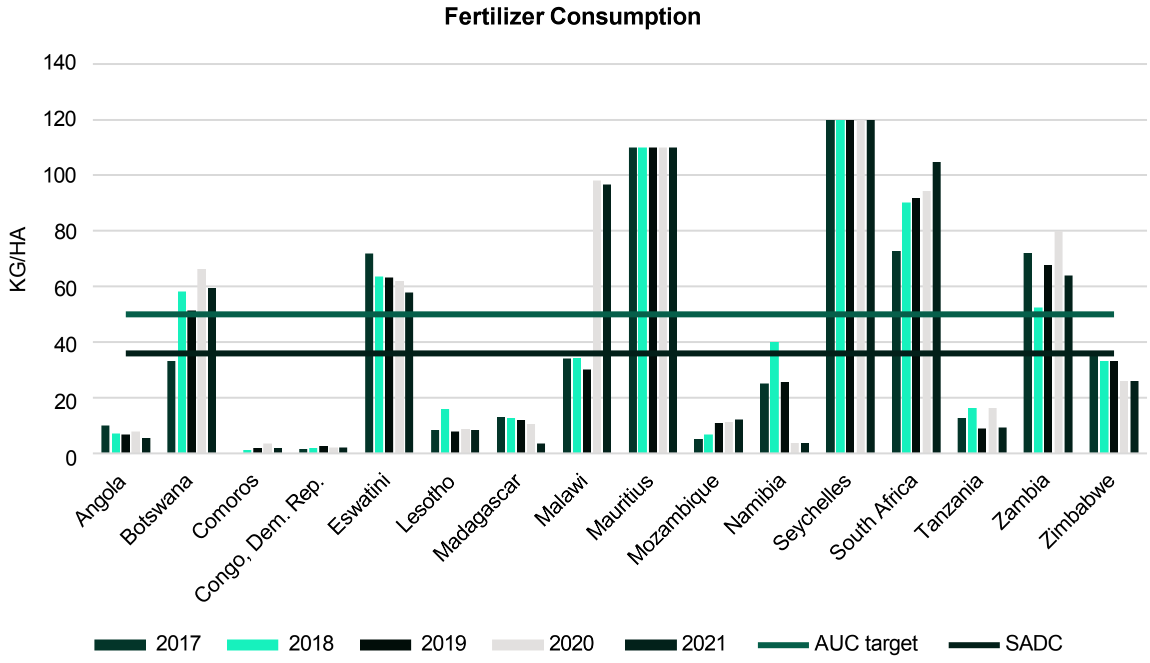
Source: Authors with World Bank Data

Figure 6: Share of food in exported merchandise and Trade as a share of GDP

Inputs use

Figure7 shows variations in fertilizer application rates in ESA countries. In 9 of the countries, fertilizer application rates have generally been less than the Abuja 2006 Declaration on Fertilizers for an African Green Revolution (AU 2006) blanket target of 50kg/ha over the years except in Eswatini, Botswana, Mauritius, Seychelles, South Africa, Zambia and Malawi for two years.

This implies that the agricultural sector consumption of inorganic fertilizers is very low especially because the target set by the African Union Commission (AUC), which countries are failing to achieve, is less ambitious. Asian countries as well as European Union (EU) and North American countries consume more than 130kg of fertilizer per hectare, which is overwhelmingly high compared to the AUC, target of 50 kg/ha.



Source: (ReSAKSS, 2023) and (World Bank, 2024)

Figure7*: Fertilizer Consumption*

The relatively high fertilizer application rates recorded in Malawi and Zambia are largely the result of the Farm Input Subsidy Programs (FISPs) that both countries have implemented over the past decade to boost agricultural productivity. These programs have expanded access to fertilizer among smallholder farmers, especially in maize production.

In the wider African context, however, fertilizer use remains far below the levels required to sustain crop productivity. Average use across the continent is less than 25 kilograms of nutrients per hectare, compared with a global average of over 130 kilograms (FAO, 2023).

Fertilizer trends in Africa should therefore be viewed differently from those in industrialized farming systems. While excessive fertilizer use is a concern in high-income regions, the key challenge in Africa is the opposite: chronic under-fertilization and nutrient depletion.

Many soils in Eastern and Southern Africa are severely degraded and lack essential nutrients such as nitrogen, phosphorus, and potassium. This makes increased investment in inorganic fertilizers a necessary foundation for raising yields and ensuring food security.

Scaling up fertilizer use must, however, be done with careful attention to efficiency and economic viability. This includes improving the timeliness, affordability, and targeting of input delivery systems, as well as strengthening farmers' knowledge of proper application techniques. Although organic fertilizers and soil amendments can complement nutrient management, they cannot supply the quantities of nutrients required to meet the region's productivity targets, given limited biomass and livestock resources.

In conclusion, increasing the use of inorganic fertilizers, combined with improved seed systems, irrigation, and effective extension services, is essential to closing Africa's agricultural productivity gap and supporting sustainable growth in food production and rural incomes.

Research and Development

Research and Development is critical for long-term productivity gains in the agricultural sector and also to ensure sustainability. Africa lags behind other countries in the field of biotechnology, and general genetic improvements. While national agriculture research systems (NARS) exist in every country, they are often under-staffed and underfunded.

There appears to be a strong reliance on international research organizations for research on crop improvement and advances in biotechnology. This is not sustainable and to help address this, countries are encouraged to endeavor to invest 1% of their agricultural GDPs in research. Thus, one popular achievement indicator within the CAADP Biennial Review appraisal is whether the share of the funds a country invests in research and development amounts to 1% of the agricultural GDP.

Figure 8 indicates that of the countries with data, only South Africa, Seychelles, Botswana and Zimbabwe appear to invest more in research over time. Many of the countries including Madagascar, Mozambique, Tanzania, Malawi, Angola, and Zambia invest less than 0.5% of their agricultural GDPs into research.

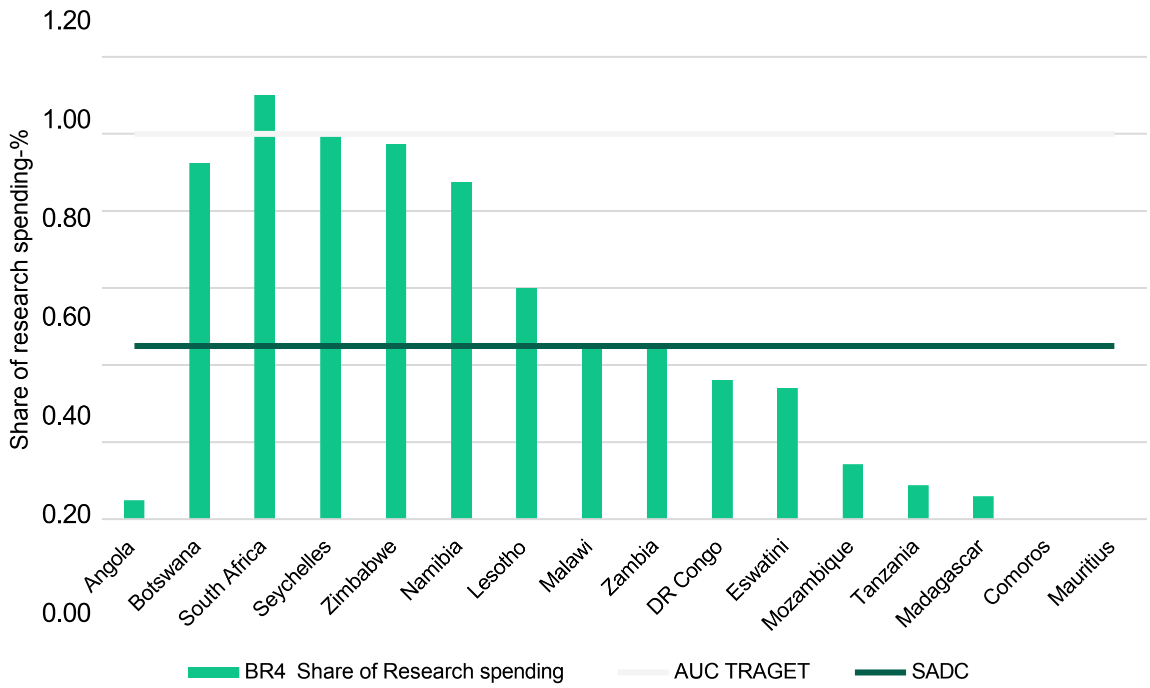
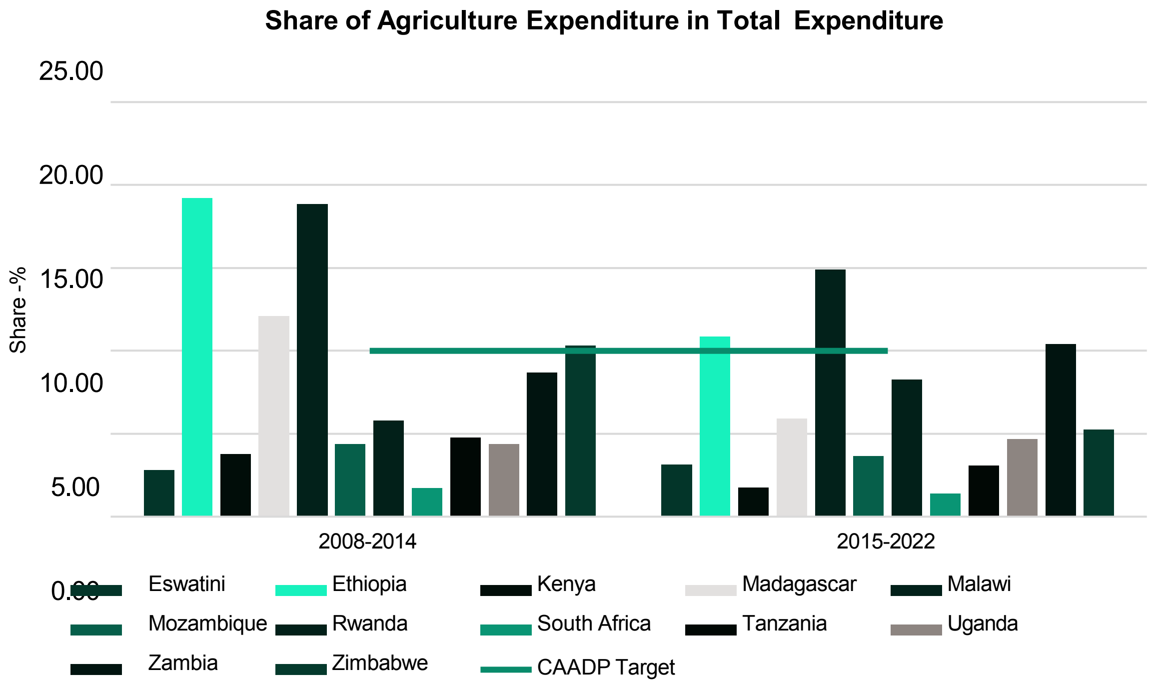


Figure 8: Agricultural research and development spending as a share of agricultural GDP among SADC member states (percent) (source: AUC, 2023)

Underinvestment in research and development is a red flag for sustainability and threatens the future of the agriculture sector in ESA. It is thus important that there be increased efforts towards increasing investments in research, skills development, data and analytics.

Total Agricultural Expenditure

Not only is there underinvestment in research and development in the agriculture sector, but there is also a general underfunding of the agriculture sector in that only Ethiopia, Madagascar, Zambia and Malawi have endeavored to invest around 10% (an AUC target) of their national resources to the agriculture sector. (***Figure 9***). Rwanda and Zimbabwe have also invested significantly in the sector, with Zimbabwe reaching the 10% threshold in the pre-Malabo period, while many of the countries have tended to invest away from agriculture for one reason or another. There is an urgent need to drum up the need to invest more in the agriculture sector as we transition into the post – Malabo era.



Source: (ReSAKSS, 2024)

Figure 9: Share of agriculture expenditure in total expenditure

It is important that there be a drive towards increasing expenditures in the agricultural sector targeting key development functions such as irrigation adoption, ecosystem building, modern extension services, fertilizers, general soil health, technology generation and dissemination, digitalization and other functions. This is important and will prove agriculture from climatic and other shocks, increase productivity, and make it more likely that agriculture can continue to be a vehicle for poverty eradication and better nutrition.

Agricultural Water Management

Water management is fundamental to agricultural transformation and resilience in Eastern and Southern Africa. Without effective systems for managing water, even rainfed agriculture cannot achieve its full potential. The severe food deficits experienced in 2024 were largely linked to droughts and floods, underscoring the need to strengthen water harvesting, storage, and control systems.

Irrigation and Water Use Efficiency

Most countries in the region allocate only a small share of cultivated land to irrigation (Figure 10). The Southern African Development Community (SADC) target is that seven percent of cultivated land should be irrigated, yet only Mauritius, Madagascar, and Eswatini exceed this benchmark. In most countries, the share remains below five percent, leaving large parts of the agricultural sector dependent on rainfall. This reliance makes the sector highly vulnerable to climate risks and fluctuations in water availability. Increased investment in irrigation infrastructure and water use efficiency would therefore strengthen productivity and stability in agricultural output.

Rainwater Harvesting, Flood Control, and Watershed Management

Complementary approaches such as rainwater harvesting, flood control, and watershed protection remain limited across the region. Techniques such as contour bunding, infiltration pits, and small water pans can improve soil moisture and reduce runoff, while investments in catchment protection and floodplain management help to mitigate the effects of recurrent floods in low-lying areas of Malawi, Mozambique, and Zimbabwe. Expanding these practices would improve resilience in both irrigated and rainfed farming systems.

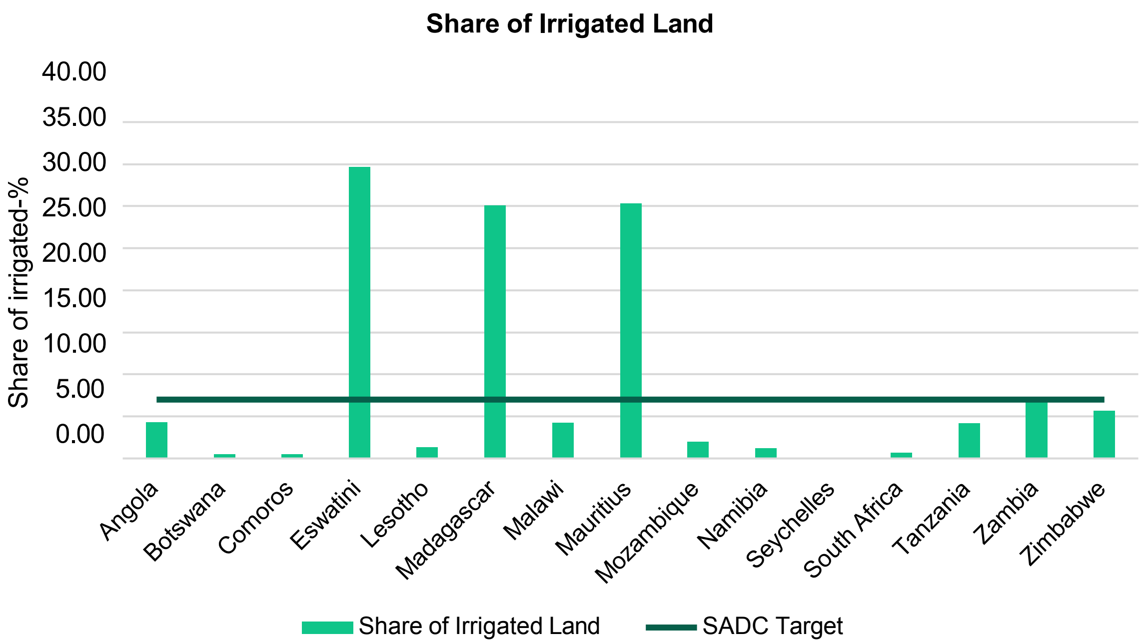
Technology and Innovation

Modern water management can be enhanced through the use of digital tools, precision irrigation, and research-based innovations that improve efficiency. Strengthening data systems, local capacity, and adaptive research will help align water management strategies with the region's changing climate and agricultural priorities.

Thus, low irrigation coverage, limited rainwater harvesting, and weak watershed protection continue to expose agriculture in Eastern and Southern Africa to climate variability.

Expanding investments in agricultural water management, including irrigation, rainwater harvesting, flood control, and watershed rehabilitation, will be essential for improving productivity and building resilience across all farming systems

The region, however, invests less in irrigation (***Figure***) and data on irrigated areas are also not readily available and reliable.



Source: (World Bank, 2024) and (ReSAKSS, 2024)

Figure 10: Share of land irrigated in total land cultivated

Agricultural Productivity trends

Agricultural value-added measures

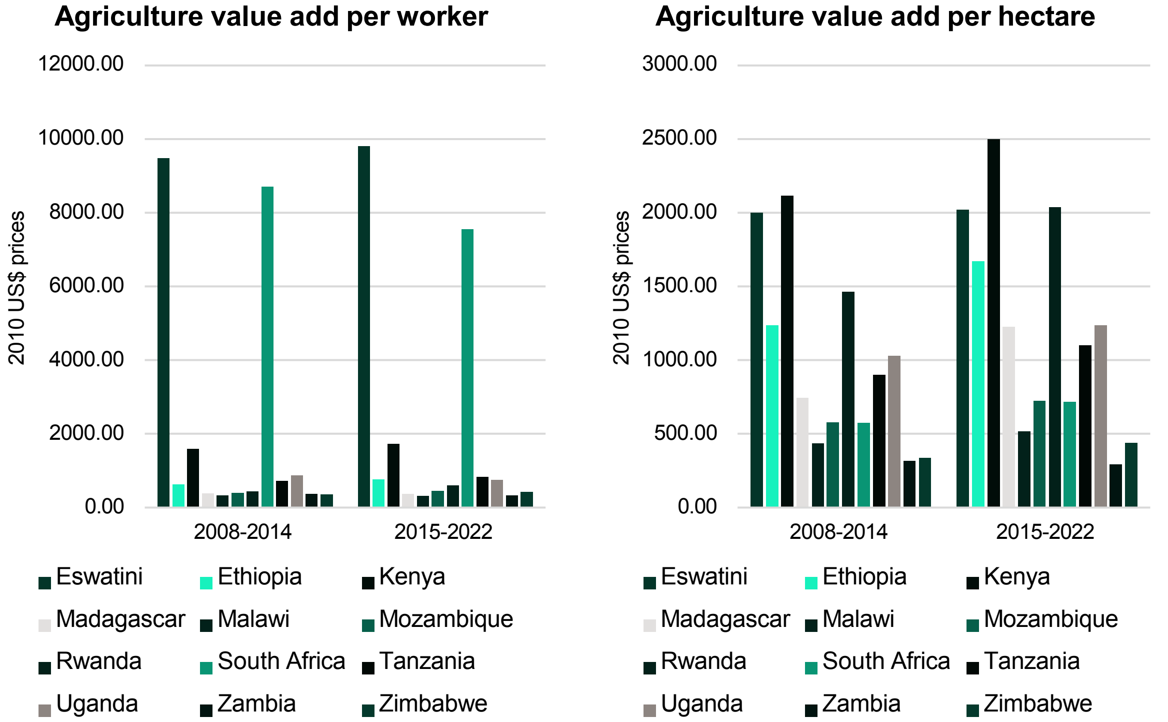


Figure 11: Agriculture value added per worker and per hectare

Source: Authors with Word Bank Data

Agriculture value -add per worker value is highest in Eswatini and South Africa, followed by Kenya, however per hectare agriculture value added is highest in Kenya, Eswatini, Rwanda and then Ethiopia.

Although the per hectare value added between the pre 2015 (before the Malabo Declaration) and the Malabo Declaration (post 2014 period) are similar, a notable improvement is noted for many of the countries which may indicate that the Malabo declaration affected productivity of agriculture positively with respect to agricultural GDP per hectare, although this is not evident for agricultural GDP per worker.

Despite recent improvements, the general observation is that for many countries in Eastern and Southern Africa, returns to agricultural labour remain low and stood at
under USD 500 in 2025. Similarly, although per hectare agriculture value improved in the Malabo period for many of the countries, it stood under 1000 USD which is low compared to per hectare costs of farming which are in the
same ranges. Thus, more needs to be done to spur better returns per hectare and per worker within the agriculture sector.

Crop Production Trends

Out of 143 recorded crop types across the region (Annex 1), countries in Eastern and Southern Africa exhibit significant diversity in agricultural production. Kenya records the highest crop diversity with 82 distinct crops, followed by Madagascar (71) and Ethiopia (69), while Eswatini reports the lowest at 29. On average, each country produces around 59 different crops, reflecting the broad ecological gradients and varied farming systems that characterize the region.

Maize remains the only crop cultivated in all 12 countries, underscoring its central role in food secu rity, farm livelihoods, and trade integration across the region.

The differences in crop diversity reflect both natural and policy influences. Countries such as Kenya and Madagascar benefit from diverse agro-ecological zones, from humid lowlands to high-altitude plateaus, which support a wide range of crop systems. Others, such as Ethiopia and Malawi, have actively pursued diversification through policy interventions aimed at stabilizing incomes, spreading risk, and improving food and nutrition outcomes.

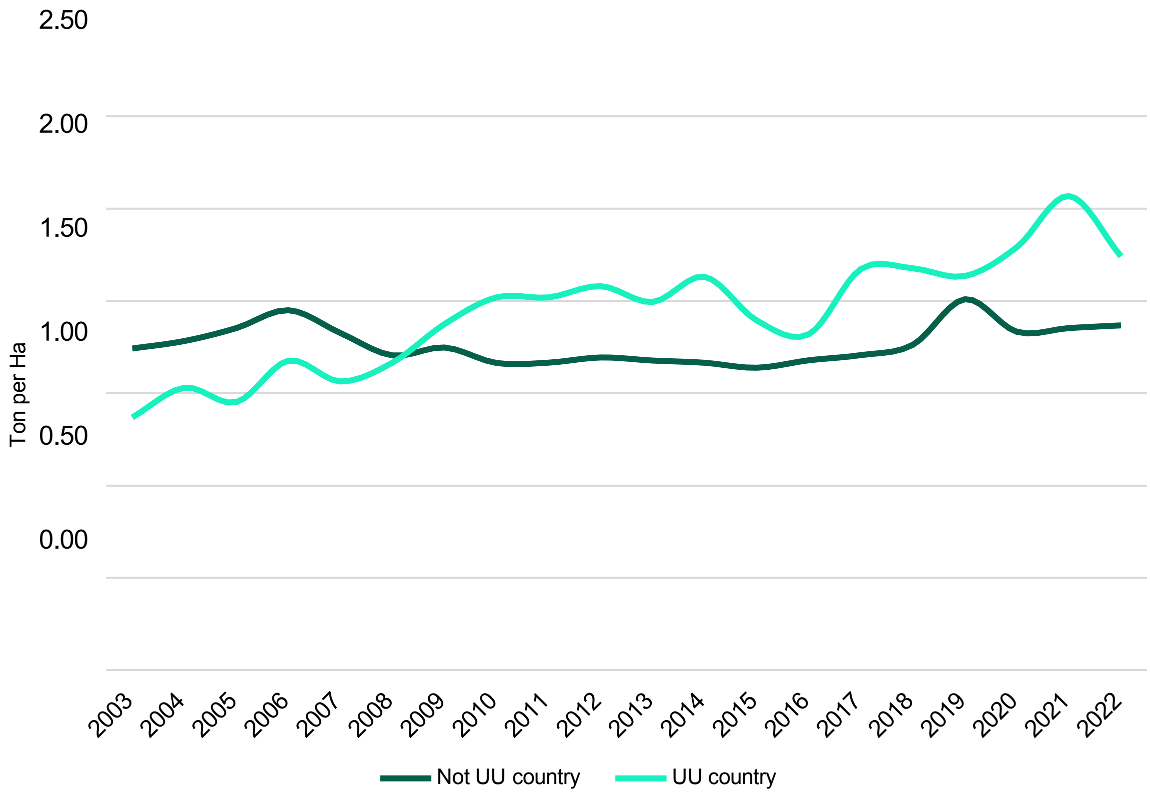
Across the region, however, production remains highly concentrated in a few staple crops. The top 10 crops account for roughly 85 percent of total production volume—about 131 million tons region-wide. These dominant crops include maize, cassava, sugarcane, rice, sweet potatoes, sorghum, beans, potatoes, groundnuts, and vegetables.

In higher-value systems such as South Africa, Kenya, and Tanzania, horticultural fruits, tea, and coffee also appear among the leading commodities. In Madagascar, rice continues to dominate, while in Malawi, Zambia, and Zimbabwe, maize alone contributes between 30 and 50 percent of total crop output by volume.

This concentration highlights a paradox: while agro-ecological conditions allow for substantial diversification, production remains heavily skewed toward a small group of staple crops that are culturally embedded and policy-supported.

Such dependence exposes national food systems to climate shocks and price fluctuations, but it also signals untapped opportunities for diversification into higher-value and climate-resilient crops - particularly legumes, oilseeds, horticultural products, and tree crops - where supportive market and infrastructure investments can unlock inclusive growth.

Figure 12: Productivity trends in maize for UU vs non-UU countries



Source: (World Bank, 2024)

While the target for cereal productivity set by the AU is just a meagre two tons per hectare, for many years, the East and Southern Africa average has been below this target. When smallholder agriculture is analyzed separately from commercial agriculture, which dominates South African agriculture, yields for cereals are clearly under two tons per hectare.

Although the ESA countries appear to register slightly higher productivity levels, this result is driven by South Africa's commercial agriculture, but even with this included the yields in ESA are still under 2.5 tons per ha which is a far cry from the seven tons per hectare realized by farmers in Western Europe, Asia and North America.

Clearly, countries in Africa and ESA in particular should do more to improve agriculture productivity. Increasing the quality of inputs including seeds and fertilizer as well as labour alongside better agricultural water management can help spur productivity.

Figure 3 Within the Eastern and Southern Africa (ESA) region, cereal yields vary widely across both countries and time. South Africa, Ethiopia, and Uganda record the highest yields, averaging more than two tons per hectare, while Eswatini, Mozambique, and Zimbabwe have yields below 1.5 tons per hectare (Figure 13). Although yields have gradually improved since 2003, the pace of growth has been modest and uneven.

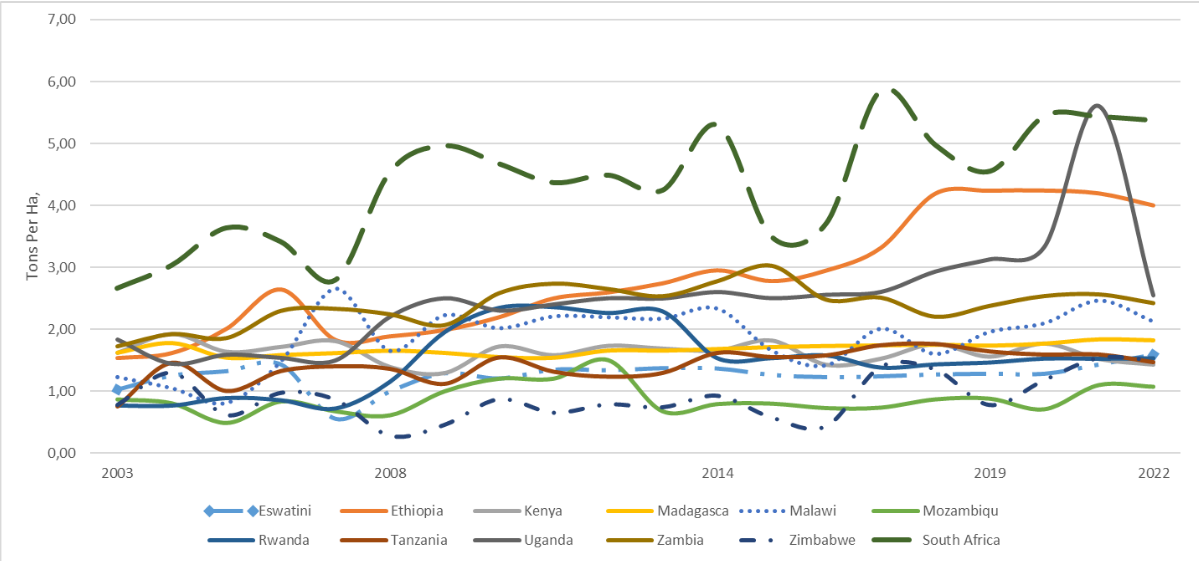
Yield variability is also pronounced within countries. South Africa, while maintaining the highest productivity levels, experiences substantial year-to-year fluctuations caused by rainfall variability, input cost shocks, and exposure to global maize markets. This volatility poses risks to the stability of national and regional cereal supply.

In contrast, Ethiopia and Uganda have shown more consistent growth, largely due to increased use of improved seed varieties, fertilizer, and extension support, as well as deliberate government investment in research and input distribution systems.

The persistence of low and unstable yields across much of the region stems from several structural constraints: limited irrigation and mechanization, low fertilizer application rates, declining soil fertility, and weak access to improved technologies and credit. Climate variability further compounds these challenges.

Improving cereal yields therefore requires a combination of policy, institutional, and technological interventions. Expanding access to inorganic fertilizers and quality seeds, improving water management and small-scale irrigation, and investing in adaptive research and climate information services would raise both the level and stability of yields.

Strengthening farmer training, credit systems, and risk management instruments such as weather-indexed insurance can also help stabilize production. These actions would not only narrow the yield gap but also build resilience in the face of growing climate and market pressures.



Source: (World Bank, 2024)

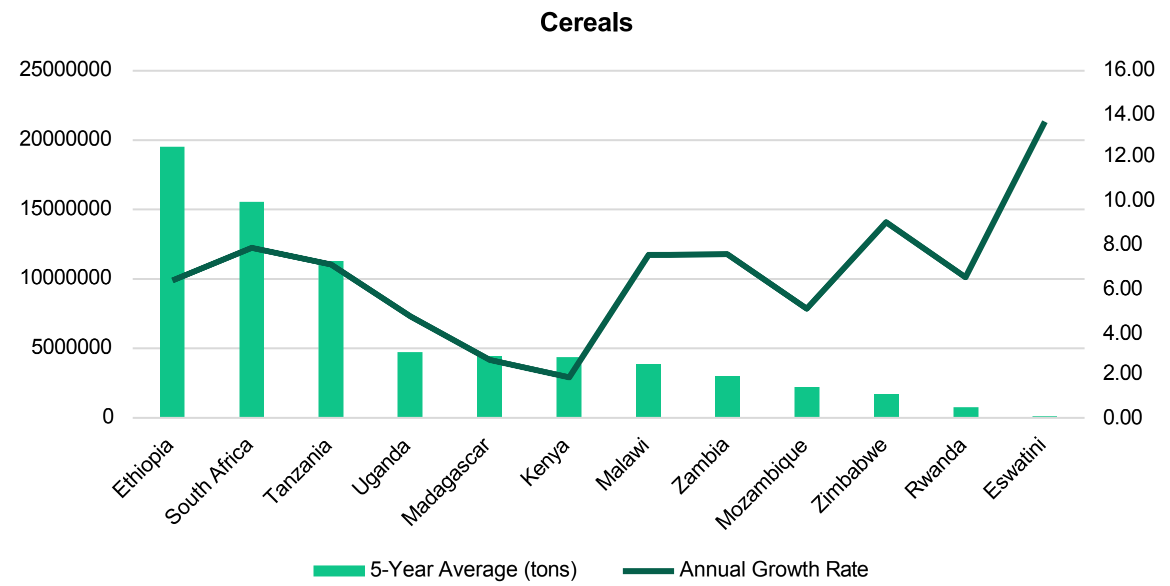
Figure 13*: ESA maize productivity*

Figure 14 presents cereal production and growth rates for countries in the Eastern and Southern Africa (ESA)

region. There are significant variations across countries, with **Ethiopia** recording the highest annual cereal
production at approximately 19.5 million tons, followed by South Africa at around 15 million tons. At the other end of the scale, Rwanda and Eswatini produce less than one million tons annually, largely reflecting their smaller land areas and limited arable land resources.

Despite their smaller production volumes, countries such as Rwanda, Eswatini, and Malawi have achieved above-average growth rates in cereal output, suggesting that productivity and area expansion efforts are beginning to yield results. The larger producers, by contrast, exhibit slower growth, reflecting already high production bases and, in some cases, market and climatic constraints.

To highlight underlying patterns and reduce year-to-year volatility in the data, the cereal growth rates in Figure 14 were smoothed using a three-year moving average method. This approach helps reveal medium-term trends while minimizing the effects of short-term fluctuations caused by weather variability or market shocks.

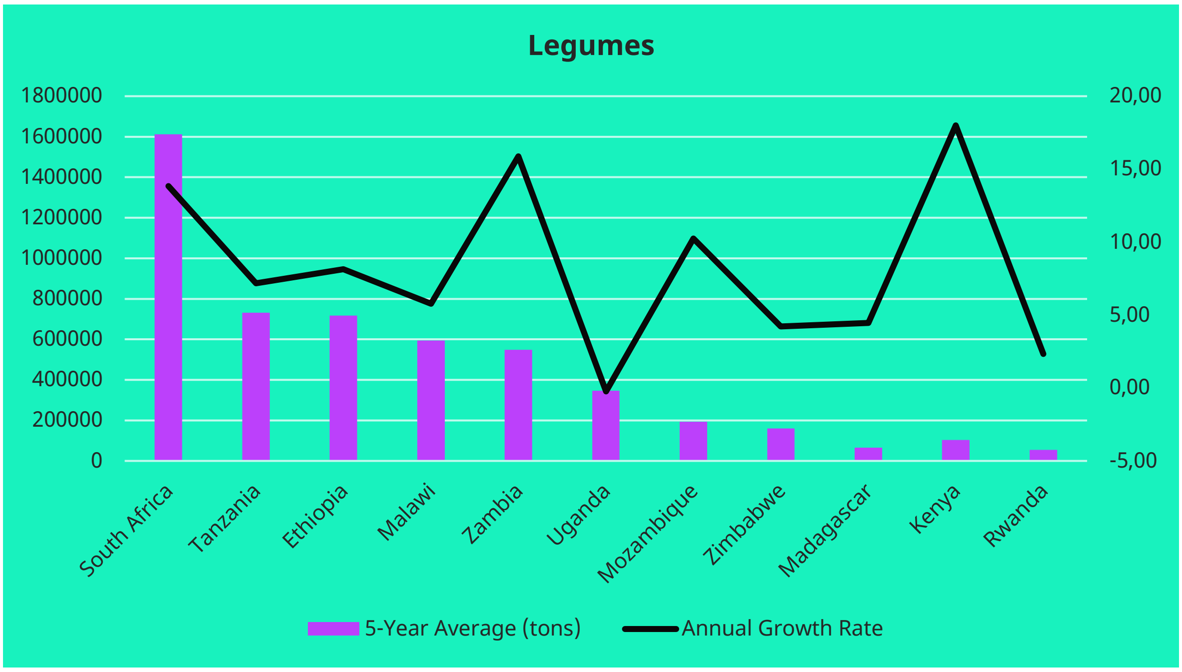


Source: Authors, with data from (World Bank, 2024)

Figure 14: Production and growth rates for cereals

The average growth rates for legumes are generally above 5% across the specified countries and production levels vary from less than 100,000 tons in Rwanda to just above1.6 million tons in South Africa (***Figure 15***).

The growth rates in Uganda, Mozambique, Zimbabwe, and Rwanda need to increase in order to ensure that the countries continue to supply the respective countries with the much-needed nutritious diets, a focus of the food systems approach to agricultural transformation.



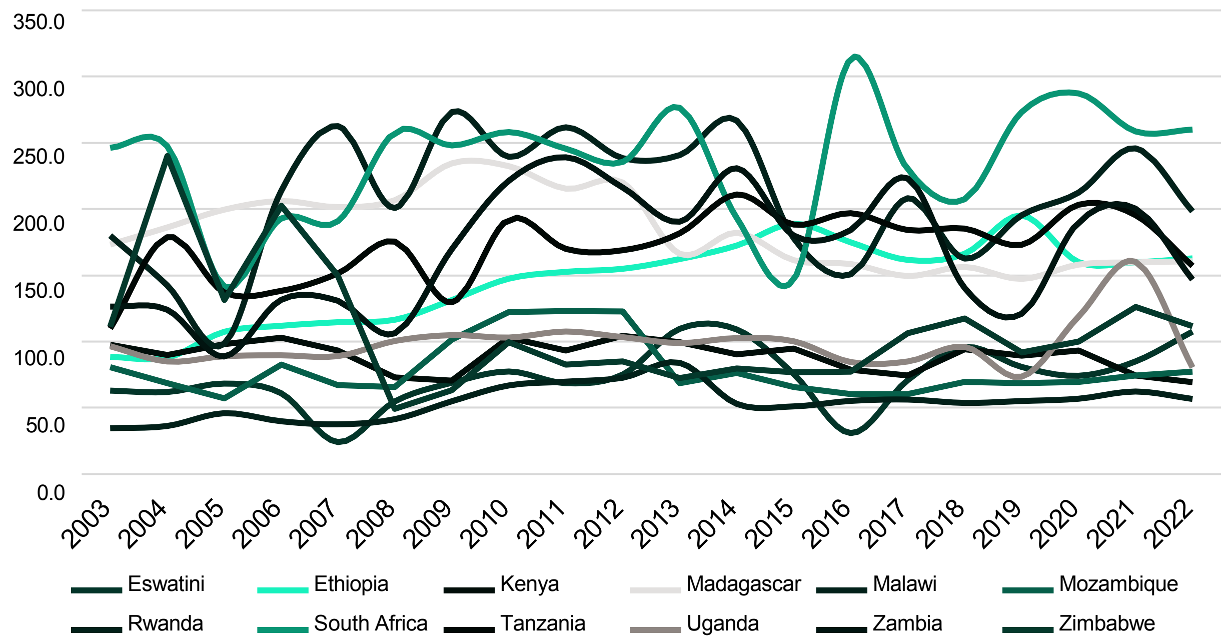
Source: Authors, with data from (World Bank, 2024)

Figure 15: Average growth rates and production for legumes

Per capita Crop Production Trends

Since cereals are a measure of food sufficiency for many of these countries, per capita production of cereals can describe the state of food security in a country. ***Figure 16*** shows per capita cereal production in the ESA and it is clear that there are annual and cross-country variations in per capita production. Generally, cereals per capita fell below the minimum requirement of 300 kg per person, which signifies food insufficiency especially because cereals constitute the bulk of food consumed in the region.

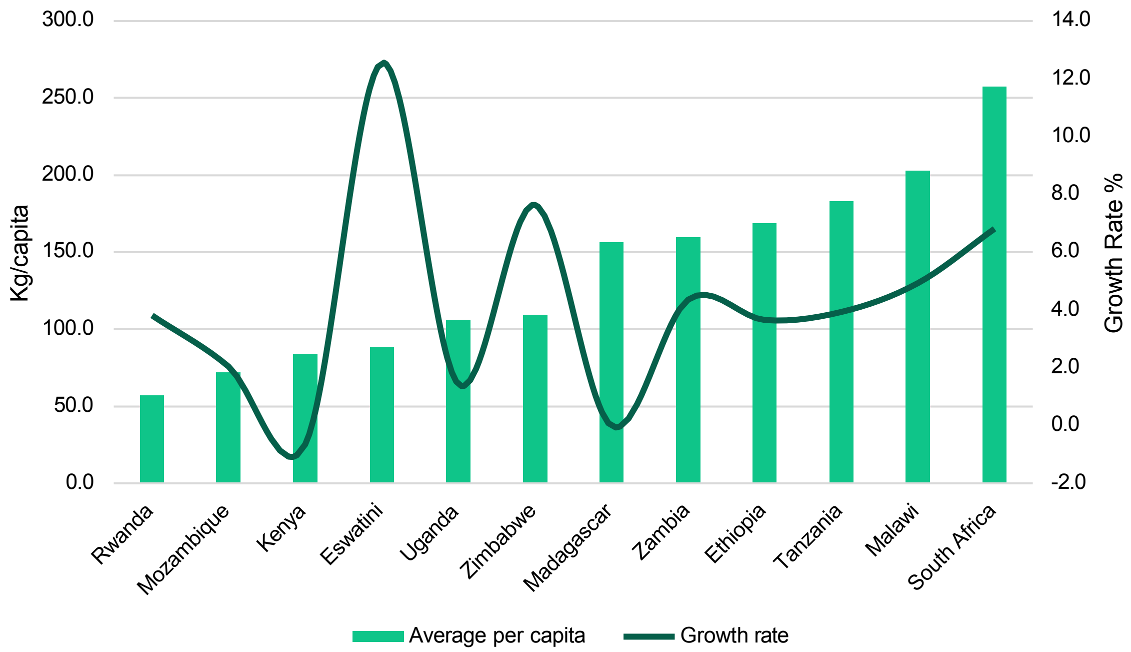
The minimum annual requirement for a human being is 300 kg of cereal equivalents per person per year (Buringh and Van Heemst 1977). Not surprisingly, the region imports over 80 kg per person to meet its dietary needs. South Africa, Malawi, Madagascar, Zambia, and Tanzania produce around 240 kg per person, which is lower but closer to the recommended threshold of 300 kg per person.



Source: (World Bank, 2024)

Figure 16*: Cereal per capita trends*

The least producers of maize per capita are Rwanda, Mozambique, Uganda, Kenya and Zimbabwe where per capita production stood at under 100 kg per person indicating food insufficiency. However, it is worth noting that cereal production growth rates are positive for many of the countries (***7***).



Source: Authors with data from (World Bank, 2024)

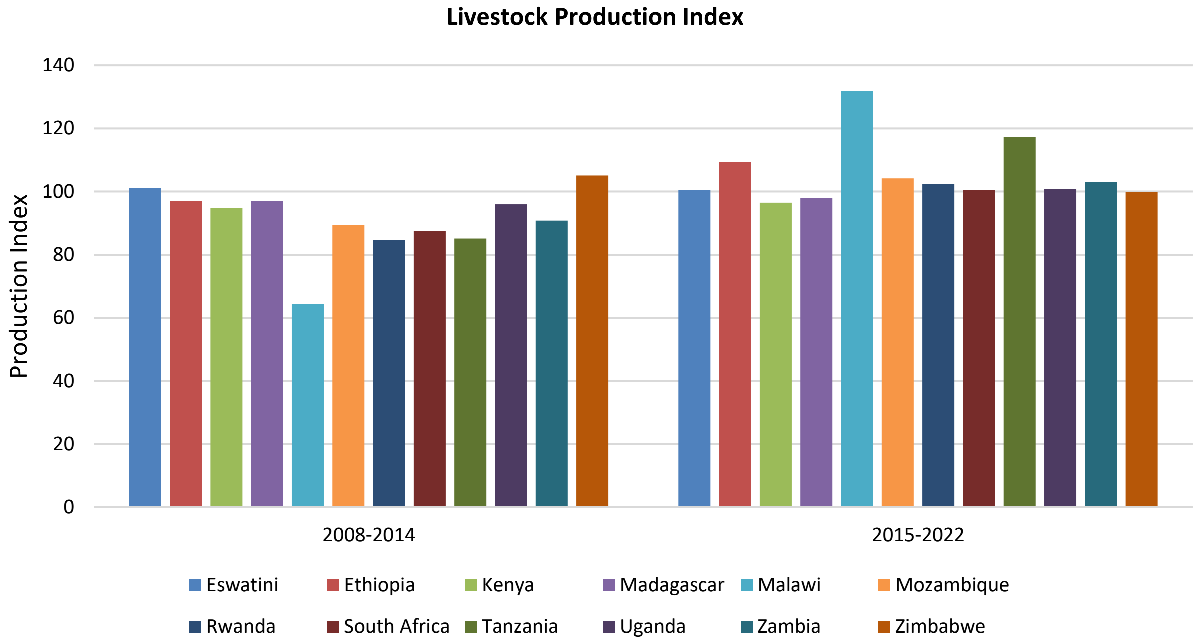
Figure 17: Growth rates of cereals production per capita (2003-2022)

While each of these countries is strong in cereal and legumes production, there are also efforts to produce diverse numbers of crops from tobacco to coffee, cassava to cashew nuts and many others (***Table 1***).

In summary, the share of maize in food and agriculture in general is still high in many of the countries under study. Equally, the share of land allocated to maize is still high. In each of these countries, maize is often grown together with legumes and other crops, but it remains a key source of calories, although Matoke is also very prevalent in the case of Uganda.

There are attempts to diversify (see ***Annex 1***), but cereals dominate. It is also observed that while growth rates of cereals and legumes are positive over the past 20 years, the growth is slower such that for many of these countries, cereals per capita trail the recommended 300 kg per hectare.

Livestock performance



<u>Figure 18</u>*: Livestock production*

Source: Authors with World Bank data

The Livestock Production Index (LPI) measures changes in the volume of livestock output relative to a base period. It is compiled by the World Bank from FAO production data and is calculated as a weighted average of production quantities for key livestock products, including meat, milk, eggs, and wool, with weights based on internationally consistent average prices.

The base value of 100 corresponds to the average production level during the reference period 2014–2016, meaning that values above 100 indicate growth in total livestock production relative to that base year.

As shown in Figure 18, livestock production increased during the Malabo era (2015–2025), with many countries reaching or exceeding an index value of 100, signifying positive growth relative to the baseline. However, the rate of increase differs across countries, reflecting differences in feed availability, animal health services, breeding quality, and access to markets.

Sustained improvement in livestock productivity will require greater investment in veterinary services, animal nutrition, breeding programs, and water infrastructure, as well as better integration of livestock into crop and value chain systems.

Expanding this subsector is also vital for nutrition outcomes, given its contribution to dietary protein and household income diversification.

Interlinkages between selected indicators

Throughout this chapter we have tried to allude to the importance of the trends and have made allegations of their importance. This section presents some correlations between a number of indicators that are assumed to have reinforcing relationships from a theoretical and practical perspective.

Figure 19 shows that land productivity has a positive relationship with fertilizer usage per hectare and so does labour productivity. Thus, investing in soil health has the potential to improve labour and land productivity, which in turn will increase agricultural production and impact on income and population health.

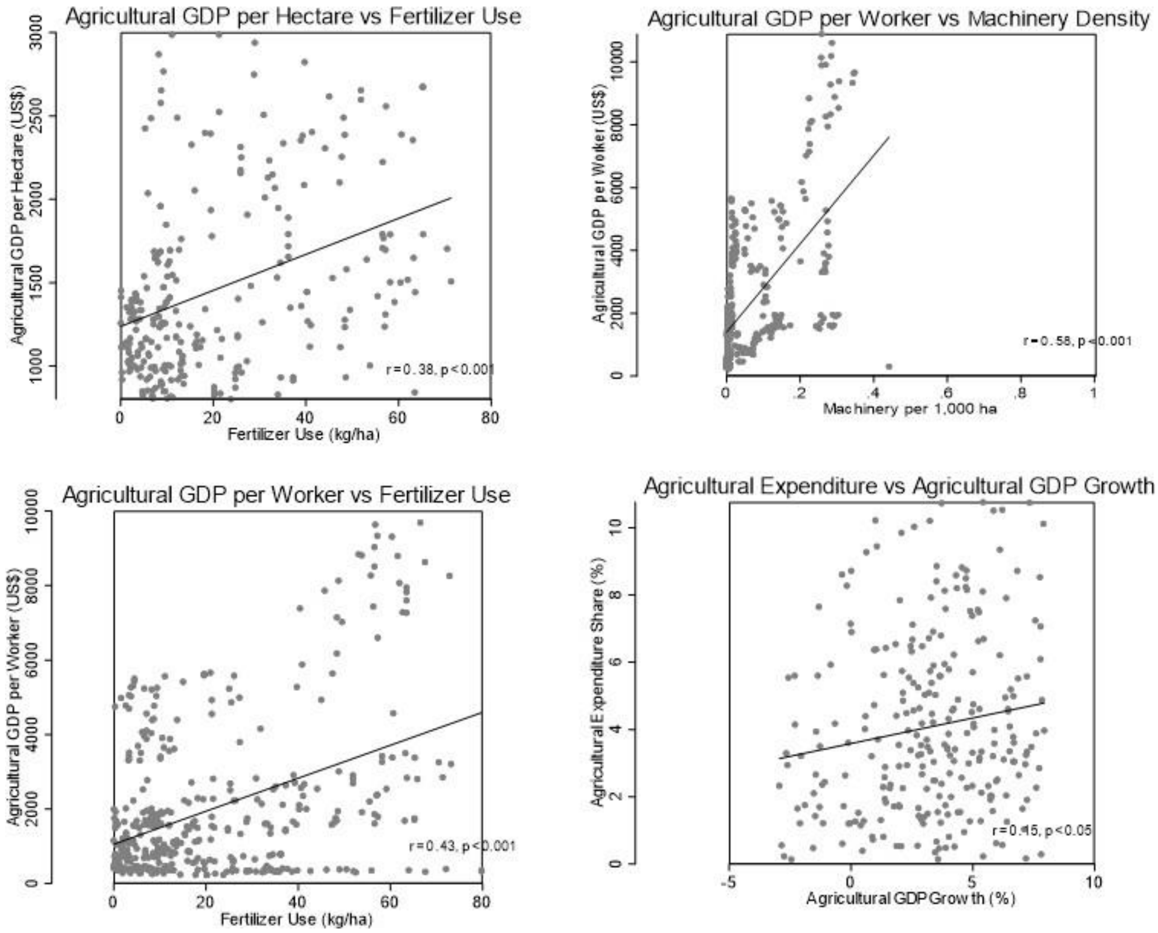


Figure 19: Agricultural GDP, Fertilizer and Mechanization

Source: Authors with World Bank data

Similarly, increased investment in farm mechanization is associated with higher labour productivity, as illustrated in Figure 19. Although the relationship is correlational rather than strictly causal, the positive association indicates that improving access to appropriate machinery and equipment can significantly contribute to agricultural transformation. To effectively boost agri-food systems transformation, investment in mechanization must therefore be intensified from its current low levels, as discussed earlier.

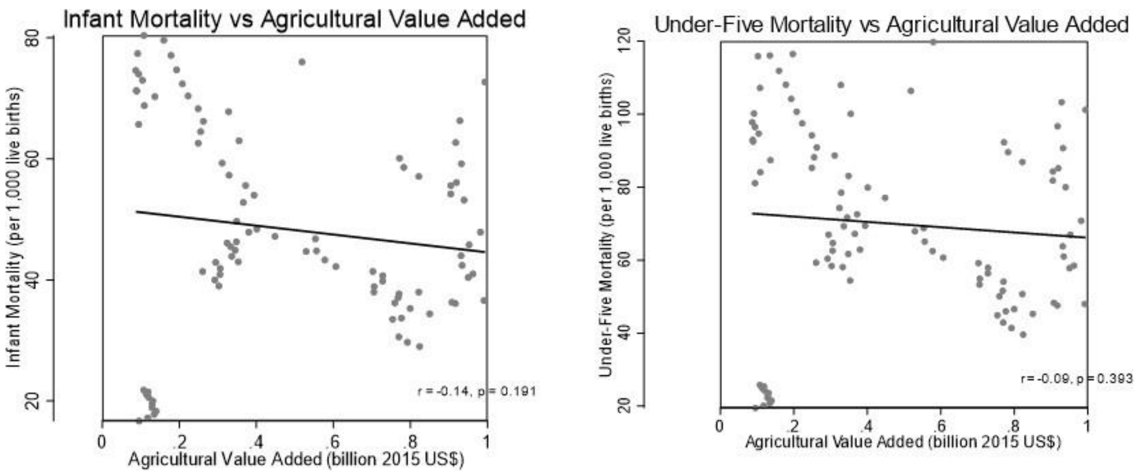
The effect of public expenditure can also be observed in the bottom right panel of Figure 19. A higher share of public spending on agriculture is consistently associated with stronger agricultural sector growth rates. This underscores the complementary role of targeted public investment in both capital formation and mechanization in driving productivity and structural change across the region.

Agricultural growth is important owing to its impacts on many other outcomes including infant mortality and income per capita, wealth creation and distribution, household resilience as well as malnourishment.

In ***figure 20*** it is clear that agricultural GDP as well as GDP growth are correlated with a lower infant mortality. Similarly, agricultural GDP growth rates are associated with under 5 mortality reduction.

Improvements in child health are often supported when the agricultural sector performs well and provides sufficient, nutritious, and affordable food. However, the relationship is not always direct. In some contexts, health outcomes have improved even when agriculture’s contribution to national output has declined, owing to gains in income diversification, better health services, and targeted nutrition programs.

Nevertheless, in much of Eastern and Southern Africa, where agriculture remains a major source of food and livelihoods, strengthening the sector continues to be an important pathway for enhancing household nutrition and child well-being.



Source: Authors with World Bank data

Figure 20: Agriculture GDP, infants and under 5 mortality rates

2.5 Conclusions and Recommendations

Agricultural transformation in Eastern and Southern Africa faces several challenges. Climate change continues to affect production, processing, storage, and trade, with frequent droughts and floods disrupting value chains and infrastructure. Many countries, including Malawi, Mozambique, Rwanda, and Zambia, need to strengthen efforts to protect agriculture from climate shocks through greater investment in adaptation and risk management.

This chapter assessed agricultural performance across five key pillars: the enabling environment, input use and technology adoption, investment and financing, trade and value addition, and human capacity and institutional development.

The findings show that progress is uneven across these areas and that improvement in all five pillars is required for inclusive and resilient agricultural growth.

Improving the enabling environment:

The enabling environment, which includes policies, institutions, macroeconomic stability, and infrastructure, remains weak in many countries. Inflation, exchange rate volatility, and high interest rates continue to constrain agricultural investment. Countries should stabilize their macroeconomies, reduce inflation, and make credit more affordable.

Adopting regular joint sector reviews in line with the Comprehensive Africa Agriculture Development Programme (CAADP) and the forthcoming Kampala Declaration will strengthen accountability and attract new investment.

Enhancing input use, technology adoption and digitalization:

Accelerating the use of high-quality agricultural inputs remains essential for raising productivity and resilience. Many countries have not yet fully exploited the opportunities offered by irrigation, mechanization, and digital technologies. The region should therefore invest in machinery, irrigation systems, and supportive infrastructure such as energy and reliable internet connectivity. These actions are consistent with the CAADP and Malabo Declaration commitments that emphasize modernization through science, technology, and innovation.

The recommendation to accelerate the digitalization of agriculture builds directly on these policy frameworks. Digital tools can enhance access to inputs, improve advisory services, and strengthen monitoring of public investments. Expanding mobile-based platforms for extension, digital input marketplaces, and data-driven decision systems would improve efficiency, inclusion, and accountability in the agricultural sector.

Expanding agricultural finance and research: Few countries have reached the ten percent agricultural budget commitment of the Maputo and Malabo Declarations. Innovative financing through private investment, blended finance, and foreign direct investment should be promoted. Public spending on agricultural research and development should also move toward the target of one percent of agricultural GDP, since innovation underpins sustainable productivity growth.

Strengthening trade facilitation and agro-processing: Trade and market access are essential for sustaining growth and reducing postharvest losses. Countries should prioritize trade facilitation by improving transport and border infrastructure and removing tariff and non-tariff barriers such as road checks, border delays, and trade bans. Investment in agro-processing will extend the shelf life of commodities, create jobs, and increase value addition within the agricultural sector.

Developing human capacity and institutional strength: Agricultural transformation also depends on skilled people and effective institutions. Low agricultural labour productivity, which averages below USD 500 per worker per year in much of Eastern and Southern Africa, reflects limited skills and low access to capital. Expanding farmer training, vocational education, and extension services will raise productivity and improve technology adoption. At the institutional level, investment in data systems, research coordination, and implementation capacity will strengthen planning, monitoring, and accountability across the agricultural sector.

In conclusion, achieving sustained transformation in the region requires coordinated progress across all five pillars: a stable enabling environment, improved input and technology adoption, adequate financing, efficient trade and value addition, and strong human and institutional capacity.

The next chapter shows how regional trade integration and diversification can help address these constraints and unlock broader market opportunities for resilient and inclusive agricultural growth.

The analysis of agricultural performance highlights the structural, institutional, and macroeconomic challenges that continue to limit productivity in the region. However, improving agricultural outcomes is also closely tied to market access and trade.

Chapter 3 explores how regional trade, and agricultural diversification can address these challenges, identifying pathways to expand market opportunities and enhance food system resilience

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Chapter 3: Regional Trade and Agricultural Diversification in Eastern and Southern Africa

Sambane Yade and Getaw Tadesse

3.1 Introduction

East and Southern Africa is highly vulnerable to climate change, with over USD 45 billion in agricultural output at risk due to rising temperatures, shorter growing seasons, and more frequent extreme weather events such as droughts and floods. Maize, a key staple crop cultivated on up to 75% of cropland in some areas, is especially at risk, with expected yield reductions of 15% or more. These climate impacts threaten regions already grappling with severe hunger and malnutrition, particularly affecting women and youth in marginalized, vulnerable communities. Diversifying agricultural systems in a sustainable way could help stabilize both regional and global agrifood systems.

This diversification can be achieved by identifying and introducing suitable crops and livestock, adopting mechanization and irrigation technologies, and implementing value chain innovations. Therefore, there is a clear need to expand and diversify regional agricultural trade and value addition in Africa as a way of ensuring regional integration, food security, job creation, and industrialization (Woldemichael et al. 2017). However, the process of diversification is being constrained by several factors including regulatory hurdles and poor infrastructure.

Regulatory hurdles (mainly associated with non-tariff measures, unfair competition, and high costs of trade) significantly reduce the export volume of countries, while infrastructural constraints (related to poor access to roads, financial services, storage facilities, access to energy and markets) significantly impede the extent of regional trade as well as investments in value additions (Tadesse and Badiane 2020).

The role of agriculture in regional and intra-regional trade varies widely among countries in East and Southern Africa (ESA).[1] These variations are related to the size of regional trade flows, the share of agriculture in regional trade and the share of regional markets in overall country trade (Odjo et al. 2023).

The purpose of this chapter is to examine regional trade and agricultural diversification and summarize the policy, infrastructural and institutional bottlenecks in ESA region. Unlike Africa's trade with the rest of the world, which mainly consists of primary commodities, intra-regional agricultural trade on the continent is heavily dominated by processed products.

Most of the bottlenecks limiting the expansion of intra-regional trade are associated with intermediary actors involved in agri-food processing, transportation and wholesale and retail trade. However, before exploring these bottlenecks, we first analyze the role of trade for agricultural diversification and the ESA countries' trade potential and competitiveness.

Regional trade plays a crucial role in agricultural diversification by providing markets for a variety of crops and agricultural products, promoting innovation, and enabling risk mitigation. Here are several key ways in which regional trade supports agricultural diversification:

[1] Ethiopia, Eswatini, Kenya, Madagascar, Malawi, Mozambique, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

3.2 The Role of Regional Trade for Agricultural Diversification

- **Access to new markets**: Regional trade agreements and partnerships create access to new markets, allowing farmers to diversify their crops to meet the demand in different regions. This reduces dependency on a single crop or product and encourages a broader range of agricultural activities. For example, farmers may grow niche products or specialty crops that have higher demand in neighboring countries.
- **Access to agricultural inputs and technology**: Regional trade facilitates the exchange of agricultural inputs such as seeds, fertilizers, and machinery. Farmers can also access new technologies and innovations from neighboring countries, allowing them to adopt practices that support the growth of diversified crops. This access fosters sustainable agricultural development and productivity.
- **Encouraging crop variety and sustainability**: Trade incentives, like preferential tariffs or trade agreements focused on agricultural products, can encourage farmers to experiment with new crops or agricultural practices. A more diverse agricultural landscape often leads to more sustainable practices, such as crop rotation and agroforestry, which can improve soil health and biodiversity.
- **Boosting value chains*:*** Agricultural diversification through regional trade enhances value chains by creating opportunities for processing, packaging, and value-added products. Countries that diversify their agricultural products can develop industries around these crops, increasing their competitiveness and opening up new trade possibilities. This is particularly important in ESA where agricultural trade is dominated by processed products.

In summary, regional trade plays an essential role in agricultural diversification by expanding market access, encouraging sustainable practices, and supporting the economic stability of farming communities. It helps countries mitigate risks, improve food security, and develop more resilient agricultural sectors.

However, the actual role played by trade in agricultural diversification depends on several factors including: (1) the extent of trade that takes place within the region; (2) the countries' trade competitiveness; (3) the regional trade potential of the countries; and (4) infrastructural and regulatory bottlenecks that limit the extent of trade between countries. The following sections discuss these factors and presents empirical evidence.

3.3 The Share of Regional Trade Within ESA Countries

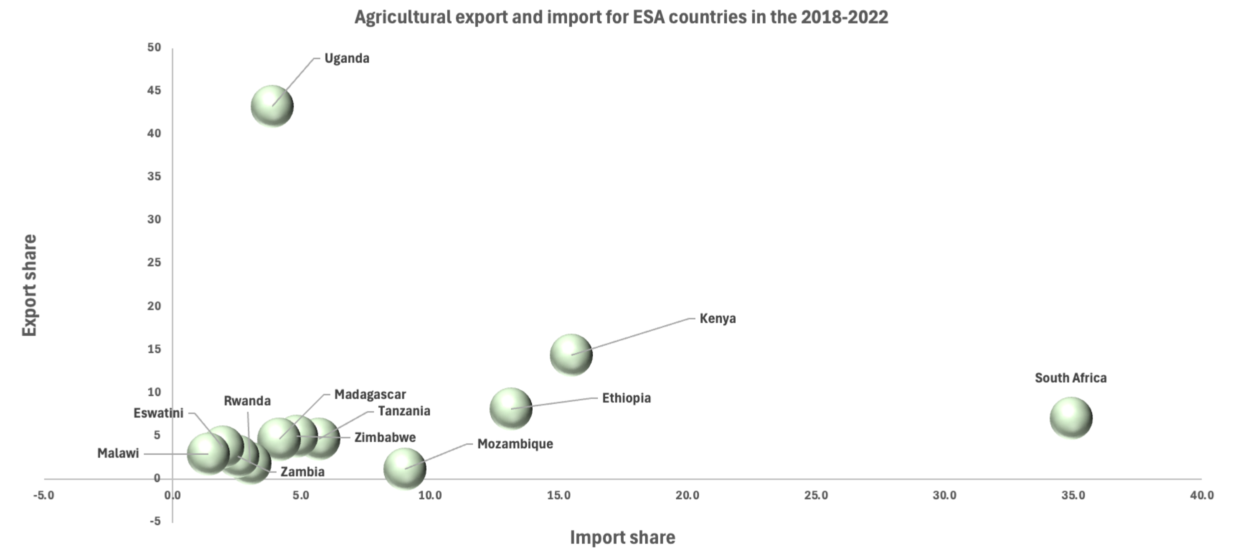
***Figure* 21** presents a comparison of agricultural export shares among ESA countries between two periods: 2013 – 2017 and 2018 – 2022. The data highlights both the share of agricultural exports in percentage and the rank of each country for both periods, as well as the variation in percentages between the two periods. Uganda dominates agricultural exports in both periods, increasing its share slightly from 40.8% to 43.3%.

Kenya's share increased from 12.5% to 14.4%. Kenya remains the second-largest exporter across both periods. The share of exportation increased from 12.5% to 14.4%. Ethiopia's share declined from 9.7% to 8.2% but despite the decrease, it holds its third position. South Africa's share also decreased, from 8.5% to 7.1% (a decline of 15.6%) but it retains fourth place. Zimbabwe slightly declined from 5.4% to 5.0% (a moderate decrease of 6.7%) but it moves up one position, from sixth to fifth position. Tanzania's share fell from 5.7% to 4.7%, then it dropped one place from fifth to sixth. Madagascar's export share rose from 3.6% to 4.7% (a large positive variation of 28.5%, one of the highest growth rates).

Therefore, it improves its ranking, moving up from ninth to seventh place. Eswatini, with a slight increase from 3.7% to 3.8%, remains steady in eighth place. Malawi export share declined from 3.9% to 3.0%. Then, it dropped from seventh to ninth place. Zambia's share decreased from 3.4% to 2.7% but it remains in tenth place.

Rwanda's export share increased slightly from 1.8% to 1.9% (positive change of 3.7%) and it stays in eleventh place. Mozambique's share increased from 1.0% to 1.2% (positive growth of 23.2%). However, it holds onto the twelfth position. This analysis suggests that Uganda and Kenya are strengthening their positions in the region's agricultural export market, while several other countries are experiencing either stagnation or decline in their export shares.

In terms of importation, South Africa remains the largest agricultural importer, though its share has declined slightly. Kenya and Ethiopia follow as the second and third largest importers, both showing positive growth in import shares. Rwanda and Madagascar have shown significant growth, with Rwanda showing the highest positive variation of 0.5%. Several countries, such as Tanzania, Zimbabwe, Uganda, and Malawi, experienced slight declines in their shares, but their rankings remained relatively stable. Malawi, Eswatini, and Zambia have smaller agricultural trade volumes in comparison.



Agricultural exportation of ESA countries					
	Share in percentage		Variation	Rank	
	2013-2017	2018-2022	(%)	2013-2017	2018-2022
Uganda	40.8	43.3	6.0	1	1
Kenya	12.5	14.4	15.8	2	2
Ethiopia	9.7	8.2	-15.0	3	3
South Africa	8.5	7.1	-15.6	4	4
Zimbabwe	5.4	5.0	-6.7	6	5
Tanzania	5.7	4.7	-17.9	5	6
Madagascar	3.6	4.7	28.5	9	7
Eswatini	3.7	3.8	2.6	8	8
Malawi	3.9	3.0	-24.2	7	9
Zambia	3.4	2.7	-21.3	10	10
Rwanda	1.8	1.9	3.7	11	11
Mozambique	1.0	1.2	23.2	12	12

Agricultural importation of ESA countries					
	Share in percentage		Variation	Rank	
	2013-2017	2018-2022	(%)	2013-2017	2018-2022
South Africa	39.0	34.9	-0.1	1	1
Kenya	14.0	15.5	0.1	2	2
Ethiopia	11.2	13.2	0.2	3	3
Mozambique	7.2	9.0	0.2	4	4
Tanzania	6.7	5.7	-0.2	5	5
Zimbabwe	5.8	4.8	-0.2	6	6
Madagascar	3.1	4.1	0.3	8	7
Uganda	4.8	3.9	-0.2	7	8
Rwanda	2.0	3.0	0.5	10	9
Zambia	2.4	2.5	0.1	9	10
Eswatini	1.8	1.9	0.1	11	11
Malawi	1.7	1.4	-0.2	12	12

Figure 21: Agricultural commodities export and import by ESA countries over the period (2013 – 2022)

Source: Author's calculation with AATM 2022 database

Table 2 presents the top twenty agricultural commodities exported or imported worldwide by the ESA countries. The share of these top 20 commodities exported is 52.9% in total agriculture exports by this region worldwide. In terms of imports, the top 20 account for 58.6% of the total agricultural commodities imports in the region of the world.

In terms of global trade, coffee, tobacco and tea are the top three most exported products by this region, while wheat, rice and palm oil are the most imported agricultural products in this region.

Table 2: Top 20 agricultural exports and import by ESA countries in the world, 2018 – 2022 Commodity (HS6)	Export share (%) 2018-2022	Commodity (HS6)	Import share (%) 2018-2022
Coffee	7.2	**Wheat meslin Other than Durum**	10.0
Tobacco	7.1	**Rice (semi-milled or wholly milled)**	9.0
Tea	5.4	**Palm oil other than crude**	8.1
Oranges	4.0	**Palm oil crude**	6.4
Grapes	3.1	**Sucrose, chemically pure**	2.9
Flowers	3.0	**Food preparations**	2.4
Maize (corn)	2.9	**Durum wheat**	2.3
Vanilla	2.6	**Cane sugar**	1.9
Sesamum seeds	2.3	**Soya-bean oil**	1.8
Cane sugar	1.9	**Maize (corn)**	1.7
Wine	1.8	**Sunflower seed or oil**	1.6
Apples	1.6	**Meat**	1.4
Mandarins	1.6	**Oil-cake**	1.4
Lemons	1.6	**Beer**	1.4
Avocados	1.3	**Cane sugar (not containing added flavoring)**	1.3
Sucrose, chemically pure	1.2	**Whiskies**	1.2
Cashew nuts	1.1	**Rice (broken)**	1.1
Macadamia	1.0	**Sunflower seed (not chemically modified)**	1.1
Wool	1.0	**Wheat or meslin flour**	0.8
Cotton	1.0	**Cattle (live)**	0.8

Source: Author's calculation with AATM 2022 database

3.4 Countries' Competitiveness for Value Chains

Evaluating the competitiveness of a country for a particular value chain is a comprehensive process that involves analyzing various factors from production efficiency to market access and sustainability. By systematically assessing these dimensions and using relevant metrics, stakeholders can identify areas for improvement and develop strategies to enhance the overall competitiveness of the value chain.

We used a Revealed Comparative Advantage (RCA) index to further assess the degree of relative competitiveness among the target study countries. The RCA index compares the share of a specific product within a given country's export basket with that of the same product in total world or regional exports.

A comparative advantage is 'revealed' if the RCA is greater than one (RCA>1). If the RCA is less than one, the country is said to have a comparative disadvantage in the commodity or industry. The normalized[2] RCA is positive for indicators that are greater than one and negative if otherwise. For very high RCA indicators, the normalized value tends towards one. The following formula is used to calculate the RCA index:

$$RCA_{ki} = \left[{X_{ki}}/{X_i}\right] / \left[{X_{kw}}/{X_w}\right]$$

Where: X_{ki} is the value of export of good k by country I, X_i is total value exports of country i.

X_{kw} is the value of world exports of good k and X_w is total world exports.

Based on the RCA normalized values, the results shown in **Table 2,** highlight the competitive strengths in specific agricultural and manufactured products across these African countries. Then, there is significant variation in RCA values across different countries and commodities, reflecting diverse areas of strength and specialization. We have estimated 738 normalized RCA indicators for the various products exported by the different target countries. We noted that 16.75% yielded a positive indicator value which mean countries have comparative advantage to export the concerned products over the period 2018 – 2022.

- **Eswatini**: The majority of Eswatini's top agricultural commodities with comparative advantage are related to sugar, with cane sugar, beet sugar, and sugars being major products. This reflects the country's strong presence in the global sugar industry. Other key commodities include citrus, pineapples, jams, and chewing gum, demonstrating diversification in processed foods and fruit products.

- **Ethiopia**: Ethiopia is renowned for its coffee production, with both coffee (not roasted or decaffeinated) and coffee husks and skins as top exports. The country also exports sesamum seeds and castor oil seeds, showcasing the importance of oilseeds in its export basket. Ethiopia also exports flowers, meat of goats, and unrooted plants, reflecting its growing horticulture and livestock sectors. For all these commodities, Ethiopia has a comparative advantage.

- **Kenya**: Kenya is well-known for its horticultural exports, with flowers, tea, and macadamia nuts among the top agricultural commodities with comparative advantage. Other top products include pineapples, goat meat, beans, and peas, highlighting Kenya's agricultural diversity.

- **Madagascar**: Madagascar is famous for its high-quality vanilla and cloves, which feature prominently in its exports. Madagascar also exports essential oils, fruit and nuts, vegetable materials, and various beans, emphasizing its focus on niche agricultural products.

[2] *The normalized RCA values are obtained with the formula: NRCA = (RCA-1)/(RCA+1).*

- **Malawi**: Malawi's most significant comparative advantage agricultural commodities are tobacco, with macadamia, tea, and pigeon peas also contributing to the country's agricultural export profile. Malawi also exports cotton seeds and Bambara beans, demonstrating a focus on oilseeds and legumes.

- **Mozambique**: Similar to Malawi, tobacco and cotton are the top agricultural commodities with comparative advantage for Mozambique, alongside sesamum seeds and macadamia. Mozambique also exports pigeon peas and cow peas, indicating the significance of legumes in its agricultural output.

- **Rwanda**: Rwanda's top agricultural commodities with comparative advantage include coffee (husks and skins) and tea, both key cash crops. Other exports include bran, cereal flour of maize, and hides and skins, reflecting Rwanda's engagement in value-added agricultural processing.

- **South Africa:** South Africa has a wide range of exports including live animals (Asses, Ostriches, Psittaciformes) and fruits such as grapefruit, oranges, and pears. South Africa also exports macadamia nuts and cotton linters, demonstrating strength in both horticulture and textile-related exports.

- **Tanzania**: Tanzania's top agricultural commodities with comparative advantage include coffee, cotton, and cloves, reflecting a focus on cash crops. Tanzania also exports sesamum seeds, pigeon peas, and chickpeas, showcasing a strong oilseed and legume sector.

- **Uganda**: Uganda's top agricultural commodities with comparative advantage include coffee (not roasted or decaffeinated) and tobacco, both critical cash crops for the country. Other exports include cereal flour of maize, vanilla, roses, and leguminous plants, highlighting Uganda's diverse agricultural export base.

- **Zambia**: Similar to its neighboring countries, Zambia exports a significant amount of tobacco and cotton. Zambia's exports also include bran, flours of soya beans, and Bambara beans, showcasing its role in oilseed production and agricultural processing. For all these commodities, Zambia has a comparative advantage.

- **Zimbabwe**: Zimbabwe's largest export by far is tobacco, a vital crop for the country. Zimbabwe also exports macadamia, Peas, and oilcake and other solid residues, emphasizing a diversified agricultural base. For all these commodities, Zimbabwe has a comparative advantage.

Table 3: Commodities Groups in which ESA countries have a comparative advantage over the period 2018 - 2022

Country	Commodity	Country	Commodity
Eswatini	Cocoa (powder)	Rwanda	Bran, sharps and other residues
Eswatini	Couscous	Rwanda	Grape Fruit
Eswatini	Chewing gum	Rwanda	Meat of primates
Eswatini	Beet sugar	Rwanda	Resinoids
Eswatini	Cane sugar	Rwanda	Bambara beans
Ethiopia	Meat of camels and other camelids	South Africa	Asses (live)
Ethiopia	Meat of goats	South Africa	Ostriches
Ethiopia	Castor oil seeds	South Africa	Skins of sheep or lambs
Ethiopia	Arrowroot	South Africa	Cotton linters
Ethiopia	Bambara beans	South Africa	Waste of coarse animal hair
Kenya	Meat of goats	Tanzania	Grain sorghum
Kenya	Castor oil seeds	Tanzania	Meal and powder of the dried leguminous vegetables
Kenya	Beans	Tanzania	Furskins
Kenya	Bambara beans	Tanzania	Oil – cake and other solid residues
Kenya	Waste of wool or of fine animal hair	Tanzania	Pigeon peas
Madagascar	Fruit and nuts	Uganda	Bran, sharps and other residues
Madagascar	Vanilla	Uganda	Germ of cereals
Madagascar	Vanilla	Uganda	Fonio
Madagascar	Beans	Uganda	Grain sorghum
Madagascar	Bambara beans	Uganda	Roses
Malawi	Cotton seeds	Zambia	Cotton seeds
Malawi	Geese	Zambia	Cotton – seed oil
Malawi	Beet sugar	Zambia	Cotton – seed oil
Malawi	Bambara beans	Zambia	Cotton linters
Malawi	Pigeon peas	Zambia	Bambara beans

Country	Commodity	Country	Commodity
Mozambique	Macadamia	Zimbabwe	Hides and skins
Mozambique	Cotton seeds	Zimbabwe	Meat of reptiles
Mozambique	Bambara beans	Zimbabwe	Oil – cake and other solid residues
Mozambique	Cow peas	Zimbabwe	Beet sugar
Mozambique	Pigeon peas	Zimbabwe	Small red (adzuki) beans

Source: Author's calculation with AATM 2022 database

Regional Trade Potentials of ESA Countries

Interest in fostering regional trade is underpinned by the expectation of a certain degree of unrealized potential to expand cross-border trade flows among neighboring countries. That potential is determined primarily by what individual countries decide to produce and trade. The more they produce and exchange different bundles of goods and services, the more likely they are to trade with one another.

The first two indicators used in this section, therefore, are the production and export similarity indices. The production similarity indices (QSI) indicates whether there is sufficient dissimilarity or a degree of specialization in the current production patterns among target study countries, and hence significant scope for cross-border trade expansion within the group and with the rest of the ESA region. So, a value of less than 60 is conventionally interpreted as reflecting the existence of a degree of dissimilarity in production patterns.

The Export Similarity Index (ESI) measures the difference in the export structure between two countries I and J, considering the market of destination H (ESA region). The index values are interpreted in the same way as the QSI. The higher the similarity, the stronger the competition between countries in terms of exported goods. The Trade Overlap Index (TOI) and Trade Expansion Index (TEI) were also used to examine the potential to expand trade within the region based on current trade patterns. The TOI measures the degree of liberalization and integration of the economy in a tiers market. So, the higher the rate is, the more the economy opens up to the ESA market. So, TEI allows us to identify which products have the highest potential for increased cross-border trade based on the degree of overlapping trade flows, without major changes in current domestic production or trade patterns.

The **Production Similarity Index** QSI is defined by the formula:

$$QSI = \left\{\sum_k min\left(q_{i,h}^k, q_{j,h}^k\right)\right\}.100$$

Where $q_{i,h}^k$ and $q_{j,h}^k$ are respectively, the production share of commodity k for countries I and j to the market h.

The **Export Similarity Index (ESI)** is defined as follows:

$$ES_{ij,h} = \left\{\sum_k min\left(x_{i,h}^k, x_{j,h}^k\right)\right\}.100$$

The **Trade Overlap Index (TOI)** is given by the following formula:

$$TOI_i = 2\left(\sum_k Min(X_{ik}, M_{ik})\right) / \sum_k (X_{ik} + M_{ik})$$

Where:X_{ik} , M_{ik} denotes the values of the exports and imports of an agricultural product k by a country ı.

The **Trade Expansion Index (TEI)** is given by $TEI_{ik} = [Min(X_{ik}, M_{ik})/Max(X_{ik}, M_{ik})]$

The QSI results reveal that 51.5% of the values per country pair in the ESA region are below 60, which means that there is sufficient dissimilarity of agricultural exports between countries in ESA region. This suggests that there is significant potential for expanding intra-regional trade based on current production and export patterns.

However, the results also reveal that for the following country pairs, the QSI value is above the threshold of 60: (Ethiopia, Eswatini), (Ethiopia, Kenya), (Ethiopia, Rwanda), (Ethiopia, Tanzania), (Ethiopia, Uganda), (Kenya, Uganda), (Malawi, Zambia), (Mozambique, Uganda). This score means that each country pair exhibits highly similar patterns of specialization in production and therefore tend to compete in regional and global export markets (***Table 3***).

Table 4: Production similarity index for ESA countries in 2018 – 2022

	Ethiopia	Eswatini	Kenya	Madagascar	Malawi	Mozambique	Rwanda	South Africa	Tanzania	Uganda	Zambia	Zimbabwe
Ethiopia		74.1	72.7	49.1	53.7	51.7	61.4	61.5	61.4	90.7	69.9	42.0
Eswatini			60.4	61.9	67.0	78.2	73.6	64.9	67.0	100.0	80.8	43.7
Kenya				46.6	48.3	41.9	56.2	52.9	57.7	63.0	49.9	40.8
Madagascar					54.8	46.9	54.4	49.0	65.4	86.4	49.5	29.9
Malawi						59.0	55.0	50.1	53.1	58.2	66.2	39.1
Mozambique							61.7	72.5	53.8	84.0	57.4	40.4
Rwanda								59.2	69.5	82.2	46.9	43.6
South Africa									62.8	99.6	90.6	41.7
Tanzania										68.6	64.7	48.6
Uganda											81.8	70.8
Zambia												52.5
Zimbabwe												

Source: Authors' calculations using FAO data 2013 - 2022 data.

As for the ESI index, we also note that 87.9% of values based on this index are less than 60 indicating that there is sufficient dissimilarity in trading patterns between countries in the region. However, for the following country pairs with an ESI value above the threshold of 60, it is expected that strong competition in terms of exported goods exists (***Table 4***).

Table 5: Exportation similarity index for ESA countries in 2018 - 2022

	Ethiopia	Eswatini	Kenya	Madagascar	Malawi	Mozambique	Rwanda	South Africa	Tanzania	Uganda	Zambia	Zimbabwe
Ethiopia		55.2	32.3	22.4	26.2	51.3	56.7	29.0	46.4	61.6	45.0	19.9
Eswatini			63.2	87.2	32.6	43.5	41.6	35.4	30.0	24.7	27.6	20.8
Kenya				29.4	28.3	25.3	44.7	16.8	20.6	22.7	15.0	12.8
Madagascar					23.3	87.0	88.7	38.8	15.4	21.9	100.0	89.0
Malawi						49.1	86.6	60.6	31.1	23.9	46.8	70.9
Mozambique							60.6	24.4	48.5	32.1	75.9	50.1
Rwanda								49.1	70.0	53.7	40.0	86.1
South Africa									23.1	29.9	26.6	41.1
Tanzania										38.4	48.0	50.7
Uganda											35.3	23.7
Zambia												36.4
Zimbabwe												

Source: Authors' calculations using AATM 2022 data

Hence, both the QSI and ESI indicate that there is huge potential for expanding intra-regional trade within current production and export patterns. However, diversification of both production and exports is needed if the ESA countries are to fully benefit from emerging trade liberalization in the region and across the continent.

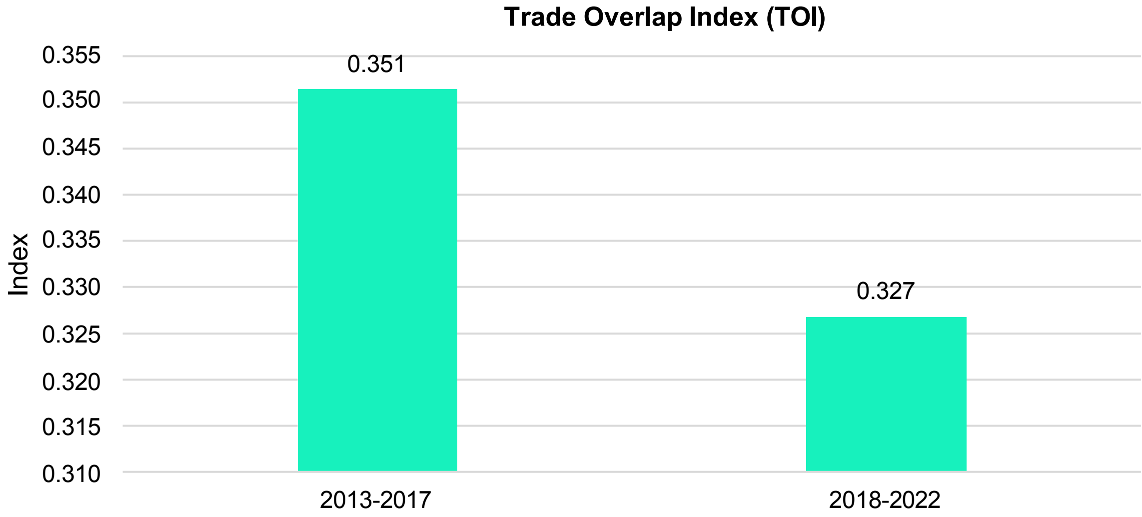
Two final indicators, the TOI and the TEI, are calculated to examine the potential to expand trade within the ESA countries based on current trade patterns. The indicators measure how much of the same product a given country or region exports and imports at the same time. The TOI measures the overall degree of overlapping trade flows for a region as a whole, while the TEI measures the overlapping trade flows at the individual product level for a region.

The results indicate that there is a considerable degree of overlapping trade flows for ESA region. The overlapping regional trade must therefore be taking place between different importing and exporting countries.

In other words, some countries are exporting (importing) the same products that are being imported (exported) by other member countries in their respective grouping, but in both cases to and from countries outside the region. By redirecting such flows, countries should be able to expand transborder trade within their groupings.

For the period 2018 - 2022 we noted in ***Figure 22*** that the value of regional trade overlaps is equal to 0.327. This means that 32.7% of countries' agricultural trade could take place within the region. However, it is important to note that TOI has fallen from 35.1% during the 2013-2017 period to 32.7% for the 2018 - 2022 period, a drop of 7%. this downward trend explains the greater integration of countries in ESA region.

Figure 22: Trade Overlap Index for the period 2008-2022 in ESA region



Source: Authors' calculations using AATM 2022 data

The TEI indicates which products have the highest potential for increased transborder trade based on the degree of overlapping trade flows. ***Table 5*** lists the 20 products with the highest TEI value in ESA region.

The findings above indicate a real potential to expand intra-trade in East and Southern African region even with current production and trade patterns. Based on this information, the region needs to engage in policy negotiations to reduce tariffs, simplify customs\ procedures, and eliminate non-tariff barriers but also ensure that infrastructure and legal frameworks are aligned with regional trade agreements to encourage smoother trade.

Table 6: Top 20 commodities with the highest trade expansion index (TEI) in ESA region over the period 2018 – 2022

Commodity (HS6 description)	TEI
Residues of starch manufacture	99.35
Albuminates and other albumin derivatives	98.90
Flour (meal and powder of potatoes)	98.85
Vegetable materials and vegetable waste	98.81
Dairy produce (fats and oils derived from milk)	98.75
Geese	98.55
Swine (in live)	98.54
Spices (turmeric)	98.01
Tomato ketchup and other tomato sauces	97.96
Meat of sheep	97.60

Commodity (HS6 description)	TEI
Meat of ducks	97.51
Coconuts	97.41
Honey (natural)	97.32
Cotton seeds	97.15
Meat and edible offal of geese	97.05
Live animals (other than mammals, reptiles, birds and insects)	96.71
Resinoids	96.67
Sweetcorn	95.92
Cardamoms	95.79
Birds' eggs	95.77
Palm nuts and kernels	95.68
Almonds	95.01
Wool	94.60
Milk and cream	94.34
Coarse animal hair	94.16
Meat of swine	93.49
Cheese of all kinds	93.20
Sweet biscuits	92.78
Fowls of the species Gallus domesticus	92.52
Germ of cereals	92.38
Sugar confectionery	92.23
Vegetables	91.98
Chewing gum	91.78
Meat of swine (hams)	90.7
Bamboo shoots	90.42
Macis	90.39
Buffalo (Pure–bred breeding animals)	90.35
Millet	90.23

Source: Authors' calculations using AATM 2022 data

Infrastructural and Regulatory Bottlenecks of Regional Trade

Unlike Africa's trade with the rest of the world, which mainly consists of primary commodities, intra-regional agricultural trade on the continent is heavily dominated by processed products. Most of the bottlenecks limiting the expansion of intra-regional trade are associated with ease-of-doing business by intermediary actors involved in agri-food processing, transportation and wholesale and retail trade.

The literature on the ease of doing business has predominantly focused on the cost of doing business (Eifert et al. 2008); legal challenges to doing business (Taplin and Synman 2004); and determinants of doing business in East Africa (Khavul et al. 2009). However, obstacles to the development of agri-food value chains in African context are more diverse and are linked to infrastructural and regulatory bottlenecks.

Major constraints to value chain upgrading include lack of access to local, regional and international markets; market orientation (Grunert et al. 2005); unavailability of resources and physical infrastructures (Porter 1990); regulatory, cognitive and normative institutions (Scott 1995); insufficient training of primary producers in production practices and unavailability of conditioned transport as well as boxes for export (Fassinou Hotegni et al. 2014). Producers also face difficulties in meeting the expenses for certification (Doherty et al. 2015).

Lack of dedicated regional trade hubs and logistical platforms for perishable products such as fruits, vegetables, meat, and dairy products are also critical challenges facing agribusiness operators (Rillo and Nugroho 2016). These logistical bottlenecks are exacerbated by unreliable supplies, increasing the transaction costs of transporting products and inputs used in the agri-food sector.

Previous studies on the short- and long-term determinants of agricultural value addition in Africa have also found that electricity consumption or access exerts a positive effect on agricultural value addition (Onoja et al. 2017). Other studies on the challenges that micro, small and medium enterprises (MSMEs) face in Africa or which examine the business environment and entrepreneurial ecosystem on the continent have used the World Bank Enterprise Survey (WBES) data.

The WBES captures barriers to entrepreneurship and high-growth opportunities such as lack of finance, lack of innovation and technology, low-skilled workforces, inadequate infrastructure, unfavorable regulations, and pervasive corruption (Nwajiuba et al. 2020). Generally, the efficiency of African food systems is constrained by the shortage of transport infrastructure (roads and rail network services) coupled with the lack of public services and specific infrastructures such as marketplaces, storage facilities, logistical services and communication networks.

In terms of cross-border trade, the World Trade Organization (WTO) identifies the following key constraints (WTO 2021):

- Lack of coordination on the development and maintenance of transport infrastructure (e.g. inefficient border infrastructures),
- Lack of standardization and harmonization (e.g. trans-loading from and between different freight modes),
- Lack of coordination and cooperation between customs and other border agencies and traders (e.g. long waiting times at customs desks),
- Burdensome document requirements and paper processing of documents (e.g. multiple clearances and declarations at customs),
- Lack of human and financial resources (e.g. shortage of skilled staff to promote better understanding of the Trade Facilitation Agreement (TFA) and,
- Insufficient equipment and digital infrastructures (e.g. information and communication technologies (ICT) and laboratory equipment for implementation of the TFA).

In summary, all of these studies on the challenges and obstacles facing value chain actors at the producer, trader and processor levels indicate that the food system transformations that can be spurred on the continent through greater intra-regional trade and value addition face significant constraints.

Some key constraints include the lack of access to public and infrastructural services, especially in the midstream segment of agricultural value chains. Midstream actors help to link smallholder producers with markets (Badiane et al. 2022) and facilitate cross-border trade. They also help generate innovations that can enhance value addition, create employment opportunities, and improve economy-wide efficiencies (Tadesse and Gachango 2022).

Specific Bottlenecks Within ESA region

We use the World Bank Enterprise Survey (WBES) data to analyze the specific policy Infrastructural and regulatory bottlenecks facing business owners and top managers in ESA region.

The WBES data provides a comprehensive view of the diverse challenges faced by businesses in the ESA region over the period 2018 - 2023. Access to finance, informal sectors, electricity, political instability, tax rates, access to land as the most significant barriers.

Access to finance is identified as the most significant obstacle across all countries, with the highest percentage of businesses in Zambia (around 35%) citing it as a major challenge. Rwanda also shows a notable concern in this area. Indeed, lack of access to finance means that enterprises will continue to invest little, have low-return production systems, and be unable to use their agricultural resources optimally. Similarly, financial constraints may prevent small and medium-scale traders and processors from expanding their capacities, effectively limiting the amount of produce they can buy from small farmers and other local suppliers of raw materials.

The presence of the informal sector is a notable challenge in Rwanda and Zambia, indicating competition from unregistered businesses. Indeed, most midstream actors involved in food processing and distribution in Africa are informal businesses which have little or no access to formal loans from financial institutions. As a result, banks do not lend money to these actors because they fear that they cannot repay debts in regular payments as agriculture is a seasonal business, associated with climate and market risks.

Electricity is a significant challenge in Zambia and Kenya, likely due to inadequate infrastructure and logistical issues. As Asongu and Odhiambo (2018) have discussed, the management of energy in African countries has generally not been effective. Energy supply remains unreliable and is insufficient to support the processing of certain agricultural products.

In the 2019 Zambian survey, firms experienced an average of 13.6 power outages in a typical fiscal year. After Ethiopia, this figure was the largest in ESA and was an increase from the average 5.2 outages recorded in the 2013 survey. Such power outages caused an average loss of 23 % of the annual sales of firms.

Political instability is a significant issue, particularly in Zambia and Kenya, where over 20% of businesses see it as a major obstacle. Indeed, political instability creates uncertainty about the future business environment, deterring both domestic and foreign investments. Investors typically seek stable environments where they can predict outcomes and returns on investments.

Tax rates and tax administration are significant concerns for businesses in all four countries, with Zambia showing the highest concern for tax rates and Kenya for tax administration. Indeed, tax administration systems, high tax rates and low volumes of cross-border trade are major impediments to doing business in Africa. High tax rates can also significantly increase the cost of doing business, reducing profit margins. This can deter investment and expansion plans. In light of this SMEs may struggle more with high tax rates, as they typically have lower financial resilience compared to larger corporations.

Access to land is a major issue, especially in Kenya and Tanzania, in that access to land is a critical factor for agricultural businesses. It influences production capacity, investment decisions, and long-term sustainability and can significantly impact agricultural operations (***Figure 23***).

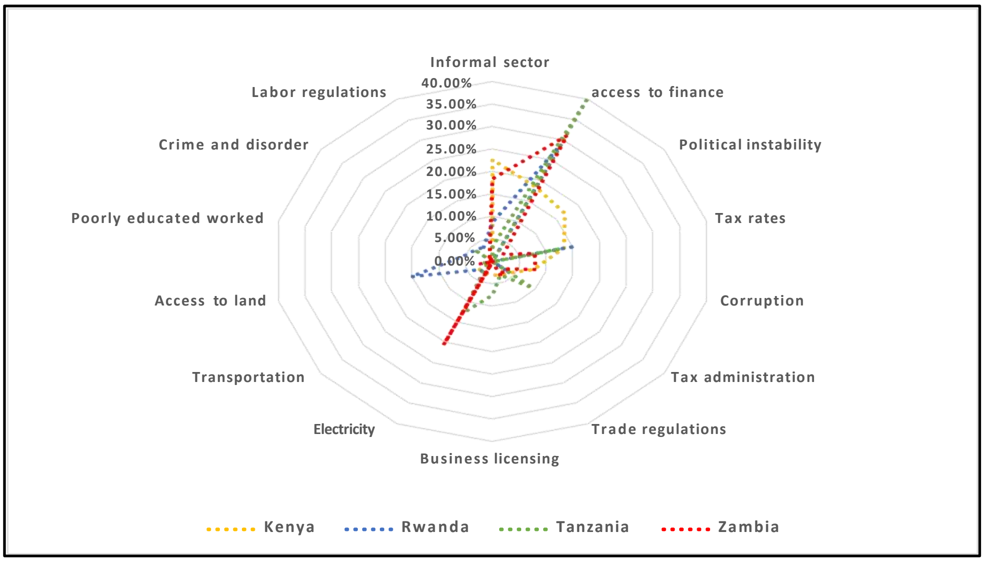


Figure 23: Major obstacles to business operations identified by business owners and top managers in ESA region over the period 2018 - 2023

Source: Authors' calculations using AATM 2022 data

3.5 Conclusion and Recommendation

In summary, this chapter addresses regional trade and agricultural diversification and summarizes the policy, infrastructural and institutional bottlenecks in ESA region. To achieve this goal, we had to adopt a three-step approach.

After recalling the role of regional trade for agricultural diversification, we analyzed regional trade indicators (such as size of regional trade, trade competitiveness, and regional trade potentials) as they are important for expanding agricultural diversification in the region. Finally, we highlighted the infrastructural and regulatory bottlenecks that are limiting the extent of regional trade within the specified ESA countries.

The assessment presented in this chapter alluded to the role that agricultural diversification plays in enhancing food security and economic resilience, and the role played by regional trade to enhance agricultural diversification and regional integration in ESA.

The agricultural sector remains vulnerable to climate change, with staple crops such as maize at risk of yield declines, exacerbating hunger and malnutrition. Regional trade offers opportunities for diversifying agricultural products through expanding markets and creating access for cheaper inputs and technologies. It also helps to foster agricultural value addition due to the fact that regional trade in Africa is heavily dominated by processed products.

However, despite huge trade potential between these countries, the current share of regional trade is very low. Trade patterns across ESA countries reveal significant variation in agricultural exports and imports, with a few countries, such as Uganda and Kenya, dominating regional trade. These countries, along with others, need to overcome overlapping trade flows that mainly occur with markets outside the region.

The region faces multiple policy, infrastructural, and institutional challenges that hinder the realization of its full potential. To pave the way for sustainable agricultural diversification and unlock the full potential of regional trade in ESA, it is essential to address the key policy, infrastructure, and institutional bottlenecks that continue to constrain these sectors.

Based on the analysis of the current challenges, the following recommendations are proposed to foster greater agricultural resilience, enhance trade competitiveness, and promote economic integration in the region:

- Governments should enhance regional trade agreements, focusing on reducing non-tariff barriers, streamlining customs procedures, and promoting fair competition. Prioritizing the harmonization of agricultural standards will also facilitate smoother cross-border trade and foster market integration.

- Facilitating access to finance for SMEs and farmers is crucial for scaling agricultural production and value addition. Governments and financial institutions should collaborate to create tailored financial products that address the unique challenges faced by agricultural enterprises, particularly in rural areas.

- Supporting the development of agricultural value chains, from processing to marketing, is key to enhancing competitiveness. Regional initiatives should focus on value-added agricultural production, which will increase export earnings and reduce dependency on primary commodity exports.

- Building the technical and managerial capacity of farmers and agribusinesses, alongside promoting the adoption of modern technologies such as mechanization and irrigation systems, will boost productivity and sustainability. Regional cooperation in sharing best practices and innovations should be prioritized.

- Governments in the region need to ensure a stable and predictable business environment by addressing political instability and improving institutional governance. This will encourage both domestic and foreign investments, which will be critical for the expansion of the agricultural sector.

While trade and market integration offer promising opportunities for agricultural transformation, these prospects must also be considered within the context of climate change.

Chapter 4 examines the impacts of climate variability on agricultural production and trade, highlighting the urgent need for adaptation strategies to safeguard regional food security.

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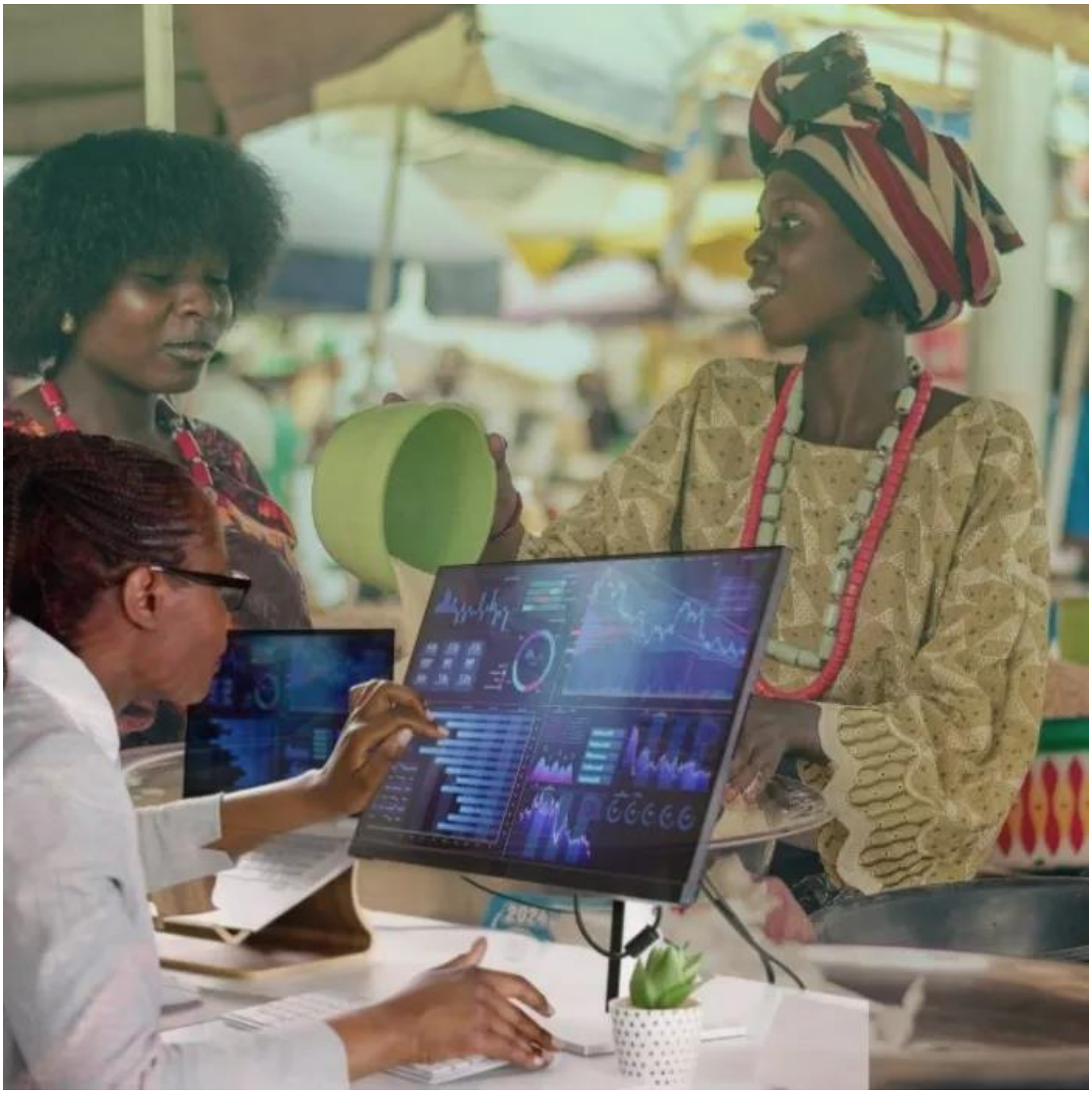


Chapter 4: Effects of climate change on future agricultural production and trade in ESA

Sherwin Gabriel, Timothy S. Thomas, Richard D. Robertson

4.1 Introduction

It is well-known that climate has been changing rapidly for decades in response to a rise in anthropogenic greenhouse gas (GHG) emissions and that it will likely continue to change for some time to come.

The agricultural sector is reliant on climate for production and therefore a changing climate impacts production and forces farmers to adapt or absorb the full impact of the change. The ESA region is extremely vulnerable to climate change because of its high reliance on agriculture for income, employment, and household food security, and because of its relatively low capacity to compensate for shocks to the sector.

However, climate change will affect agricultural production in the rest of the world, as well, and it is not clear apart from careful analysis whether Africa will have a relative comparative advantage under climate change for at least some crops.

Additionally, given projected changes in global commodity prices and productivity changes resulting from investment in seed development and improved farm management practices, whether shifts in amount of land devoted to each crop might take place within the region. Using climate models, crop models, and bioeconomic models, this chapter will attempt to answer those questions.

Climate Projections

The Coupled Model Intercomparison Project (CMIP) is a collaborative framework for improving climate models. Most importantly, CMIP informs the Intergovernmental Panel on Climate Change (IPCC) assessment reports that are published every 6 to 8 years and that survey the state of knowledge in regard to climate change and its impacts. The most recent assessment report was the sixth report, and the climate model output for it was assembled under the “CMIP6” designation.

The Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) is an international network of modelers investigating the impact of climate change on multiple sectors. ISIMIP produces climate and socioeconomic datasets that can be used for consistent analysis across sectors. The climate model data produced by ISIMIP revolves around 5 climate models also referred to as General Circulation Models (GCMs) that were part of the IPCC’s Sixth Assessment Report (AR6).

Climate Modelling Results

Figure 24 shows what each of the five climate models projects for changes in precipitation between 2020 and 2050, based on 20-year averages around each year. These are averaged at the country and regional levels, with the values reported in ***Table 7***. We observe that East Africa is predicted to be wetter in three of the five models, and the northern part of East Africa is predicted to be wetter in every model.

Southern Africa is different. Three out of the five models predict it to become drier, though that has some caveats, with the Geophysical Fluid Dynamics Laboratory (GFDL) model predicting the northeastern part to become much wetter (offsetting the reduced rainfall in the rest of the region), and the MPI giving mixed impressions for the northeastern part. The MRI model projects Lesotho and a large portion of South Africa near it to become wetter.

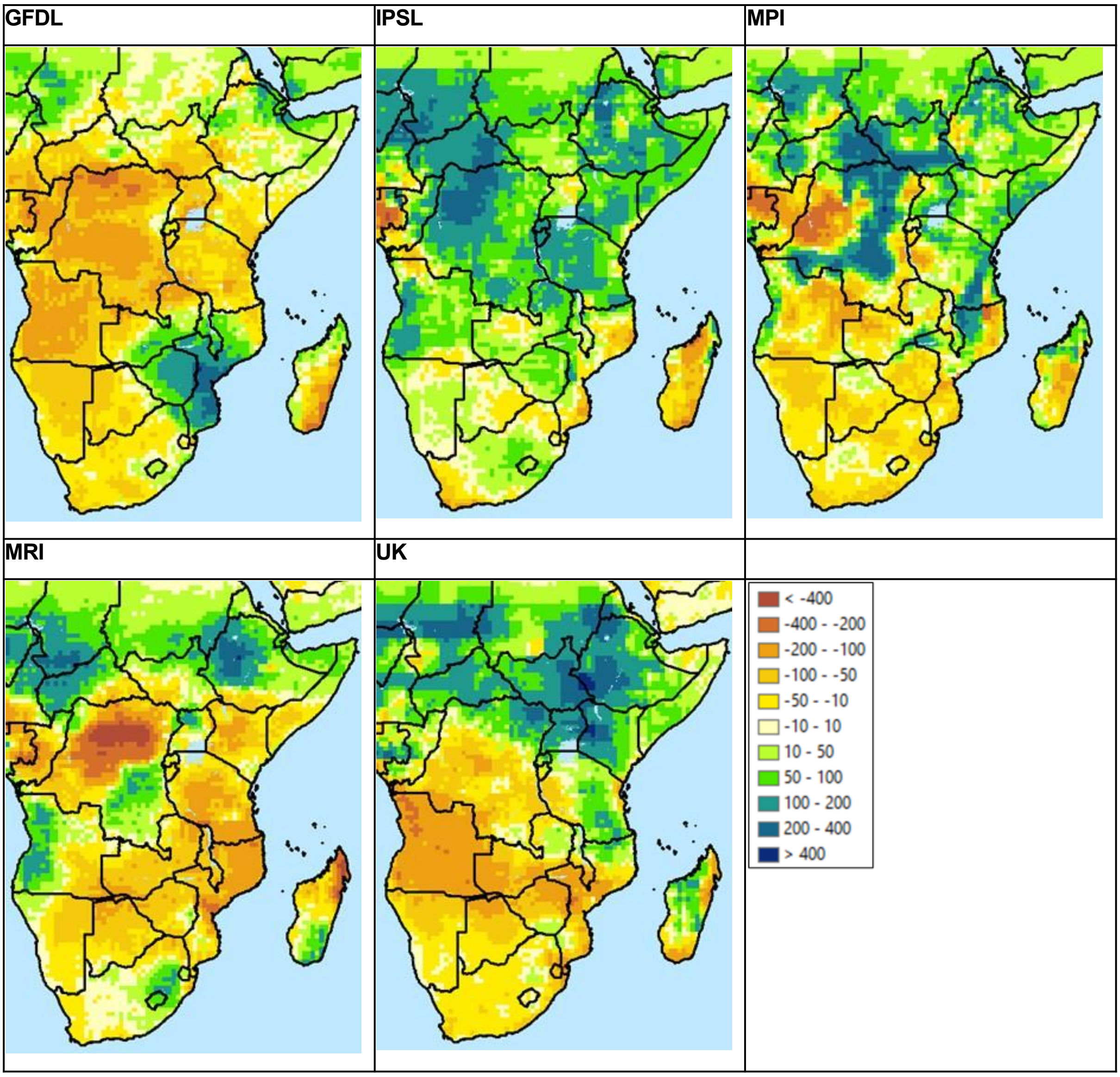


Figure 24: Change in mean annual precipitation, 2010 - 2030 to 2040 - 2060 (in millimetres)

Source: ISMIP 3b

Figure 24 shows projected changes in mean daily maximum temperature for 2010 - 2030 to 2040 - 2060 for the 5 ISIMIP climate models. These temperatures are aggregated to country level and presented in ***Table 7***, where we see that the projections for temperature rise in the region under climate change are smaller than for the rest of the world (except for MRI, which is almost the same).

We also note that the temperature increase is projected to be higher in Southern Africa than in Eastern Africa, and with the western portion of Southern Africa generally being higher than the eastern portion. The UK GCM is projecting a much higher temperature than the other GCMs. In Southern Africa, it is projected to increase by 30% more than the second hottest projection.

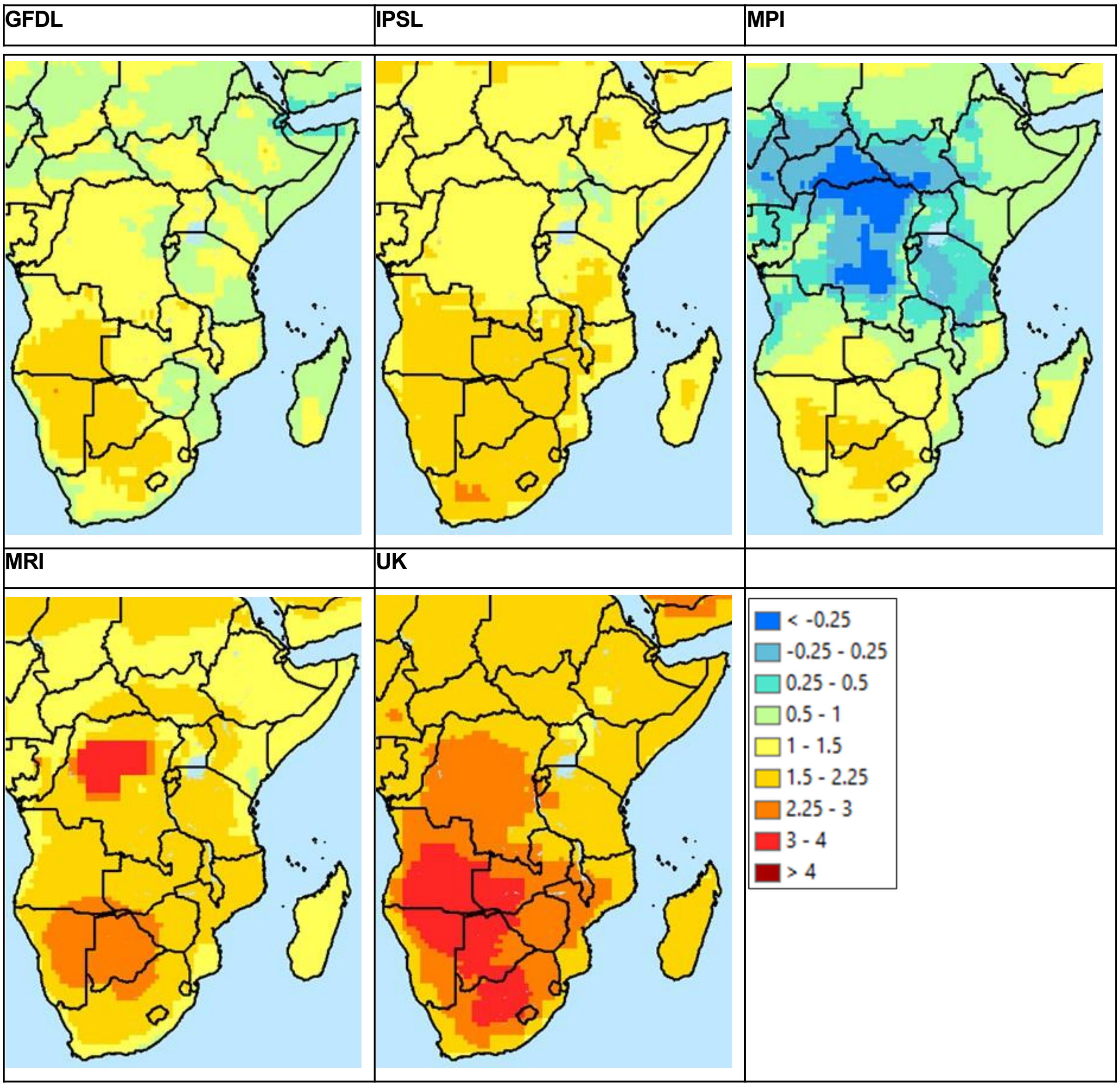
Worse, in Southern Africa, the two GCMs projecting the greatest temperature rise also project the greatest reduction in rainfall. If either of these models prove to be correct, that could be a significant blow to agricultural productivity. Our crop model projections should be able to quantify by how much the reduction would be.

Table 7: Change in annual precipitation for each ISIMIP GCM, by region and country under SSP5 - 85, comparing 2010 - 2030 to 2040 - 2060 (millimetres)

Precipitation change: 2000-2050

Country / Region	GFDL	IPSL	MPI	MRI	UK
World	-1	29	4	19	28
ESA	-7	42	12	-29	11
Eastern Africa	-19	92	57	-1	90
Burundi	-55	124	-30	-18	4
Comoros	-23	-25	66	-135	-35
Djibouti	81	69	44	71	56
Eritrea	26	66	79	30	92
Ethiopia	13	111	62	85	150
Kenya	-35	90	55	-61	128
Rwanda	-13	122	19	-7	57
Somalia	18	67	55	11	26
Tanzania	-63	104	52	-85	25
Uganda	-84	36	73	4	157
Southern Africa	2	7	-21	-49	-45
Botswana	-40	0	-25	-59	-56
Lesotho	20	48	-17	67	-12
Madagascar	-39	-62	-9	-54	-1
Mozambique	104	-4	6	-110	-55
Mauritius	21	-72	169	-4	138
Malawi	55	31	-1	-91	-38
Namibia	-56	13	-37	-32	-47
Reunion	3	-334	109	-121	12
Eswatini	-9	-12	-12	19	-85
South Africa	-19	7	-32	3	-29
Zambia	-15	45	-20	-71	-63
Zimbabwe	115	47	-32	-58	-82

Source: Authors, based on ISIMIP



Source: ISIMIP 3b

Figure 25: Mean daily maximum temperature change, 2010 - 2030 to 2040 – 2060 (℃)

Table 8: Change in mean daily maximum temperature for the warmest month for each ISIMIP GCM, by region and country under SSP5 - 85, comparing 2010 - 2030 to 2040 – 2060 (℃)

Temperature change: 2000-2050

Country / region	GFDL	IPSL	MPI	MRI	UK
World	1.3	1.8	1.1	1.6	2.7
ESA	1.1	1.5	0.9	1.7	2.2
Eastern Africa	0.9	1.2	0.6	1.4	1.8
Burundi	0.9	1.2	0.4	1.6	2.2
Comoros	0.7	1.1	0.8	1.1	1.4
Djibouti	0.4	1.2	0.9	1.3	1.9
Eritrea	0.8	1.3	0.8	1.4	1.8
Ethiopia	0.8	1.3	0.6	1.3	1.8
Kenya	1.0	1.1	0.6	1.4	1.6
Rwanda	1.1	1.3	0.4	1.6	2.1

Temperature change: 2000-2050

Somalia	0.7	1.2	0.8	1.2	1.7
Tanzania	0.9	1.4	0.3	1.7	2.0
Uganda	1.1	1.1	0.3	1.5	1.6
Southern Africa	1.3	1.7	1.2	1.9	2.6
Botswana	1.7	1.9	1.4	2.6	3.1
Lesotho	1.4	2.0	1.5	1.8	2.9
Madagascar	0.9	1.3	1.0	1.3	1.8
Mozambique	1.0	1.4	0.9	1.7	2.2
Mauritius	0.6	0.9	0.8	1.1	1.3
Malawi	1.1	1.6	0.7	1.9	2.4
Namibia	1.7	1.8	1.4	2.3	2.7
Reunion	0.6	0.9	0.8	1.2	1.3
Eswatini	1.3	1.8	1.2	1.5	2.3
South Africa	1.3	1.9	1.4	1.8	2.6
Zambia	1.3	1.6	0.8	2.0	2.7
Zimbabwe	1.0	1.6	1.2	2.1	2.8

Source: Authors, based on ISIMIP

Projected changes in yields, area, production, demand, and trade under climate change

We use the Decision Support System for Agrotechnology Transfer (DSSAT) software to model the effect of climate on yields. DSSAT is a well-documented and well-respected modelling tool. We use aggregated monthly averages in the DSSAT weather simulator to simulate yields for a baseline climate of 2005 and the future climate as projected by 5 CMIP6 GCMs under RCP5-85.

The weather simulator generates daily weather consistent with the monthly climate aggregate given to it. We generate multiple simulated daily weathers at each pixel; compute yields for them and then average the yields across the multiple simulations to give the yield that is typical for that pixel and crop under that climate.

In addition to climate, crop yields are affected by the level of atmospheric CO_2 , which is the main greenhouse gas responsible for climate change. Higher CO_2 helps C3 crops to have higher yields, while C4 crops are not greatly affected by higher CO_2. C4 crops include maize, sorghum, teff, millet, sugar cane, and some grasses. All other crops are C3 crops, including rice, wheat, soybeans, beans, and groundnuts. East and Southern Africa are particularly disadvantaged relative to just about every other region of the world under climate change because of the high concentration of maize, sorghum, and teff that are produced in the region.

The CO_2 fertilization effect has been measured in the Free-Air CO_2 Enrichment (FACE) Experiments (US DOE 2020) which tested the yield response of plants to higher levels of CO_2. They found that a plant's ability to respond is contingent on sufficient moisture and nitrogen. Yield boost can be counteracted by ozone. There is some debate in the literature about whether to incorporate the CO_2 fertilization effect into our expectations about future growth.

Toreti et al. (2020) argue that the scientific results are so clear that researchers on the impact of climate change on agriculture should stop showing results that do not include CO_2, fertilization. Li et al. (2017) reported that the globally rising net primary production (NPP) is primarily due to CO_2 fertilization. Allen et al. (2020) argue that the FACE experiment under-estimated the actual yield boost of CO_2 fertilization. However, Zhu et al. (2023) and Yuan et al. (2019), for example, challenge the idea that there is a yield boost.

In *Table 9*, we summarize the DSSAT crop model results for the seven crops that were modelled in support of the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model, and which were analyzed in more detail in this paper. Except for rice, the median yield change for each of the crops projected greater losses/lower increases for Southern Africa than for Eastern Africa.

Table 9: Summary of direct climate impact on yields of 7 crops in the region, 2005 – 2050

			With CO2 fertilization
Crop	**Country / region**	**Hectares (SPAM 2005)**	**Median**
Rainfed maize	World	112,319,452	-12.5
	ESA	14,590,365	-7.5
	Eastern Africa	6,115,676	-3.0
	Southern Africa	8,474,690	-9.4
Rainfed sorghum	World	38,378,712	-2.4
	ESA	3,891,597	6.8
	Eastern Africa	3,101,840	9.3
	Southern Africa	789,757	2.9
Rainfed rice	World	41,780,098	8.2
	ESA	883,253	-0.1
	Eastern Africa	590,084	-4.5
	Southern Africa	293,169	6.6
Irrigated rice	World	61,643,678	7.8
	ESA	1,200,399	6.2
	Eastern Africa	158,272	3.1
	Southern Africa	1,042,128	6.5
Rainfed groundnuts	World	18,806,166	9.3
	ESA	1,567,489	2.7
	Eastern Africa	631,816	12.4
	Southern Africa	935,673	5.3
Rainfed wheat	World	149,386,363	21.1
	ESA	2,237,992	-1.5
	Eastern Africa	1,576,215	1.1
	Southern Africa	661,777	-4.9
Irrigated wheat	World	44,226,635	8.0
	ESA	251,280	0.7
	Eastern Africa	4,094	8.5
	Southern Africa	247,187	0.6
Rainfed soybeans	World	84,471,616	6.9
	ESA	433,573	13.9
	Eastern Africa	123,378	21.9

	Southern Africa	310,195	11.0
Rainfed potatoes	World	15,732,227	0.9
	ESA	732,420	-13.6
	Eastern Africa	447,404	-6.0
	Southern Africa	285,016	-28.0

Source: Authors

Of the seven crops modelled in DSSAT, ESA makes important contributions to the global cultivated area of maize, sorghum, groundnuts, and potatoes. The percentage of ESA cultivation in global area of wheat, rice, and soybean is very small. The projected impact on crop yields of climate change is more positive / less negative for maize, sorghum, and soybeans in the region relative to the rest of the world, and by itself, this suggests a possible comparative advantage.

In addition to DSSAT for modelling climate impact on crop yields, we use the IMPACT model to examine the full effect on area, yields, production, consumption, and trade. The IMPACT model has been used since the mid-1990s to study future global supply, demand, and trade in the agriculture and food sector, and has climate change embedded as a fundamental component. Details of the model can be found in Robinson et al. (2015), but in this introduction we will give a brief overview.

IMPACT is a multimarket and partial equilibrium model that solves for global prices that equate supply and demand for every year and commodity in the model. Production is computed at the level of IMPACT's FPUs (food production units), which are the intersection of regions (which are in most cases countries) and major water basins. IMPACT has 159 regions and 154 water basins, which combine for 320 FPUs. IMPACT has 62 commodities, including 39 crops, 6 types of livestock, and 17 processed foods. IMPACT solves annual for 2005 through 2050.

IMPACT draws on inputs from other models. We have already discussed the CMIP6 climate models and the DSSAT crop model. IMPACT also includes water models (hydrology, water basin management, and water stress models). IMPACT takes into account population growth, GDP growth, changes in consumer demand, productivity growth due to agricultural progress both in seed technology and farm management. It accounts for changes in global demand and global supply, which determine global prices and therefore influence what producers choose to produce and what households choose to consume.

Table 10 shows projected changes in cultivated areas for 2020 – 2050 from the IMPACT model. Without accounting for climate change, based only on changes in global demand driven primarily by population and GDP, and changes in global supply driven by changes in productivity - global cropland is projected to increase by 11%.

However, **in the ESA region, cropland is projected to grow considerably more, at 27%, with Eastern Africa expanding by 30% and Southern Africa by 21%.** The lower value for Southern Africa is large partly due to South Africa being projected to increase by only 1 %, while most of the other countries are projected to expand by 21 to 34%.

Climate change itself is projected to have a relatively small impact on change in cultivated area, generally with no more than two percentage point change, and with the median projections being smaller. Lesotho is an exception, with agriculture becoming much more productive with rising temperature. Namibia is another exception, with agriculture becoming much less productive, also because of the temperature increase.

The expanding demand for cropland may conflict with the desire of many countries to preserve forest and other natural habitats. **If the projection from IMPACT is correct, expansion in East Africa is going to require an additional 150,000 square kilometres**. While actual land may be lower (much of East Africa is in the inter-tropical convergence zone and has two rainy seasons, possibly reflecting the need for only 75,000 square kilometres of additional land to be converted for cropland), this is a very large quantity in a relatively short period of time.

Table 10: Change in total cultivated area, 2020 – 2050

Country/ Region	Cultivated area, 2020 (000s hectares)	Percent change in area, 2020-2050	Percent difference from no-climate-change scenario, 2050					
			No CO_2 fertilization			With CO_2 fertilization		
			Minimum	Median	Maximum	Minimum	Median	Maximum
World	**1,426,109**	**11.2**	**0.4**	**0.5**	**1.8**	**-0.9**	**-0.8**	**0.2**
ESA	**72,547**	**27.2**	**0.1**	**0.4**	**1.9**	**-1.2**	**-0.9**	**0.4**
Eastern Africa	**48,639**	**30.4**	**-0.1**	**0.4**	**1.9**	**-1.3**	**-0.8**	**0.5**
Burundi	1,830	27.7	-0.2	0.5	1.3	-1.5	-0.6	-0.1
Djibouti	12	18.1	1.2	2.6	2.8	-1.6	-0.1	0.1
Eritrea	634	37.2	0.1	0.9	1.9	-1.1	-0.3	0.5
Ethiopia	15,475	32.2	-0.3	0.5	1.8	-1.3	-0.6	0.5
Kenya	5,922	29.8	0.3	0.8	2.9	-1.5	-1.0	0.9
Rwanda	2,152	25.1	0.5	1.0	1.7	-0.7	-0.1	0.5
Somalia	563	40.0	-0.6	-0.3	0.3	-1.4	-1.1	-0.7
Tanzania	14,578	29.2	-0.1	0.3	1.7	-1.4	-1.0	0.1
Uganda	7,474	30.4	-0.3	0.5	2.3	-1.4	-0.6	1.0
Southern Africa	**23,908**	**20.8**	**0.3**	**0.8**	**1.9**	**-1.0**	**-0.5**	**0.4**
Botswana	140	26.2	0.0	1.2	2.7	-1.1	0.1	1.6
Lesotho	192	21.0	3.2	3.8	6.1	2.2	2.7	5.0
Madagascar	2,786	23.9	0.4	0.6	1.5	-1.3	-1.2	-0.4
Mozambique	5,953	27.8	0.1	1.1	1.9	-1.6	-0.7	0.0
Malawi	4,405	30.2	0.1	0.7	1.7	-1.1	-0.5	0.3
Namibia	337	33.6	-2.7	-2.1	0.7	-3.7	-3.1	-0.4
Eswatini	182	15.3	0.8	1.5	3.3	-0.3	0.6	2.2
South Africa	5,855	1.0	0.5	0.9	2.5	-0.4	0.0	1.3
Zambia	2,245	27.1	0.0	0.7	1.8	-0.9	-0.2	0.7
Zimbabwe	1,812	24.0	0.3	0.9	1.7	-0.7	-0.1	0.6

Source: Authors, based on IMPACT model results. RCP8.5, SSP2, with 5ISIMIP GCMs

Notes: Small discrepancies with FAO cultivated area due to exclusion of small island nations from this table, and other differences caused by modelled values.

Similarly, the IMPACT model suggests that **Southern Africa will need to convert roughly 50,000 square kilometres to cropland.** Policymakers will need to consider whether they want to shape the growth of cropland through establishing protected areas and enacting land acquisition policies that might influence the rate and location for the transition. Knowledge of agricultural potential under future climates as well as information related to sustainability of each area and potential harm to the environment and biodiversity.

Table 11 focuses on the projected changes between 2020 and 2050 to the top ten crops by land area in 2020. We note that maize, which represents a quarter of all croplands in the region, will decline slightly in its relative weight for cropland in 2050, but in absolute area, it will nonetheless rise by 8.5%. Sunflower seed will decline in importance as well. Crops that will rise in importance include beans, sorghum, and vegetables.

What we conclude from this is that the pace of transition out of maize-based cultivation is likely to be relatively slow, unless policymakers intervene to hasten the transition. The slow speed of transition is due, in part, to the relatively low impact of climate change on maize in the region (relative to the rest of the world) and rising global demand which will cause maize prices to rise, making farmers less willing to stop cultivating it.

What could help is a focused intervention on crops for which the region could have a comparative advantage, and which would potentially give farmers a large return for their labour. These could include higher-value crops, which might include fruits, nuts, oilseeds, and vegetables. Once a crop or crops are selected, policymakers could develop a full range of services and interventions, similar to how Ethiopia intervened and has experienced over a decade of sustained and high yield growth in many key crops (Bachewe et al. 2017).

The intervention could include investment in producing climate-appropriate higher-yielding seeds; propagating and selling the seeds in large enough quantities to meet farmer demand; intervene with fertilizer prices and marketing, if appropriate; develop markets for farmers to sell domestically, and possibly internationally; and expand advisory services so that farmers have the knowledge to succeed with cultivating crops that they have little experience with.

Table 11: Summary of full impact on cultivated areas of the 10 leading crops for the region

Percent of all croplands

				2050	**CO2 fertilization, 2050**		
Crop	**Rank in 2020 for region**	**Region**	**2020**	**No CC**	**Min**	**Med**	**Max**
Maize	1	ESA	24.8%	21.2%	22.4%	22.8%	23.1%
	1	Eastern Africa	20.7%	17.2%	18.2%	18.4%	18.8%
	1	Southern Africa	33.2%	30.0%	31.6%	32.2%	32.7%
Beans	2	ESA	8.9%	9.8%	9.6%	9.7%	9.7%
	2	Eastern Africa	10.3%	10.6%	10.5%	10.6%	10.8%
	5	Southern Africa	6.0%	8.0%	7.4%	7.5%	7.8%
Cassava	3	ESA	6.3%	6.0%	5.9%	6.0%	6.1%
	5	Eastern Africa	6.2%	5.8%	5.8%	5.9%	6.0%
	3	Southern Africa	6.4%	6.2%	6.2%	6.3%	6.4%
Sorghum	4	ESA	6.0%	7.8%	7.9%	8.0%	8.1%
	3	Eastern Africa	7.7%	9.9%	10.1%	10.2%	10.4%

	9	Southern Africa	2.6%	3.2%	3.2%	3.2%	3.3%
Teff and other cereals	5	ESA	4.6%	4.4%	4.1%	4.1%	4.1%
	4	Eastern Africa	6.7%	6.4%	5.9%	5.9%	5.9%
Rice	6	ESA	4.2%	4.0%	3.8%	3.8%	3.9%
	14	Eastern Africa	2.7%	2.3%	2.2%	2.2%	2.3%
	2	Southern Africa	7.2%	7.7%	7.3%	7.4%	7.5%
Groundnuts	7	ESA	4.2%	4.4%	4.3%	4.4%	4.5%
	10	Eastern Africa	3.2%	3.2%	3.2%	3.3%	3.4%
	4	Southern Africa	6.2%	6.9%	6.6%	6.8%	7.0%
Wheat	8	ESA	3.6%	3.8%	3.6%	3.6%	3.7%
	6	Eastern Africa	4.1%	4.5%	4.3%	4.4%	4.4%
	11	Southern Africa	2.5%	2.2%	1.9%	2.0%	2.1%
Sunflower seed	9	ESA	2.8%	1.9%	1.8%	1.8%	1.8%
	15	Eastern Africa	2.7%	1.7%	1.7%	1.7%	1.7%
	7	Southern Africa	3.1%	2.2%	2.1%	2.2%	2.2%
Vegetables	10	ESA	2.7%	3.6%	3.3%	3.4%	3.5%
	11	Eastern Africa	3.0%	3.9%	3.6%	3.8%	3.8%
	15	Southern Africa	2.1%	2.7%	2.4%	2.6%	2.6%

Source: Authors, based on IMPACT model results, RCP 8.5, SSP2, with 5 ISIMIP GCMs

Table 12 shows the 20 leading agricultural commodities for ESA (as of 2020) by weight. It includes livestock products alongside annual and perennial crops. These often get overlooked, and yet livestock are an important part of the agricultural sector in the region. Without the climate effect, highest rates of increase between 2020 and 2050 are seen for sorghum, vegetables, sweet potatoes, plantains, and wheat. The slowest projected growth rates in production are for maize and temperate fruits. This reflects both a change in the productivity of the crop along with a change in harvested area for the crop. Some of the growth is driven by changes in price that are driven by shifts in global supply and demand. However, it is worth mentioning that climate will alter the production of many of these crops, most within a 10 % range, and all within a 21 % range.

Table 12: Change in production of the 20 leading agricultural commodities in the region (by weight)

Commodity		**Percent change in**	**Percent difference from no-climate-change scenario, 2050**	
			No CO_2, fertilization	**With CO_2, fertilization**

	Production, 2020 (000s tons)	production, 2020-2050	Minimum	Median	Maximum	Minimum	Median	Maximum
Sugar cane	57,289	66.9	-1.0	3.3	6.0	-2.4	1.5	3.7
Maize	43,788	42.5	-3.2	2.7	8.3	-0.7	5.5	10.8
Cassava	32,873	75.7	-2.3	-1.3	0.2	-1.8	-1.0	0.7
Milk	22,900	77.9	-0.6	-0.2	-0.1	-0.5	-0.2	-0.1
Sweet potatoes	18,353	136.9	-2.7	-0.3	1.5	-3.4	-0.6	0.9
Vegetables	17,675	154.7	-19.2	-14.0	-11.3	-11.9	-6.5	-3.8
Bananas	9,822	76.2	-7.8	-0.5	2.8	-9.1	-1.8	1.6
Potatoes	9,384	57.1	-19.6	-10.9	-7.2	-21.0	-10.9	-7.1
Plantains	8,119	128.9	-11.7	-1.9	1.9	-7.6	3.7	7.9
Sorghum	7,316	154.9	1.9	3.1	3.9	2.6	3.6	4.3
Wheat	7,097	122.0	-12.3	-11.6	-7.7	-6.7	-5.6	-2.7
Beans	6,081	85.6	-1.6	2.1	7.0	-0.4	5.0	9.3
Teff, etc.	5,907	87.9	-12.7	-10.5	-5.0	-11.7	-9.7	-4.9
Tropical fruits	5,744	72.4	-5.7	-5.1	0.0	-4.9	-4.1	0.8
Rice	5,545	104.7	-5.3	-0.8	6.9	-8.1	-3.3	3.4
Beef	3,067	96.8	0.0	0.0	0.1	-0.2	-0.2	-0.1
Other roots	2,991	113.9	-2.4	-1.8	-1.2	0.6	1.2	2.0
Temperate fruits	2,930	31.9	-18.8	-10.9	-5.6	-13.9	-5.5	0.1
Barley	2,673	78.3	-10.2	-8.5	-3.6	-11.9	-10.3	-6.3
Poultry	2,619	100.1	-1.1	0.0	0.1	-0.1	0.7	0.8

Source: Authors, based on IMPACT model results. RCP 8.5, SSP2, with 5 ISIMIP GCMs.

4.2 Commodities of concern

A number of key agricultural commodities in the region play a crucial role in food security and agricultural development. There is a risk that changing climatic and water availability, rising demand, and price pressures, may be sources of vulnerability.

In this section, we explore the potential food security risks for major staples in the region, including maize, rice, wheat, and cassava. We also consider commodities which do not show favorable production or export outlooks to warrant attention.

The analysis is based on long-term projections of the food system, based on a version of the IMPACT model described in Rosegrant et al (2024).

Maize

Maize is a strategically important crop for food security and agricultural production. It is the main source of calories for consumers in most countries of East and Southern Africa. In countries such as Lesotho, Malawi, and Zambia, maize products account for more than half of the per capita calorie availability.

Major producers include South Africa, Ethiopia, Tanzania, Kenya, Uganda, and Malawi. Outside of South Africa, domestic production of maize is typically from smallholder farmers, cultivated under rainfed conditions. Between 2020 and 2030, production of maize is projected to grow by around 2.1 %per year, driven by higher production in Ethiopia, South Africa, and Tanzania. However, climate change effects are projected to cause a slowdown in this growth to around 1.0% per year, between 2030 and 2050.

In Kenya, Malawi, Uganda, and Zambia, more than 70 % of maize demand is for food, highlighting its importance for food security. However, in these countries, maize production is expected to grow by an average of 1.1 % over 2020-2030, and 0.6 % over 2030 - 2050. This is less than half of the projected demand growth in those countries.

Malawi is expected to produce less maize in 2050 than 2020, as rainfed maize yields fall as a result of climate change. Growth in maize production in Kenya and Tanzania is expected to slow to less than 1% per year between 2030 and 2050.

With strong demand for maize, covering this shortfall is likely to become an important challenge. This vulnerability extends through most of the region and is likely to lead to increased dependency on imports. Import dependency makes countries more vulnerable to price shocks, especially if global prices, or bilateral exchange rates, are volatile.

Countries such as Namibia, Botswana, Eswatini and Lesotho already rely on imports to meet their maize demand, although their currencies are pegged, or generally stable, with the South Africa's rand, which is often the major trade partner for food.

However, as production falls short of demand throughout many parts of the region, more countries in the region are expected to become significant net importers of maize.

Figure 26 shows the projected shift in the net trade of maize by countries in the region. Countries shaded in red are those where imports make up more than a quarter of food demand, indicating high import dependency, while countries shaded in green suggests surplus production available for exports. Countries shaded in yellow reflect those where exports or imports make up a minor share of food demand for maize.

Between 2020 and 2050, several countries are expected to show increased dependence on imports of maize, threatening food security in several countries, as maize is the key staple. The deterioration in net exports comes mainly from increased local demand, and limited growth in production, especially in areas where a warmer climate reduces expected maize yields. By 2035, more than two thirds of countries in the region are expected to have net imports of maize exceed 25% of household demand.

Uganda is expected to shift from being a net exporter to a net importer of maize. Tanzania, Zambia and Malawi, where imports typically make up less than 20 per cent of maize food demand, are expected to become highly dependent on imports.

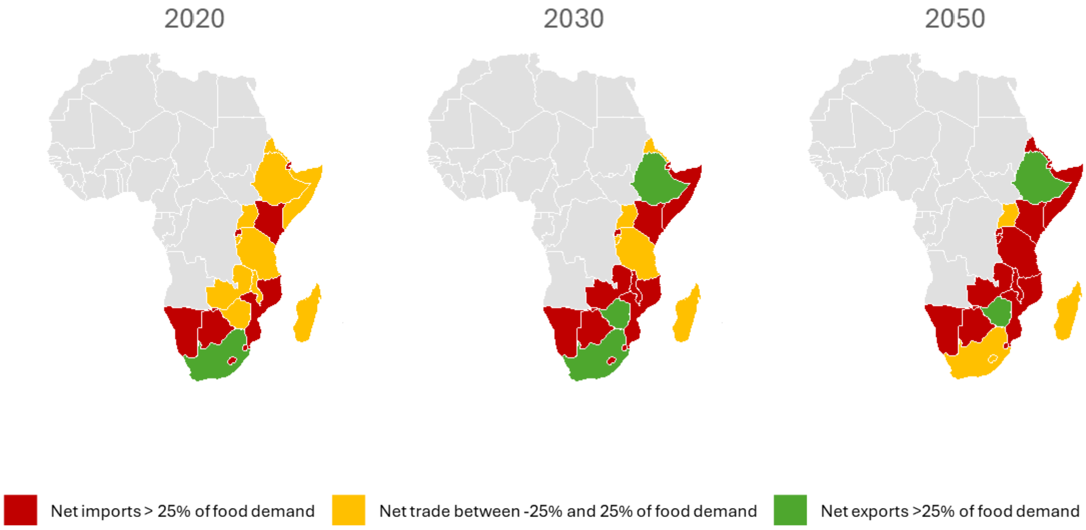


Figure 26: Net trade of maize, as a percentage of household food demand

Source of basic data: IMPACT model projections
Modelled scenario assuming SSP2 socio-economic projections and RCP7.0 emissions profile

On the other hand, Ethiopia and Zimbabwe are expected to emerge as net exporters of maize, due to favorable yield and a gradual expansion of crop areas. Ethiopia has considerable potential for maize exports and based on our projections, could be the region's largest net exporter of maize by 2050. Lesotho is projected to become more self-sufficient in maize, but its exportable supplies are expected to be minor.

South Africa is expected to remain a net exporter of maize, although the volume of exportable maize is expected to fall considerably, as demand for maize as livestock feed expands.

Maize exports in the region are unlikely to be sufficient to meet maize import demand from countries experiencing shortfalls in maize supply. Outside of the region, Angola is projected to become a net exporter, but this, too, is not expected to cover import needs.

This means that countries in East and Southern Africa are likely to need to import maize from outside the region. By 2050, the major exporters of maize are projected to be in Latin America (Brazil, Argentina) and in Europe (Ukraine, Russia, Romania). The longer distances from these supplies can lead to significant shipping costs, which are expected to exert further pressure on maize prices.

Efforts to improve maize production can go a long way in reducing the extent of import dependency; however, it is unlikely that the need for increased imports can be avoided. Still, given its importance in the food system in the region, approaches to reduce and manage import dependency can be meaningful to for food security, supporting smallholder farmers, promoting diversification of food systems, and encourage investments.

National and regional policies for climate-smart agriculture and improved water management, lower trade barriers, and improvements to infrastructure and supply chains can help to build resilience in the face of climate risks, and in managing economic risks that may affect food security.

Wheat

Wheat is a secondary staple in Ethiopia, Kenya, and much of Southern Africa, where it accounts for 10-20% of calorie availability, and is often the second-most important cereal after maize. It is not grown in significant quantities in the region. Production in East and Southern Africa accounts for about 1% of global production. Within that, only Ethiopia and South Africa are significant producers. There is little capacity for exportable wheat in those countries, as local demand is strong.

Yet, wheat is one of the most imported commodities in the region. All countries in East and Southern Africa were net importers in 2019, and this trend is likely to continue. Demand for wheat is expected to rise strongly, as population and income growth drive demand for wheat-based products such as flour and bread.

Global wheat prices are expected to increase moderately, and the anticipated volume of wheat imports in the region is expected to grow strongly in response to a sharp increase in demand. Between 2020 and 2030, regional food demand for wheat is projected to grow by 2.6 per cent per year, slowing to 1.6 per cent per year over the period 2030-2050, which could pressure food import bills of several countries.

Access to wheat in global markets is not expected to be difficult, as there are many countries projected to be net exporters of wheat, including Russia, Canada, and Ukraine. Wheat is entrenched in the food culture in many countries, including in East and Southern Africa, but there is limited potential for local production as the climatic conditions for wheat are not favorable.

Rice

Rice is the key staple in Madagascar, accounting for more than half of average calorie availability. It is also a significant component of the average diet in Djibouti, Eswatini, Mozambique, and Tanzania. Like wheat, rice is one of the most imported agricultural commodities in the region. Most countries in the region are heavily dependent on imports of rice, as domestic production capacity is limited.

Madagascar is close to being self-sufficient in rice. Projections suggest that an expansion of crop area and rice yields could push production well beyond domestic demand, and lead to exportable surpluses. Madagascar is the only country in the region for which large net exports of rice are projected. Tanzania is also a large producer of rice, although it imports around 20% of its food needs.

Future demand for rice is projected to be large. Aggregate rice demand between 2020 and 2030 is expected to grow by an average of 2.8% a year, and by 1.9% a year between 2030 and 2050. Much of the demand is expected to come from Madagascar, Tanzania, and Kenya. Although Tanzania produces a significant amount of rice, local production is not expected to keep up with rising household demand. Kenya is expected to remain heavily dependent on imports to meet rice demand.

Rice, already one of the most expensive cereal commodities, is expected to see an increase in global prices. With strong dependence on rice imports, the impact on food import bills is expected to be significant. Pakistan, India, Thailand, and the United States are likely to remain the main net exporters of rice.

Cassava

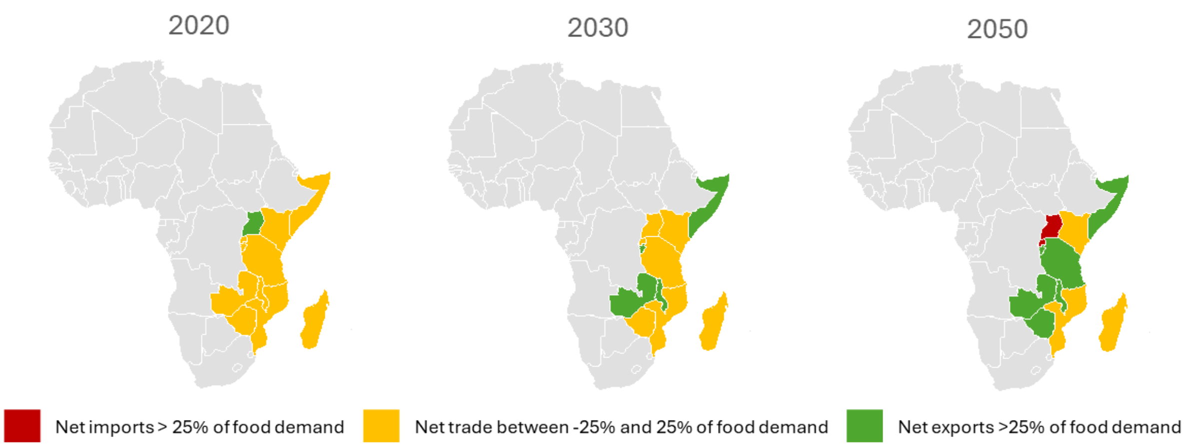


Figure 27: Net trade of cassava, as percentage of household food demand

Source of basic data: IMPACT model projections

Modelled scenario assuming SSP2 socio-economic projections and RCP7.0 emissions profile

Cassava is an important staple in Burundi, Zambia, Mozambique, Madagascar, and Rwanda, and is widely produced throughout the region. As cassava tends to be a drought tolerant crop, it is expected to be more resilient under climate change than other staples, such as maize.

IMPACT projections suggest that cassava production could grow relatively faster than demand in most countries in the region. Burundi, Kenya, Tanzania, and Zambia are expected to show a pronounced increase in production owing to better yields. Only Uganda is projected to show lower cassava production in 2050, compared with 2020.

The excess production of cassava suggests that it could be used as an alternative staple should other crops, like maize, be insufficient. Cassava products are often made by small-scale operations and requires complex processing.

In the face of food security challenges under climate change, there may be scope to invest in cassava processing and related infrastructure. As a result of improved production, more countries are expected to have surpluses to export. ***Figure 27*** shows that more countries in the region are projected to have exportable supplies of cassava.

However, cassava is rarely traded because of its low shelf life, and may, at best, be traded with neighboring countries. Nevertheless, there may be opportunities for trade to cover shortfalls. For example, projections indicate that Uganda and Rwanda would be large net importers of cassava, but neighboring Tanzania is projected to have large enough surpluses to supply unmet needs. Angola and the Democratic Republic of Congo, although not considered as part of this regional grouping, are also projected to show large shortfalls in cassava supply.

There may also be further opportunities to export processed cassava products to markets such as Nigeria. However, these should be taken into the context of other producers in Central and West Africa that may have exportable surpluses, such as Ghana and Cameroon.

Vegetables

Most countries in the region are self-sufficient in the production of vegetables. However, this is likely to change as domestic output is projected to be slower than demand in many countries. In Tanzania, for example, household demand for vegetables is projected to grow by an annual average of close to 3% per year-driven mostly by stronger anticipated growth in population and income.

However, production of vegetables is expected to expand by less than 0.5% per year. This is expected to create considerable pressure for imports to satisfy domestic demand. Zambia, Rwanda, and Uganda are projected to face similar challenges.

Conversely, Kenya, Malawi, and Mozambique are projected to show strong growth in vegetables production over the period 2020 to 2050.

Figure 28 shows that, in 2020, most countries were close to self-sufficient in "the demand of vegetables. By 2050, several are expected to rely on imports to meet food demand. The robust growth in production can support exports and potentially ease anticipated shortfalls in nearby countries.

However, the degree to which imports can be used to meet unmet domestic demand largely depends on the cost and feasibility of such trade – including storage and transport – which can differ by the specific type of vegetable considered. Because of this higher cost, vegetables can exert significant pressure on a country's import bill. Like cassava, however, vegetables are easily perishable, so their viability for trade is limited to relatively short distances.

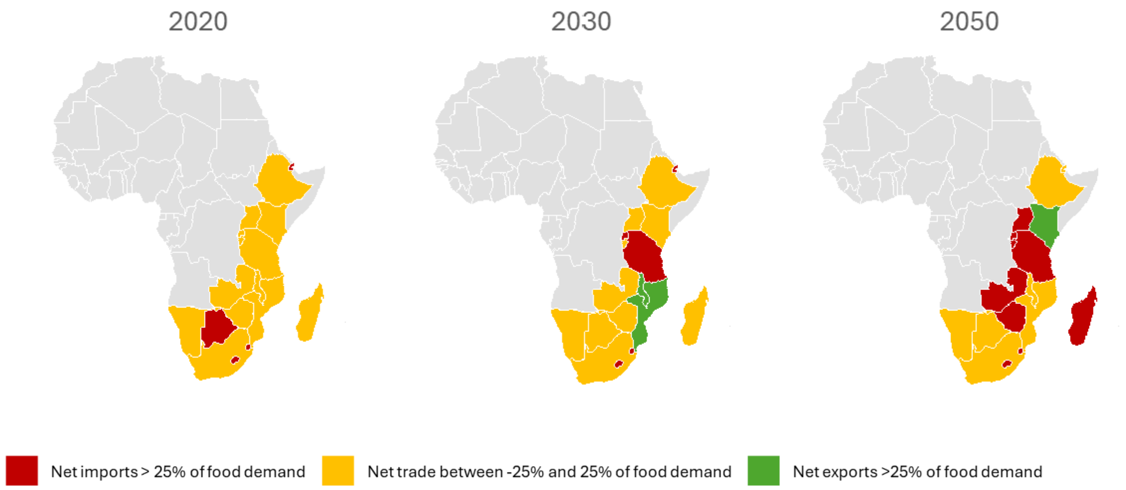


Figure 28: Net trade of vegetables, as percentage of household food demand

Source of basic data: IMPACT model projections

Modelled scenario assuming SSP2 socio-economic projections and RCP7.0 emissions profile

Potato

As shown in ***Table 9***, the direct climate impact on potato yields is projected to be negative in Eastern and Southern Africa. While the yield impact is greater in Southern Africa, more of the region's potato cultivation takes place in Eastern Africa. It is an important component of the agricultural sectors of Rwanda, where roots, tubers, and bananas are the major agricultural commodities. Table 9 continues to show that potato production for the region as a whole is expected to decline.

Potato production is a significant component of the agricultural sectors in the region. Major producers, such as Kenya, Malawi, Rwanda, and Tanzania, are expected to experience low to negative growth in output between 2020 and 2050. Potatoes are an important component of agricultural production in Rwanda, where roots, tubers, and bananas account for about one-third of agricultural land.

4.3 Key findings

Eastern and Southern Africa is vulnerable to climate change. Northern parts of East Africa (Djibouti, Eritrea, Ethiopia, Uganda, and Somalia) are expected to be wetter, while much of Southern Africa is expected to be warmer.

These conditions are expected to affect agricultural productivity in key crops such as maize, wheat, and potatoes, where rainfed yields are expected to fall. Yields of commodities such as rainfed soybeans, and sorghum, are expected to increase throughout the region. Climate change indirectly affects the allocation of cropland, as farmers consider the effect of yields in the context of market prices for different commodities.

As a result, production of commodities such as vegetables, potatoes, wheat, teff, and barley are expected to come under considerable pressure, as lower yields affect agricultural productivity. Crops such as maize, wheat, cassava, and rice are critical for food security in the region. Maize is especially vulnerable to climate change, and most of the region is projected to become highly dependent on imports to meet demand.

Wheat and rice are not widely produced, as climatic and technical conditions are not feasible in many areas of the region. Growing food demand for these commodities is expected to add further pressure on food imports.

Meanwhile, long-term production outlooks for cassava are favorable, as it is generally drought resistant; however local demand growth is projected to be weak. Although not generally considered to be a tradeable good, cassava exports may be feasible across short distances, allowing some food trade to smooth shortages if necessary.

Similarly, the potential for trading vegetables across the region is limited due to potentially low shelf lives. There may be opportunities for cross-border trade networks to support food security.

Identifying these vulnerabilities and constraints aim to inform policymakers about important considerations at the intersection of climate change, food security and nutrition, agricultural development, and trade policy. The climate projections and their expected impacts on agriculture underscore the need for forward-looking approaches.

Building on these insights, **Chapter 5** presents scenario-based planning tools to explore possible futures for agriculture in Eastern and Southern Africa, identifying key choices and investments needed for climate-resilient, pro-poor agricultural development.

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Chapter 5: Pro-Poor Agricultural futures in ESA- Insights from Scenario planning

Shiluva Nkanyani, Sithembile Mwamakamba and Noah Zimba

5.1 Introduction

Agriculture plays a critical role in East and Southern Africa's economy, contributing significantly to GDP and employment. Approximately 67% of the labor force is engaged in agriculture, which accounts for 30-40% of GDP in many countries (World Bank 2024). However, agricultural productivity has stagnated, particularly affecting smallholder farmers who are often the poorest. The region faces severe vulnerabilities due to climate change, economic instability, and food insecurity. For instance, over 50% of the population is chronically undernourished, with countries like Madagascar and Ethiopia experiencing significant food insecurity exacerbated by extreme weather events (FAO 2024).

The production of maize, a main staple crop in the region, is essential for ensuring food security and sustainable livelihoods. Still, its productivity remains low, partly owing to the negative effects of climate variability. While the negative effects of climate change are prevalent, knowledge about how to adapt in the face of climate change is scarce, which undermines adaptation efforts.

Scenario planning allows stakeholders to envision different future scenarios based on various assumptions regarding economic conditions and environmental changes. This foresight helps farmers and policymakers develop adaptive strategies to mitigate risks associated with climate variability and market fluctuations (Powers et al. 2021).

By exploring diverse scenarios, agricultural planners can identify strategies that enhance resilience among vulnerable populations. For example, integrating climate-smart agricultural practices can reduce dependency on single crops like maize, which is susceptible to price volatility and input shortages (Schmitt Olabisi et al. 2020).

As a result, the scenario planning process facilitates discussions among stakeholders, including government agencies, NGOs, and local communities about inclusive growth strategies that prioritize the needs of the poorest farmers. This collaborative approach can lead to targeted interventions that improve access to resources such as credit, training, and technology (Lukyanova et al. 2020). Furthermore, effective policies need to be informed by potential future scenarios that consider socio-economic dynamics and environmental changes. This helps create a conducive environment for agricultural growth while addressing poverty reduction goals (Lukyanova et al. 2020).

The CGIAR initiative on Diversification for Resilient Agrifood Systems in East and Southern Africa also known as Ukama Ustawi (UU), is designed to use science-based evidence to empower farmers, value chain actors, and consumers in maize-mixed systems by promoting climate-smart intensification, diversification practices, improved water and land management, digital agro-advisory, agricultural risk management (ARM) solutions, and sustainable agribusiness development.

To support countries within the ESA region, the Ukama Ustawi initiative, in collaboration with IWMI, FANRPAN and IFPRI convened a participatory scenario development workshop from 13 – 14 June 2024 in Pretoria, South Africa bringing together key stakeholders from across the region to engage in a collaborative and forward-looking process to explore potential future scenarios and strategies for enhancing agrifood systems in the region to enhance resilience and adaptability.

The workshop facilitated a multi-stakeholder dialogue, acknowledging the region's multifaceted challenges. Participants identified a range of predictable trends, including socio-economic shifts, evolving environmental governance, technological advancements, and changing dietary patterns. Critically, the discussions moved beyond simply recognizing these trends to identifying key uncertainties that could profoundly reshape the future of the maize-mixed system.

Through a dynamic group process, stakeholders developed detailed narratives for each scenario, weaving together potential future contexts shaped by climate change, technological innovation, policy decisions, economic forces, societal values, and other factors that shape the food systems as outlined in (Matchaya et al. 2023). IFPRI enriched these narratives by modeling the potential consequences of various choices and decisions within each scenario, providing valuable quantitative insights. By providing a robust, evidence-based foundation for understanding potential future pathways, this initiative empowers stakeholders to develop proactive and adaptive strategies, ultimately contributing to a more sustainable and food-secure future for the region.

5.2 The Scenarios Development Approach

The scenario development workshop served as an important platform that brought together key regional stakeholders to collectively explore and develop plausible future scenarios for agriculture and food security in the ESA region. Through discussion, against a list of trends not limited to (social and economic development; demographic shifts and urbanization; environmental governance and growing emphasis on sustainable food systems; the adoption and dissemination of agricultural technologies; and shifting dietary patterns) were regarded as predictable. The two trends (population growth and higher life expectancy) were impactful trends (or critical uncertainties) that have high uncertainty in the way they would develop and shape the food system.

During the workshop, stakeholders created narrative storylines for different scenarios. These storylines described the potential future contexts, considering various drivers and uncertainties related to climate, technology, policy, economics, and societal factors. Participants provided additional insights by drawing on work around, modeling the potential consequences of different choices and decisions under the conceived scenarios provided. After the workshop, the developed scenarios were refined based on stakeholder feedback and input. The goal was to ensure the scenarios were coherent and plausible and captured a range of uncertainties.

This iterative process ensures that the scenarios accurately represent the diverse perspectives and potential future trajectories. The goal was to create awareness and stimulate discussions around the implications of different future pathways. These scenarios are intended to serve as a valuable baseline to conceptualize inputs for policymakers, decision-makers, and stakeholders to develop adaptive strategies and policies that align with the potential future.

Observed changes in Maize-mixed food systems

The maize food system has experienced significant transformations in response to various socio-economic factors with reference to population growth, increased educational attainment, and human and industrial interference with natural resource habitats, alongside challenges posed by pests and diseases. These changes have notably affected productivity, often resulting in reduced maize output across different regions. Some notable changes emerging from the workshop discussions include the following:

- **Shift from Monoculture to Diversified Cropping Systems -** Stakeholders noted a shift from predominantly maize monoculture to the integration of diverse crops, including legumes (beans, cowpeas), tubers (sweet potatoes, cassava), and vegetables. Signifying a change towards the enhancement of soil fertility, reducing pest and disease pressures, and improving resilience against climate variability. Socio-economic factors influencing this shift include the need for sustainable farming practices to cope with reduced productivity, as well as land pressure, which drives farmers to maximize output by intercropping or mixing crops (Biazin et al. 2012; Babinga 2022).

- **Adoption of Climate-Smart Agriculture -** Participants highlighted a move from conventional farming practices with minimal adaptation to climate change to the implementation of climate-smart agricultural practices such as conservation agriculture, agroforestry, and water harvesting techniques. Reflecting an increased awareness and proactive approach to mitigating the impacts of climate change on maize production and overall food security, driven by educational improvements and structured awareness campaigns (Setimela et al. 2017; Partey et al. 2018).

- **Increased Focus on Nutrition and Food Security -** Stakeholders reported a shift from a narrowed focus on maize as the primary food and income source to diversified diets with a combination of maize and other nutrient-rich crops, addressing micronutrient deficiencies. This represents a shift towards more holistic food systems that aim to improve overall nutrition and health outcomes for rural communities. An increase in wealth strengthening individual purchasing power and improved education has resulted in dietary diversification and adjustments (Omotoso 2024; NEPAD 2022).

- **Integration of Livestock and Crop Production -** There has been a shift from separate and less integrated crop and livestock systems to mixed farming systems driving and epochal integration between livestock and crop production, providing manure for soil fertility and using crop residues as livestock feed. This shift demonstrates a move towards more sustainable and closed-loop farming systems that enhance resource use efficiency and farm productivity (Biazin et al. 2012; Setimela et al. 2017).

- **Market Access and Value Addition -** Stakeholders highlighted a positive transformation in the experiences of maize farmers, as they moved from restricted market access to improved market linkages, robust value chains, and innovative products such as fortified maize flour. This shift represents the economic empowerment of farmers through better market integration and value addition, resulting in higher incomes and diversified livelihoods. The growth of commerce, particularly informal trade, significantly impacts dietary habits and economic prospects (TAAT Maize Compact 2023; Babinga 2022).

- **Urbanization and Dietary Changes –** The participants shed light on an observed shift from traditional organic dietary habits towards increased consumption of fast foods driven by accelerated urbanization trends as younger generations migrate from rural areas for urban opportunities – reflecting a changing population and evolving dietary patterns (Omotoso 2024; NEPAD 2022).

Stakeholders in the region recognize that the transformation of the maize food system from traditional, less diverse practices to more integrated, diversified, and sustainable approaches signifies a pivotal shift toward enhancing agricultural resilience, improving food security, and fostering economic empowerment among farming communities in ESA.

This evolution not only addresses the pressing challenges posed by population growth, climate change, and market dynamics but also promotes a more holistic and adaptive agricultural framework. By embracing these changes, stakeholders can better equip farmers to thrive in a rapidly changing environment, ultimately contributing to the region's long-term sustainability and prosperity.

Drivers and Trends of maize production in East and Southern Africa

Key drivers and trends of maize production in the ESA region include population growth, which has increased demand for food; advancements in education that enhance farmers' capacity to adopt new practices; and environmental challenges such as climate change and land degradation. Additionally, evolving market dynamics and trade policies play a crucial role in shaping maize production trends.

Understanding these drivers is essential for developing effective strategies that promote sustainable agricultural practices and improve the resilience of farming communities in ESA. The following section will delve into the specific trends influencing maize production in the region.

- **Population Growth and Higher Life Expectancy** - Rapid population growth and increased life expectancy have heightened the demand for food, making it imperative to optimize agricultural output on finite land resources to ensure food security. This demographic and environmental context necessitates a transition towards more diversified and sustainable agricultural practices (United Nations 2019).
- **Access to Inputs and Production Technologies** - Limited access to improved seeds continues to constrain net yields per hectare. Stakeholders pointed out that most smallholder farmers in the region, who constitute the bulk of the agricultural workforce, are registering low productivity — less than 40% of their yield potential — due to the lack of improved seed varieties (Nash et al. 2013).
- **Environmental Degradation** – Deforestation, driven by the conversion of forests to agricultural land, has diminished crucial carbon sinks, thereby exacerbating climate change and its associated volatility. Human and industrial activities, including deforestation and land degradation, have forced farmers to adopt more sustainable practices, such as agroforestry and conservation agriculture, to mitigate environmental degradation and preserve soil fertility. Persistent use of inappropriate production technologies and poor agricultural practices will continue to degrade soil health, further eroding maize productivity (FAO 2021; WWF 2023).
- **Urbanization and Industrial Activities** - Urbanization and mining have compounded changes in countries like South Africa and Zambia (UNECA 2017; UNECA 2018). Mining land remains unrehabilitated, and significant portions of state-owned and traditional land remain unproductive. Efforts to bring communal land into production in South Africa have been largely unsuccessful. However, while South Africa faces physical water scarcity, the country has experienced bumper harvests due to a combination of favorable climatic conditions, the adoption of high-tech farming practices — including improved seed varieties and advanced soil management techniques coupled with the strategic use of technology to optimize water use for irrigation (World Bank 2020).
- **Climate Change** - The increasing frequency and severity of climate events have highlighted the vulnerability of traditional maize monocultures. As a result, there is a growing adoption of climate-smart agriculture practices that enhance resilience to climate variability and ensure long-term food security. Stakeholders noted that climate variability and change would likely instigate volatility in food prices, exacerbated by high population growth. This volatility directly affects both the availability and access to maize, a staple food in the region (IPCC 2022; Partey et al. 2018).
- **Post-Harvest Losses** - Post-harvest losses, affecting as much as 40% of the maize produced, significantly erode the returns of farmers (Affognon, Mutungi, Sanginga, & Borgemeister, 2015). Low investment in post-harvest technologies and infrastructure remains a challenge across all countries in the region, except for South Africa. This issue highlights the need for better storage, processing, and transportation solutions to reduce losses and improve farmer incomes (FAO 2021).

- **Linkages to Markets** - The stakeholders emphasized that persistently weak market linkages act as a substantial deterrent to increased entrepreneurial activity in the agricultural sector. Even in the presence of surpluses, produce often goes to waste due to market access limitations – this recurring issue hampers the economic potential of maize production and discourages farmers from increasing their output (UNECA 2018; World Bank 2020).
- **Systematic Poor Trade Performance** – While quality requirements and food safety standards are in place, awareness and understanding of these standards remains limited, particularly among smallholder farmers. The region's agricultural trade potential remains significantly hampered by systemic challenges. These challenges include trade barriers, underdeveloped trade infrastructure, and difficulties in meeting quality and safety standards, all of which contribute to persistently poor trade performance. While the existence of trade policies and the implementation of the African Continental Free Trade Area (AfCTA) offer a framework for progress, achieving the ambitious goals of these initiatives necessitates addressing these fundamental, systemic issues (UNECA 2017; AfCFTA Secretariat 2023).
- **Government Policies and Support** - Policies promoting sustainable agriculture, improved infrastructure, and market access have played a crucial role in driving change. Government initiatives supporting research and development, extension services, and farmer education have facilitated the adoption of new practices and technologies (World Bank 2020).

These drivers collectively illustrate the dynamic interplay of socio-economic, environmental, and policy factors shaping the maize food system in ESA. They highlight the need for continued adaptation and innovation to ensure sustainable and resilient agricultural practices in the region.

Anticipated future drivers of maize production in East and Southern Africa

Stakeholders identified several anticipated future drivers that are poised to significantly influence maize production in the ESA region. These insights reflect a collective vision for the agricultural sector's evolution in the region. As the landscape of agriculture continues to change due to factors such as climate variability, technological advancements, and shifting market dynamics, understanding these potential drivers is crucial for developing adaptive strategies.

This section explores the key factors anticipated to shape the future of maize production, highlighting the importance of proactive measures to ensure sustainability and resilience in the face of emerging challenges:

- **Technological Advancements** - Stakeholders underscored the pivotal role of emerging technologies in the future of maize production. Innovations in precision agriculture, biotechnology, and digital farming tools are anticipated to yield substantial gains in productivity, efficiency, and sustainability. The importance of sustained investment in agricultural research and development was emphasized to ensure that these cutting-edge technologies are accessible to smallholder farmers (Setimela et al. 2017; Gennaro and Forleo 2019).
- **Climate Change Adaptation** - Participants emphasized the importance of continuous adaptation strategies in response to the challenges posed by climate change. Future efforts will focus on developing and disseminating climate-resilient crop varieties, improving water management practices, and adopting integrated pest management strategies. Stakeholders stressed the importance of proactive measures to mitigate the impacts of climate variability on maize production (Saddique et al. 2020; Affognon et al. 2015).

- **Market Dynamics and Trade Policies** - Stakeholders anticipate that evolving market dynamics and trade policies will significantly influence maize production. Enhanced market access, regional trade agreements, and value chain development are expected to create new economic opportunities for farmers. Participants noted the necessity of aligning trade policies with quality and safety standards to facilitate smoother intra-regional trade (UNECA 2018; World Bank 2020).
- **Urbanization and Dietary Shifts** - Participants observed that urbanization and associated dietary shifts will continue to drive changes in maize production. The increasing urbanization trend will drive a surge in demand for a wider variety of convenient food options. This trend will encourage farmers to diversify their crops and engage in value-added processing to meet evolving consumer preferences (UNECA 2017).
- **Improved Participation of Women** - Stakeholders highlighted that enhancing the participation of women in agriculture is crucial for future maize production. Despite current support measures, women continue to encounter substantial obstacles, highlighting the inadequacy of existing efforts. Furthermore, prevailing inheritance systems and land ownership patterns represent a significant factor that will continue to shape access to productive resources for people in the region (FAO 2021; Gennaro and Forleo 2019).
- **Youth Engagement and Education** - Stakeholders stressed the importance of actively involving youth in the agricultural sector. Future drivers include targeted education and training programs aimed at attracting youth to the agricultural sector, as such participants highlighted the need for policies and initiatives that make farming an attractive and viable career option for young people (World Bank 2020; UNECA 2018).
- **Sustainable Land and Water Management** - Participants noted that sustainable land management practices will be pivotal in the future. Preventing land degradation, rehabilitating unproductive lands, and conserving natural resources will be essential for ensuring long-term agricultural productivity. Stakeholders called for increased efforts to promote agroecological approaches and land restoration projects (Saddique et al. 2020).
- **Financial Inclusion and Investment** - Stakeholders highlighted the importance of financial inclusion and investment in the agricultural sector. Future drivers include improved access to credit, insurance, and investment opportunities for smallholder farmers. In addition, participants stressed the need for innovative financial products and services tailored to the needs of the agricultural community (UNECA 2018; World Bank 2020).
- **Extension Services and Knowledge Transfer** - Participants observed that the role of extension services in transferring knowledge and skills is crucial for achieving improved productivity. Enhanced access to production technologies, such as irrigation, is necessary to adapt to the impacts of climate variability and change. Extension services are crucial to equip farmers with the knowledge and resources necessary to extend growing seasons and successfully transition from rain-fed to irrigated agriculture (Setimela et al. 2017; Affognon et al. 2015).
- **Policy Support and Governance** - Participants agreed that strong policy support and effective governance will be crucial for driving future changes. Comprehensive agricultural policies, robust extension services, and transparent governance structures will create an enabling environment for sustainable maize production. Stakeholders called for continued collaboration between governments, private sector, and civil society to achieve these goals (UNECA 2017; FAO 2021).

These anticipated future drivers highlight the importance of a multifaceted approach to enhancing maize production in ESA. By addressing these drivers, the region can work towards achieving sustainable agricultural development and food security in the coming years.

Identifying the most critical uncertainties

In the context of maize production in East and Southern Africa (ESA), stakeholders engaged in a comprehensive discussion to identify the most significant uncertainties that could impact the future of farming in the region. These uncertainties encompass a range of critical factors, including environmental variability, market fluctuations, and socio-economic changes.

By recognizing these key uncertainties, stakeholders aim to better understand the potential challenges and opportunities that lie ahead for maize-mixed farming. This section outlines the critical factors identified during the discussions, emphasizing their implications for agricultural planning and decision-making in the region.

- **Climate Change**: Stakeholders expressed significant concern regarding the potential impact of climate change on maize production, particularly through alterations in rainfall patterns, increased frequency of droughts, and the occurrence of extreme weather events. These changes can disrupt the growth cycle of maize, leading to substantial uncertainty about future yields. Research indicates that rising temperatures and shifting climatic conditions may exacerbate these challenges, further complicating agricultural planning and management (Lobell et al. 2011; IPCC 2022).
- **Pest and Disease Outbreaks**: The emergence of pests such as the fall armyworm (*Spodoptera frugiperda*) and diseases like maize lethal necrosis disease poses a significant threat to maize harvests. Stakeholders highlighted the uncertainty surrounding the forecasting of these outbreaks and the effectiveness of control measures. Improved pest and disease management strategies are essential to mitigate these risks and safeguard maize production (Kassie et al. 2019; Plantwise 2022).
- **Market Pricing and Economic Conditions**: Fluctuations in both local and global maize prices can directly affect farmers' earnings and their ability to invest in improved inputs and technologies. Stakeholders noted that economic instability in the region could exacerbate this uncertainty, impacting the overall viability of maize farming. Understanding market dynamics is crucial for developing strategies that enhance resilience against price volatility (World Bank 2020; UNECA 2018).
- **Access to Technology and Inputs**: Access to improved maize varieties, fertilizers, and other agricultural inputs is vital for enhancing productivity. Stakeholders identified uncertainties related to infrastructure, policy support, and affordability that could impede the widespread adoption of these technologies. Addressing these barriers is essential for improving agricultural outcomes in the region (Nash et al. 2013; FAO 2021).
- **Political Stability and Policy**: Government policies regarding agriculture, trade, and land use significantly influence maize output. Stakeholders noted that political instability could disrupt agricultural operations and hinder market access, creating an unpredictable environment for maize production. Strong governance and stable policies are necessary to foster a conducive atmosphere for agricultural growth (UNECA 2017; World Bank 2020).
- **Water Availability:** The reliability of water resources for irrigation is increasingly uncertain due to growing competition for water and climate change impacts on water availability. Stakeholders emphasized the critical importance of effective water management practices to address these uncertainties and ensure sufficient irrigation for maize production (Saddique et al. 2020; FAO 2021).

- **Efficacy of Agricultural Research and Extension Services**: The effectiveness of agricultural research and extension services in disseminating information and technology to farmers is paramount for enhancing productivity. Stakeholders expressed concerns about uncertainties related to funding, coordination, and outreach of these services, which are essential for advancing maize production practices (Setimela et al. 2017, 2024; Kassie et al. 2019).
- **Changes in International Trade Policy**: Alterations in tariffs, export restrictions, and other international trade policies can significantly impact maize markets. Stakeholders discussed how these changes could influence production decisions, adding another layer of uncertainty to the agricultural sector's dynamics (UNECA 2018; World Bank 2020).

The identification of these critical uncertainties highlights the imperative for strategic planning and adaptive measures to effectively address the challenges facing maize production in East and Southern Africa (ESA).

By prioritizing sustainable development practices and fostering collaboration among stakeholders, the region can better navigate uncertainties and secure a more stable and productive future for maize farming. This forward-looking strategy will be crucial in ensuring food security and economic empowerment for farming communities in ESA.

Presented Scenario Cases

To provide a predictive framework for maize productivity in East and Southern Africa (ESA), stakeholders outlined several scenarios that reflect potential future developments in the maize food system. These scenarios serve as a matrix for understanding the various factors that could influence maize production dynamics in the region.

Scenario 1: Increased prices of maize

Stakeholders predicted that maize prices could rise significantly due to insufficient availability, primarily driven by low yields resulting from inadequate production technologies and their limited adoption. As demand continues to outstrip supply, market dynamics are expected to push prices higher. This scenario raises concerns about exacerbating food insecurity, particularly in a region where maize is a staple food. The implications of rising prices could lead to increased economic pressure on consumers, necessitating urgent policy interventions to stabilize the market and protect vulnerable populations (World Bank 2020).

Scenario 2: Politics of maize

The politicization of maize as a staple food was highlighted as a critical concern among stakeholders. The significant political interest surrounding maize can hinder efforts to diversify the food basket, posing a regional threat to food security. Stakeholders emphasized that without measures to mitigate political influences and promote agricultural diversification, socio-economic and political consequences will persist. They advocated policy interventions aimed at depoliticizing maize and fostering a more diverse agricultural landscape to enhance food security (UNECA 2018).

Scenario 3: Maize a leading crop in 2050

Participants foresaw that maize would continue to be a leading crop by 2050, driven by sustained consumer demand and deeply ingrained cultural habits surrounding its consumption. As a fundamental food source, maize is likely to remain central to the regional diet, influencing consumer behaviors and preferences. Despite potential challenges, stakeholders predicted that maize's cultural significance would ensure its continued prominence in agricultural systems across ESA (FAO 2021).

Scenario 4: Diversification from Maize-mixed systems

In response to the fluctuations in maize production caused by climatic factors, stakeholders discussed the necessity for diversification within agricultural systems. They envisioned a future where integrated investments and campaigns would facilitate the transition to alternative food crops that are more adaptable to climate change.

By diversifying away from maize, the region could enhance its resilience to climate impacts and reduce reliance on a single crop. This scenario suggests that maize would gradually assume a more varied role within a diversified agricultural framework, serving as an adaptation strategy to ensure long-term food security (Babinga 2022).

Policy Implications and Key Recommendations

The role of maize as a strategic staple food for East and Southern Africa cannot be undermined. The future of maize production in ESA, as depicted by the four scenarios discussed during the workshop, presents a range of challenges and opportunities. To navigate these potential futures effectively, it is crucial to implement targeted policies that address the unique needs and circumstances of each scenario. The following section outlines the policy implications and corrective measures necessary to ensure sustainable and resilient maize production in the region.

By addressing these policy implications, governments and stakeholders can create a more resilient and sustainable maize production system in ESA, capable of meeting the region's food security needs in the face of future uncertainties.

Table 13: Policy implications for Scenarios and Recommendations

Scenarios	Policy Implications	Recommendations
Increased prices of Maize	In this scenario, maize prices rose significantly due to insufficient availability caused by low yields. This scenario demands a comprehensive approach to stabilize maize prices and improve productivity.	**Investment in Agricultural Technologies** - Governments should prioritize investments in advanced and appropriate agricultural technologies that can boost maize yields. Policies should encourage the development and adoption of innovative farming practices, precision agriculture, and biotechnology. **Subsidies and Incentives** - Provide subsidies and financial incentives for farmers to adopt high-yield and climate-resilient maize varieties. This can help mitigate the impact of low yields and stabilize maize prices. **Market Regulation -** Implement policies to regulate the maize market, preventing excessive price volatility and ensuring fair pricing mechanisms. This could include setting price floors or ceilings and monitoring market activities to prevent exploitation.

Scenarios	Policy Implications	Recommendations
Politics of Maize	In this scenario, maize remains highly politicized, hindering efforts to diversify the food basket and posing a significant regional threat.	**Depoliticizing Maize** - Formulate policies to reduce the politicization of maize and promote a balanced approach to food security. This could involve separating agricultural policy from political agendas and focusing on evidence-based decision-making. **Diversification Strategies** - Develop and implement policies that encourage the diversification of the food basket. This includes supporting the cultivation and consumption of alternative crops that can complement maize and enhance food security. **Inclusive Governance** - Ensure that agricultural policies are inclusive and consider the voices of all stakeholders, including farmers, consumers, and industry representatives. This can help create a more equitable and transparent policy environment.
Maize as a leading crop in 2050	In this scenario, maize continues to be a leading crop, driven by sustained consumer demand and cultural preferences.	**Consumer Education** - Launch educational campaigns to raise awareness about the benefits of a diverse diet while respecting cultural preferences for maize. Encourage the incorporation of other nutritious crops into daily diets. **Support for Traditional Farming** - Provide support for traditional maize farming practices that are sustainable and culturally significant. Policies should aim to preserve indigenous knowledge and promote agroecological farming methods. **Research and Development** - Increase funding for research and development focused on improving maize varieties that are high-yielding, nutritious, and resilient to climate change. This ensures that maize remains a viable and beneficial crop for the future.
Diversification from Maize-mixed **systems**	In this scenario, the fluctuations in maize production caused by climatic factors necessitate diversification to alternative food crops.	**Promotion of Alternative Crops** - Formulate policies that promote the cultivation of alternative crops that are adaptable to climate change. This includes providing support for research, seed distribution, and farmer training programs for these crops. **Integrated Investment Programs** - Develop integrated investment programs that focus on improving the entire agricultural value chain. This includes investments in infrastructure, storage facilities, and processing units for both maize and alternative crops. **Climate Adaptation Policies** - Implement climate adaptation policies that support diversified farming systems. Encourage practices such as intercropping, crop rotation, and agroforestry to build resilience against climate variability.

5.3 Summary of Key Findings

The Pro-Poor Agricultural Futures in East and Southern Africa section of the report presents several critical insights into the challenges and opportunities within the maize-mixed farming systems in the region. The area faces significant vulnerabilities stemming from climate change, economic instability, and food insecurity, with more than 50% of the population experiencing chronic undernourishment. Agricultural productivity has stagnated, particularly impacting smallholder farmers who are often among the poorest. This stagnation is further exacerbated by low maize productivity, which is influenced by climate variability and insufficient adaptation strategies.

The scenario planning approach has emerged as a valuable tool for stakeholders, enabling them to collaboratively envision diverse future contexts and develop adaptive strategies that enhance resilience in agricultural systems against uncertainties such as climate variability and market fluctuations. Notable observed shifts within the region include a transition from monoculture to diversified cropping systems, an increased adoption of climate-smart agricultural practices, and a heightened focus on nutrition and food security. These changes reflect a growing recognition of the need for sustainable agricultural practices that can better withstand environmental pressures while improving food security outcomes for vulnerable populations.

Looking Ahead: What is the role for the region in diversification?

The region should prioritize diversification to enhance resilience against climate variability and market fluctuations. Stakeholders are encouraged to shift from maize monoculture to diversified cropping systems, which improve soil fertility and overall resilience. Additionally, implementing climate-smart agricultural practices, such as conservation agriculture and agroforestry, can help mitigate the adverse effects of climate change on maize production. Furthermore, strengthening market linkages and value chains will economically empower farmers and facilitate dietary diversification, ultimately contributing to a more sustainable agricultural landscape.

What is the role for programs such as Ukama Ustawi?

Programs such as Ukama Ustawi play a pivotal role by empowering stakeholders and providing evidence-based strategies for farmers, value chain actors, and consumers to promote climate-smart intensification and diversification practices.

Furthermore, these programs facilitate collaboration, bringing together diverse stakeholders to co-create adaptive strategies that address regional agricultural challenges. Lastly, programs like Ukama Ustawi support policy development by informing effective agricultural policies that consider socio-economic dynamics and environmental changes.

The transformation of the maize food system in East and Southern Africa signifies a crucial shift towards more integrated, diversified, and sustainable agricultural practices. This evolution is essential for addressing challenges posed by population growth, climate change, and market dynamics while promoting economic empowerment among farming communities.

To ensure a sustainable agricultural future in East and Southern Africa, the following recommendations are proposed:

1. **Investment in Agricultural Technologies** - Governments should prioritize investments in advanced agricultural technologies to enhance maize yields, encouraging the development and adoption of innovative farming practices, precision agriculture, and biotechnology.
2. **Subsidies and Incentives** - Providing financial incentives and subsidies for farmers to adopt high-yield and climate-resilient maize varieties can help mitigate low yields and stabilize maize prices.
3. **Market Regulation** - Implementing policies to regulate the maize market is essential to prevent excessive price volatility and ensure fair pricing mechanisms, potentially through price floors or ceilings and monitoring market activities.

2. **Diversification Strategies** - Policies should encourage the diversification of the food basket by supporting the cultivation and consumption of alternative crops that complement maize, enhancing overall food security.

3. **Research and Development** - Increasing funding for research and development focused on improving high-yielding, nutritious, and climate-resilient maize varieties is crucial for maintaining maize as a viable crop for the future.

The scenario analysis highlights the interlinkages between agricultural performance, trade, climate risks, and future development pathways.

The concluding chapter synthesizes these findings and offers actionable recommendations to foster a more resilient, inclusive, and sustainable agricultural sector across the region.

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Chapter 6: Conclusions and recommendations

The Eastern and Southern Africa (ESA) region, where the Ukama Ustawi Initiative and now the CGIAR Scaling for Impact (S4I) Program focus, spans nearly 100 million hectares of cultivated land, with significant trade potential and a large share of Africa's population.

However, the region remains highly vulnerable to climate shocks, including frequent droughts and floods, which continue to disrupt agricultural production, processing, storage, transport, and consumption. These disruptions severely affect livelihoods, while associated pest and disease outbreaks further undermine food system efficiency.

Climate projections indicate that northern parts of East Africa (Djibouti, Eritrea, Ethiopia, Uganda, and Somalia) will likely become wetter, while much of Southern Africa will experience warming. These shifts are expected to impact agricultural productivity: rainfed yields of key crops such as maize, wheat, and potatoes are projected to decline, while yields of some crops like rainfed soybeans and sorghum may increase. Climate change will also influence land-use decisions, as farmers adjust their cropping choices based on market dynamics and changing yields.

Crops such as vegetables, potatoes, wheat, teff, and barley are likely to face significant productivity pressures. Maize, wheat, cassava, and rice, critical for regional food security, are especially at risk. The region is projected to become increasingly reliant on imports to meet food demand, particularly for maize.

Trade plays a crucial role in mitigating these risks by expanding markets, lowering costs of inputs and technologies, and enhancing agricultural value addition, particularly through processed goods. However, several challenges, policy gaps, weak infrastructure, and institutional inefficiencies, to constrain the region's trade potential.

Key Recommendations

1. Improve the Enabling Environment:

- Reduce inflation and stabilize interest and exchange rates to support investment and protect incomes.
- Strengthen political stability and governance to ensure a predictable business environment.
- Implement robust joint sector performance reviews aligned with CAADP and the forthcoming Kampala Declaration, ensuring accountability and unlocking investment finance.

2. Enhance the Use of Quality Inputs and Technologies:

- Invest in mechanization, irrigation, digital infrastructure, energy, and internet connectivity.
- Prioritize soil health improvements alongside fertilizer management to restore productivity.
- Scale up drought-tolerant and climate-resilient crop varieties to mitigate rainfall variability and extreme events.
- Strengthen farmer capacity through skills development programs on technology use and weather-risk management.

3. Increase Public and Private Agricultural Financing:

- Develop innovative financing mechanisms that leverage private capital and foreign direct investment.
- Promote partnerships for agricultural finance to make inputs affordable and accessible.
- Raise agricultural research and development spending toward the AU-recommended 1% of agricultural GDP target.
- Tailor financial products to meet the unique needs of rural agricultural enterprises.

4. Facilitate Trade and Promote Agro-Processing:

- Remove tariff and non-tariff trade barriers, including road harassment, border delays, trade bans, and poor infrastructure.
- Invest in agro-processing and value addition to extend shelf life and reduce export dependence on unprocessed commodities.
- Strengthen regional trade agreements by reducing non-tariff barriers, simplifying customs processes, and fostering fair competition.
- Harmonize agricultural standards to ease cross-border trade and deepen market integration.

By addressing these priority areas, ESA can foster a more resilient, inclusive, and competitive agricultural sector that supports food security, reduces poverty, and enhances regional economic stability in the face of climate and market uncertainties.

Annex 1: Crops grown over the period studied

Country	Top 10 Crops (by Production Volume, 2022)	Total Production (Top 10, '000 t)	Share of Regional Total (%)	Total Number of Crops Grown
South Africa	Maize, Sugarcane, Grapes, Apples, Wheat, Potatoes, Citrus, Soybeans, Tomatoes, Vegetables	42 600	32.5 %	68
Ethiopia	Maize, Teff, Wheat, Sorghum, Barley, Coffee, Pulses, Oilseeds, Sweet potatoes, Chat	30 200	23.0 %	69
Tanzania	Cassava, Maize, Rice, Bananas, Beans (dry), Sweet potatoes, Sorghum, Vegetables, Sugarcane, Potatoes	14 700	11.2 %	66
Malawi	Cassava, Maize, Sweet potatoes, Groundnuts, Rice, Beans, Tobacco, Tomatoes, Vegetables, Mangoes	11 400	8.7 %	63
Kenya	Maize, Tea, Sugarcane, Bananas, Potatoes, Wheat, Vegetables, Tomatoes, Coffee, Cabbages	8 900	6.8 %	82
Mozambique	Cassava, Maize, Groundnuts, Beans, Rice, Sorghum, Sugarcane, Sweet potatoes, Vegetables, Bananas	8 000	6.1 %	42
Uganda	Cassava, Bananas, Coffee, Maize, Sweet potatoes, Beans, Sugarcane, Plantains, Vegetables, Tea	6 200	4.8 %	41
Zambia	Maize, Cassava, Groundnuts, Sorghum, Rice, Sugarcane, Soybeans, Potatoes, Sweet potatoes, Vegetables	5 100	3.9 %	35
Madagascar	Rice, Cassava, Maize, Sugarcane, Sweet potatoes, Tomatoes, Bananas, Vegetables, Mangoes, Groundnuts	4 500	3.4 %	71
Rwanda	Bananas, Cassava, Maize, Beans, Potatoes, Sweet potatoes, Sorghum, Tomatoes, Vegetables, Tea	3 300	2.5 %	43
Zimbabwe	Maize, Sugarcane, Sorghum, Wheat, Groundnuts, Vegetables, Potatoes, Tobacco, Tomatoes, Sweet potatoes	3 000	2.3 %	68
Eswatini	Sugarcane, Maize, Citrus, Oranges, Potatoes, Bananas, Groundnuts, Sweet potatoes, Tomatoes, Vegetables	2 200	1.7 %	29
Regional Total	—	**≈ 131 000 ('000 t = 131 million t)**	**100 %**	—

Source: FAOSTAT (2024), Production – Crops and Livestock Products; authors' calculations. Quantities expressed in thousand tonnes ('000 t)

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