INTERNATIONAL DEVELOPMENT IN FOCUS

Transport Connectivity for Food Security in Africa

Strengthening Supply Chains

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WORLD BANK GROUP

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Foreword

Food security continues to be a major challenge in Sub-Saharan Africa. Despite rising agricultural production, too many people in Africa and around the world still struggle to access nutritious meals. The reasons are complex: low agricultural productivity that does not keep up with population growth, extreme weather patterns, conflict, and economic pressures. But one critical issue often gets overlooked: how food moves.

Weak transport and logistics systems delay deliveries, drive up costs, and increase food waste. This report examines how four major staples—cassava, maize, rice, and wheat—move across the continent. Poor roads, inefficient border crossings, and supply chain bottlenecks mean that food in Sub-Saharan Africa takes on average four times longer to reach consumers than it does in Europe. As a result, food becomes more expensive, harder to access, and more likely to spoil—with 36 percent of food lost along the way.

A major barrier is that many African countries import food from distant markets rather than trade with neighbors. This happens because local roads and transport networks are not reliable or efficient, and restrictive trade policies make it easier to buy food from overseas than from neighboring countries.

Investing in better logistics is essential to reversing this trend. At the World Bank Group, we recognize how urgent the problem is. Food and nutrition security is one of our top global priorities. Through initiatives such as the Food Security and Nutrition Action Plan and Global Challenge Programs, we are working with countries to build stronger and more resilient food systems—ones that can withstand shocks, improve access, and ensure food reaches those who need it the most.

This report does not just highlight the problem—it lays out a clear road map for action, identifying 50 critical investments that can ease supply chain bottlenecks, lower food prices, and reduce waste: 20 critical land border crossings that need to be modernized, 20 road segments and corridors that are crucial for food transport, and 10 high-stress ports that need to be upgraded.

This isn't just about infrastructure—it's also about making food systems work better for everyone. At the World Bank Group, we are committed to turning research into real solution. Through our new Knowledge Compact and Global Challenge Programs, we are working directly with partners to build local capacity and drive evidence-based policy making. This report is a step toward a future where Africa's food supply chains are more resilient, efficient, and equitable so that no one goes another day without the food they need.

Axel van Trotsenburg
Senior Managing Director
The World Bank

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Main Messages

Food production in Africa has increased over the past two decades. Oddly, so has the number of food-insecure people. Although the causes are many and interact in complex patterns, poor transport connectivity, limited surplus production in many countries, and high costs of transport exacerbate the problem. Africa generally imports food from overseas markets rather than from within the continent. Intracontinental trade makes up only 5 percent of Africa's trade in cereals, and accessing food takes up to 10 times longer than in developed regions. This report explores the nexus of transport and food insecurity and identifies possible measures to strengthen the continent's food supply chains.

The challenges of the food supply chain are at different scales, from local to international.

- **Poor rural road access.** Lack of access isolates farmers from markets. Approximately 60 percent of Africa's rural population live more than 2 kilometers from an all-season road. Inefficient rural transport networks slow food distribution and increase costs. Farmers struggle to obtain fertilizers and seeds, perpetuating low productivity and production and leading to food insecurity.
- **High costs of transport services.** In some countries, market distortions in transport services result in monopolistic practices, allowing a few operators to inflate prices. This issue limits affordable transport options for farmers and consumers, exacerbating food security risks. Fragile infrastructure, characterized by especially patchy or poorly maintained domestic transport systems, makes the networks vulnerable to damage from extreme climate events. Farmers in remote areas face significant challenges in transporting goods to markets, especially during the rainy season.
- **Regional trade barriers.** At the regional scale, there is limited trade in staple food commodities between African countries. Nontariff barriers (NTBs),

such as bureaucratic delays and hidden costs, increase regional trade costs by 8–25 percent, further disconnecting markets. As a result, food surpluses in one country or region often fail to reach neighboring areas.

- **Long supply chains.** Because of insufficient production and inefficient distribution, Africa has a high import dependence, with as much as 25 percent of its food being imported even when neighboring countries have surpluses. Food travels an average of 4,000 kilometers, taking up to 10 times longer to transport compared with developed regions of the world. Inefficient ports, with only 52 of 138 having equipment for handling significant food volumes, lead to delays, congestion, and higher costs.
- **Limited storage.** Last, Africa's food supply chain operates on an almost "just-in-time" basis, with limited food storage in case of emergencies or supply shocks from global markets. Limited storage capacity, with less than 30 percent of annual production being stored, results in significant postharvest losses. A significant amount of locally produced food, 37 percent, is wasted as a result of insufficient storage and cold chain infrastructure.

The report makes several practical recommendations for Africa to leverage transport for food security.

- **Upgrading maritime transport, seaports, and corridors.** Modernize and upgrade critical seaports to improve efficiency and reduce delays. Key measures include streamlining customs and border controls to reduce both costs and time to enhance the flow of goods. Investing in key regional corridors is critical to efficiently connect surplus and deficit areas.
- **Addressing NTBs.** Tackle NTBs and address inefficiencies in intra-African trade to reduce reliance on overseas imports. Aligning and implementing trade policies, with an emphasis on NTBs within and across regional economic communities, will help lower costs and promote cross-border trade between African states.
- **Increasing efficiency of transport services.** Encourage competition and provide financing for new trucking operators to enter the market. Addressing the common issue of empty running trucks is also crucial. Electronic cargo platforms that match real-time demand with suppliers can help reduce this inefficiency. The evidence is clear: Lowering transport costs by 10 percent could increase trade by 25 percent, boosting regional economies.
- **Enhancing local and national connectivity.** Maintain and upgrade existing roads. Expanding access to all-season roads will connect rural farmers to markets and stabilize food distribution. Develop transportation infrastructure that can endure disruptions caused by severe weather and other hazards. Enhance rural logistics to guarantee efficient delivery of essential inputs, such as fertilizers and seeds.

- **Building storage.** Develop modern storage facilities to minimize postharvest losses and stabilize food supply chains. Investment in regional cold chain infrastructure can help reduce food waste. A long-term strategy will invite public-private partnerships to fund storage expansion and operational improvements.

Food insecurity arises from a complex interplay of many factors. Transport connectivity is one of the main factors. Farmers and countries need efficient transport and logistics networks and storage facilities to manage the spatial mismatch between supply and demand in their food systems. This report identifies opportunities for African countries to improve their food supply chains and reduce the risk of food insecurity.

Abbreviations

AfCFTA	African Continental Free Trade Area
AMC	Agriculture Marketing Corporation
BCP	border crossing point
CAADP	Comprehensive Africa Agriculture Development Programme
CEMAC	Central African Economic and Monetary Community
CGE	computable general equilibrium
COMESA	Common Market for Eastern and Southern Africa
COVID-19	coronavirus disease 2019
DPPC	Disaster Preparedness and Prevention Commission
EAC	East African Community
ECCAS	Economic Community of Central African States
ECLAC	Economic Commission for Latin America and the Caribbean
ECOWAS	Economic Community of West African States
ECX	Ethiopia Commodity Exchange
EDR	Ethio-Djibouti Railway
EFSRA	Emergency Food Security Reserve Administration
EGMB	Ethiopian Grain Marketing Board
EGTE	Ethiopian Grain Trade Enterprise
ETBC	Ethiopian Trading Businesses Corporation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Statistical Database
FTA	free trade area
GDP	gross domestic product

GFDRR	Global Facility for Disaster Reduction and Recovery
GFSI	Global Food Security Index
GHS-POP	Global Human Settlement Population
GTAP	Global Trade Analysis Project
IGAD	Intergovernmental Authority on Development
IMF	International Monetary Fund
IPC	Integrated Food Security Phase Classification
NDRMC	National Disaster Risk Management Commission
NGO	nongovernmental organization
NTB	nontariff barrier
NTM	nontariff measure
OD	origin-destination
OEC	Observatory of Economic Complexity
PIDA	Program for Infrastructure Development in Africa
RAI	Rural Access Index
RAMP	Rural Access and Mobility Program
REC	regional economic community
RFSR	Regional Food Security Reserve
RoW	rest of world
RRC	Relief and Rehabilitation Commission
SACU	Southern African Customs Union
SADC	Southern African Development Community
SFRA	Strategic Food Reserve Agency
SNNP	Southern Nations, Nationalities, and Peoples Region
SPAM	Spatial Production Allocation Model
SSA	Sub-Saharan Africa
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNCTAD	United Nations Conference on Trade and Development
USAID	US Agency for International Development
VAT	value-added tax
WFP	World Food Programme

All dollar amounts are US dollars unless otherwise indicated.

1 Introduction

CONTEXT

Africa stands at a critical juncture in addressing its persistent food security challenges. Although progress has been made in agricultural production, inefficiencies in transport, logistics, and storage continue to undermine the continent's ability to feed its population effectively. These inefficiencies have far-reaching consequences: They inflate food prices, exacerbate waste, and heighten vulnerability to disruptions caused by climate change, conflict, and global supply chain shocks. The urgency to address Africa's food security challenges has never been greater. With a rapidly growing population, intensifying climate pressures, and a dangerous overreliance on imported food, the continent's food systems are at a tipping point. The current trajectory cannot sustain the rising demand or protect against future shocks.

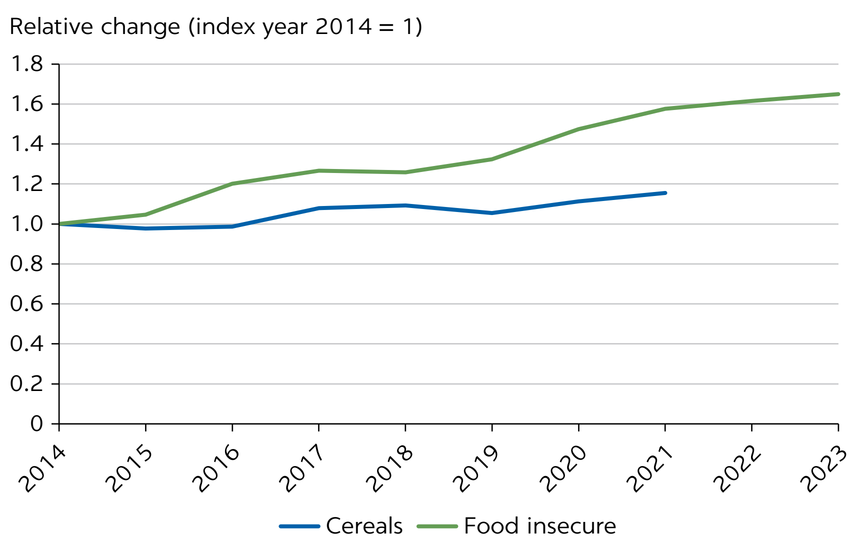
The causes of food insecurity are many, and they vary across countries and even zones within the same country. However, a few patterns can be observed. Africa at a continental level does not produce enough food to meet its needs, faces significant inefficiencies in distributing what it does produce, and depends heavily on distant markets for key staples for its food basket. On average, African countries produce about 75 percent of their food needs in-country, by quantity, with the rest being imported from overseas markets, mostly from Europe and Asia. Only about 5 percent of food trade takes place between countries in Africa. In addition, 37 percent of what is produced locally is wasted in postharvest losses, and many food-insecure populations are cut off from the food supply chain because of their remote location. These patterns not only perpetuate food insecurity but also expose the continent to significant vulnerabilities in supply chains. This report is the first of its kind to provide a detailed analysis of the critical nexus among transport, logistics, and food security in Africa. It provides empirical evidence based on modeling the pivotal role played by transport connectivity, performance, and cost in ensuring food availability, affordability, and access.

Many countries in Africa still struggle to produce enough food to meet their needs. Although over the past 30 years agricultural production in Africa increased by 160 percent—more than the global average of 100 percent—the food-insecure population paradoxically grew faster than in any other region in the world, and the productivity gains were not sufficient to offset the continent's persistent food insecurity challenges. Over the past 10 years, for example, the food-insecure population in Africa grew by 60 percent, whereas agricultural productivity increased by 20 percent during the same period, suggesting that the level of productivity was not enough to address the continent's food insecurity problem (refer to figure 1.1). Moreover, since 2000, at least 20 countries in Africa have faced food shortages, with some facing severe and persistent food scarcity, including episodic famines. Despite the progress made in improving agricultural productivity and the continent's agricultural potential, many African countries remain trapped in food insecurity, malnutrition, and vulnerability to supply chain disruptions.

Most countries in Africa lack efficient food distribution systems that can effectively move food from surplus production regions to food-insecure areas. The domestic and regional food supply chains suffer from missing transport links, inadequate food storage, and border crossing bottlenecks. As a result, food transfers in Africa take up to 10 times longer than in the United States. Transport expenses can account for up to 45 percent of the market price of some low-value commodities, making food prohibitively expensive for some segments of the population, especially those who live in remote, isolated areas and the urban poor. Additionally, many farmers struggle with limited access to market information, hindering their ability to respond to demand, plan effectively, and invest in productivity improvements.

FIGURE 1.1

Change in African cereal production and food-insecure population, 2014–23



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: The cereals are cassava, maize, rice, and wheat.

This report provides a detailed analysis of the supply chains of key food commodities in Africa and sheds light on how transport deficiencies affect production, distribution, and imports and, ultimately, food security across the continent. Although many studies have been carried out to explain the persistent food insecurity problem in Africa, this report is the first to use a supply chain approach to provide a comprehensive view of how transport, logistics, and storage affect food security.[1] The analysis uses the World Bank's in-house FlowMax model to explore the movement of food between production and consumption, including global trade. The model tracks the flow of four essential commodities—cassava, maize, rice, and wheat—that provide almost half of Africa's caloric intake to provide insights into how weaknesses and gaps in the supply chain affect the flow of these commodities within a country, between countries, and to and from overseas markets.

On the basis of the analysis in this report, we highlight five key questions that are crucial in addressing food supply chain challenges in Africa.

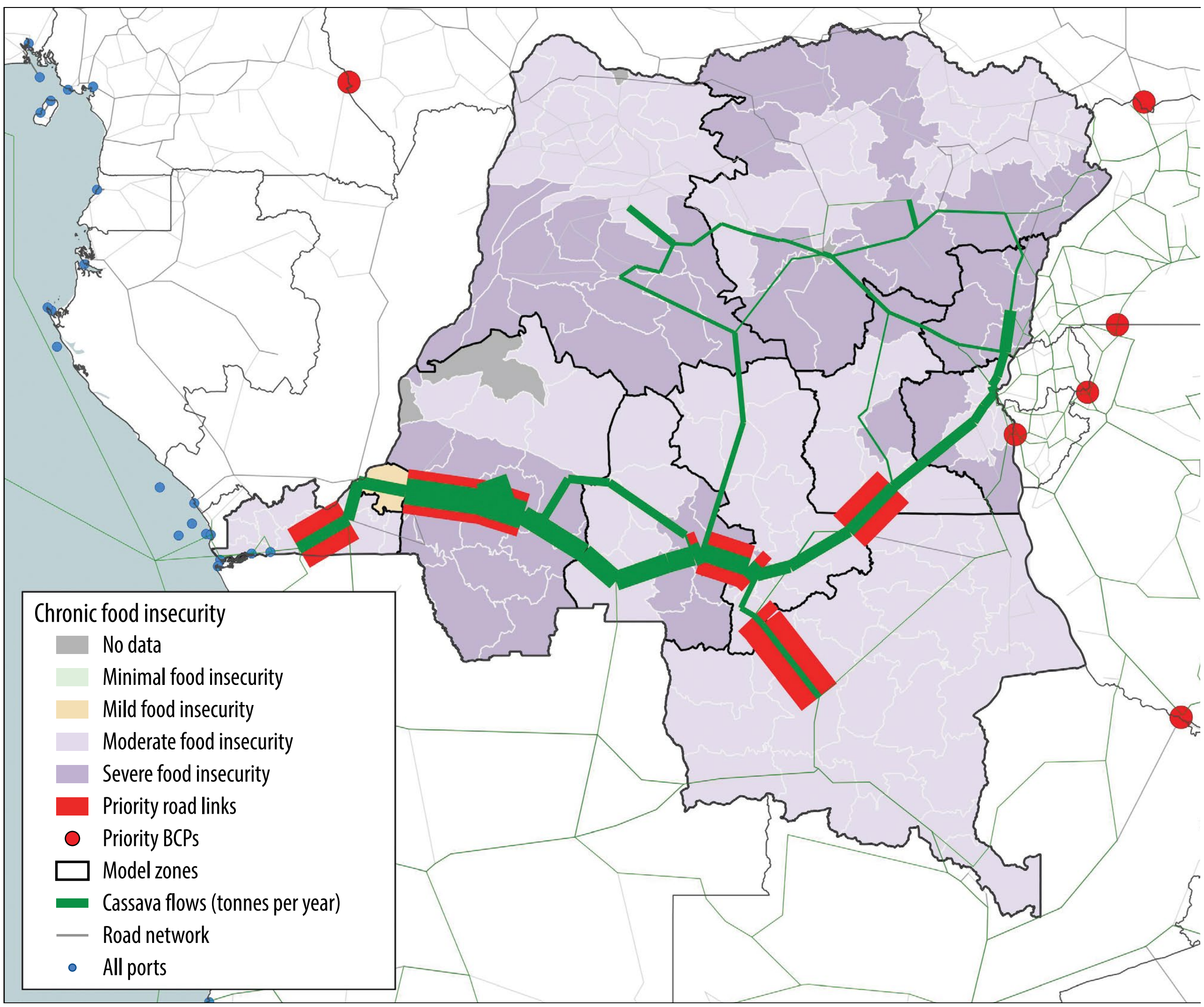
WHAT IMPEDES THE DISTRIBUTION OF FOOD WITHIN COUNTRIES?

Although many African countries have the potential to produce enough food, poor transport connectivity hinders the movement of food between surplus-producing areas and deficit regions. Almost a third of the countries in Africa can produce enough of a commodity in aggregate terms but have districts and provinces that regularly suffer food shortages, pay a premium to get their food, or both. The availability of quality roads, railways, and ports significantly affects the efficiency and effectiveness with which food is distributed within and between countries. Poor transport networks lead to high transportation costs, delays, and increased postharvest losses, which in turn affect the availability and affordability of food. This is particularly important in regions with a significant spatial mismatch between food production areas and consumption centers and in landlocked countries whose food supply depends on the performance of the gateway country's transport system, including cross-border transit policies. When transport networks are well developed, food can move seamlessly across regions, reducing the risk of shortages and stabilizing prices. Conversely, poor connectivity can lead to localized food shortages and price volatility, exacerbating food insecurity.

The Democratic Republic of Congo provides an example of the risks of limited domestic connectivity. It has great potential in food production, but it also has significant food insecurity in some of its provinces, exacerbated by poor transport infrastructure and logistical inefficiencies. Staple foods, such as rice and wheat, are still heavily imported from overseas, highlighting the shortcomings of domestic supply chains. The Democratic Republic of Congo's sparse transport network leaves vast areas dependent on a limited number of critical links (refer to map 1.1). In such situations, if a road link is disrupted, the costs of rerouting food can be astronomical. This example highlights how inefficient domestic transport networks contribute to localized food shortages, even in countries with sufficient overall production. The model output indicates that the Democratic Republic of Congo is one of the countries that experiences significant transport stress in relation to food security, with reasons including high transport costs compared with incomes, vulnerability of the transport network, long distances from growing areas, and high costs and delays at borders and ports.

MAP 1.1

Distribution of cassava flows across the domestic transport network, Democratic Republic of Congo, 2024



Source: Original map for this publication, based on model outputs and the Integrated Food Security Phase Classification 2024, https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1157078/?iso3=COD.

Note: The map depicts the flow of cassava; the thickness of the lines corresponds to the relative volume of trade. BCPs = border crossing points.

Strengthening transport networks, and especially building redundancy, is important for an efficient and resilient domestic system. Investments in domestic transport networks are crucial to bridging the gap between food production and consumption areas, reducing waste, and making food more accessible and affordable. Addressing these challenges is particularly urgent in countries such as the Democratic Republic of Congo, where strategic improvements could unlock significant gains in food security.

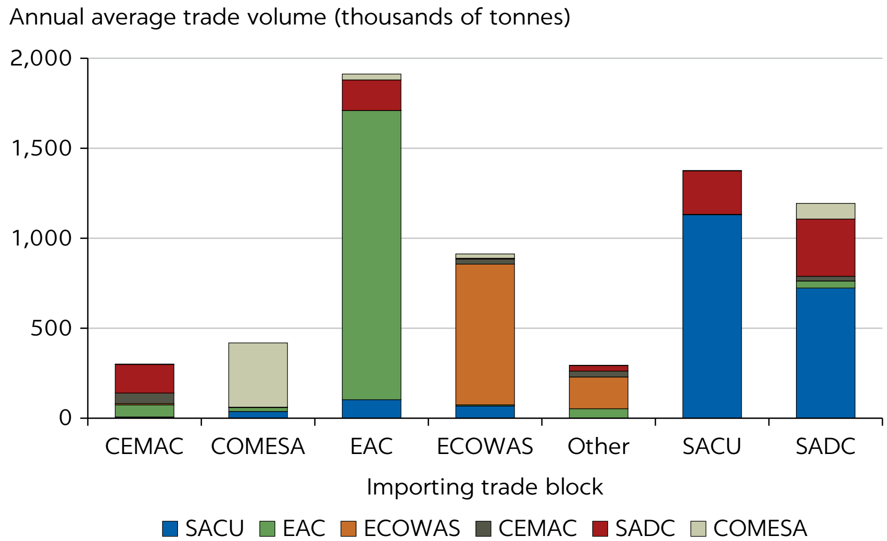
HOW CAN REGIONAL ECONOMIC BLOCS FACILITATE A MORE EFFICIENT EXCHANGE OF FOOD BETWEEN COUNTRIES?

Costs of trade of agricultural commodities are 20 percent higher between African countries than between those countries and their external trade partners. Regional economic blocs, such as the East African Community (EAC), play a crucial role in addressing inefficiencies in cross-border food distribution by harmonizing policies and improving transport infrastructure. The EAC has made good progress since the 1990s in raising the share of intraregional agriculture trade in total trade for many staple commodities. Even so, high transport costs and cumbersome border procedures remain significant impediments to effective distribution. For instance, maize transport within East Africa averages $66 per tonne—lower than the $124 per tonne for rice and the $134 per tonne for wheat, but it still represents 16 percent of the final consumer price. This highlights the opportunity for even modest cost reductions to significantly benefit consumers. Nontariff barriers further exacerbate these challenges, contributing to 8–14 percent of total transport costs and making intra-Africa trade 8–25 percent more expensive than intercontinental trade. Corruption and inefficient border procedures add to these costs, incentivizing countries such as Kenya to source maize from overseas instead of regional markets, despite local surpluses in neighboring countries

Available data show major hurdles for food trade to cross borders in Africa. Although tariffs are low or have been eliminated within some regional economic communities, poor implementation of nontariff measures (NTMs) continues to be a barrier to trade. NTMs are often needed to ensure safety and protect society, but when they are poorly formulated and implemented, they become barriers and impede the free movement of food across borders. The effect is that some countries experience food shortages or face high variations in transport costs. Such countries may then source food from overseas rather than regional markets (refer to figure 1.2).

FIGURE 1.2

Source of intra-Africa imports, by trade bloc, for cassava, maize, rice, and wheat, 2016–22



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; SACU = Southern African Customs Union; SADC = Southern African Development Community. "Other" = other communities not listed.

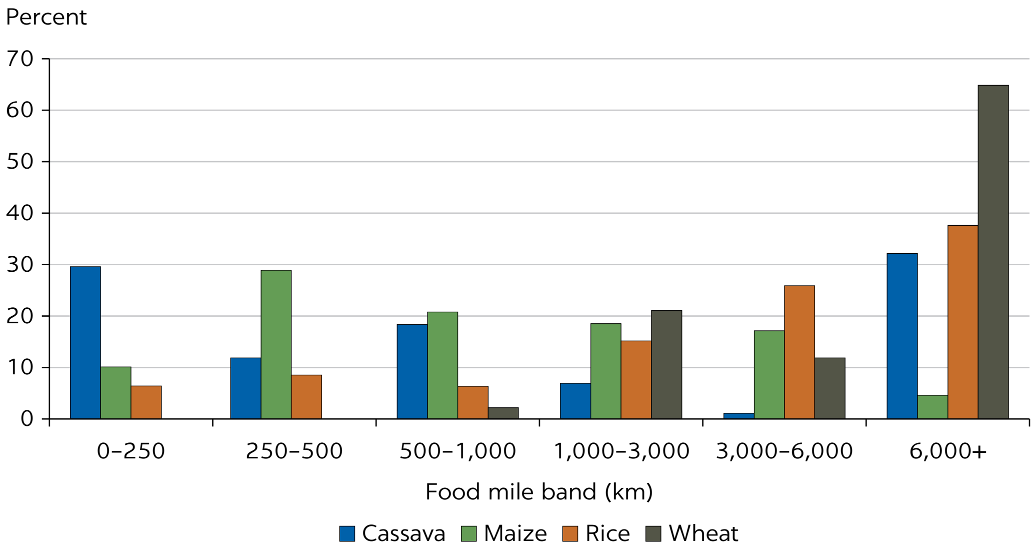
Regional trade facilitation can be improved by streamlining procedures at the border crossing points (BCPs). The report identifies 20 BCPs that are critical for the flow of food trade between countries. It recommends investments along priority, regional corridors, including in border infrastructure, and in complementary policies and procedures to protect society from harmful products while reducing the costs of cross-border food flows. In addition, cross-border trade can be promoted at a local level by facilitating exchanges between border communities through smaller BCPs and connecting access roads.

WHY DOES AFRICA HAVE LONG FOOD SUPPLY CHAINS?

Africa has long food supply chains because significant proportions of staple foods are imported from overseas markets. The average distance over which food is transported into African countries is almost 4,000 kilometers, and it takes at least three weeks for the average country to access all the food required to meet its consumption needs. The long distances over which food is transported reflect the reliance of many African countries on overseas markets, especially for rice and wheat imports (refer to figure 1.3). As a result, African commodity supply chains are particularly long, almost four times longer than those of Europe. The extended nature of the supply chains results in many vulnerabilities and can be a source of delays and other risks. Due to both the long distances and the low quality of infrastructure in some countries, it takes 23 days on average, excluding administrative time, for African countries to access all the food that they require.

FIGURE 1.3

Estimated population of Sub-Saharan Africa within defined food mile distance bands for different commodities, 2022



Source: Original figure for this publication, based on model outputs.
Note: A band is the average distance over which food is transported. Omitted bands denote a negligible percentage.

Addressing the problem of extended food supply chains in Africa requires a multifaceted approach that tackles inefficiencies in production and distribution. Improving infrastructure is crucial, because poor domestic transport networks and long distances between production and consumption areas contribute to delays and food losses. Investments in roads, railways, and ports can significantly reduce lead times and improve the reliability of food supply chains. Streamlining logistics and reducing regulatory bottlenecks can enhance the speed and reliability of food distribution, and promoting intraregional trade can help balance food surpluses and deficits across different regions. Developing adequate storage facilities is essential to mitigate the risks posed by long supply chains, and implementing policies that support agricultural development and food security can address the root causes of long supply chains.

DOES AFRICA HAVE A TRANSPORT INFRASTRUCTURE PROBLEM THAT IMPACTS THE FOOD SUPPLY CHAIN?

Africa's food supply chain is fragmented and high cost, and it has low reliability. Infrastructure for food production, distribution, and trade takes four main forms, namely, local, regional, and international transport elements and storage facilities.

Local

Rural roads are fundamental for food production and distribution. There is strong evidence, such as from Ethiopia and Mozambique, that improved rural roads boost agricultural productivity, facilitate market access, and ultimately contribute to economic welfare. However, indices such as the widely used Rural Access

Index, which reflects the accessibility of rural areas to markets and services, show that Africa in general has low levels of rural access, with close to 60 percent of the rural population living more than 2 kilometers from an all-season road. Limited access hampers farmers' ability to obtain inputs and sell their produce, thereby reducing productivity, and can negate the benefits of other interventions, including the expected increases in productivity from using more fertilizer.

Scaling rural road investment is an effective strategy to ensure two-way flows of agricultural commodities. The India Pradhan Mantri Gram Sadak Yojana rural roads program and the World Bank–financed Rural Access and Mobility Program in Nigeria show the impacts of scale on rural development outcomes, including food production and availability. However, it is important to note that large-scale and countrywide investments are essential to maximize the network benefits of investing in rural roads because disbursed and limited investment would not be able to address the spatial mismatch that exists between different regions within the country. It is also important to select and identify roads on the basis of the role that a region plays in a national food system. Additionally, providing local storage solutions can help farmers store their produce safely and reduce losses, thereby improving food security at the local level.

Regional

Regional transport corridors play a key role in distributing food within and between countries. These corridors are particularly important for Africa's 16 landlocked countries. Africa has a well-defined corridor network that was designed primarily to give such landlocked countries access to the sea. The continental Program for Infrastructure Development in Africa (PIDA) prioritizes filling the gaps in the corridor network and improvement of transport infrastructure to connect high-productivity agricultural regions to continental markets.[2] The performance of these corridors is highly variable, although they have received billions of dollars of investment, including from the World Bank. This report estimates that implementing the various infrastructure programs would reduce the cost of trading by 5 percent and save up to 16 percent in travel time. This underscores the importance of improving the performance of transport services if the impacts are to be maximized. By strengthening trade corridors, the continent will have the basic infrastructure for more efficient trade across the continent.

International

Internationally sourced commodities are highly dependent on sea shipping. Although many African countries have their own ports and can receive food shipments by sea from all over the world, this report finds that many ports have very limited facilities to accommodate large-bulk vessels that carry agricultural commodities. Only 52 of 138 ports studied for this report handle food shipments as one of their top three types of cargo. In addition, only 32 ports had an average of 100 or more bulk vessel calls per year over 2019–23. Most of the bulk shipments were minerals. This pattern suggests that food imports into Africa arrive on general cargo vessels, at high cost, or they face delays if they are delivered by bulk carriers. In addition, many ports lack the facilities and equipment to handle agricultural commodities. Bagging of grains, which is common, increases handling and transportation costs at both the overseas and local ports and is more expensive.

The report identifies 10 critical seaports, 20 key sections of regional transport corridors, and 20 BCPs that are essential for the efficient movement of food across Sub-Saharan Africa (refer to table 1.1). These transport network elements collectively handle approximately 23 percent of the total calorie flow of the four staple crops—cassava, maize, rice, and wheat—that represent 45 percent of Sub-Saharan Africa's total calorie consumption. They therefore have an outsized role in ensuring food reaches deficit regions.

Although many of the identified critical transport links and nodes align with the continent's flagship infrastructure initiatives, significant gaps remain, particularly in underserved and landlocked regions where connectivity is weakest (refer to map 1.2).[3] These gaps must be urgently addressed to unlock Africa's full potential for food security and trade. The combination of PIDA-1, PIDA-2, and the Trans-African Highway framework establishes a solid foundation, focusing on critical infrastructure, such as the roads, ports, and border crossings essential for regional connectivity and food accessibility. PIDA-2 builds on PIDA-1 by targeting previously overlooked areas, but missing investments in key roads and border points continue to disrupt efficient food flows and trade. By prioritizing closing these gaps and fully integrating the transport network, Africa can significantly reduce costs, enhance food distribution, and create a resilient system capable of meeting future demands and ensuring food security across the continent.

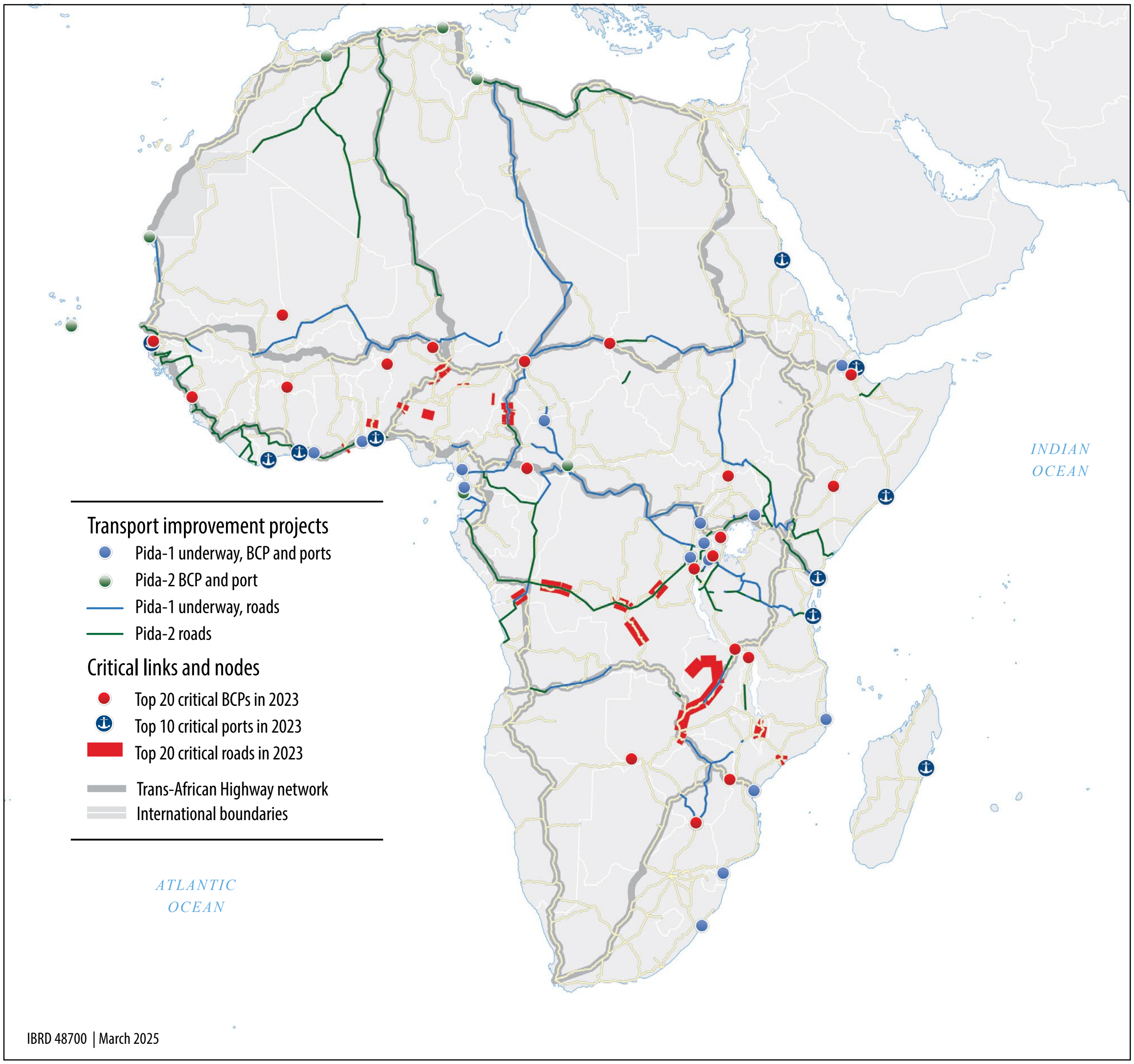
TABLE 1.1 Critical infrastructure for food handling and distribution in Sub-Saharan Africa, 2022

INFRASTRUCTURE	COUNTRIES OR PORTS	IMPACT
Ten critical seaports, which handle food volumes equivalent to 78 billion kcal per year	Abidjan and San-Pédro (Côte d'Ivoire), Banjul (Gambia, The), Cotonou (Benin), Dar es Salaam (Tanzania), Djibouti (Djibouti), Mogadishu (Somalia), Mombasa (Kenya), Port Sudan (Sudan), and Toamasina (Madagascar).	Improved gateway performance attracts shipping connectivity and reduces costs and delays.
Twenty critical road sections across nine countries, which manage 102 billion kcal of food per year	Benin; Cameroon; Congo, Dem. Rep.; Côte d'Ivoire; Ghana; Malawi; Mozambique; Nigeria; Zambia	Regional corridors are critical for domestic distribution and regional trade.
Twenty key BCPs, which link 30 countries and are vital for intraregional food trade	Benin; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Congo, Dem. Rep.; Côte d'Ivoire; Djibouti; Ethiopia; Gambia, The; Guinea; Kenya; Malawi; Mali; Mauritania; Mozambique; Namibia; Niger; Nigeria; Rwanda; Senegal; Sierra Leone; Somalia; South Africa; South Sudan; Sudan; Tanzania; Uganda; Zambia; Zimbabwe	BCPs are regional gateways to trade. Infrastructure and system improvements reduce delays and costs and increase the supply of services, especially trucking.

Source: Original table for this publication, based on model outputs.
Note: BCPs = border crossing points; kcal = kilocalories.

MAP 1.2

Top critical links and nodes related to continental transport infrastructure initiatives in Africa



Source: Original map for this publication, based on model outputs.
Note: The ports are Abidjan and San-Pédro (Côte d'Ivoire), Banjul (Gambia, The), Cotonou (Benin), Dar es Salaam (Tanzania), Djibouti (Djibouti), Mogadishu (Somalia), Mombasa (Kenya), Port Sudan (Sudan), and Toamasina (Madagascar). BCPs = border crossing points; PIDA = Program for Infrastructure Development in Africa.

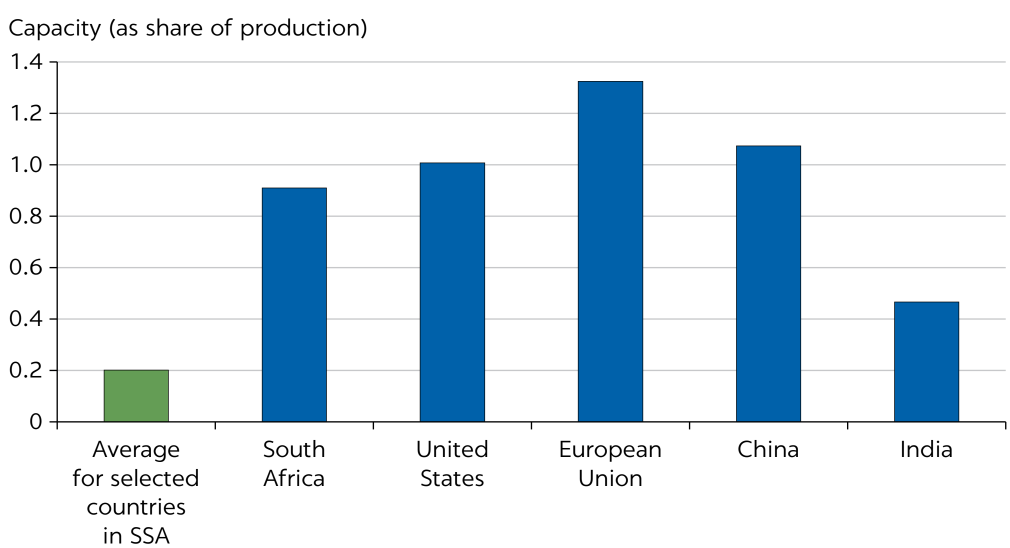
Africa's food transport system is susceptible to shocks. Any disruption—because of natural hazards, conflicts, or infrastructure failure—could severely impede the movement of food, leading to higher costs and exacerbating shortages in vulnerable areas. Africa is highly vulnerable to climate change, which affects agricultural production through extreme weather events, droughts, and changing rainfall patterns and poses risks to transport infrastructure. This report finds that transport network elements in some high-risk countries are sparse, and significant food flows rely on a few links and nodes. The limited redundancy and resilience of transport infrastructure restrict routing options and can significantly increase costs during disruptive events. Strategic investments to improve resilience, create alternative routes, and enhance operational efficiency at these points are essential to safeguard food supply chains and reduce their vulnerability to disruption.

Storage

Sub-Saharan Africa has a severe deficit in food storage infrastructure. Although most regions of the world have more agricultural storage capacity than their annual production, the amount of available storage in Sub-Saharan Africa is less than 30 percent of annual production (refer to figure 1.4). In fact, because of lack of storage, most African supply chains operate "just in time," without buffer stocks to respond to emergencies and smooth consumption during seasonal variations. One of the compelling lessons after the Russian Federation's invasion of Ukraine was that Ukraine had significant capacity to store more than 60 million tonnes of grain. Had it not had storage infrastructure, the food would have gone to waste instead of eventually being released to global markets. The limited storage capacities across Africa exacerbate the problem of high postharvest food losses and waste, including the estimated 40 percent loss of perishable crops and 20 percent loss of other food commodities.

FIGURE 1.4

Estimated grain storage capacity, 2022



Sources: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data) and various public sources.

Note: The SSA estimates are for 12 countries: Botswana, Burkina Faso, Cameroon, Lesotho, Malawi, Mozambique, Namibia, Niger, Senegal, Tanzania, Zambia, and Zimbabwe. SSA = Sub-Saharan Africa.

There are practicable solutions to the storage problem, but they have risks. This report uses the example of Ethiopia and the Economic Community of West African States (ECOWAS) to illustrate two approaches to building storage capacity, one national and the other regional. The evolution of policy in Ethiopia has over time improved coordination among different levels of government and between the public and private sectors, which can create opportunities for investment, and the ECOWAS example shows the importance of information flows and transport services for a regional solution to work efficiently. Leveraging storage by establishing dedicated institutions or agencies to oversee logistics and storage, and by promoting public-private partnerships, can enhance food security. Storage infrastructure should include appropriate technology for tracking and inventory management, which can further improve food distribution networks. Establishing modern storage facilities, such as silos, can help mitigate postharvest losses and ensure better management of food reserves.

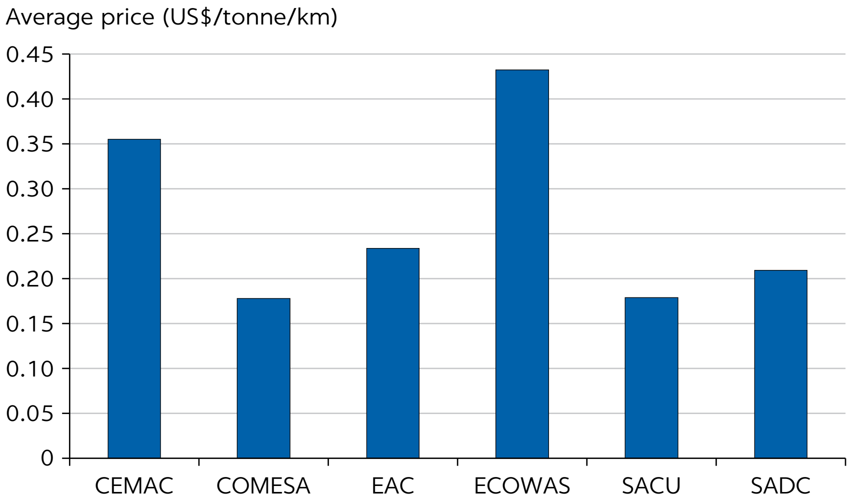
DO MARKET DISTORTIONS IN TRANSPORT SERVICES CONTRIBUTE TO HIGH COSTS OF FOOD IN AFRICA?

The market characteristics of transport services markets affect the costs of food distribution. On the basis of transport input costs, this report estimates that transport costs contribute 5 percent and 14 percent to the market price of rice and wheat, respectively. However, on the basis of the observed transport prices obtained from actual contracts, the respective contributions of transport costs to commodity prices are 13 percent and 31 percent for rice and wheat, respectively. The contribution is much higher for cassava, at 45 percent. Competition in transport markets, therefore, has a significant impact on the cost of food distribution within and between countries.

Countries or regions experiencing violence and conflict face particularly high transport costs. Herrera Dappe et al. (2024) have found wide differences in transport prices across developing countries and conclude that the variation is 75 percent because of local factors, such as infrastructure, geography, and market structure. In particular, conflict is found to significantly affect transport prices, with transport prices in conflict zones, such as the Democratic Republic of Congo and Somalia, ranging from $0.14 to $0.56 per tonne-kilometer (ptkm), compared with $0.06–$0.08 in more stable countries, such as South Africa and Uganda, respectively. There are also wide differences in costs between regions, with the Southern African Customs Union (SACU) region having the lowest average transport costs for food shipments ($0.18 ptkm), whereas the regions of the Central African Economic and Monetary Community (CEMAC) and Economic Community of West African States (ECOWAS) have costs that are more than double those of the SACU (refer to figure 1.5). Overall, poor and high-cost transport services discourage trade and disincentivize production for markets, particularly where farming is small scale and individual farmers do not produce enough to influence market prices.

FIGURE 1.5

Average transport prices, by regional economic community in Sub-Saharan Africa, 2022



Source: Original figure for this publication, based on Herrera Dappe et al. 2024.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; SACU = Southern African Customs Union; SADC = Southern African Development Community.

Improving transport services is critical to reducing the costs of food. Weak competition in transport, especially in rural areas, requires specific interventions. Support instruments can include financing for vehicle fleets and reducing the incidence of running empty trucks, which is a common problem. Support systems that match demand and suppliers are also crucial. There are many examples of successful electronic cargo platforms, many started and managed by the private sector. These measures can lower transport costs, reduce delivery times, and improve reliability, thereby boosting productivity and production for farmers and enhancing food security.

CONCLUSION

Africa is at a pivotal moment in addressing its food security challenges. Despite progress in agricultural production, transport inefficiencies, logistical gaps, and inadequate storage systems continue to impede the continent's ability to effectively meet its population's needs. These systemic weaknesses inflate food prices, contribute to significant postharvest losses, and leave the region vulnerable to climate shocks, conflicts, and global supply chain disruptions. The situation is particularly dire in landlocked and underserved regions where poor connectivity exacerbates the challenges of food distribution and accessibility.

The findings of this report underscore the urgent need for targeted interventions to address these issues. Prioritizing investment in rural and regional transport networks, modernizing critical seaports, and developing efficient storage infrastructure are essential to bridging the gap between production and consumption areas. Improved logistics and streamlined customs processes can enhance intraregional food flows, and public-private partnerships and climate-resilient designs will ensure long-term sustainability and adaptability. These measures are vital not only to reduce transport costs but also to stabilize food supply chains and address Africa's overreliance on distant imports for staples, such as wheat and rice.

The report emphasizes that a one-size-fits-all approach will not work, given the diverse challenges across regions and countries. Central Africa's reliance on cassava, East Africa's maize trade, and West Africa's heavy import dependency each require tailored solutions. Integrated frameworks, such as PIDA-1 and PIDA-2, offer strong starting points, but unaddressed critical links, such as missing roads and BCPs, must be included in future prioritization efforts. By focusing on these gaps, Africa can create a comprehensive and efficient food transport network that supports economic growth and regional trade.

The time to act is now. With a growing population, rising urbanization, and intensifying climate pressures, Africa's food systems must adapt to meet future demands. Strategic investments in transport, storage, and trade facilitation will not only improve food security but also strengthen resilience against future shocks. By adopting these recommendations, Africa can build a sustainable, inclusive, and adaptive food system, ensuring that no population is left behind in the fight against hunger and malnutrition.

STRUCTURE OF THIS BOOK

The remainder of this book is organized as follows. Chapter 2 identifies the main patterns of Africa's agricultural supply chains and the possible explanatory factors for persistent food insecurity. Chapter 3 examines the structure and characteristics of food supply chains in Africa, focusing on the movement of four staples (cassava, maize, rice, and wheat). It presents the model that was built to understand how transport connectivity and trade patterns affect food security. Chapter 4 explores the importance of shipping and ports in ensuring food security in Africa. Chapter 5 examines the role of regional trade in food security, highlighting the importance of regional economic communities and continental initiatives, such as the African Continental Free Trade Area. Chapter 6 investigates the relevance of domestic access and distribution in ensuring food security, particularly in low-income countries. Chapter 7 examines the significant postharvest losses incurred in Africa because of inadequate storage and poor handling practices. Chapter 8 distills the main insights from the analysis and proposes measures to strengthen the resilience of food systems through transport interventions.

NOTES

1. Several studies acknowledge transport and logistics as factors in Africa's food insecurity but do not focus on them comprehensively. Tefera (2012) highlights small transport-related losses in maize systems but emphasizes other postharvest inefficiencies. Similarly, Delgado, Tschunkert, and Smith (2023) and Sheahan and Barrett (2017) recognize transport's role in broader supply chains but prioritize issues such as storage and agrifood systems.
2. There have been two phases of PIDA: the first (PIDA-1) covering the period 2012–20 and the second (PIDA-2) covering 2021–30.
3. *The Africa Transport and Food Security Outlook*, a companion to this report, analyzes continental transport infrastructure improvements and policy initiatives that could enhance food security across the continent. By modeling policy scenarios, it provides strategic guidance for infrastructure investments and decisions to build more resilient and efficient food systems in Africa.

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2 Agricultural Supply Chains and Food Insecurity

ABSTRACT

Improving transport to help reduce food insecurity requires a multilayered approach. This chapter presents the supply chain framework applied in this report to explore the trade-offs inherent in Africa's food system, identify the segments in which weaknesses are most apparent, and suggest how best to target investments in transport to build stronger food supply chains.

KEY FINDINGS AND MESSAGES

- Although food production has increased in Africa, the continent still imports significant quantities of rice and wheat. Even commodities produced in large quantities in Africa, such as maize, are imported from other parts of the world rather than from subregions within Africa.
- Transport connects all stages of the food system, from production to domestic, regional, and global markets.
- Trade policy and nontariff barriers (NTBs) are major impediments to the efficient distribution of food on the continent. Regional economic communities have enjoyed only limited success in nurturing food trade because NTBs and export bans continue to be used in response to shocks.
- Poor transport compounds the continent's vulnerability to global food system shocks, such as price volatility, climate change, and conflict, which disrupt production, trade, and access to food. These shocks are compounded by high transaction costs and lack of competition, which raise food prices and limit market access for farmers.
- The absence of large-scale storage increases volatility and contributes to enormous food losses and price variability across the supply chain.

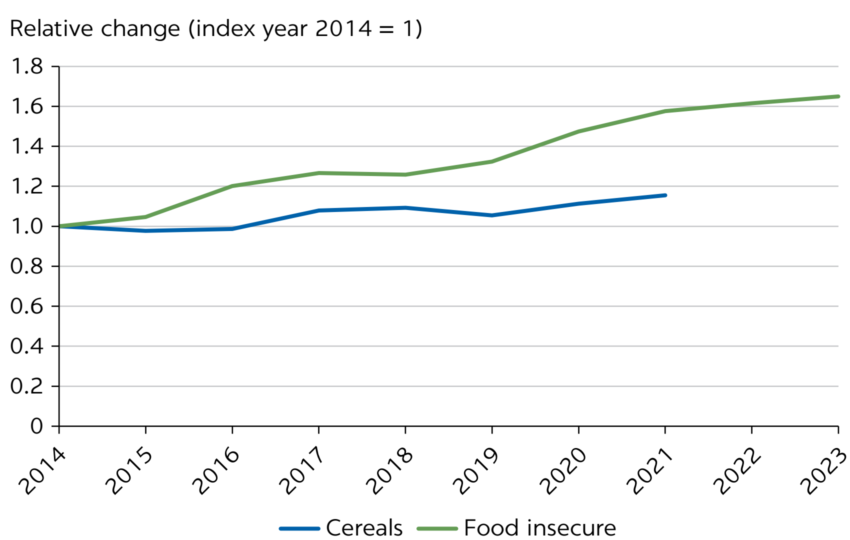
FOOD TRADE IN SUB-SAHARAN AFRICA

Although agricultural production in Africa has grown, the population that is food insecure has also increased over time. Cereal production in Africa has increased significantly, by 160 percent, over the past 30 years. However, the number of people who are food insecure increased by 60 percent between 2014 and 2023 (refer to figure 2.1). In fact, since the turn of the millennium, almost 40 percent of African countries have faced food insecurity at different moments, more severe and persistent in some countries than in others. Therefore, despite the continent's progress and great potential, it remains paradoxically ensnared in food insecurity and malnutrition and vulnerable to supply chain disruptions resulting from political developments or climate change. The risks underscore the importance of preparedness in food security and especially of investing in a proactive manner in sectors such as transport in places where delivery of infrastructure and services takes time.[1]

Sub-Saharan Africa has vast potential for agriculture. Since the turn of the millennium, however, almost 40 percent of its countries have faced food insecurity at different times. The persistence and prevalence of the problem point to its complex and multifaceted nature. First, food production in Sub-Saharan Africa has struggled to keep pace with the rapid population growth and the increasing impacts of climate change. According to Porteus (2023), the region's agricultural output is significantly affected by weather extremes, such as droughts, floods, and storms, which damage crops and livestock, leading to reduced food supplies and higher prices. These climate-related challenges disproportionately affect smallholder farmers and pastoralists, who rely heavily on agriculture for their livelihoods.

FIGURE 2.1

Change in African cereal production and food-insecure population, 2000–23



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: The cereals are cassava, maize, rice, and wheat.

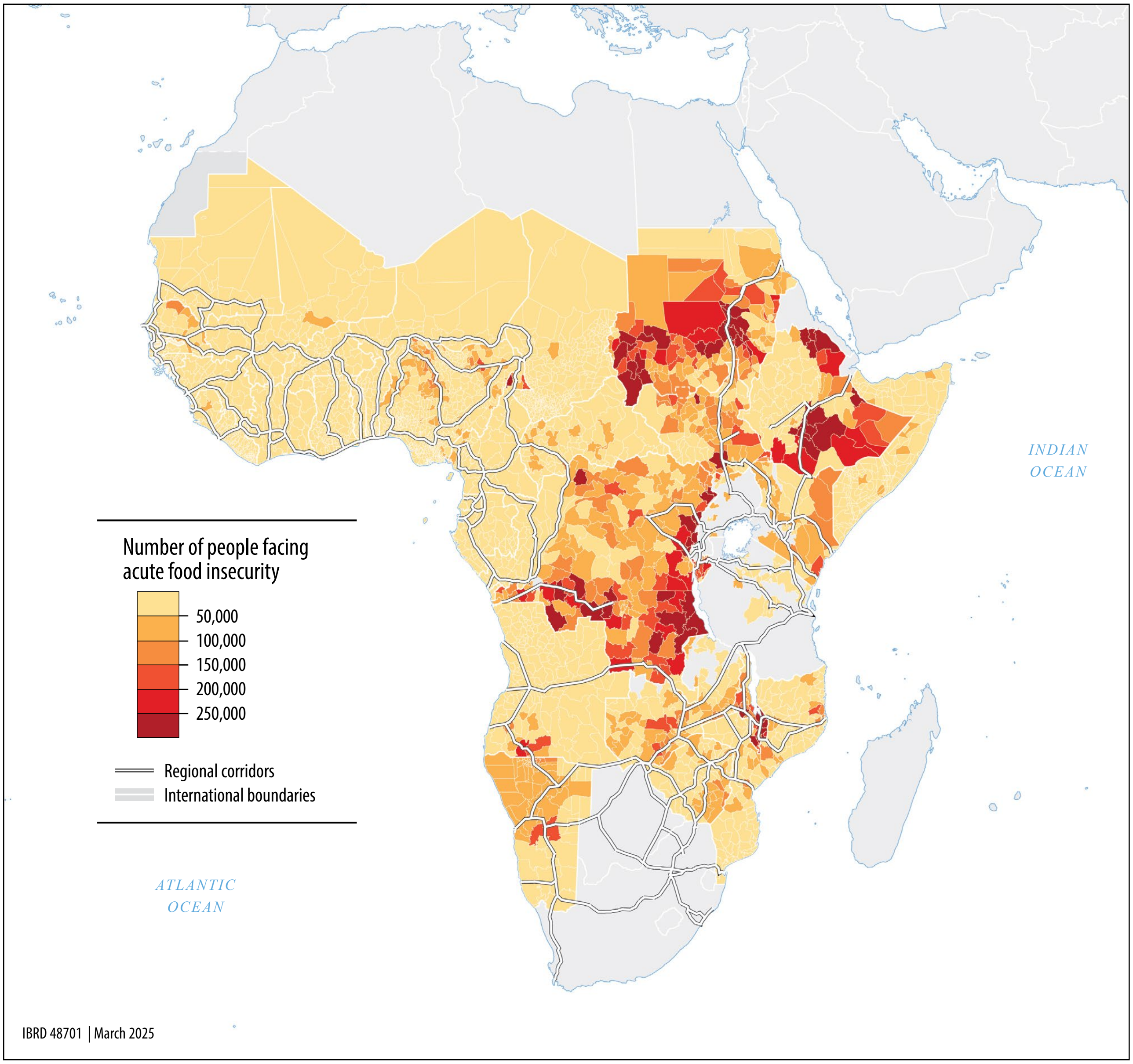
Conflict and insecurity lead to or exacerbate food insecurity by disrupting food production and trade, creating scarcities, and driving up food prices (World Bank 2021). The interplay among conflict, food insecurity, and transport connectivity becomes evident when overlaying food-insecure zones across Sub-Saharan Africa with transport networks. Map 2.1 illustrates the distribution of food-insecure zones in 2024 for most countries and the alignment of regional corridors across Sub-Saharan Africa. The Integrated Food Security Phase Classification (IPC), an initiative involving various partners (governments, United Nations agencies, the World Bank, nongovernmental organizations, civil society, and other actors), systematically determines the severity and magnitude of acute and chronic food insecurity in a country, as well as acute malnutrition situations, using consistent scientific standards. The IPC distinguishes among five phases of food insecurity: minimal, stressed, crisis, emergency, and catastrophe or famine. Map 2.1 shows the aggregate number of people in the three most severe classes—crisis, emergency, and catastrophe or famine—and the alignment of regional corridors. The map confirms that insecurity can be widespread across countries and regions with different characteristics and endowments and can change over time; data for all countries shown are for 2020–24. Notably, the two countries with the highest populations facing severe food insecurity in 2024 were the Democratic Republic of Congo (26 million people) and Sudan (21 million people), both of which were (and are) experiencing conflict. In Sudan, conflict affected the most agriculturally productive region of the country, with implications for food supply (Button 2024). Generally, large-scale internal displacements, market disruptions, and trade restrictions, as highlighted by Hall et al. (2017), contribute to instability in food supply chains.

In addition, economic shocks, macroeconomic instability, high unemployment rates, and currency depreciation, as noted by the International Monetary Fund (Salgado Baptista et al. 2022), add another layer of complexity to the issue of food security. The uneven economic recovery from the coronavirus disease 2019 (COVID-19) pandemic (Wallingford et al. 2024) played a role in hindering progress toward food security. Low productivity resulting from limited technology adoption and poor infrastructure (Onyeaka et al. 2024), along with the volatility of global food prices (Songwe 2012), make it difficult for African farmers to plan and manage their operations effectively. Additionally, limited storage facilities and lack of access to competitive markets force farmers to sell their produce at low prices or switch to other crops, leading to significant postharvest losses (Songwe 2012).

Inadequate infrastructure and services for food distribution exacerbate the problem. Deficiencies in transport connectivity weaken food supply chains and leave them highly vulnerable to shocks. Interventions that have proved successful in different parts of the continent and other world regions could strengthen the resilience of food systems and reduce food insecurity.

MAP 2.1

Food insecurity and regional corridor connectivity, Sub-Saharan Africa, 2020–24

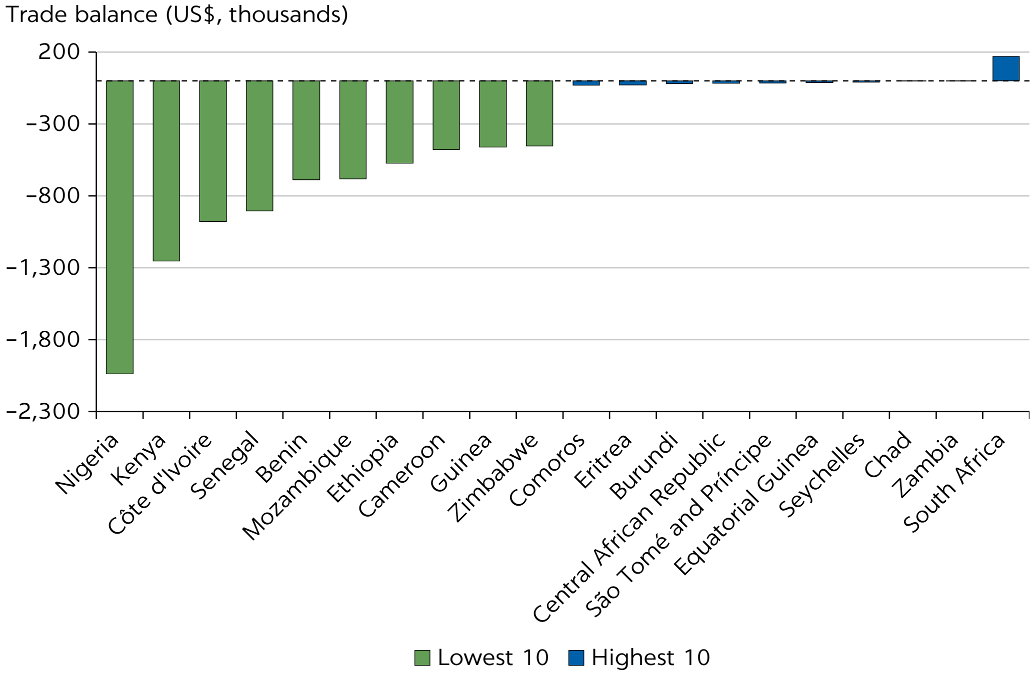


Source: Original map for this publication, based on data from IPC 2024.

The factors outlined in the preceding paragraphs result in fragile food supply chains, some seasonal and others more systemic. Almost three-quarters of countries in Sub-Saharan Africa were net importers of cereal in 2023, with the remainder exporting small volumes of cereals (refer to figure 2.2). Reliance on supplies from overseas makes transport an integral system in all stages of food supply chains, as it enables trade, production, physical and economic access to food, and market operations.

FIGURE 2.2

Lowest and highest cereal trade balances, Sub-Saharan Africa, 2023



Source: Original figure for this publication, based on data from International Trade Centre Trade Map (https://www.trademap.org/Index.aspx).

In 2023, the net cereal trade balance picture varied widely across the continent, with the two largest economies at opposite ends: Nigeria had a negative balance of $2 billion, and South Africa had a net positive balance of $170 million. Seven countries had negative balances of more than $500 million, 24 had negative balances of $100–$500 million, and 17 countries had negative balances of up to $100 million. The region had a negative balance of more than $13 billion on cereals alone.

Most of the countries on the global list of WFP-FAO (2024) hunger hotspots are in Africa. More specifically, Sub-Saharan Africa had the lowest average food security score as measured by the Global Food Security Index (GFSI) (Economist Impact 2022). The GFSI is a comprehensive assessment that measures food security according to four key pillars: affordability, availability, quality and safety, and sustainability and adaptation. It covers 113 countries, the majority of which are in Africa.

Christiaensen and Demery (2018) argue that problems start at the farm, where high transport costs neutralize the expected increase in production associated with greater use of fertilizers. Other researchers (including Bonuedi et al. 2020, Okou, Spray, and Unsal 2022, World Bank 2012, and Wudil et al. 2022) point to low productivity; inadequate infrastructure;

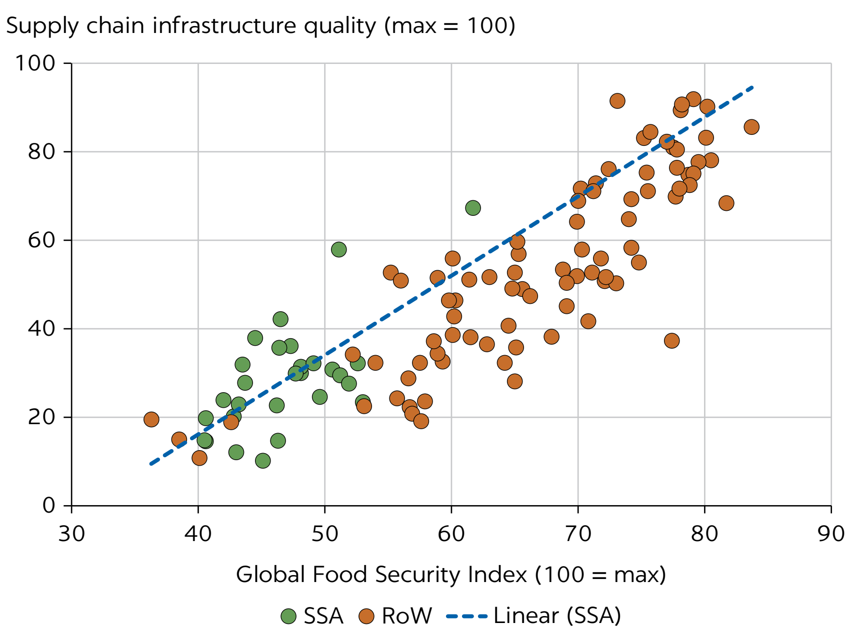
limited access to modern technology; and inefficient transportation, logistics, and storage facilities.

Africa's agricultural supply chains are strained from the local level to the national, regional, and global levels. The GFSI shows a correlation between supply chain infrastructure (which includes transportation networks, storage facilities, and logistics systems) and food system outcomes (Economist Impact 2022). Supply chain infrastructure is defined as the systems and structures that support the efficient movement of food from production to consumption; it includes transportation networks, storage facilities, and logistics services that ensure that food can be delivered in a timely and cost-effective manner. The index shows that with a few exceptions, African countries have weak supply chain infrastructure, low food security scores, and therefore a high level of vulnerability to shocks to their food systems (refer to figure 2.3).

The geographical vastness and diverse climatic conditions across Africa mean that food must often travel long distances from production areas to consumers, with many points of potential or actual weakness and high risks of food spoilage and loss. Targeted measures are therefore needed to strengthen and streamline supply chains to ensure their resilience and sustainability.

FIGURE 2.3

Correlation between the Global Food Security Index and supply chain infrastructure, Sub-Saharan Africa and rest of world, 2022



Source: Original figure for this publication, based on data from Economist Impact 2022.
Note: RoW = rest of world; SSA = Sub-Saharan Africa.

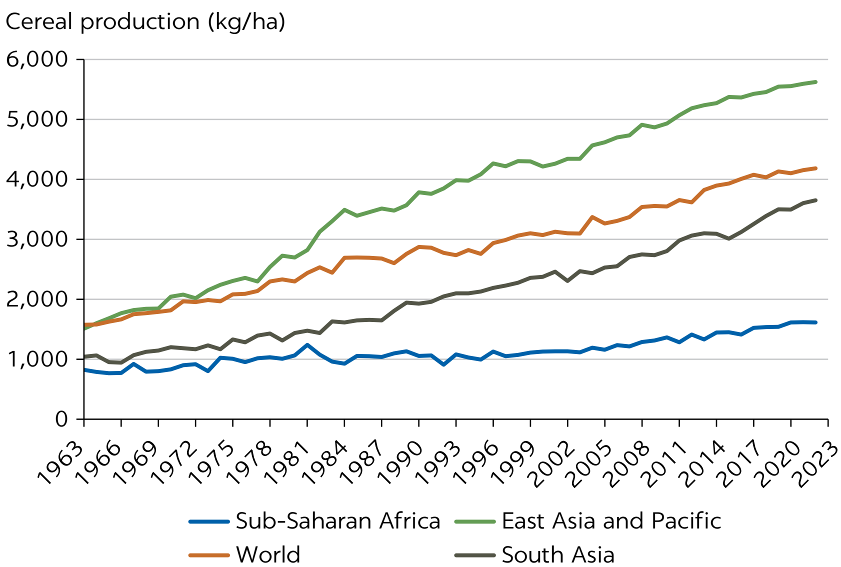
There is no one-size-fits-all solution. Reducing food insecurity requires multidimensional interventions, for several reasons. First, Sub-Saharan Africa does not produce enough food to meet its consumption needs. The continent has weak agricultural productivity (Wudil et al. 2022). Oukou, Spray, and Unsal (2022) estimate that cereal yields in Africa average just 1.5 tonnes per hectare—about 45 percent the yield in South Asia and just over 25 percent the yield in East Asia and the Pacific in 2023 (refer to figure 2.4).

Shortfalls in production of food must be met through imports. On the basis of data from FAOSTAT, Africa imports about one-quarter of its food requirements. The volume of food imports has continued to grow even as exports have increased (refer to figures 2.5 and 2.6). Imports are particularly high for some of the main sources of calories, especially maize, rice, and wheat. Some commodities, such as cassava, are primarily produced and consumed domestically, with limited cross-border trade.

Europe is Sub-Saharan Africa's main source of food imports, followed by South America and then East and South Asia. Less than 5 percent of staple imports come from other African countries (refer to figure 2.7).

FIGURE 2.4

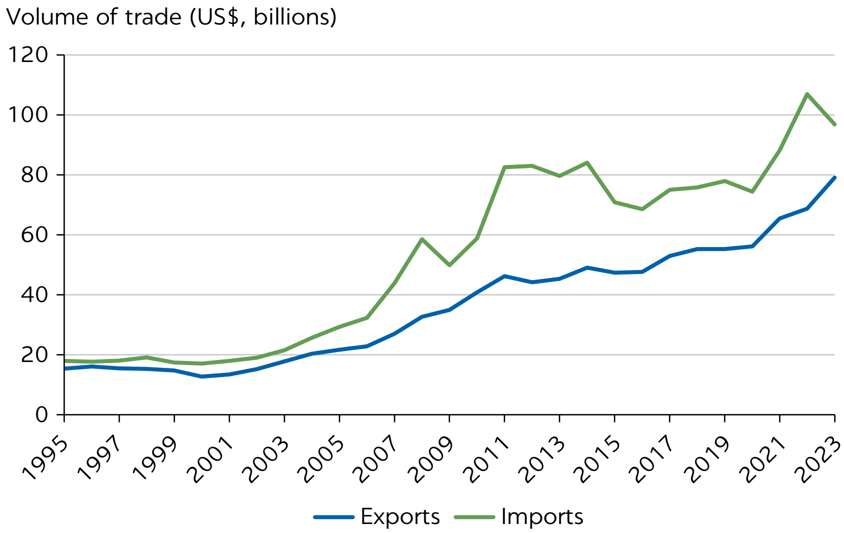
Cereal yield, by region and world, 1963–2023



Sources: Original figure for this publication, based on data from Oukou, Spray, and Unsal 2022 and World Development Indicators Database (https://data.worldbank.org/indicator/AG.YLD.CREL.KG?end=2022&locations=ZG-1W-8S-Z4&skipRedirection=true&start=1961&view=chart).

FIGURE 2.5

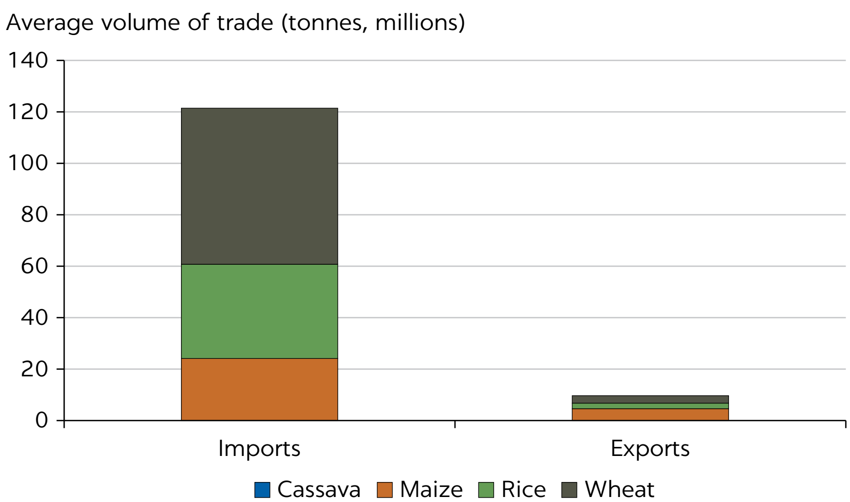
Value of Sub-Saharan Africa's food imports and exports, 1995–2023



Source: Original figure for this publication, based on data from UNCTADStat (https://unctadstat.unctad.org/EN/).

FIGURE 2.6

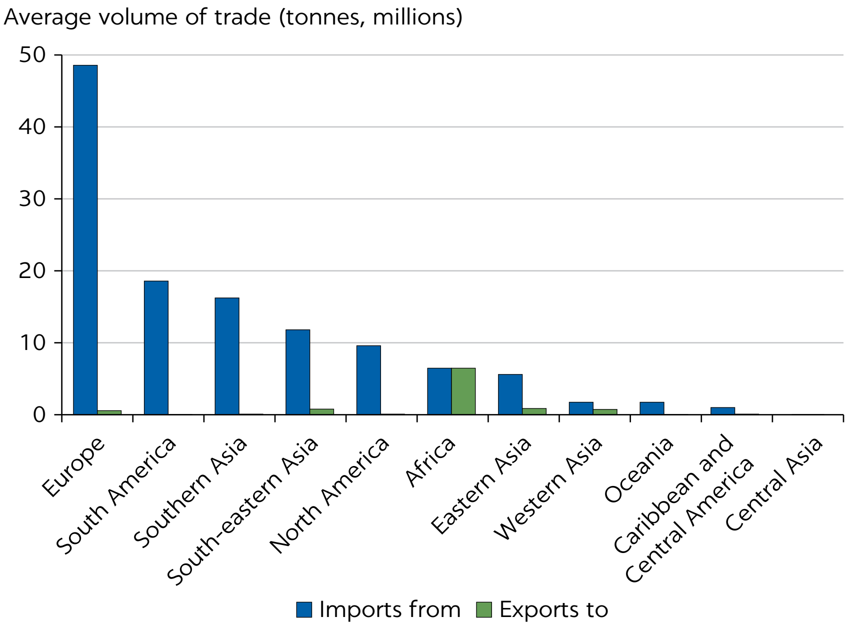
Average volume of Sub-Saharan Africa's imports and exports of cassava, maize, rice, and wheat, 2016–22



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: Cassava is largely consumed in the country where it is grown.

FIGURE 2.7

Sources and destinations of food trade in Sub-Saharan Africa, 2016–22



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: Regional groupings and nomenclature are those used in the FAOSTAT data set.

FOOD INSECURITY AS A SUPPLY CHAIN PROBLEM

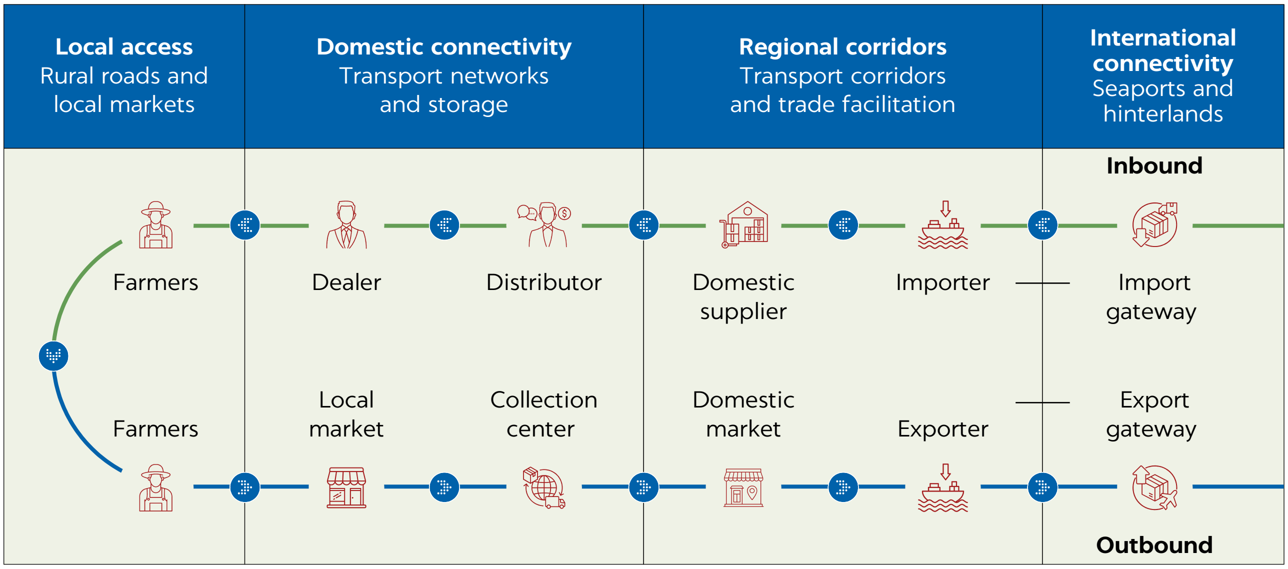
The role of transport and logistics in food system performance and outcomes is a common theme in the discourse on food security. Poor transport and logistics performance hinders countries' ability to manage supply and demand cycles for food across regions, preventing a steady supply throughout the year. Rural households suffer most from food insecurity because of limited access to markets, although pockets of food insecurity exist in urban areas, too (Pinto et al. 2023).

The availability and costs of transport affect food security on a local to a global scale. Failure at any point in the supply chain can lead to shortages or higher food prices for consumers and reduced competitiveness for food producers. For this reason, this report adopts a supply chain framework to explore how the nexus between transport and logistics affects food insecurity in Sub-Saharan Africa at the country level.

Figure 2.8 shows the different scales of connectivity needed for food security. The scales of analysis of transport and food security in Africa encompass various levels, each critical to understanding and addressing the continent's challenges. Locally, access to transport infrastructure is vital for ensuring that communities can reach markets, thereby reducing

FIGURE 2.8

Food supply chain framework used in this report



Source: Original figure for this publication.

spoilage and enhancing the distribution of agricultural products. Domestically, connectivity within countries is essential for linking different regions but especially for linking rural areas, where most food is produced, to urban centers, where demand is concentrated. Regionally, integration of transport networks across African countries facilitates trade and movement of goods, which is crucial for surplus food from one area to be distributed to areas experiencing shortages across borders, and international connectivity through ports enables Africa to engage in global trade, importing food to supplement local production and exporting agricultural products to generate revenue. Each of the scales of analysis plays a significant role in creating a resilient and efficient food system that can withstand various shocks and stresses.

Local access

An important step in increasing food availability is providing farmers and consumers with access to markets. Balineau et al. (2021) find that market infrastructure plays a critical role in improving food system sustainability. It encompasses physical and institutional infrastructure that links farmers to consumers, including urban markets, storage units, consolidation areas, retailers, wholesale markets, supermarkets, and shippers. This infrastructure makes trade possible; directly affects consumer and producer food prices; and affects farmers' physical spaces, market access, and regional development balance. Market infrastructure also determines the quality of food; reduces food losses; and helps farmers, including smallholders and local producers, access markets.

Access to physical markets need to be complemented by access to information. One report (WFP 2022) finds that lack of timely and accurate information on production and market conditions, including buyer requirements and product grades, hindered producers' ability in Mali to make informed decisions and compete effectively in international markets. Addressing such information gaps is crucial to enhance market access and agricultural productivity and reduce waste. Box 2.1 illustrates how the different scales of food distribution in Kenya interact, creating heterogeneous effects across places even in the same country.

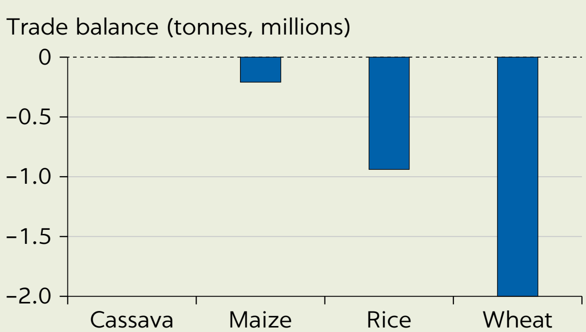
Box 2.1

Global, regional, and local dimensions of food distribution in Kenya

Kenya illustrates the relationship between local and international connectivity and the need to upgrade and expand transport infrastructure and services across food supply chains. Kenya is on the list of hunger hotspot countries: An estimated 1.7 million people who live on arid and semiarid lands were projected to face acute food insecurity between October 2024 and January 2025 (IPC 2024). In general, Kenya is a net food importer of the four crops—cassava, maize, rice, and wheat—studied in this report (refer to figure B2.1.1). In total, the country imported 3.2 million tonnes of these commodities in 2022.

FIGURE B2.1.1

Kenya: Trade balance of four crops, 2022



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: Cassava trade volumes are very small.

Most of Kenya's food imports are from overseas and come through the port of Mombasa. The port is one of the major gateways in East Africa and has bulk grain-handling capacity. The port also has storage silos with a total capacity of 245,000 metric tonnes and bagging facilities, along with bulk rail and road loading facilities for transfers inland to the rest of the country but also to neighboring landlocked countries, such as Burundi, eastern Democratic Republic of Congo, Rwanda, South Sudan, and Uganda. The Northern Corridor, which runs from the port to all these countries, is therefore an important element of the food transfer system.

However, regional trade in agricultural commodities experiences many impediments. This is particularly evident in the maize trade. Maize is an essential part of the diet in East Africa, notably in Kenya, Tanzania, and Uganda. Most of it is produced and consumed locally, but Tanzania and Uganda often produce surpluses, whereas Kenya and South Sudan run deficits. The imbalance between production and demand could be addressed through trade. However, although the East African Community, of which all these countries are members, no longer has tariffs on internal trade, many nontariff measures continue to hamper the free circulation of commodities.

continued

Box 2.1 Global, regional, and local dimensions of food distribution in Kenya, *continued*

At a domestic level, Kenya often has food surpluses in agriculturally productive regions, such as the Rift Valley. However, price differentials and food shortages in the drier, northern parts of the country point to poor market integration. In fact, Gitau and Meyer (2018) estimate that with efficient market integration, price differentials across markets in Kenya would quickly be corrected. The fundamental constraints are gaps in infrastructure for efficient domestic distribution. The lack of cohesive and reliable domestic infrastructure and transport services results in bottlenecks that prevent food from reaching areas of need in a timely manner.

In addition, limited storage facilities along transportation routes in Kenya lead to significant food losses, particularly of perishable goods, which deteriorate quickly without proper cold chain infrastructure.

Sources: Original box for this publication, based on model outputs; Abodi, Obare, and Kariuki 2021; and Gitau and Meyer 2018.

Domestic connectivity and transport services

Transport connectivity is essential for agricultural growth and economic outcomes. Nelson et al. (2021) use a geospatial framework to model the resilience of national food transport networks in 90 countries. They find that robust transport infrastructure and logistics are critical for ensuring food security. Countries with more localized food transport and denser transport networks exhibit greater resilience to disruptions; low-income countries generally have lower levels of resilience, leaving them more vulnerable to disruptions.

Investing in transport infrastructure is crucial for enhancing food security, because improved connectivity boosts agricultural productivity, facilitates market access, and ultimately contributes to economic welfare. Expanding access to road infrastructure is vital to achieving sustainable food security across the continent, for a variety of reasons.

Soft infrastructure—especially the availability and quality of transport services, trade policies, border management, and trade facilitation—also affects food transport systems. One topic that is particularly important is transport services and their costs. In a seminal work on transport prices, Teravaninthorn and Raballand (2009) describe the low productivity of Africa's trucking industry, which suffers from infrastructure constraints and low levels of competition between haulers. Using a cross-country regression, they estimate that a 10 percent decrease in transport costs would increase trade by 25 percent. Herrera Dappe et al. (2024) investigate transport prices in agricultural shipments and find that they are influenced by a variety of factors, including infrastructure, regional integration, and the degree of competition in transport services markets.

Regional corridors

On the basis of data from the United Nations Economic and Social Commission for Asia and the Pacific/World Bank International Trade Costs data set,[2] trade costs in Africa are higher for agricultural commodities than for other products. In the absence of access to regional export markets, surges in production in national markets with thin volumes of trade can lead to price collapses, potentially reducing production and investment in agriculture.

Trade facilitation is critical to reducing the costs of food trade between countries. One study estimates that logistics account for 28 percent of the final market price in Kenya—more than twice the 13 percent in some Asian countries (MasterCard Foundation and Mercy Corps AgriFin 2020). The large price differentials between markets in African countries, and between Africa and the world market, reflect high trade costs. Political borders often separate surplus food production zones from the markets they would normally serve, impeding the free flow of people and goods.

NTBs and export bans add to the costs of trading food commodities. Nontariff measures (NTMs) are policies and regulations imposed to ensure food safety, protect plant and animal health, and meet environmental standards. When poorly formulated and implemented—or adopted to limit competition—they can delay or increase the costs of imports and exports of food products. A report by UNCTAD (2021) finds that NTMs can significantly increase costs and impact on trade in food.

In some instances, African countries ban exports, especially in times of shocks to their food systems. Porteous (2017) finds that export bans on cereals in East and Southern Africa divert trade into the informal sector and lead to higher prices.

International connectivity

Disruptions to global supply chains during and after the COVID-19 pandemic and after the Russian Federation's invasion of Ukraine in 2022 highlighted the global reach of food supply chains.[3] The availability and efficiency of logistics systems at the global scale are essential for managing food imports because delays or bottlenecks in transit and storage in some other part of the world can lead to shortages, spoilage, increased costs, and potential food insecurity on the African continent. Because agricultural commodities are best shipped over long distances by low-cost modes of transport (such as ships), the availability and cost of sea shipping services, the performance of seaports, and connectivity between ports and hinterland destinations are key features of the international segment of food supply chains.

NOTES

1. The World Bank and other partners support countries to develop and operationalize their preparedness plans (World Bank n.d.).
2. ESCAP World Bank: International Trade Costs, https://databank.worldbank.org/source/escap-world-bank-international-trade-costs.
3. The Russian invasion of Ukraine, particularly the blockade of critical Black Sea ports, disrupted grain exports to Africa, exacerbating food insecurity across the continent (El Bilali and Ben Hassen 2024).

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3 Food Supply Chains in Africa

ABSTRACT

This chapter examines Africa's food supply chains, focusing on maize, cassava, rice, and wheat. It integrates food balance and transport modeling to analyze how transport connectivity and trade patterns affect food security, particularly availability and access costs. The model provides detailed insights into the first-level administrative divisions within countries and includes external trade zones to account for Africa's reliance on food imports. The analysis highlights infrastructure and logistics challenges while identifying opportunities for improvement.

KEY FINDINGS AND MESSAGES

- Transport costs account for a significant portion of food prices. On average, transport costs represent 13–31 percent of the final price of maize, rice, and wheat and as much as 45 percent of the price of cassava. The variation in costs has a direct impact on food affordability, particularly for low-income households.
- Locally grown crops, such as maize and cassava, have shorter, more efficient supply chains than other crops. Maize production, for example, is widely distributed across Sub-Saharan Africa, meeting local demand in many regions. In contrast, 75 percent of wheat and 50 percent of rice consumed in Sub-Saharan Africa are imported, with longer path (route) lengths—more than 6,000 kilometers in some cases—raising transport costs and increasing vulnerability to supply disruptions.
- Countries with long supply chains for staples, such as wheat and rice, face higher transport costs and are more vulnerable to supply disruptions than other countries. Dependency on imports of wheat and long supply chains expose these countries to global price volatility and delays, which increased during the coronavirus disease 2019 (COVID-19) pandemic and after the Russian Federation's invasion of Ukraine in 2022.

- Investments in infrastructure and policy reforms are critical to address inefficiencies in food supply chains. Improving road quality and port efficiency in, for instance, Benin, the Democratic Republic of Congo, Kenya, Somalia, and Zambia could reduce time and transport costs by 5–16 percent. Streamlining customs processes and reducing nontariff trade barriers (NTBs), which account for up to 15 percent of transport costs in some regions, could facilitate quicker and cheaper movement of food across borders.

TRANSPORT AND FOOD FLOW MODEL

This report is based on the results of a transport and food flow model that is built to explore global freight flows. (A detailed description of the model is provided in Annex 3A.) The model uses a spatially disaggregated database on food production and consumption and transport networks and combines food balance analysis and transport modeling. It builds on and extends the Global Freight Flow Model and Explorer (FlowMax) model that the World Bank's Transport Global Practice built to analyze trade and transport connectivity and prioritize connectivity investments on the basis of their potential impacts.[1]

The model is at a subnational scale, where the countries of Africa are divided into 786 traffic zones representing the first-level administrative divisions in every country on the continent. The rest of the world is represented as external zones, one for each region outside Africa (refer to map 3.1, panel a). The model assigns the movement of the four most important staple foods in Africa—cassava, maize, rice, and wheat—but emphasizes Sub-Saharan Africa to reveal the challenges and vulnerabilities inherent in African food supply chains. Through this detailed examination, the chapter identifies opportunities for improvements to enhance the resilience and efficiency of food supply chains across the continent.

The transport network of the model consists of the highway network across Africa and the maritime links that interconnect African countries and Africa to other continents (refer to map 3.1, panel b). Traffic (cargo) assignment across routes is done on an all-or-nothing basis,[2] in which the shortest path is defined by the generalized cost, a combination of monetary cost and time. This assignment facilitates the analysis of a variety of factors, including the likely impacts of NTBs, represented as time and cost, financial penalties, and time delays. These costs are applied to the network on each link, with border crossings and ports having additional frictions because of process and procedures as well as NTBs. Because the model looks only at agricultural commodities, equilibrium-based modeling was not used. As such, the exclusion of other forms of traffic, including nonagricultural goods and passengers, may affect the capacity of links and nodes on the network. The typical costs, speeds, and delays for road, maritime, ports, and border crossing points (BCPs) were researched and compiled from various sources. These costs and speeds inform the route choice.

MAP 3.1

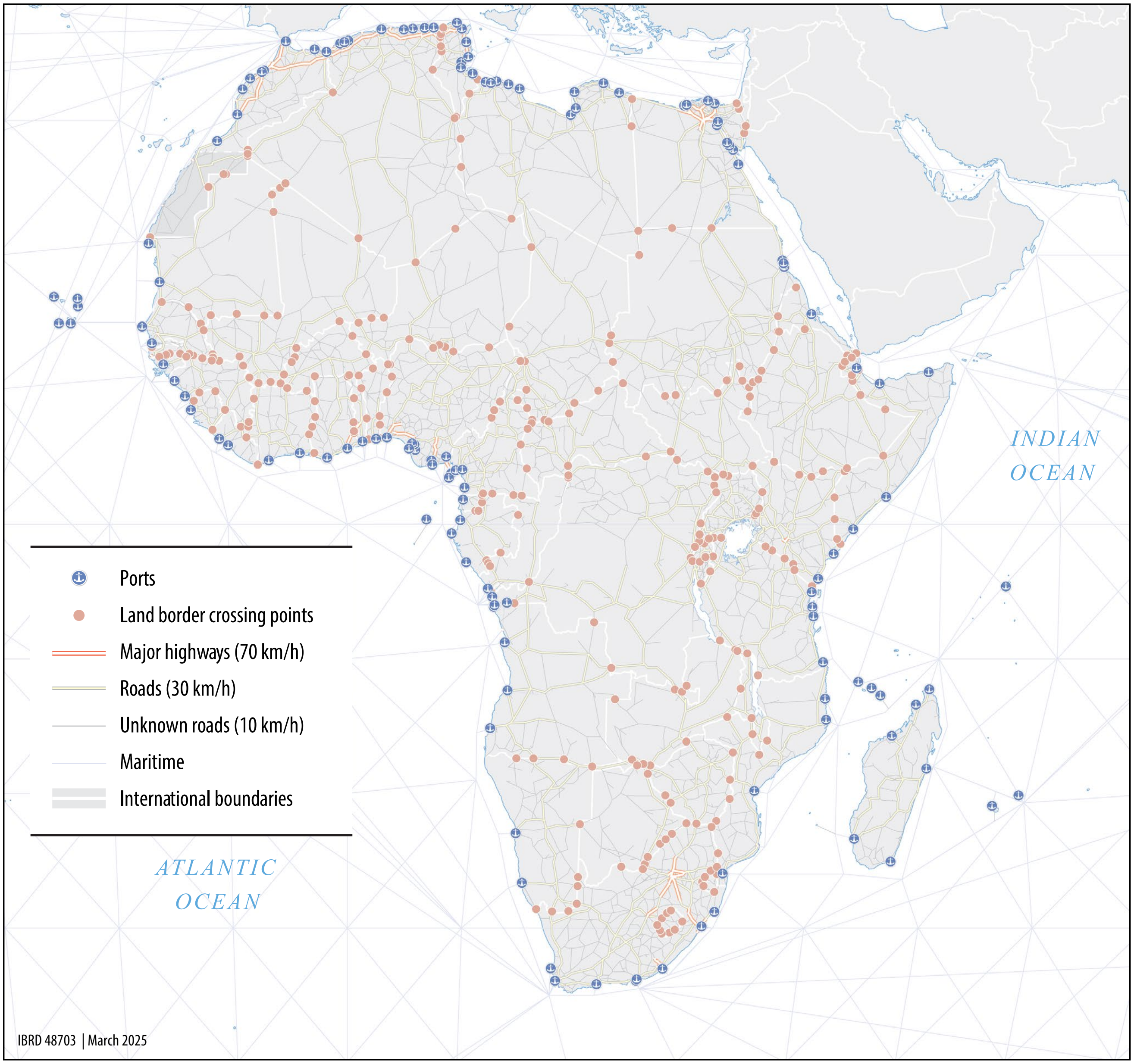
Traffic zones and networks in Africa as defined in the model

a. Zones

continued

MAP 3.1 *continued*

b. Networks



Sources: Original maps for this publication using the World Bank World Subnational Boundaries dataset (level 1 administrative divisions) and the transport network as implemented in FlowMax.
Note: Unknown roads are those for which attributes are not known.

The analysis is based on an exploration of the flow patterns of cassava, maize, rice, and wheat to shed light on the intricate web of transport costs and the time required to access food, two critical factors affecting food security. The four commodities account for 45 percent of total calories consumed across the continent:[3]

- Sub-Saharan Africa produces much of its cassava requirements. The crop provides 127 million kilocalories per year. Because cassava is highly perishable, imports and exports are limited, and movement is mostly domestic. The highest consumption is in Central Africa, especially the Democratic Republic of Congo, and West Africa. All countries that consume significant amounts of cassava, except Burkina Faso, are nearly self-sufficient in production.
- Maize is widely grown across Sub-Saharan Africa. It accounts for 149 million kilocalories per year. Maize is a food staple in East and Southern Africa, but it is also consumed in some parts of West Africa. Most countries in Sub-Saharan Africa that consume significant amounts of maize are nearly self-sufficient in its production. Countries that rely more heavily on imports are Angola, Botswana, and Zimbabwe, in Southern Africa, and Guinea-Bissau and Senegal, in West Africa.
- Rice is imported in large amounts from other continents, although some African subregions, particularly West Africa, produce significant quantities of rice. There are large international import flows as well as intraregional trade. Rice and associated products, such as flour, account for 92 million kilocalories per year. Consumption of rice is higher in coastal countries, including Guinea, Liberia, Madagascar, and Sierra Leone. Coastal countries, including Benin, Cameroon, Gabon, Kenya, Liberia, and Togo, as well as all countries in Southern Africa, tend to be more dependent on rice imports than other countries.
- Wheat is heavily imported from other continents, with only a small proportion of Africa's consumption grown on the continent. Wheat and wheat products account for 80 million kilocalories per year. Countries that produce significant amounts of wheat are Ethiopia, South Africa, and parts of Sudan. These countries are also major consumers of the commodity. Wheat consumption is highest across North Africa and high in per capita terms in Gabon, Kenya, Namibia, and the Republic of Congo, which rely more on imports.

Origin-destination matrices were produced by synthesizing information on production and consumption at the zonal level with international trade at the country level. A five-year average was calculated, for 2017–22 (excluding 2020, the first and worst year of the COVID-19 pandemic). The distribution of food grown and consumed within a country was assessed using a gravity model. Imports and exports were assigned to each zone on the basis of the amount of surplus or unmet demand.

Table 3.1 lists the data sets used in the model build and expands on those used in Nelson et al. (2021). The model includes scripts that process these data sets in their raw formats, so that the model can be updated for future simulations.

The model yields three primary outputs:

- Volumes of flows of the four staples that move by road, over the international maritime network, and through BCPs and ports (tonnes per year)
- Transport costs for imports and exports of food to and from each zone and the way in which these costs are apportioned between operating costs and NTBs (dollars per tonne)
- Transport time for imports and exports of food to and from each zone and the way in which the total time is apportioned between on-road movement, maritime movement, and delays at BCPs and ports (days).

TABLE 3.1 Key model inputs for model used in this report

MODEL INPUT	SOURCE
Zone system	World Bank Subnational Boundaries GeoJSON (https://wbwaterdata.org/dataset/world-subnational-boundaries)
Model network	FlowMax model network and nodes: road and maritime
Average travel speed by link type	Speeds for each country provided by a scrape of Google traffic speeds
Rural Access Index	Socioeconomic Data and Applications Center
Production and consumption by crop	FAO Food Balance Sheets (https://www.fao.org/faostat/en/#data/FBS)
International crop trade	FAO detailed trade matrix (all data, normalized) (https://www.fao.org/faostat/en/#data/TM)
Spatial population distribution	GHS-POP Epoch 2020 Release 2023A 30 arcsecond (https://human-settlement.emergency.copernicus.eu/ghs_pop2023.php)
Spatial crop production distribution	SPAM 2017 version 2.1 (for Sub-Saharan Africa) and SPAM 2010 version 2.0 (for North Africa) (https://mapspam.info/data/)
Value of time for generalized costs	Values used in Eastern Partnership trade model
Vehicle operating costs per kilometer	Prices from Herrera Dappe, Lebrand, and Stokenberga (2024), for food shipments by major humanitarian organization
Tariffs	Original calculations for this publication
Border delays, costs, and penalties	Original calculations for this publication

Source: Original table for this publication, after Nelson et al. 2021.
Note: FAO = Food and Agriculture Organization of the United Nations; GHS-POP = Global Human Settlement Population; SPAM = Spatial Production Allocation Model.

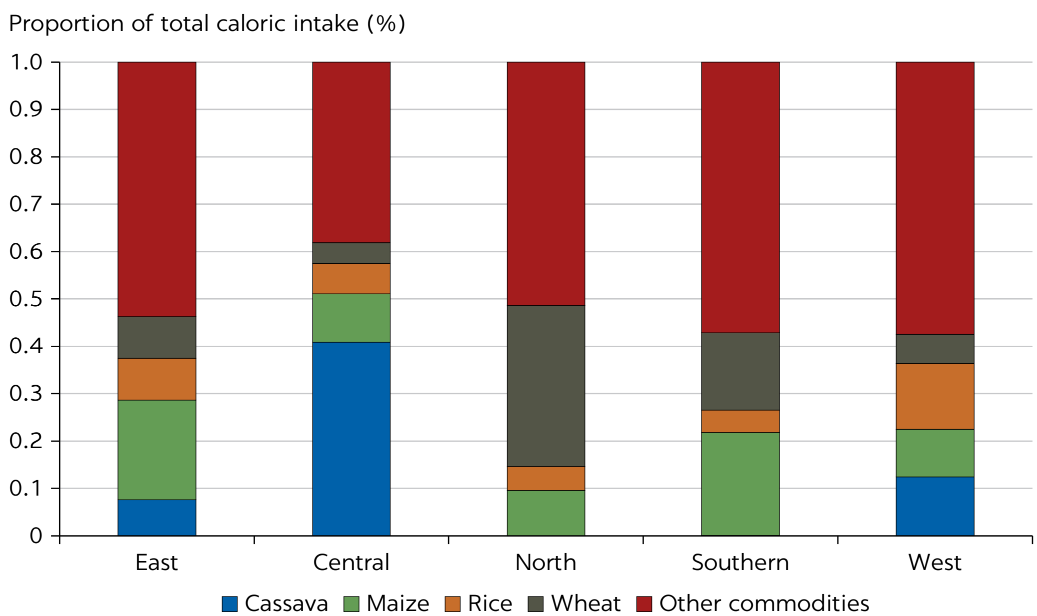
ESTIMATES OF FOOD FLOWS IN AFRICA

The four commodities studied account for almost half of the caloric intake in Africa, ranging from 43 percent in Southern and West Africa to 62 percent in Central Africa (refer to figure 3.1).

Map 3.2 shows estimates of the quantities of crop production and food consumption for each staple, estimated from the FAO Food Balance Sheets data set and spatially disaggregated within each country by population distribution. The model assumes that crops can be used for food purposes (consumption by people) and nonfood purposes (use as animal feed or for industrial purposes). The self-sufficiency ratio, which indicates the extent to which a country relies on its own production resources, is an important factor in the average transport cost of food in a country. It is defined as the percentage of food produced that is consumed in a country. The higher the ratio, the greater the self-sufficiency. Where self-sufficiency is high, the total transport costs tend to be lower, because food is not transported over long distances, reducing direct transport costs, and fewer trips across borders are required, reducing the costs of NTBs.

FIGURE 3.1

Contribution of cassava, maize, rice, and wheat to total caloric intake in Sub-Saharan Africa, by subregion, 2022

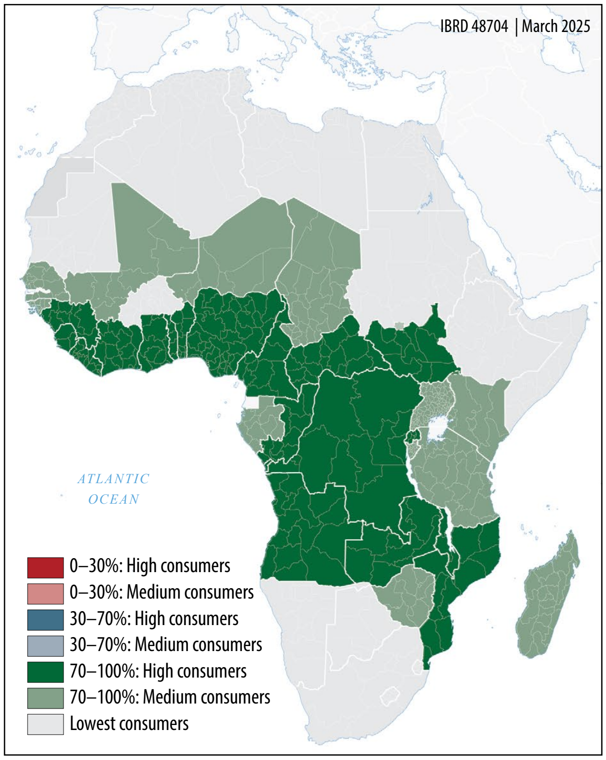


Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).

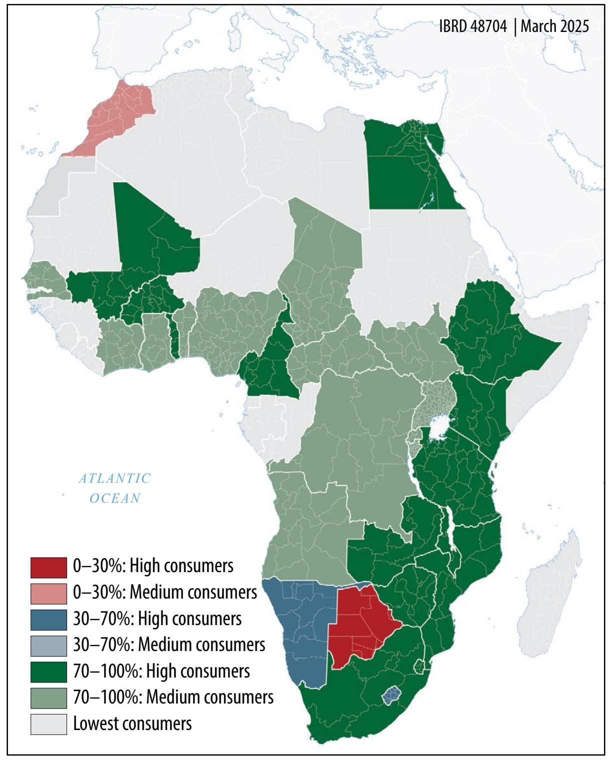
MAP 3.2

Self-sufficiency ratios for cassava, maize, rice, and wheat in Africa, as a proportion of food demand, 2022

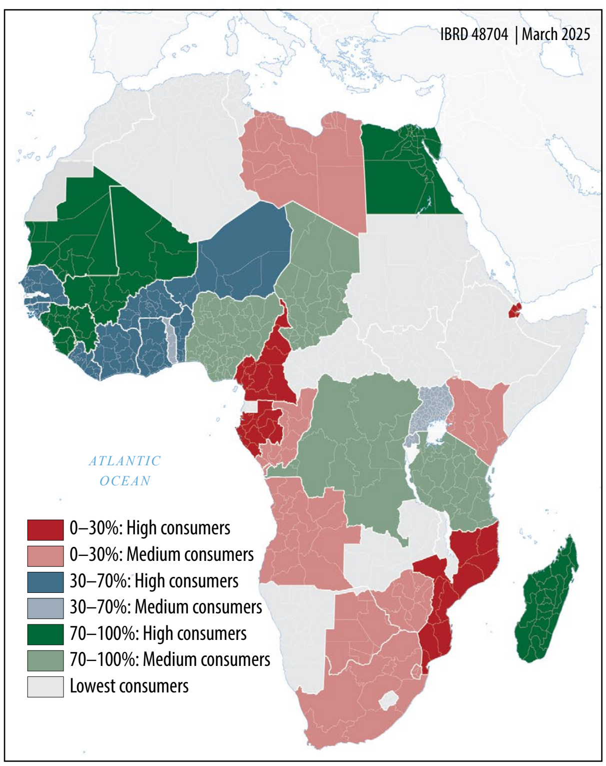
a. Cassava



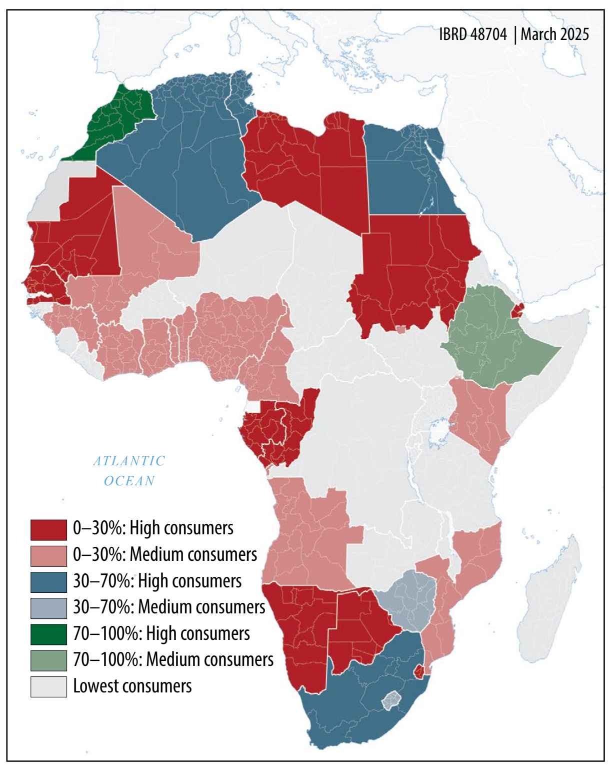
b. Maize



c. Rice



d. Wheat



Source: Original maps for this publication, based on model outputs and FAO Food Balance Sheets (https://www.fao.org/faostat/en/#data).
Note: Self-sufficiency is defined as the ratio of consumption by people to crop production.

Length of food supply chains

We estimate the distance food travels to reach consumers in each subnational zone as well as the quantity of food that is accessible within defined periods of time, including two days, the maximum transport time of a perishable commodity such as cassava (Tomlins et al. 2021). The estimate of time identifies areas potentially cut off from accessing food in an emergency, making them more vulnerable to supply chain disruptions.

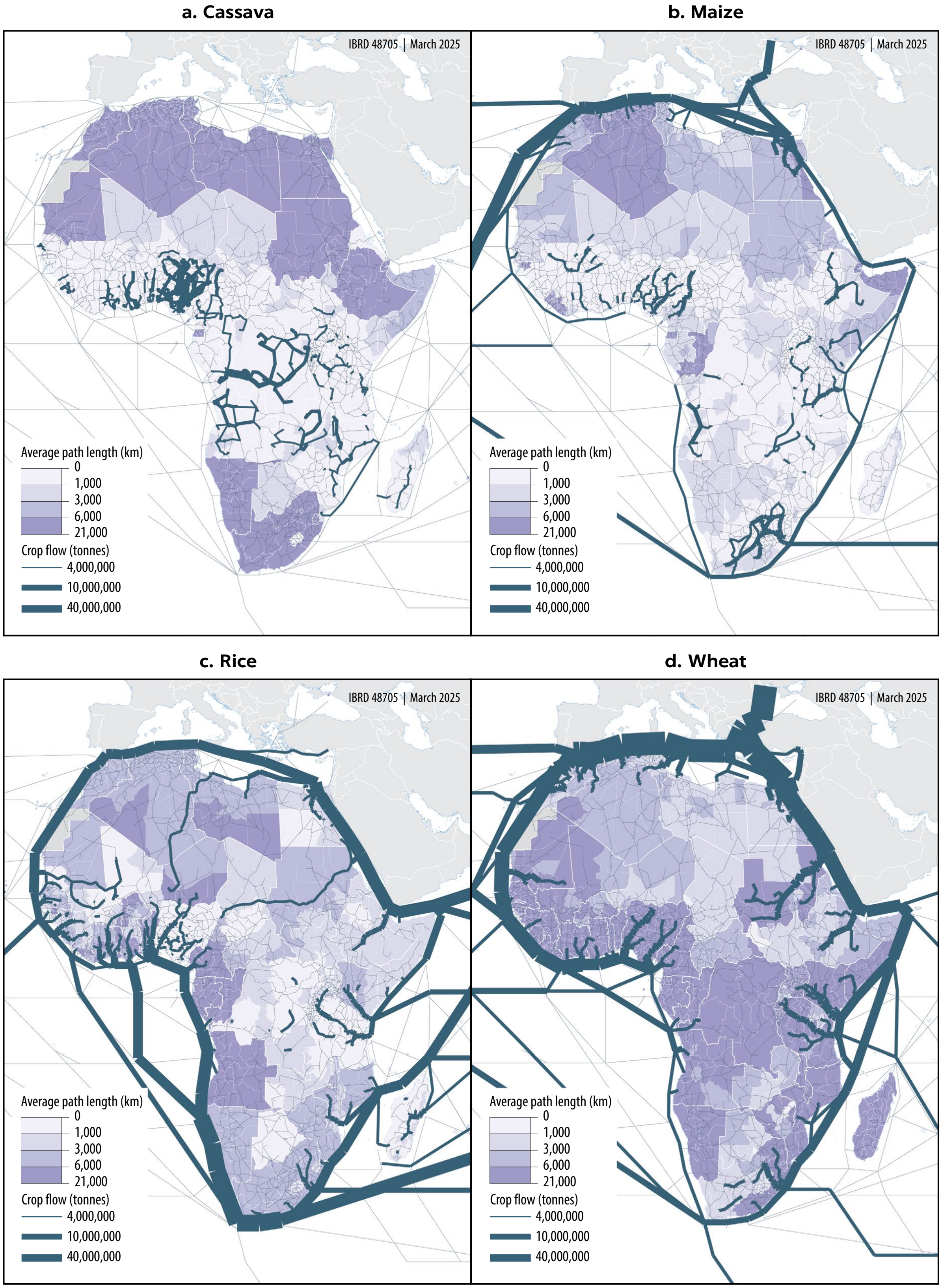
Map 3.3 shows the flow patterns for each staple consumed, based on the 2022 pattern of production, consumption, and trade. The darker the shading, the greater the distance required to transport the staple to consumers. The distances do not include food that is produced and consumed within a zone; only food that moves between zones is considered.

The patterns show the following:

- Most of Sub-Saharan Africa is self-sufficient in cassava. Because of its high perishability, it is usually consumed locally. Most areas with significant consumption have short paths. Areas with longer paths include western Angola, eastern Central African Republic, eastern Democratic Republic of Congo, northeastern Nigeria, northern Republic of Congo, southern and western South Sudan, and southern Zambia.
- Maize is grown throughout Sub-Saharan Africa, and a significant proportion of demand is met with locally grown crops, resulting in relatively short path lengths across much of the continent. Locations of potential concern are those with high consumption and longer distances. They include eastern Angola, Cameroon, eastern Kenya, northern Mali, Namibia, northern South Africa, and parts of Zimbabwe.
- About half of the rice consumed in Sub-Saharan Africa is grown in Africa, and the other half is imported. Many of the largest consumers, such as Nigeria and Tanzania, are also major producers. The countries with high consumption and import dependence include Guinea and Sierra Leone, as well as Benin, Côte d'Ivoire, Liberia, Senegal, and central Tanzania.
- Three-quarters of wheat consumption in Sub-Saharan Africa is imported, mostly from North America, Europe, and Central Asia. Areas that consume significant amounts of wheat but also have relatively short path lengths are Ethiopia, South Africa, and parts of Zimbabwe, all of which grow a portion of their requirements.

MAP 3.3

Flow patterns of cassava, maize, rice, and wheat in Africa, 2022



Source: Original maps for this publication, based on model outputs.
Note: The thickness of the lines corresponds to the relative size of the flow.

Although some countries in Sub-Saharan Africa are self-sufficient in rice at the national level (e.g., the Democratic Republic of Congo, Nigeria, and Tanzania), they still have a spatial mismatch between production and consumption, for which an efficient transport system is needed to move food around. For example, central Nigeria produces more rice than it consumes; the surplus is transported to the north and south of the country. In the Democratic Republic of Congo, the north of the country produces a surplus of rice, for which there is demand in the south of the country. If areas of production and population centers are remote and it is difficult to move commodities around a country, then the high cost of transport can increase food insecurity.

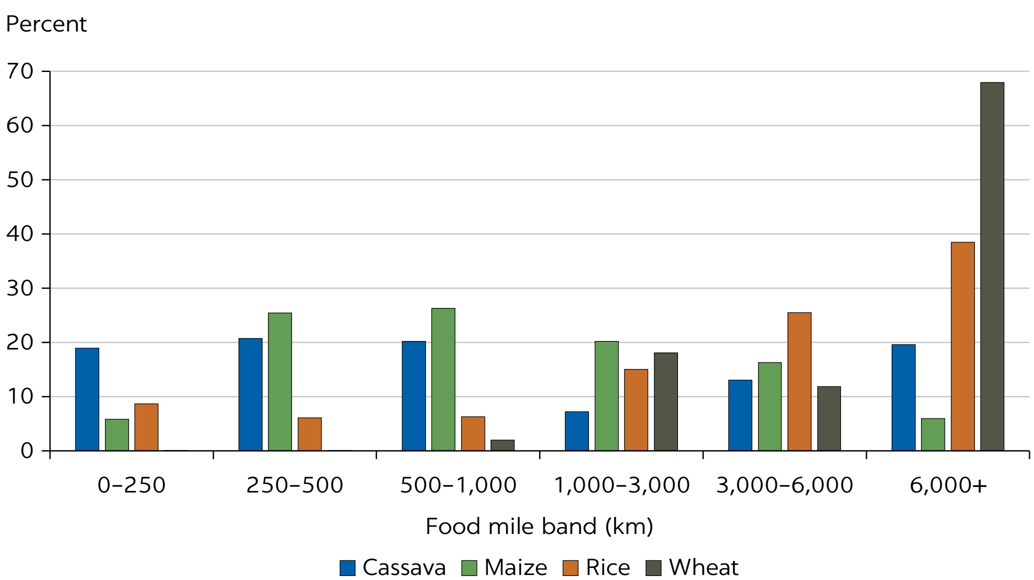
Shipping food over long distances does not necessarily have a negative effect on food security, however; in some cases, longer routes may be cheaper than shorter ones, especially if there are impediments to the flow of traffic. Long distances do increase vulnerability to disruptions, as was evident during the COVID-19 pandemic and after Russia's invasion of Ukraine.

Figure 3.2 shows the number of people living within selected path-length bands. It reveals that rice and wheat have the longest average distances to travel. These commodities have the most stretched supply chains.

There is a great variation in the distances over which food commodities are transported in Africa. The distances vary by country, commodity, and the

FIGURE 3.2

Share of population living within selected distance bands in Sub-Saharan Africa, 2022



Source: Original figure for this publication, based on model outputs.
Note: A food mile band is the range of distances over which food is accessible.

commodity's geography of trade. Among the countries with generally long path lengths are

- Burkina Faso for rice, which is locally produced in small amounts and must be imported;
- Namibia for all four staples, because of limited domestic production;
- Niger for rice and wheat (however, the main staples consumed in Niger are sorghum and millet, which are not modeled);
- Somalia, for all four staples, largely because of limited domestic production; and
- Sudan, for all four staples (however, sorghum is the most consumed staple in this country).

Transport costs

Transport costs play a crucial role in food security in Africa because of the continent's vast size and often isolated rural areas. Because road transport is the dominant mode of transport in Africa, poor road quality and limited rural access make it difficult for farmers to move produce to markets, leading to high postharvest losses and limited market reach. A corollary is that inefficiencies in transport services can add significantly to the cost of shipping food and deter trade between African economies. For these reasons, the model includes the costs associated with moving food commodities across each segment of the supply chain. Many other factors affect transport prices. Herrera Dappe, Lebrand, and Stokenberga (2024) provide a comprehensive analysis of how efficient, high-quality infrastructure can reduce transport costs and improve connectivity (refer to box 3.1).

Box 3.1

Targeting markets and places to reduce costs

By addressing market failures and frictions and implementing effective policies, African countries can enhance their transport systems and increase access to food, according to a comprehensive report on trucking prices by Herrera Dappe, Lebrand, and Stokenberga (2024). The report shows that trucking rates vary significantly within and across countries, with about three-quarters of the variation in trucking prices per tonne-kilometer found within countries. Local factors, such as infrastructure, geography, and market structure, are particularly important in determining transport prices within and across countries.

The premium for transport services between countries is very high: Shipping food across a border in low- and middle-income countries is about 70 percent more expensive than shipping within a country, likely because of cost efficiency and better utilization of assets. The premium in low-income countries is smaller when trucking companies from a richer neighboring country are allowed to compete in the local market, as seen in several of the countries surrounding South Africa.

Conflict also affects transport prices. In conflict-ridden locations, such as the Democratic Republic of Congo and Somalia, trucking rates are

continued

Box 3.1 Targeting markets and places to reduce costs, *continued*

$0.14–$0.56 per tonne-kilometer—significantly higher than the $0.06 in South Africa and $0.08 in Uganda. The higher prices reflect the expenses associated with checkpoints, roadblocks, and other security measures, as well as higher salaries and risk premiums charged by carriers. Countries facing food insecurity also experience high trucking rates because of limited supply and the risks faced by operators.

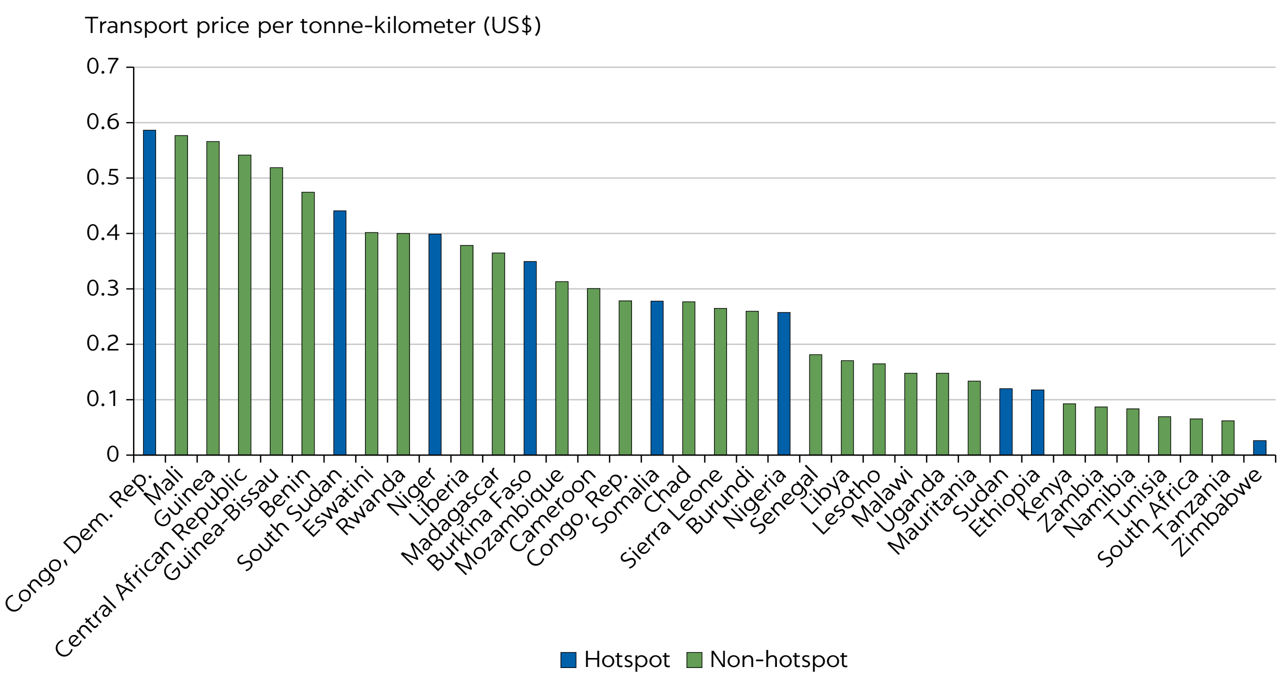
The report shows how market failures, government policies, and the distribution of economic activity across space raise transport prices. Empty running trucks and cargo vessels are common, increasing transport costs.

Regulations that limit the ability of trucks and vessels to pick up cargo at the destination and information frictions that limit the ability of shippers and carriers to find each other increase the probability of empty trips.

Herrera Dappe, Lebrand, and Stokenberga (2024) recommend making markets and places efficient, including by strengthening competition, promoting the development of efficient transport service providers, and improving the efficiency of ports and border crossings. These policies can help reduce transport costs and improve food security by making it easier and cheaper to move food from producers to consumers.

FIGURE 3.3

Transport prices used in the model, by country in Sub-Saharan Africa, 2019–20



Source: Original figure for this publication, based on Herrera Dappe, Lebrand, and Stokenberga 2024.
Note: A food security hotspot is a country where a significant portion of the population faces a high level of acute food insecurity and is at risk of malnutrition, starvation, or even famine.

The model was calibrated with transport prices from the food supply contracts in Herrera Dappe, Lebrand, and Stokenberga (2024) (refer to figure 3.3). Although food aid delivery costs may be higher than typical market rates, they generally reflect market conditions and operating practices, including empty running, which is prevalent in agricultural logistics.

Table 3.2 and Figure 3.4 present the average transport costs of each staple commodity across all countries in Sub-Saharan Africa. The table also compares the costs with the typical consumer price. The length of the supply route is reflected in transport costs, with locally produced and consumed maize and cassava having lower average transport costs (about $66–$92 per tonne) than rice and wheat, which tend to be imported over long distances and have higher transport costs (about $124–$134 per tonne).

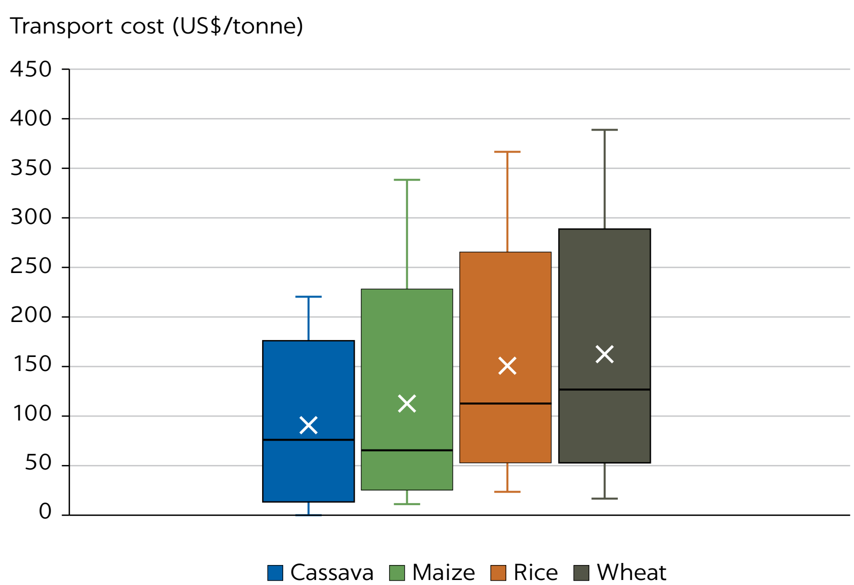
TABLE 3.2 Average transport cost and price of maize, cassava, rice, and wheat in Sub-Saharan Africa

FOOD TYPE	TOTAL TRANSPORT COST (US$/TONNE)[a]	AVERAGE CONSUMER PRICE (US$/TONNE)[b]	TRANSPORT COSTS AS % OF AVERAGE PRICE
Maize	66	390	16
Cassava[c]	92	205	45
Rice	124	954	13
Wheat	134	423	31

Source: Original table for this publication based on model outputs.
Note: Total transport costs are from model outputs; they include operating costs and the cost of NTBs. NTB = nontariff barriers.
a. Total transport costs from model outputs representing the sum of operating costs and the cost of NTBs.
b. The average consumer price for imported commodities is from the Food Price Monitoring and Analysis Tool (https://fpma.fao.org/giews/fpmat4/#/dashboard/home).
c. The price of cassava is for Ghana, as estimated by the authors. All prices are for 2024.

FIGURE 3.4

Range of transport costs for cassava, maize, rice, and wheat in Sub-Saharan Africa, 2022



Source: Original figure for this publication, based on model outputs.
Note: Whiskers present the range in average costs for countries. X indicates the average transport cost.

Transport costs represent 13–31 percent of the final price of rice, maize, and wheat and 45 percent of the final price of cassava. This is due to the relative values of the different commodities. Transport prices (fuel, wages, vehicle hire, markup) are the main elements of transport costs, followed by the cost of NTBs. Transport costs vary significantly by location, with maize showing the widest spread with an interquartile range of $17–$40 per tonne.

Figure 3.5 presents the proportion of Africa's population that live in different transport cost bands. Maize consumers are concentrated in regions with moderate transport costs, reflecting greater local production and relatively efficient local supply chains. In contrast, wheat, most of which is imported, faces higher transport costs because of longer routes. Boosting local wheat production could reduce costs and improve food security.

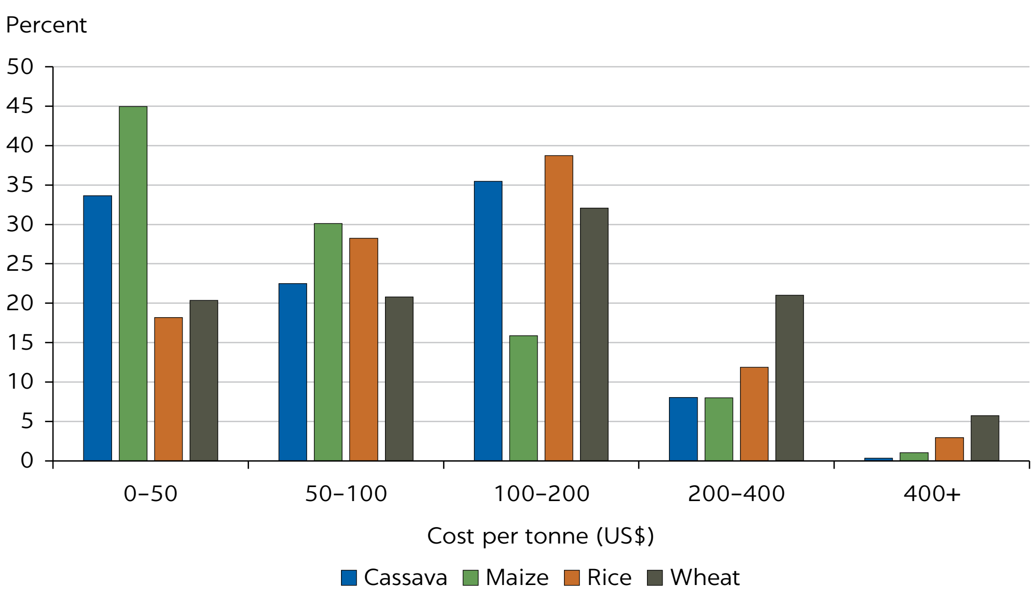
Other costs of gaining access to markets

Transport costs are composed of transport prices and other costs incurred to gain access to markets, especially NTBs. The most significant NTB in terms of cost is the cost of capital (equivalent to 2–4 percent of total transport cost), followed by sanitary and phytosanitary measures (0.7–1.8 percent) and policing (0.6–1.2 percent) (refer to table 3.3).

At the aggregate level, NTBs do not play a significant role in transport costs, representing less than 2 percent of total trade and transport costs. They nevertheless affect food security because some of the measures may involve actual bans on trade in specific commodities. Table 3.3 also presents the average transport costs for food traded across borders within Africa and food imported from Europe, Asia, or the Americas.

FIGURE 3.5

Share of population within transport cost bands for cassava, maize, rice, and wheat in Sub-Saharan Africa, 2022



Source: Original figure for this publication, based on model outputs.

TABLE 3.3 Average NTBs and transport costs of cassava, maize, rice, and wheat in Sub-Saharan Africa, 2022

US$ per tonne

FOOD TYPE	TRUCK OPERATING COST[a]	MARITIME OPERATING COST[a]	SANITARY AND PHYTOSANITARY MEASURES	OVERPOLICING AND CORRUPTION	LIMITED BORDER INFRASTRUCTURE	FINANCIAL COMPLICATIONS	TOTAL TRANSPORT COST
Local trade							
Cassava	89	0	0	2	< 1	< 1	92
Maize	60	2	< 1	2	< 1	< 1	66
Rice	80	34	1	4	2	2	124
Wheat	85	36	2	5	3	4	134
Intra-Africa trade							
Cassava	142	1	9	8	1	13	174
Maize	134	6	8	6	6	16	176
Rice	185	3	8	9	2	11	218
Wheat	159	48	2	6	4	5	161
Imports from outside of Africa							
Cassava	121	65	1	4	21	3	215
Maize	72	47	2	5	5	5	136
Rice	82	66	2	6	4	4	163
Wheat	97	48	2	6	4	5	161

Source: Original table for this publication, based on model outputs.
Note: NTB = nontariff barrier.
a. Operating costs include fuel, driver wage, maintenance, insurance, vehicle purchase, and hire of truck or maritime transport.

Total transport costs are higher for intra-Africa trade (8–14 percent of the price of commodities for imports from outside of Africa), except for cassava, which is rarely imported from overseas. The higher intra-Africa transport costs reflect NTBs. Rice is both imported from outside of Africa and traded within Africa. Sanitary and phytosanitary measures add $5.37 per tonne for intra-Africa trade but only $0.77 per tonne for imports from outside of Africa. The cost of finance associated with food shipments is also higher for intra-Africa trade than it is for imports from outside of Africa ($9.25 per tonne compared with $1.62 per tonne, respectively).

The primary reason NTBs are higher for intra-Africa trade is that the paths cross more borders than do goods imported through ports, and the costs of currency exchange can be higher between African countries than it is for imports from overseas. The cost to trade within Africa is therefore typically higher than the cost of importing from outside of Africa. Historically, the cost of freight in Africa has been the highest in the world (Herrera Dappe, Lebrand, and Stokenberga 2024). As a result, countries in Sub-Saharan Africa trade more with other continents than with their neighbors (UNECA 2024). Reducing transport costs and NTBs between countries could therefore facilitate greater trade between Sub-Saharan African countries, allowing for more efficient use of surpluses and increasing the number of food suppliers that can be accessed.

Table 3.4 presents the total transport costs of various ways of sourcing food for each country. The data show the significant variation in costs across countries but also how they depend on the origin. For example, the average transport cost for shipping the four staple commodities for Zambia is $73 per tonne for domestic shipments, $247 per tonne from other African countries, and $257 per tonne for overseas shipments.

TABLE 3.4 Average food staple transport costs in Sub-Saharan Africa, 2022

US$ per tonne

COUNTRY	ALL METHODS, INCLUDING DOMESTIC SHIPMENTS	FOR FOOD FROM INTRA-AFRICA TRADE ONLY	FOR FOOD FROM IMPORTS OUTSIDE OF AFRICA
Niger	331	426	454
Equatorial Guinea	229	289	121
Mali	180	288	291
South Sudan	179	244	317
Cameroon	165	265	232
Congo, Dem. Rep.	159	374	400
Congo, Rep.	159	328	224
Burkina Faso	151	255	351
Namibia	150	188	143
Chad	146	361	381
Angola	146	214	172
Gabon	130	258	183
Central African Republic	128	327	415
Somalia	120	174	116
Mozambique	113	164	152
Botswana	109	116	185
Côte d'Ivoire	96	179	154
Mauritania	95	252	100
Nigeria	95	370	192
Senegal	92	230	111
Benin	90	293	153
Eswatini	89	100	146
Guinea	87	238	170
Kenya	83	156	133
Guinea-Bissau	78	121	110
Liberia	78	201	123

continued

TABLE 3.4 Average food staple transport costs in Sub-Saharan Africa, 2022, *continued*

COUNTRY	ALL METHODS, INCLUDING DOMESTIC SHIPMENTS	FOR FOOD FROM INTRA-AFRICA TRADE ONLY	FOR FOOD FROM IMPORTS OUTSIDE OF AFRICA
Madagascar	75	188	131
Togo	73	167	140
Zambia	73	247	257
Gambia, The	69	114	74
Cabo Verde	66	88	68
Rwanda	66	122	206
São Tomé and Príncipe	64	94	72
South Africa	59	152	113
Ghana	56	230	152
Lesotho	51	74	140
Zimbabwe	47	125	154
Mauritius	47	137	50
Ethiopia	45	175	127
Sierra Leone	43	178	133
Djibouti	40	110	39
Uganda	40	135	181
Malawi	30	180	215
Tanzania	30	155	103
Burundi	25	135	198
Comoros	24	50	37

Source: Original table for this publication, based on model outputs.

Table 3.4 shows that transport costs can vary significantly depending on the country and the source of food. The five countries with the highest costs (Cameroon, Equatorial Guinea, Mali, Niger, South Sudan) are a mix of coastal and landlocked countries.

The areas with greatest transport cost burden for maize are in the Sahel region (eastern Central African Republic, northern Chad, northern Mali, Niger, Somalia, South Sudan, and southern Sudan) and the Republic of Congo. Not all these locations are major consumers of maize, however.

The areas with the greatest transport cost burden for wheat are in Central Africa (the Central African Republic, the Democratic Republic of Congo, eastern Republic of Congo), the Sahel (Burkina Faso, northern Chad, northern Mali, Niger, Somalia, eastern South Sudan, and western Sudan), and Malawi, northern Mozambique, and western Zambia. Wheat consumption is low in the Central Africa Republic and the Democratic Republic of Congo.

Botswana and Zambia stand out as having high transport costs across all staples (per kilometer). For Zambia, three main factors drive high costs: the long haul from ports in South Africa and Mozambique and the poor road conditions through Zimbabwe; the poor capacity of the ports, which frequently leads to delays in transfer of cargoes from ships to trucks; and the lack of capacity of transit border facilities, which frequently leads to long and costly delays for trucked cargoes.

The Democratic Republic of Congo, a large country with poor infrastructure, also has high transport costs. River-based shipments predominate, much of which take place on small and relatively inefficient vessels. Investment in trunk roads linking the western seaboard to central and eastern provinces would likely reduce transport costs, as would significant improvement and modernization of the inland waterway system.

TIME REQUIRED TO ACCESS TRADABLE FOOD

Time performance—the speed and reliability with which goods move from producers to consumers—is one of the main indicators of weakness in African supply chains. It is weak for several reasons, including inadequate infrastructure, inefficient logistics, and regulatory bottlenecks:

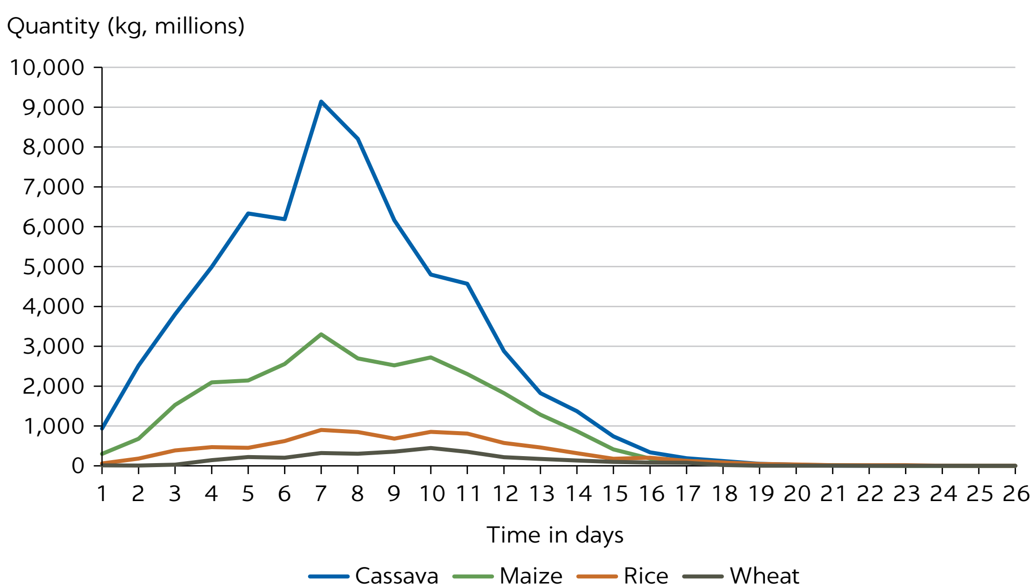
- *Inadequate infrastructure*. Poor infrastructure causes congestion and slow speeds (Herrera Dappe, Lebrand, and Stokenberga 2024). Many African countries have poor road networks, limited rail connectivity, and underdeveloped port facilities. These infrastructural deficits lead to significant delays in the transportation of staple foods. Transport costs in Africa are estimated to be more than 50 percent higher than in advanced countries, such as the United States, largely because of poor infrastructure and weak competition (Herrera Dappe, Lebrand, and Stokenberga 2024).
- *Inefficient logistics*. Poor logistics in Africa exacerbate delays. They include a lack of modern storage facilities, outdated transportation fleets, and insufficient cold chain systems. As a result, postharvest losses are high, with significant volumes of perishable commodities lost across the supply chain.
- *Regulatory bottlenecks*. Bureaucratic hurdles and inconsistent regulatory frameworks across different countries in Africa also contribute to delays. Customs procedures, border controls, and varying standards can significantly slow the movement of goods. For example, it can take several days to clear goods at African borders, compared with just a few hours in more developed regions.

A measure of time was used to determine the quantity of surplus food production that can be accessed from a zone within a defined period of time, starting with two days of travel time (refer to figure 3.6), the maximum transport time for a perishable commodity such as cassava (Tomlins et al. 2021).[4] Food that is reachable is added to a zone's own local production and compared with local food demand. The results show that most of the population can access cassava and maize relatively quickly, with the highest amounts of the food accessible within eight to ten days; imported rice and wheat are slower to reach markets because of longer transport routes.

The case of trade in rice, which is grown in some parts of Sub-Saharan Africa but not widely across many countries, is illustrative. Some countries (including the Democratic Republic of Congo, Nigeria, and Tanzania) are self-sufficient in rice at the national level, but national figures mask local disparities in production and consumption. Central Nigeria produces more rice than it consumes, so the surplus is then transported to the north and south of the country, which lack sufficient production. The north of the Democratic Republic of Congo produces a surplus of rice, which is in demand in the south. If areas of production and population centers are remote and it is difficult to move goods around the country, higher transportation costs can affect food security.

FIGURE 3.6

Quantity of food accessible in Africa, in number of days, 2022



Source: Original figure for this publication, based on model outputs.

In West Africa, most zones can meet their rice demand within two days of travel, including across borders. If intra-Africa trade were more competitive, disruptions to intercontinental trade could be mitigated by the use of alternative suppliers in the region. Regional economic groupings could facilitate the reallocation of food surplus in West Africa, mitigating food insecurity impacts.

The time performance of agricultural supply chains is important to food security for three main reasons:

- *Delays raise food prices*. Delays in the supply chain lead to higher transportation and storage costs, which raise the prices of staple foods.
- *Delays increase vulnerability to shocks*. Poor time performance in supply chains increases vulnerability to disruptions from natural disasters, political instability, and economic crises. Slow and unreliable supply chains mean that any disruption can quickly lead to severe shortages, increasing food insecurity.
- *Delays lead to food losses and waste*. Inefficient supply chains contribute to substantial food losses, especially for perishable items. Not only do these losses decrease the overall food supply, they also waste resources, such as water, labor, and agricultural inputs. Addressing postharvest losses could potentially provide food for millions in the region.

SUMMARY

Strengthening food supply chains requires improved road, rail, and port infrastructure to reduce transport costs, shorten supply chains, and reduce food loss. Improving logistics by addressing inefficiencies in the logistics sector, including modernizing storage facilities, upgrading transportation fleets, and developing cold chain systems, is essential for reducing food loss and improving time performance. Adopting a comprehensive approach that integrates technical, social, economic, and policy dimensions is necessary to reduce postharvest losses. It should include improving storage technologies, improving handling practices, and providing economic incentives to farmers.

ANNEX 3A: TRANSPORT AND FOOD FLOW MODEL

This report is based on the results of a transport and food flow model built to explore global freight flows. The model uses a spatially disaggregated database on food production and consumption and transport networks and combines food balance analysis and transport modeling. The model builds on and extends the Global Freight Flow Model and Explorer (FlowMax) model that the World Bank's Transport Global Practice built to analyze trade and transport connectivity and prioritize connectivity investments on the basis of their potential impacts.

This annex provides a description of FlowMax.

RATIONALE

Over the past decade, the World Bank has experienced increasing demand to apply its extensive knowledge around the world to provide both strategic insights on trade and transport connectivity and to inform responses to new and urgent policy questions in a timely fashion. A particularly relevant example comes from the transport sector globally, which faces new challenges to decarbonize while ensuring the achievement of sustainable development goals. In this context, some questions often arise:

- What infrastructure development policies can deliver the highest economic benefits to regional trade activities and countries' economies, considering the interdependence of world economies?
- How can greenhouse gas emissions from both domestic and international transport activities be reduced in a cost-effective manner?
- What are the transport and connectivity requirements of global challenges, such as food security and movement of minerals critical for the energy transition?

These growing and continuously evolving challenges demand that the World Bank acquire foresight and analytical modeling that has global coverage as its scope and nature.

Although the World Bank has supported various modeling projects in the past, FlowMax is the first instance in which it has developed a truly global model that can be deployed to swiftly respond to the preceding questions.

The model projects international freight transport activities (in tonne-kilometers) for global commodities transported with available transport modes and routes. This approach enables the assessment of different transport and economic policy measures (e.g., the development of new infrastructure networks or the alleviation of trade barriers) on a multiregional or global scale. The model is designed on the established four-step freight transportation modeling approach explained in Halim et al. (2018).

FLOWMAX FRAMEWORK

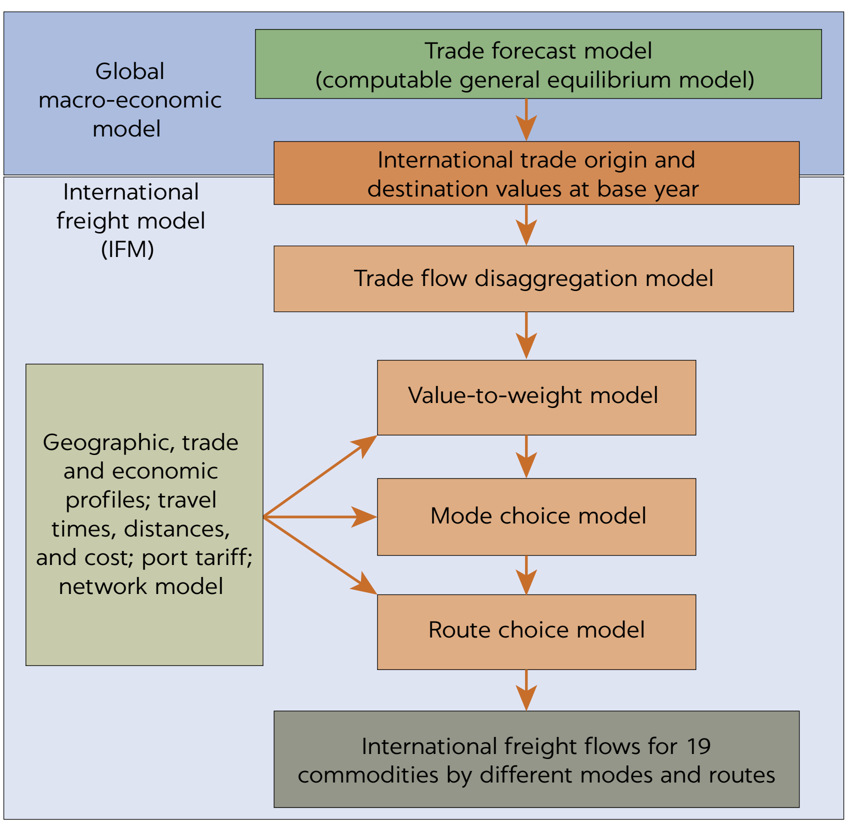
Figure 3A.1 provides a conceptual design of the FlowMax framework. It first estimates the weight of commodities traded between countries, the choices between modes, and the transport routes used to transport these commodities. The characteristics of the transport network and the relevant socioeconomic variables, such as transport costs and time, are used as inputs for these models. Next, each component of the model in the framework is introduced, including the data source, methodology, and data source for validation.

The four submodels used in FlowMax are as follows:

- Trade flow disaggregation model
- Value-to-weight model
- Mode choice model
- Route choice model.

FIGURE 3A.1

FlowMax model framework



Source: Halim et al. 2018. Adapted with permission.

International trade disaggregation

Data sources for international trade or transport demand for global freight transport are typically available in the form of import or export values in the monetary unit (US$) or volumetric unit (tonne) of commodities transported between countries or regions worldwide. Although historical or present-time data can be obtained from customs declarations, such as those compiled in the United Nations (UN) Comtrade database, the projection of international trade typically requires the help of a macroeconomic model. The output of a macroeconomic trade model, such as a computable general equilibrium (CGE) model (for example, the Global Trade Analysis Project [GTAP]), or gravity trade model can be used as input for estimating the demand for freight transport in terms of volume between origin and destination zones. These trade models project the dynamic evolution of international trade in terms of trade relations and commodity composition due to the changes in the global production and consumption of commodities.

Usually, such global macroeconomic models as GTAP do not have high granularity for the regions that are covered. One of the most well-developed CGE models, the GTAP model includes 141 countries worldwide in its latest version 10 database. Even then, its level of granularity does not allow the estimation of transport flows with precision because it does not allow a proper discretization of the travel path used for different types of products. Therefore, a common approach implemented in the literature is to disaggregate the regional origin-destination (OD) trade flows into a larger number of production and consumption centroids.

In FlowMax, centroids are determined using an adapted *p*-median procedure for all the cities around the world classified by the UN in 2010 relative to their population (2,539 cities). The objective function for this aggregation is based on the minimization of a distance function that includes two components: gross domestic product (GDP) density and geographical distance. The selection is also constrained by allowing one centroid within a 500-kilometer radius in a country, which results in 431 centroids.

$$T_{odk}^{y} = T_{VLK}^{y}\left(\frac{GDP_o^y}{\sum_{v=1}^{V} GDP_k^y}\right)\left(\frac{GDP_d^y}{\sum_{l=1}^{L} GDP_l^y}\right), \tag{3A.1}$$

In Equation (3A.1),

T_{odk}^{y} = trade values from centroid *o* to centroid *d* in year *y* for commodity *k*,

T_{VLK}^{y} = trade values from origin region *V* to destination region *L*,

o, *d* = origin and destination centroids,

k = commodity *k*,

y = year of analysis,

v = centroid that belongs to the origin region V, and

l = centroid that belongs to the destination region L.

The benefit of disaggregating international trade data from a single global model is that trade flow data estimated at a more granular level (e.g., on district-to-district level) will be consistent with the international trade data on the country or regional level. By doing so, we avoid having inconsistencies in international trade values that may arise from differing underlying assumptions that are applied to the different regional models available. For example, there are different shared socioeconomic pathways that can be applied to different regional models, which result in varying global trade patterns between those pathways. Furthermore, new disaggregate regions or countries can be incorporated into the model with minimal effort using a consistent trade disaggregation approach if socioeconomic data for the relevant countries are available.

Value-to-weight conversion model

International trade data that can be obtained from a macroeconomic model are typically specified in terms of monetary unit. Hence, to allow analysis that pertains to logistics systems, these data need to be converted into demand data in volumetric unit. An example of a model that can be used to estimate the rate of conversion of value units (dollars) into weight units of cargo (tonnes) is the Poisson regression model. An example of this model, also called a value-to-weight model, has been implemented in Equitable Maritime Consultants' international freight model. The model has been estimated using data sets from Eurostat and the Economic Commission for Latin America and the Caribbean (ECLAC) data on value-to-weight ratios for different commodities.[5]

In the Poisson regression model, the natural logarithm of the trade value in millions of dollars is used as the offset variable, with panel terms by commodity, a transport cost proxy variable (logsum calculation for maritime, road, rail, and air transport costs per tonne between each pair of centroids), and geographical and cultural variables: binary variables for the trade agreements and land borders used in the model and a binary variable identifying whether two countries have the same official language. Moreover, economic profile variables are included to describe the trade relationship between countries with different types of production sophistication and scale of trade intensity. We validate the output of the value-to-weight model using the UN Comtrade database that provides values and weights of all commodities traded between any countries worldwide.

$$w_{odk}^{y} = T_{odk}^{y}\, e^{rs_{odk}^{y}}. \tag{3A.2}$$

$$rs_{odk}^{y} = a + b_1\, e^{gdp\%_o^y} + b_2\, e^{gdp\%_d^y} + b_3\, e^{gdp_c\%_o^y} + b_4\, e^{gdp_c\%_d^y} + b_5 \ln\left(\frac{gdp_{c_o^y}}{gdp_{c_d^y}}\right) + b_6\, contig_{od} + b_7\, lang_{od} + b_8\, rta_{od} + lgs_k e^{-logsum(\text{cost}_{od})}. \tag{3A.3}$$

In Equations (3A.2) and (3A.3),

w_{odk}^{y} = weight of commodity k that is traded between origin o and destination d for year y (in tonnes),

T_{odk}^{y} = value of trade for commodity k between origin o and destination d for year y (in US$),

rs_{odk}^{y} = value-to-weight conversion factor for commodity k between origin o and destination d for year y (in tonne/US$),

$gdp\%_o^y$ = GDP percentile of origin in year y,

$gdp\%_d^y$ = GDP percentile of destination in year y,

$gdp_c\%_o^y$ = GDP per capita percentile of origin in year y,

$gdp_c\%_d^y$ = GDP per capita percentile of destination in year y,

$\ln\left(\frac{gdp_{c_o^y}}{gdp_{c_d^y}}\right)$ = natural logarithm of the ratio between GDP per capita of origin and GDP per capita of destination in year y,

$contig_{od}$ = land contiguity between origin o and destination d, $contig$ = (0, 1),

$lang_{od}$ = shared language between origin o and destination d, $lang$ = (0, 1),

rta_{od} = trade agreement between origin o and destination d, rta = (0, 1),

$logsum(cost_{od})$ = *logsum* variable of transport costs using different modes between origin o and destination d, and

lgs_k = *logsum* coefficient/panel term for commodity k.

Mode choice model

The mode choice model (in weight) in modeling international freight flows is intended to estimate the transport mode used for trade between any OD pair of centroids. This also helps to analyze the impacts of policy measures on the preferences of shippers regarding their choice of transport mode.

Different types of discrete choice models can be used to estimate modal share of transport modes. The most widely used models are the logit and probit models (Ben-Akiva and Bierlaire 1999). The multinomial logit model is suitable for the purpose of estimating a mode choice model for freight transport across different modes: road, rail, inland waterway, and sea on a global scale. This is because it is relatively simple and features a choice probability function that is easy to interpret. It is parsimonious yet able to capture choice behavior of shippers across multiple transport modes.

The mode attributed to each trade connection is represented by the longest transport section. Apart from road freight, other transport modes typically require intermodal transport at both the origin and the destination. This domestic component of international freight (the virtual link between the centroid and the nearest intermodal nodes, such as terminals or ports) is usually not accounted for in the literature but is included in our framework. In particular, the network model considers hinterland transport using road, rail, and waterways as part of international maritime transport. We also envision the inclusion of commodity-type panel terms on travel times and cost in the model's attributes to allow estimation of the value of time and cost elasticity for each commodity.

Transport costs and travel times are estimated using a global multimodal network model, the schematization of which can be obtained from both the World Bank's existing regional models and other specialized institutes that provide mode-specific network GIS files. The model considers geographical and economic context variables, such as trade agreements between countries and the existence of a land border between trading partners. The model's parameters will be estimated on the basis of the observation data for the volume of commodities and their mode of transport from available sources, such as the Eurostat, ECLAC, and Comtrade data sets.

An important part of model development is validation of the model against the observed statistics on global trade that cover broader regions of the world. This is done to ensure the validity and robustness of the mode choice. Such indicators as bilateral trade values, volume of freight transported, and tonne-kilometer by mode can be used to validate and calibrate the mode choice model. These observed data are obtained from reports of various organizations, such as the International Maritime Organization, the International Civil Aviation Organization, and the World Bank.

$$u_{odk}^{m} = asc_m + CF_k\ TC_{od}^{m} + TF_k\ TT_{od}^{m} + Ct^{m}\ contig_{od} + Rt\ rta_{od}. \qquad (3A.4)$$

$$P_m = \frac{e^{u_{odk}^{m}}}{\sum_{m=1}^{M} e^{u_{odk}^{m}}}. \qquad (3A.5)$$

In Equations (3A.4) and (3A.5),

P_m = the choice probability of mode *m,*

u_{odk}^{m} = the choice utility of mode *m* for commodity *k* between origin *o* and destination *d,*

asc_m = alternative specific constant for mode *m,*

CF_k = transport cost coefficient for commodity *k,*

TC_{od}^{m} = transport cost for mode *m* between origin *o* and destination *d,*

TF_k = travel time coefficient for commodity *k,*

Ct^m = contiguity coefficient for mode *m,*

$contig_{od}$ = contiguity variable between origin *o* and destination *d, contig* = (0, 1),

Rt = trade agreement coefficient, and

rta_{od} = trade agreement variable between origin *o* and destination *d, rta* = (0, 1).

Route choice and assignment models

The assignment model is a part of transport modeling technique typically deployed to analyze the impact of transport policy measures on the route choice of shippers, which shapes the spatial pattern of freight traffic on a transport network.

To allow assessment of traffic patterns and route choices on a detailed intermodal transport network, we suggest the implementation of a path generation algorithm in combination with a path size logit model. The path generation algorithm enumerates the most likely routing alternatives between origins and destinations, considering access and egress of the total transport chain. For international maritime transport, the least-cost port-hinterland and port-to-port paths are computed using a cost-minimizing optimization model. However, the path size logit model is used to compute the probability of each identified route being chosen by the shippers. The path size algorithm is capable of properly taking into account overlaps between the alternative routes and distinguishing the transport costs associated with these alternatives. The basis of this model can be found in Ben-Akiva and Bierlaire (1999). The combination of a stochastic assignment model (path size logit) and this path generation algorithm would allow the assignment of volume of freight transport across all possible routes between all origins and destinations with reasonable computation time. This approach also reduces the need to use tedious and time-consuming equilibrium assignment.

The assignment model is calibrated and validated by minimizing the difference between observed and modeled port throughputs for more than 550 major ports in the world.

$$C_r = \sum_{p\in r} A_p + \sum_{l\in r} c_l + \alpha\left(\sum_{p\in r} T_p + \sum_{l\in r} t_l\right) \tag{3A.6}$$

In Equation (3A.6),

C_r = unit cost of route *r* from origin centroid to destination centroid (US$/20-equivalent unit [TEU]),

p = ports used by the route,

l = links used by the route,

A_p = unit cost of transhipment at port p (US$/TEU),

c_l = unit cost of transportation over link l (US$/TEU),

T_p = time spent during transhipment at port p (days/TEU),

t_l = time spent during transportation over link l (days/TEU), and

α = value of transport time (US$/day).

The route probabilities are given by

$$P_r = \frac{e^{-\mu(C_r + \ln S_r)}}{\sum_{h=1}^{H} e^{-\mu(C_h + \ln S_h)}}, \tag{3A.7}$$

and the path size overlap variable S is defined as

$$S_r = \sum_{a \in LK_r} \frac{Z_a}{Z_r} \frac{1}{N_{ah}}, \tag{3A.8}$$

In Equations (3A.7) and (3A.8),

P_r = the choice probability of route r,

C_r = generalized costs of route r,

C_h = generalized costs of route h within the choice set,

h = path indicator or index, $h \in CS$,

μ = logit scale parameter,

a = link in route r,

S_r = degree of path overlap,

Lk_r = set of links in route r,

Z_a = length of link a,

Z_r = length of route r, and

N_{ah} = number of times link a is found in alternative routes.

FOOD FLOW MODEL

The core FlowMax model was enhanced for a more granular exploration of transport and food flows in Africa. The model is therefore at a subnational scale, where the countries of Africa are divided into 786 traffic zones representing the first-level administrative divisions in every country on the continent. The rest of the world is represented as external zones, one for each region outside Africa (refer to map 3.1, panel a).

The model assigns the movement of the four most important staple foods in Africa but emphasizes Sub-Saharan Africa to reveal the challenges and vulnerabilities inherent in African food supply chains. Through this detailed examination, the model provides insights into opportunities for improvements to enhance the resilience and efficiency of food supply chains across the continent.

Other modifications for the food case study include defining the transport network as consisting of the highway network across Africa and the maritime links that interconnect African countries and Africa to other continents (refer to map 3.1, panel b). Traffic (cargo) assignment across routes is done on an all-or-nothing basis, in which the shortest path is defined by the generalized cost, a combination of monetary cost and time. This assignment facilitates the analysis of a variety of factors, including the likely impacts of nontariff barriers (NTBs), represented as time and cost, financial penalties, and time delays. These costs are applied to the network on each link, with border crossings and ports having additional frictions because of process and procedures as well as NTBs. Because the model looks only at agricultural commodities, equilibrium-based modeling was not used. As such, the exclusion of other forms of traffic, including nonagricultural goods and passengers, may affect the capacity of links and nodes on the network. The typical costs, speeds, and delays for road, maritime, ports, and BCPs were researched and compiled from various sources. These costs and speeds inform the path (route) choice.

The analysis in this book is based on an exploration of the flow patterns of four staple foods (cassava, maize, rice, and wheat) to shed light on the intricate web of transport costs and the time required to access food, two critical factors affecting food security. The four commodities account for 45 percent of total calories consumed across the continent.

OD matrices for food were produced by synthesizing information on production and consumption at the zonal level with international trade at the country level. A five-year average was calculated for 2017–22 (excluding 2020, the first and worst year of the COVID-19 pandemic). Food that is grown and consumed within a country was distributed using a gravity model. Imports and exports were assigned to each zone on the basis of the amount of surplus or unmet demand.

Table 3A.1 lists the data sets used in the model build and expand on those used in Nelson et al. (2021). The model includes scripts that process these data sets in their raw formats so that the model can be updated for future simulations.

TABLE 3A.1 Key inputs for model used in this report

MODEL INPUT	SOURCE
Zone system	World Bank Subnational Boundaries GeoJSON (https://wbwaterdata.org/dataset/world-subnational-boundaries)
Model network	FlowMax model network and nodes: road and maritime
Average travel speed by link type	Speeds for each country provided by a scrape of Google traffic speeds
Rural Access Index	Socioeconomic Data and Applications Center
Production and consumption by crop	FAO Food Balance Sheets (https://www.fao.org/faostat/en/#data/FBS)
International crop trade	FAO detailed trade matrix (all data, normalized) (https://www.fao.org/faostat/en/#data/TM)
Spatial population distribution	GHS-POP Epoch 2020 Release 2023A 30 arcsecond (https://human-settlement.emergency.copernicus.eu/ghs_pop2023.php)
Spatial crop production distribution	SPAM 2017 V2.1 (for Sub-Saharan Africa) and SPAM 2010 V2.0 (for North Africa) (https://mapspam.info/data/)
Value of time for generalized costs	Values used in Eastern Partnership trade model
Vehicle operating costs per kilometer	Prices from Herrera Dappe, Lebrand, and Stokenberga (2024), for food shipments by major humanitarian organization
Tariffs	Original calculations for this publication
Border delays, costs, and penalties	Original calculations for this publication

Source: Original table for this publication, after Nelson et al. 2021.
Note: FAO = Food and Agriculture Organization of the United Nations; GHS-POP = Global Human Settlement Population; SPAM = Spatial Production Allocation Model.

The model yields three primary outputs:

- Volumes of flows of the four staples that move by road, over the international maritime network, and through BCPs and ports (tonnes per year)
- Transport costs for imports and exports of food to and from each zone and the way in which these costs are apportioned between operating costs and NTBs (dollars per tonne)
- Transport time for imports and exports of food to and from each zone and the way in which the total time is apportioned between on-road movement, maritime movement, and delays at BCPs and ports (days).

LIMITATIONS

The model used for the report does not deal with all domestic flows in countries. It also does not consider feedback mechanisms where improvements in transport connectivity may affect the functioning of agricultural markets, land use, and other effects. The model does not include railway, inland water, and short sea transport (coastal shipping services). These modes are rarely used for food shipments except in very specific instances. However, as explained in the description of mode choice, the model is designed to handle multimodal transport chains.

NOTES

1. The FlowMax model has been tested on various corridor initiatives in the Africa region. For this report it was extended by adding more traffic zones to enable a more granular exploration of food flows. A technical note on FlowMax will be disseminated separately.
2. All-or-nothing assignment means that all the demand for a particular zone pair is assigned to the best path between two zones, even if there is more than one way to get from one zone to another.
3. In five countries, the four crops selected are not the main source of calories: Chad and Niger rely on sorghum and millet, Mali on millet, and South Sudan and Sudan on sorghum.
4. The surplus production of a zone is defined as the amount of production remaining after local demand is subtracted.
5. For ECLAC's data on the value and volume of trade from which value-to-weight estimates can be obtained, refer to CepalStat, https://statistics.cepal.org/portal/cepalstat/dashboard.html?lang=en.

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4 Access to International Markets

ABSTRACT

This chapter explores the importance of shipping and ports in ensuring food security in Africa. It describes how ports and hinterland connectivity affect food flows in Africa.

KEY FINDINGS AND MESSAGES

- Efficient ports are key to securing food availability across the African continent. Food imports through seaports represent 14 percent of trade of all African countries (22 percent for landlocked nations and 37 percent for the lowest-income countries).
- Inadequate infrastructure at some ports leads to congestion and delays, which significantly increase transport costs. Many African ports lag global standards in cargo handling efficiency.
- Poor governance, including inconsistent regulations, significantly raises food transport costs. A World Bank (2022) study estimates that inefficiencies in West Africa add as much as 30 percent to the price of goods.
- Poor hinterland connectivity is major source of inefficiency for food imports.
- Poor road conditions cost Africa hundreds of millions of dollars every year in economic losses. Investing in vital routes is essential to enhancing food security and ensuring efficient food distribution across Africa.

IMPROVING AFRICA'S PORTS

Shipping and ports are indispensable for food security in Africa. Efficient maritime logistics ensure the steady flow of food products, stabilize prices, and support agricultural exports.

The sector faces significant challenges, including infrastructure deficits, governance issues, logistical inefficiencies, and disruptions, according to the International Monetary Fund's PortWatch platform. Addressing these challenges is crucial to enhance food security across the continent.

Shipping and ports are integral to the global food supply chain, particularly in Africa, where many countries are net food importers. The import of food by African countries constitutes approximately 14 percent of their merchandise trade (22 percent for landlocked countries and 37 percent for the lowest-income countries) (Humphreys et al. 2020). Efficient maritime logistics are thus crucial for ensuring a steady supply of food products, mitigating the risks of food shortages, and stabilizing food prices.

For African countries, especially those that are landlocked, access to maritime ports is vital for both importing food and exporting agricultural products. A study of the East African Community finds that a 10 percent reduction in transport costs to maritime ports could significantly boost the production of export crops, such as coffee, tea, and tobacco (Iimi et al. 2015). Not only does improved port connectivity enhance export potential, but it also increases the income of farmers, contributing to food security by enabling them to invest more in agricultural inputs and technologies.

One of the primary challenges is the weak infrastructure. Many African ports lack the modern facilities and capacity needed to handle large volumes of cargo efficiently. For example, inadequate infrastructure at the port of Dar es Salaam has long been recognized to cause significant delays (Iimi et al. 2015). Weak hinterland connectivity, including road and rail links to ports, is also underdeveloped, exacerbating the logistical challenges.

Governance and regulatory issues also hinder the efficiency of maritime logistics. Corruption, red tape, and inconsistent regulatory frameworks lead to high transactions costs and delays. Tariffs, import and export restrictions, and other regulatory barriers add to the costs and delays.

Logistical inefficiencies, including poor coordination and lack of technological integration, are significant barriers to efficient maritime logistics. The coronavirus disease 2019 (COVID-19) pandemic highlighted these inefficiencies; many African ports experienced a decline in port calls and an increase in blank sailings, which disrupted the supply chain and led to food price increases in several markets (Humphreys et al. 2020).

The lack of advanced logistics management systems and digital tracking exacerbates these inefficiencies, leading to delays and increased costs.

PortWatch data provide real-time monitoring of shipping disruptions at ports and critical shipping lanes around the world. These data can show how disruptions to a major trade lane, such as the Red Sea, can ripple through the global shipping network and seaports, affecting the timely delivery of commodities, such as food imports to African ports (Salgado Baptista et al. 2022). The disruptions can increase food prices and shortages, exacerbating food insecurity in the region.

All of Sub-Saharan Africa's 10 most food-critical ports have road and rail links to the hinterland (refer to table 4.1 and map 4.1). Disruption of these ports would significantly reduce food security.

TABLE 4.1 Ten critical ports for food in Sub-Saharan Africa

PORT	ADDITIONAL TRANSPORT COST (US$/YEAR, MILLIONS)	FOOD FLOW (KCAL/YEAR, BILLIONS)	OBSERVATIONS
Mombasa, Kenya	257	11,713	The port of Mombasa has significant bulk grain handling capacity. It can handle up to 414,300 metric tons of dry bulk cargo, with 258,500 metric tons specifically for grain. *Storage:* The port has storage silos with a total capacity of 245,000 metric tons. *Bagging facilities:* The terminal includes bagging facilities, along with bulk rail and road loading facilities. Conventional grain bagging is mainly done when there is a long list of ships lining up for the Grain Bulk Handlers Ltd. berth terminal. *Hinterland connectivity:* The port is a major gateway for Burundi, the Democratic Republic of Congo, Rwanda, South Sudan, and Uganda, which are connected by road. Uganda also has a railway link.
Abidjan, Côte d'Ivoire	230	9,212	The port of Abidjan's grain terminal can handle between 200,000 and 300,000 tonnes of wheat per year, with an operating rate of nearly 3,000 tonnes per day. *Storage:* The terminal is equipped with six storage silos. *Bagging facilities:* The port has bagging machines for flour, fertilizer, and rice, with a rate of 2,000–5,000 tonnes per day. *Hinterland connectivity:* Road, rail Burkina Faso, Mali, and Niger rely on this port.

continued

TABLE 4.1 Ten critical ports for food in Sub-Saharan Africa, *continued*

PORT	ADDITIONAL TRANSPORT COST (US$/YEAR, MILLIONS)	FOOD FLOW (KCAL/YEAR, BILLIONS)	OBSERVATIONS
Cotonou, Benin	113	10,516	The port of Contonou has a grain handling capacity of 2 million tonnes and has been undergoing reforms that have improved its performance. *Bagging facilities:* The port has bagging facilities, and rice is typically offloaded into bagging machines alongside the vessels. This indicates that the port is equipped to handle bulk commodities and convert them into bagged form for easier distribution and handling. The port is a major gateway for Benin and landlocked countries to its north: Burkina Faso, Mali, and Niger.
Djibouti, Djibouti	104	9,601	The port of Djibouti has significant grain handling capacity. It can handle up to 8,500 tonnes of bulk grain per day. *Storage:* The port is equipped with eight silos that have a storage capacity of 29,000 tonnes of wheat and 40,000 tonnes of fertilizers. *Bagging facilities:* The port has 6 mobile bagging machines and storage space, including 45,000 m^2 of open yards and 10 warehouses. *Hinterland connectivity:* The port of Djibouti is the main gateway for Ethiopia, with road and rail connections.
Toamasina, Madagascar	100	2,454	The port of Toamasina is the largest in Madagascar. It has a grain handling capacity of approximately 1,600,000 tonnes of cargo annually. *Storage:* The port has a separate silo facility for handling bulk. *Bagging facilities:* The port handles diverse shipments. *Hinterland connectivity:* Road, rail
Port Sudan, Sudan	92	11,982	Port Sudan has a dedicated berth for grain handling *Storage:* The port has more than 500,000 tonnes of silo capacity spread across several state and private facilities. It handles Sudanese exports of sorghum and imports of different grains, including wheat. *Bagging facilities:* Port Sudan has bagging facilities for grains and fertilizer. *Hinterland connectivity:* Road, rail The Central African Republic, Chad, and South Sudan also use the port.

continued

TABLE 4.1 Ten critical ports for food in Sub-Saharan Africa, *continued*

PORT	ADDITIONAL TRANSPORT COST (US$/YEAR, MILLIONS)	FOOD FLOW (KCAL/YEAR, BILLIONS)	OBSERVATIONS
Dar es Salaam, Tanzania	87	8,736	The port of Dar es Salaam has an automated grain handling facility with silos that have a capacity of 30,000 metric tons. *Bagging facilities:* Grains can be discharged and bagged along the quay at an average rate of more than 2,000 metric tons per day or transferred to a silo using dump trucks. The facility is equipped with fumigation, aeration, and temperature control systems to ensure the quality of the stored grain. The port is a gateway for several landlocked countries, including Burundi, eastern Democratic Republic of Congo, Rwanda, Uganda, and Zambia.
San-Pédro, Côte d'Ivoire	83	4,810	The port of San-Pédro has facilities for grain and bulk handling and a dedicated mooring point. The grain is discharged with grabs into hoppers that feed into underground conveyor belts, which carry the grain into the silos on site. *Hinterland connectivity:* Road, rail
Banjul, The Gambia	79	6,920	The port of Banjul mostly handles The Gambia's own trade traffic. It is a multipurpose port handling a mix of cargo. *Bagging facilities:* The port has bagging facilities for grain.
Mogadishu, Somalia	72	2,239	The port of Mogadishu is a dedicated bulk grain handling terminal. It has grain silos with storage capacity of 30,000 tonnes and three warehouses, each 5,000 m^2, for a total of 15,000 m^2.

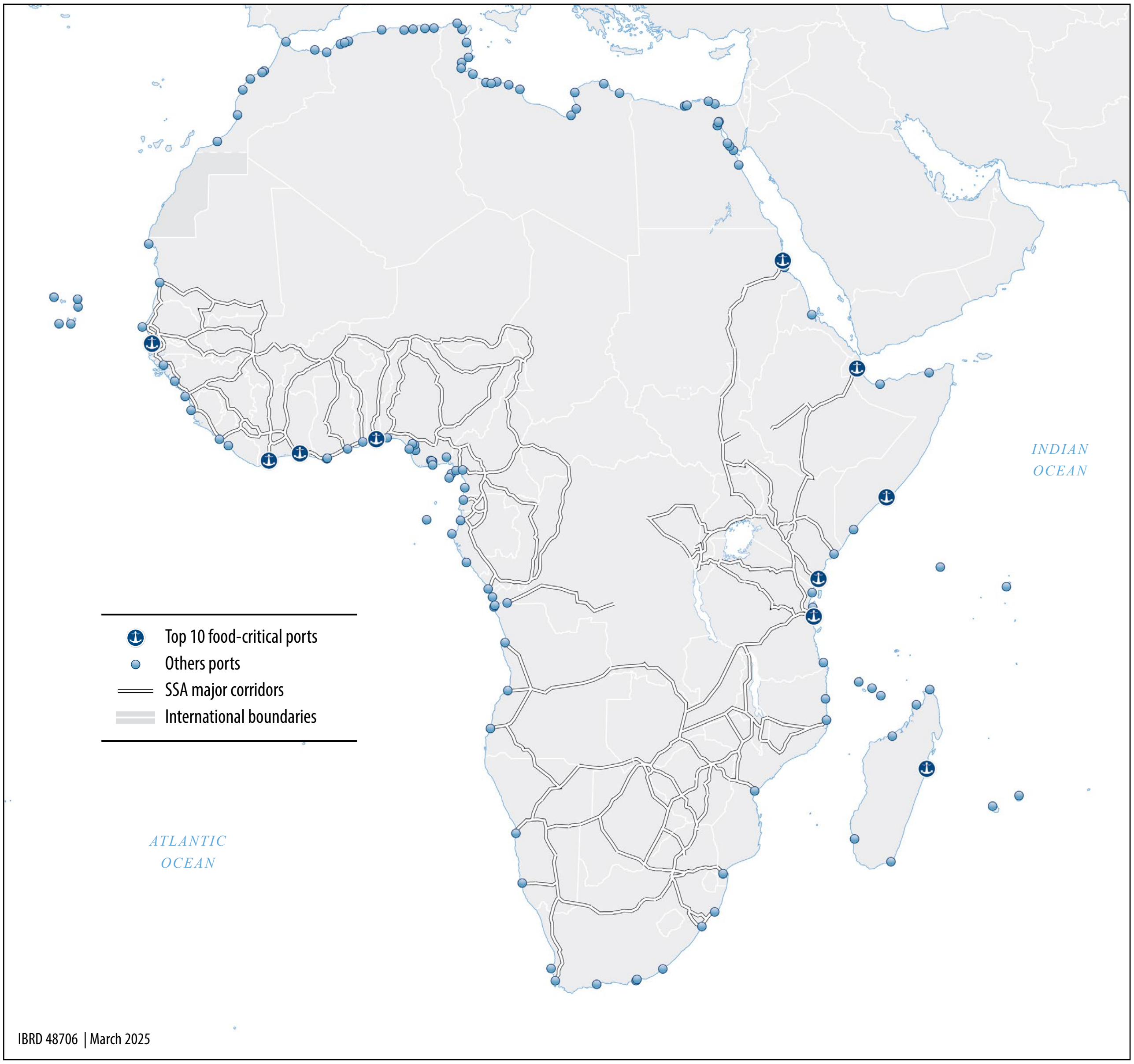
Source: Original table for this publication, based on model outputs.
Note: Additional costs are the transport costs incurred due to the need to reroute traffic to other ports; kcal = kilocalories; m^2 = square meters.

Port accessibility is vital for agricultural growth in central and southern Africa, where agrobusinesses have developed, and relatively less critical in parts such as the Sahel, where subsistence farming remains predominant. Generally, the performance of African ports in handling dry bulk food commodities has been evolving.

- *Dry bulk throughput has increased*. The volume of dry bulk throughput in East and Southern African ports has been increasing over the past decade (Humphreys, Menendez, and Eijbergen 2019; Humphreys et al. 2019). However, the number of vessel calls at African ports remains low (refer to figure 4.1). Many ports hardly ever receive dry bulk vessel calls of the type that carry agricultural commodities in large quantities, and, in fact, only 35 ports receive a call once every three to four days. Even then, many of those vessels carry mineral commodities.

MAP 4.1

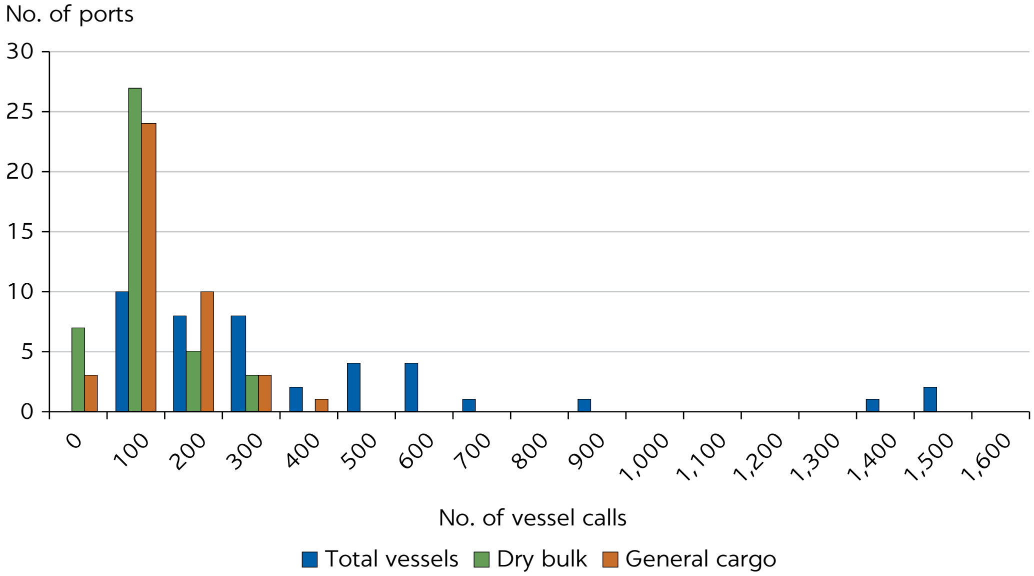
Ten critical ports for food in Sub-Saharan Africa, 2022



Source: Original map for this publication, based on model outputs.
Note: SSA = Sub-Saharan Africa.

- *Cargo handling costs remain high.* Cargo handling costs at African ports are higher than they are in mature markets because of technical and institutional deficiencies, including low operating efficiency, lack of maintenance, poor planning, and capacity constraints (Humphreys et al. 2019).
- *Port performance varies.* Some ports are inefficient; others have achieved international benchmarks, demonstrating the potential for improvement.

FIGURE 4.1
Distribution of vessel calls at African ports, 2019–23



Source: Original figure for this publication, based on IMF PortWatch (https://portwatch.imf.org).

INCREASING CONNECTIVITY BETWEEN PORTS AND HINTERLANDS

Port-hinterland connectivity and regional corridors are vital components of Africa's transport infrastructure that have a direct impact on food security. By facilitating the efficient movement of food and agricultural inputs, these transport systems help ensure that food is available, affordable, and accessible to all. Investing in the development and maintenance of these networks is essential for addressing the continent's food security challenges and promoting sustainable economic growth.

Graff (2019) finds that the colonial era transport revolution, which initially benefited Africa, has created a lock-in effect that continues to hinder efficient trade. He also finds evidence that the locations of origin of national leaders of African countries tend to have significantly more infrastructure than is nationally efficient. His findings suggest that political power dynamics play a role in shaping the allocation of infrastructure resources, potentially leading to inefficiencies in the overall trade network and therefore the distribution of food in economies and across borders.

Regional corridors—major transport routes that link multiple countries and regions—facilitate the movement of goods across borders, promoting regional trade and economic integration. By enhancing regional trade, they help balance food supply and demand across the continent, reducing the risk of food shortages and price volatility (Task Force on Transport and Connectivity 2021).

Development of regional corridors also supports the growth of agribusinesses and rural economies. Improved transport infrastructure reduces the cost and time associated with moving agricultural products to markets, making farming more profitable and encouraging investment in the agricultural sector. Efficient transport networks can also help reduce postharvest losses by ensuring that food reaches markets quickly and in good condition (World Bank 2023). Efficient transport systems can also reduce the environmental impact of food distribution by reducing the distance food needs to travel (Byiers 2015).

Countries that have the worst transport stress include Mali, Niger, South Sudan, and Sudan. The staple consumed most in these countries is sorghum or millet, which this report did not model. The quality of the highway network (as measured by average speeds) and the arrangement of the network is most important for the import of wheat and rice (from suppliers outside of Africa). It is especially important for road and border crossing point links to ports.

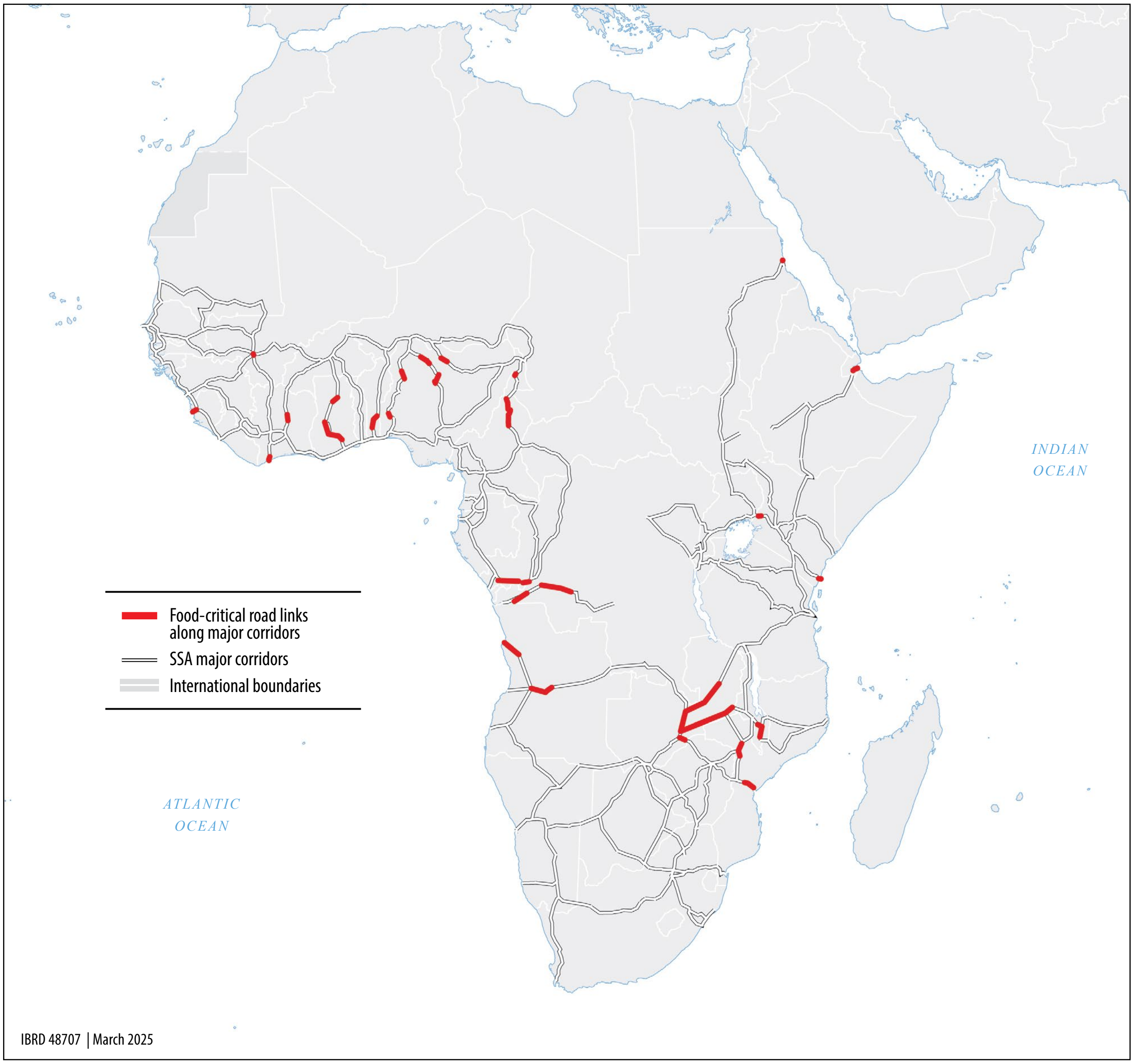
Map 4.2 shows the top road links for food flows that are aligned with the major, officially designated corridors in Sub-Saharan Africa. Table 4.2 identifies a subset of 20 road links with the highest detour cost.[1] Many of the links that need attention are in West and Central Africa. Other critical links are between the Republic of Congo and the Democratic Republic of Congo, as well as those in Cameroon, which support port access for Chad. The condition of the links and the condition of the wider network are important when determining network resilience. A road might need to be improved to prevent degradation; it might need to be widened to ensure that the link can operate if there is an accident; it might need to be upgraded; or a new road link might need to be built that can support diversionary routes.

Among the countries whose main staples are modeled, the following experience the worst transport stress:

- *Republic of Congo:* high cost of network disruption and high transport costs
- *The Democratic Republic of Congo:* High transport costs, high transport cost burden, and high cost of network disruption, although the average distance to get staples to consumers is low
- *Equatorial Guinea:* Long average distance for consumed food, poor local access to surplus production, and high cost of network disruption

MAP 4.2

Food-critical road links along officially designated corridors in Sub-Saharan Africa, 2022



Source: Original map for this publication, based on model outputs.
Note: SSA = Sub-Saharan Africa.

- *Mauritania:* poor access to surplus production, high average distances, and high cost of network disruption
- *Somalia:* high transport cost burden and poor local access to surplus production
- *Zambia:* high transport costs and high costs of network disruption, although the average distance to get staples to consumers is low.

TABLE 4.2 Top 20 critical road links with highest detour costs in Sub-Saharan Africa, 2022

COUNTRY	CORRIDOR	ADDITIONAL TRANSPORT COSTS (US$/YEAR, MILLIONS)	FOOD FLOW (KCAL/YEAR, BILLIONS)
Benin	RNIE2 Bohicon to Dassa-Zoume	159	6,286
Cameroon	N1 from Ngaoundere to Gidjiba	196	6,004
	N1 from Gidjiba to Ngong	145	2,923
Congo, Dem. Rep.	N1 from Matadi to Kikwit via Kinshasa	2,200	6,413
	N1 from Kananga to Mbuji-Mayi	1,210	5,243
	N2 Lubao to Kasongo	171	3,541
	N1 Luputa to Lueji 11	166	1,832
Côte d'Ivoire	Autoroute du Nord in Abidjan and connections to port	230	9,214
Ghana	N1 from Accra to Tema	464	5,679
Malawi	M1/M3 + M8 Blantyre to Balakas	243	2,585
Mozambique	N1 Nicuadala to Funganha	159	3,179
Nigeria	A13 Jimeta to Ngurore	220	2,587
	A2 Kano to Bankaura	217	5,621
	A2 from Lokoja to Abaji	179	6,726
	A2 Zaria to Kano	162	9,256
	A1 Oko Erin to Mokwa	147	11,777
Zambia	T2 Lusaka to Mpika	390	3,296
	M1 Mpika to Kasama	384	2,710
	T2 Chikwele to Sigongo	217	5,621
	M3 Kasama to Mansa	166	1,393

Source: Original table for this publication based on model outputs.
Note: kcal = kilocalories.

The case of the Nacala corridor illustrates how disruptions to links connecting to a gateway port can have impacts over a wide area (refer to box 4.1). The Nacala corridor is a key transport route linking Malawi, Mozambique, and Zambia to the port of Nacala, in Mozambique. It handles general trade traffic, including foodstuffs. The box describes a simulated scenario that shows how a disruption can have cascading effects throughout the transport network.

Box 4.1

Mapping the hinterland of a regional port

The critical road links in Malawi, Mozambique, and Zambia are all part of the hinterland of a regional corridor that is anchored at the port of Nacala, in Mozambique. The corridor is a vital transport route connecting the three countries, and it is a major gateway for international trade. It is crucial for the export of food commodities and the import of staples, such as wheat and rice. Disruptions along this corridor can severely affect connectivity and food security.

A disruption scenario is simulated using the transport model, where transport links to the port are rendered impassable. The disruption forces freight traffic to shift to less efficient routes, increasing costs and delivery times. For instance, goods destined for Lusaka (Zambia) are rerouted through southern networks, adding further delays and expense. Malawi experiences a 10–11 percent rise in sea transport costs, and road transport costs increase by 1.6–2.0 percent. Following closely is Zimbabwe, where unit transport costs increase by 0.8–1.2 percent. Logistics costs surge across the region, with South Africa and Tanzania bearing the largest absolute financial costs because of their higher trade volumes. Road transport remains dominant for destinations such as Lusaka and Harare (Zimbabwe), where reliance on alternative ports becomes necessary during the disruption. Elsewhere the disruption triggers a significant modal shift, with rail transport replacing road freight on key routes. Rail's modal share more than doubles, from 6.1 percent to 13.3 percent, particularly for transport between Nacala and cities such as Lilongwe (Malawi) and Tete (Mozambique). This shift demonstrates the importance of multimodal infrastructure in mitigating the impact of disruptions.

The effects of the disruption on food security are profound. Landlocked countries, among them Malawi, are heavily reliant on efficient corridors, such as Nacala, for timely food imports. Although rail infrastructure mitigates some of the impacts, the scenario underscores the vulnerability of hinterland regions to supply chain disruptions. Although the port of Nacala saw less than a 1 percent reduction in throughput because of rerouting, the exercise highlights the need for greater resilience in port-hinterland connectivity.

SUMMARY

Access to maritime ports is crucial for the food security of African countries, particularly landlocked ones, because it facilitates both food imports and agricultural exports. Improved international connectivity not only boosts export potential, it also increases farmers' income, allowing them to invest more in agricultural inputs and technologies, thereby strengthening overall food security.

Efficient port-hinterland connectivity and regional corridors are also essential for improving food security in Africa by ensuring the smooth movement of food and agricultural inputs. Mapping the hinterland of regional ports is a critical first step in understanding the connectivity requirements of different zones on the basis of their role in regional and global food trade.

Several challenges impede the efficiency of shipping and ports in Africa, including infrastructure deficits, governance issues, and logistical inefficiencies. Many ports lack modern facilities, leading to congestion and delays. Governance problems, such as corruption and bureaucratic hurdles, increase the costs of transactions. Logistical inefficiencies that came to the fore in the aftermath of the COVID-19 pandemic disrupt supply chains and raise food prices.

Addressing these challenges is essential for enhancing food security. Regional trade groups play a key role in facilitating food trade. They must overcome issues such as inconsistent tariffs and inadequate infrastructure to fully realize their potential in promoting a resilient food system.

NOTE

1. Detour cost is the additional transport cost incurred when a link is removed, and transport is rerouted. It is calculated on the basis of the commodity flows that would normally use the link.

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5 Importance of Regional Trade

ABSTRACT

This chapter examines the importance of regional trade in improving food security in Africa. It emphasizes the need to reduce trade barriers, enhance infrastructure, and strengthen regional cooperation to ensure efficient cross-border food flows and reduce costs.

KEY FINDINGS AND MESSAGES

- The African Continental Free Trade Area (AfCFTA) could boost intra-African trade by as much as 30 percent, but poor trade facilitation and inefficiencies at critical nodes add to trade and transport costs. Maximizing the AfCFTA's benefits requires targeted investment to reduce nontariff barriers (NTBs) and improve border-crossing efficiency.
- Strengthening regional trade is essential to balancing food supply, stabilizing prices, and enhancing food security across the continent. Empirical analysis suggests that a 10 percent improvement in regional trade efficiency can increase food availability by 5 percent and reduce prices by 3 percent, benefiting millions of African households.
- Inefficiencies like road checkpoints and bureaucratic delays in such regions as West Africa can double transport times and raise costs by as much as 25 percent. Harmonizing policies and improving infrastructure within regional economic communities (RECs) is vital to unlocking the potential of intra-African agricultural trade.
- Addressing bottlenecks at certain border crossings would greatly reduce transport costs, improve food distribution, and enhance food security across the continent.

ENHANCING FOOD SECURITY AND GROWTH THROUGH REGIONAL TRADE

Regional trade in food is crucial for enhancing food security, economic stability, and sustainable development, particularly in developing countries. By facilitating the movement of food products across borders, regional trade helps balance supply and demand, ensuring that food surpluses in one area can alleviate shortages in others. Doing so not only reduces the risk of food insecurity, it also stabilizes food prices, making essential commodities more affordable for consumers.

Regional trade also fosters economic growth by opening new markets for farmers and agribusinesses, encouraging investment in agricultural infrastructure and innovation. It also promotes the diversification of food sources, which can enhance dietary diversity and nutrition. Regional trade agreements often include provisions for improving food safety standards and reducing trade barriers, which can lead to more efficient and resilient food systems.

Complex regulatory procedures can create bureaucratic hurdles for traders, increasing transaction costs and discouraging cross-border trade. These barriers not only limit the flow of food within Africa, they also hinder the continent's integration into global food markets, reducing the potential to benefit from international trade. Addressing these policy barriers is crucial for promoting agricultural development, improving food security, and fostering economic growth in Africa.

Continent-wide policies

Three continental policies and initiatives in Africa affect food security (refer to table 5.1).

The most prominent of these programs is the Comprehensive Africa Agriculture Development Programme (CAADP), a continent-wide framework aimed at transforming agriculture, creating wealth, ensuring food security and nutrition, and promoting economic growth and prosperity. CAADP includes the Renewed Partnership for a Unified Approach to End Hunger by 2025, a collaborative effort involving the African Union, the Food and Agriculture Organization of the United Nations, the New Partnership for Africa's Development, and other institutions. This program seeks to increase agricultural productivity, improve food systems, and enhance resilience to climate change.

TABLE 5.1 Continental initiatives in Africa that affect food security

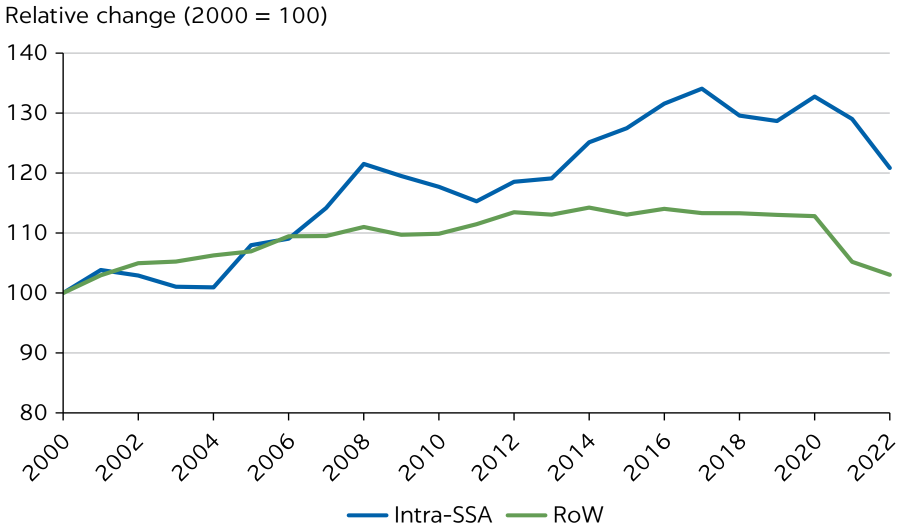
POLICY OR PROGRAM	OBJECTIVE
Agenda 2063[a]	Agenda 2063 is the African Union's strategic framework for the socioeconomic transformation of the continent over the next 50 years. It emphasizes the importance of food security as a cornerstone for sustainable development. By focusing on social and economic transformations, Agenda 2063 aims to eliminate hunger through initiatives that provide people with the necessary skills and create jobs to improve incomes and livelihoods. This agenda underscores the need for increased agricultural productivity, improved infrastructure, and enhanced intra-African trade to ensure food availability and accessibility.
Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods	The declaration, adopted by the African Union in 2014, aimed to end hunger and halve poverty by 2025 through agriculture-led growth. It emphasized the need for increased investment in agriculture, enhanced agricultural productivity, and improved market access for farmers. The declaration also called for the reduction of postharvest losses and the promotion of sustainable agricultural practices. In 2024, the African Union launched the Post-Malabo Agenda to continue the efforts of the Malabo Declaration but adapt them to new challenges, including the sustainability of food systems, climate change, and enhanced resilience to risks and shocks. The Post-Malabo Agenda includes a road map for the next 10 years, with an emphasis on evidence-based approaches and continuous adaptation to changing contexts.
AfCFTA	The AfCFTA is a landmark agreement of African states aimed at creating a single continental market for goods and services, with free movement of businesspeople and investments. By reducing tariffs and nontariff barriers, AfCFTA seeks to boost intra-African trade, including of agricultural products. Its objectives are directly relevant to food security, because increased trade can lead to more efficient distribution of food across the continent, reduce food prices, and enhance food availability.

Source: Original table for this publication.
Note: AfCFTA = African Continental Free Trade Area.
a. The World Bank's Building Institutions and Systems to Harness and Realize Agenda 2063 project (P180117) supports implementation of the AfCFTA as part of Agenda 2063 by strengthening institutional capacity, concluding trade negotiations, facilitating trade and investment, monitoring commitments, developing dispute resolution mechanisms, engaging stakeholders, and providing technical assistance to enhance intracontinental trade and integration.

Africa is not on track to meet the objectives of the Malabo Declaration. On the basis of data from the United Nations Economic and Social Commission for Asia and the Pacific and World Bank Trade Costs data set,[1] trade costs for agricultural products are 20 percent higher between African countries than they are between African countries and the rest of the world (refer to figure 5.1). Intra-African trade costs for agricultural products have also risen over time; they were 20 percent higher in 2022 than in 2000.

FIGURE 5.1

Ad valorem trade costs for agricultural products in Sub-Saharan Africa



Source: Original figure for this publication, based on data from the United Nations Economic and Social Commission for Asia and the Pacific and World Bank Trade Costs data set (https://databank.worldbank.org/source/escap-world-bank-international-trade-costs).
Note: RoW = rest of world; SSA = Sub-Saharan Africa.

Regional patterns of food trade connectivity

The production, consumption, and trade patterns of food staples vary across Africa's seven RECs (refer to tables 5.2 and 5.3)

TABLE 5.2 Regional economic communities in Africa

REC	NO. OF MEMBERS	MEMBERS
CEMAC	6	Cameroon; Central African Republic; Chad; Congo, Rep. of; Gabon; Equatorial Guinea
COMESA	21	Burundi; Comoros; Congo, Dem. Rep.; Djibouti; Egypt, Arab Rep.; Eritrea; Eswatini; Ethiopia; Kenya; Libya; Madagascar; Malawi; Mauritius; Rwanda; Seychelles; Somalia; Sudan; Tunisia; Uganda; Zambia; Zimbabwe
EAC	8	Burundi; Congo, Dem. Rep.; Kenya; Rwanda; Somalia; South Sudan; Tanzania; Uganda
ECCAS	11	Angola; Burundi; Cameroon; Central African Republic; Chad; Congo, Dem. Rep.; Congo, Rep. of; Gabon; Equatorial Guinea; Rwanda; São Tomé and Príncipe
ECOWAS	15	Benin; Burkina Faso; Cabo Verde; Côte d'Ivoire; Gambia, The; Ghana; Guinea; Guinea Bissau; Liberia; Mali; Niger; Nigeria; Sierra Leone; Senegal; Togo Burkina Faso, Mali, and Niger left ECOWAS in 2024.
SACU	5	Botswana, Eswatini, Lesotho, Namibia, and South Africa
SADC	16	Angola; Botswana; Comoros; Congo, Dem. Rep.; Eswatini; Lesotho; Madagascar; Malawi; Mauritius; Mozambique; Namibia; Seychelles; South Africa; Tanzania; Zambia; Zimbabwe

Source: Original table for this publication.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; REC = regional economic community; SACU = Southern African Customs Union; SADC = Southern African Development Community.

TABLE 5.3 Trade regimes of African regional economic communities and implications for trade in food

REC	INTERNAL TRADE	EXTERNAL TRADE	IMPLICATIONS FOR FOOD SUPPLY CHAINS
CEMAC	Goods move freely within CEMAC. All members use the Central African franc, which facilitates monetary interaction. The Bank of Central African States oversees the monetary system and issues currency for the CEMAC subregion.	A common external tariff is levied on imports from countries outside CEMAC. All states use the Central African franc	No tariffs are imposed on food; VAT does apply. Sanitary and phytosanitary certification is required for all unprocessed agricultural products.
COMESA	COMESA is a FTA. Of its 21 member states, 11 have eliminated their tariffs on COMESA-originating products. The FTA signatories are working on the eventual elimination of quantitative restrictions and other NTBs. Trade between members is not according to uniform rules and procedures, with considerable variation in NTMs.	COMESA does not yet have a common external tariff structure. It has stated its intention to establish one, with rates of 0 percent for raw materials and capital goods, 10 percent for intermediate products, and 25 percent for products.	VAT is not payable on food commodities, but sanitary and phytosanitary certification is required for all unprocessed agricultural products. Some countries also impose periodic export bans.
EAC	The EAC is a customs union, with most goods and services being traded duty-free between the member states. In most EAC member states, unprocessed agricultural produce is not charged VAT or excise tax.	A common external tariff that applies to imports from third countries.	The EAC does not charge VAT on food imports from within the group or on imports from outside the group. However, it requires sanitary and phytosanitary certification for unprocessed agricultural products. The EAC also uses export bans from time to time.
ECCAS	ECCAS does not yet appear to have harmonized internal trade and tariff policies. Countries' membership in overlapping trade groups complicates the ability to do so.	In 2022, ECCAS adopted a resolution to establish a common external tariff. It has not done so, however; each member state continues to levy its own tariff structure, unless it has agreed to a different structure as a member of another REC.	ECCAS imposes some tariffs on food, and some of its member countries charge VAT on food imports. Sanitary and phytosanitary certification is required for all unprocessed agricultural products. Road checkpoints contribute significantly to delays on major corridors.

continued

TABLE 5.3 Trade regimes of African regional economic communities and implications for trade in food, *continued*

REC	INTERNAL TRADE	EXTERNAL TRADE	IMPLICATIONS FOR FOOD SUPPLY CHAINS
ECOWAS	ECOWAS aims for regional economic integration, the elimination of tariffs and NTBs, and regulatory cooperation. Goods produced within ECOWAS member states are granted preferential treatment, promoting intraregional trade and industrial development. Tariffs are applied to intra-ECOWAS trade in basic foods, but the rates are lower than on the same items sourced from outside the REC. NTMs are the main instrument used to regulate trade.	ECOWAS adopted a common external tariff in January 2015. It is only partially applied, however. Nigeria, for example, still sets its own external tariffs on many items. Most states use the West African CFA franc.	Some tariffs are applied to food. Ghana imposes a VAT of 15 percent on food. Sanitary and phytosanitary certification is required for all unprocessed agricultural products. Road checkpoints contribute significantly to delays on major corridors.
SACU[a]	SACU is the oldest customs union in the world; it has no internal tariffs and a common external tariff. All members except Botswana form a currency union that uses the South African rand as the base currency. (Eswatini, Lesotho, and Namibia each have their own currency, with its own name, but their values are identical to the South African rand.)	A common external tariff is levied on imports from countries outside SACU.	SACU has no customs duties on unprocessed agricultural products and fertilizers between the members but charges a 15 percent VAT on some food products. Sanitary and phytosanitary certification is required for plant-based products.
SADC	The SADC FTA was created in August 2008. Members have reduced their tariffs at different rates. A facility is in place for SADC customs regulations to give preferential treatment to goods that originate in member states. Goods that fall under SADC rules of origin, including agricultural produce and agricultural inputs, are not subject to tariffs when imported or exported within the FTA.	Each member state maintains its own external tariffs for nonmembers of SADC.	Customs tax, excise tax, and VAT are applied to most food products. Phytosanitary certification is required for plant-based products from exporting countries. Periodic bans on imports and exports are imposed.

Source: Original table for this publication.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; FTA = free trade area; NTBs = nontariff barriers; NTMs = nontariff measures; REC = regional economic community; SACU = Southern African Customs Union; SADC = Southern African Development Community; VAT = value-added tax.
a. All SACU members are also members of the SADC.

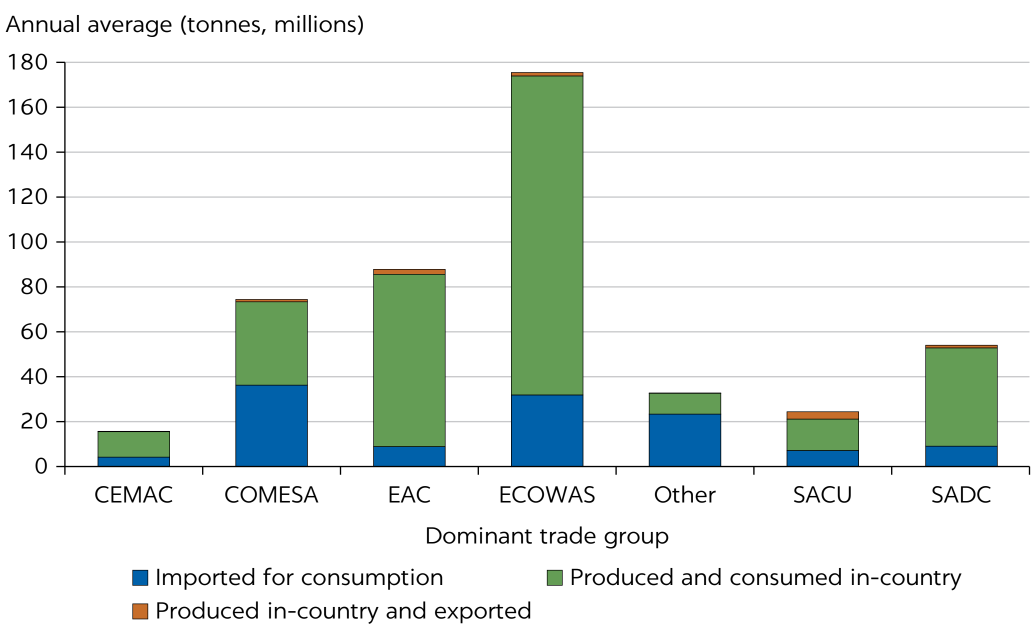
Figures 5.2 and 5.3 show the patterns of intra-African food trade by the major trade blocs. They reveal that most food trade occurs within a REC.

Implementation of continental programs is typically coordinated by RECs, particularly those related to economic integration and trade. This report looked in detail at the policy environment for food trade of the seven RECs in table 5.2.[2] Several countries belong to more than one REC; Mauritania does not belong to any REC in Sub-Saharan Africa.

These and other groupings aim to facilitate economic integration by reducing barriers to trade among their member countries and across the continent (refer to table 5.3). Doing so is crucial to meeting the goals of the Malabo Declaration, which committed to tripling intra-Africa trade in agricultural commodities and services by 2025. As shown in chapter 1, that target has not been realized. By harmonizing food safety standards and improving their implementation, especially at borders, RECs can help ensure the smooth flow of agricultural products, thereby enhancing food security.

FIGURE 5.2

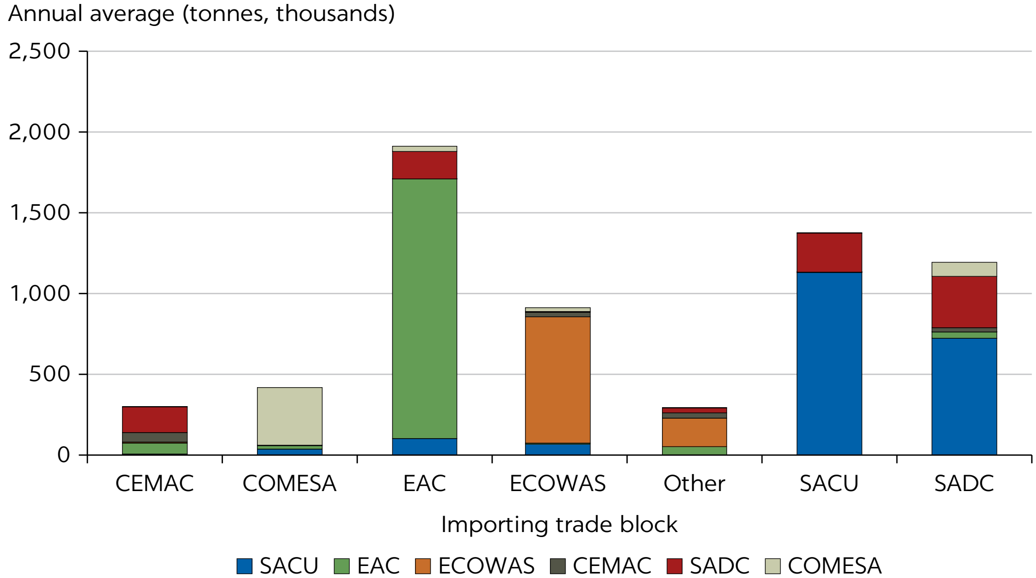
Share of staples imported for consumption, produced and consumed in-country, and produced in-country and exported, by Sub-Saharan Africa RECs, 2016–22



Source: Original figure for this publication.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; RECs = regional economic communities; SACU = Southern African Customs Union; SADC = Southern African Development Community. "Other" includes regional economic groupings not otherwise mentioned.

FIGURE 5.3

Sources of intra-Africa imports of food staples, 2016–22



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: Each bar represents the total volume of the four staples studied. CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; SACU = Southern African Customs Union; SADC = Southern African Development Community. "Other" includes regional economic groupings not otherwise mentioned.

Two of these RECs (the Southern African Customs Union [SACU] and the Economic Community of West African States [ECOWAS]) have currency unions and generally trade with common currencies. Most countries are outside of a currency union, and most trade is done in US dollars. Changing their own currency (typically into dollars) and transmitting it to the vendor, who must then change it back into its own currency, is both expensive and time-consuming.

Three of the seven trading groups (the Common Market for Eastern and Southern Africa, ECOWAS, the Southern African Development Community) do not have common external tariffs on imports, making internal trade more difficult and potentially expensive. The practice also provides opportunities and incentives for fraud, unrecorded food flows, and smuggling. There are numerous examples of illicit trade between a low-tariff importing country and a high-tariff country in the same region.

Only three of the trading groups (East African Community [EAC], Central African Economic and Monetary Community [CEMAC], SACU) have a functional internal free trade area (FTA). The others have announced and agreed to create FTAs, but these intents remain aspirational. The lack of an FTA has raised the costs of internal trade and creates incentives for fraud and corruption.

Although the different RECs have policies that are conducive to trade in agricultural products, their member countries often institute restrictive measures. For instance, as the world responded to the coronavirus disease 2019 (COVID-19) pandemic, one of the go-to policy responses was to close borders to exports of food. Between January and June 2022, the World Bank and the Global Trade Alert counted 135 policy measures that had been announced or implemented affecting trade in food and fertilizers (Espitia, Rocha, and Ruta 2022). Two-thirds of the measures were full bans on exports.

The barriers imposed by individual countries or regional blocs take various forms, including tariffs, quotas, sanitary and phytosanitary measures, and complex regulatory procedures. Tariffs and quotas directly increase the cost of imported food, making it less accessible to consumers and reducing the competitiveness of domestic producers. Sanitary and phytosanitary measures are necessary to protect public health, but they are often used to restrict trade.

INCREASING REGIONAL CONNECTIVITY

Two measures were used to assess the link between transport connectivity and the circulation of food within RECs: path lengths (food miles) and transport costs, broadly defined to include all costs of shipping food.

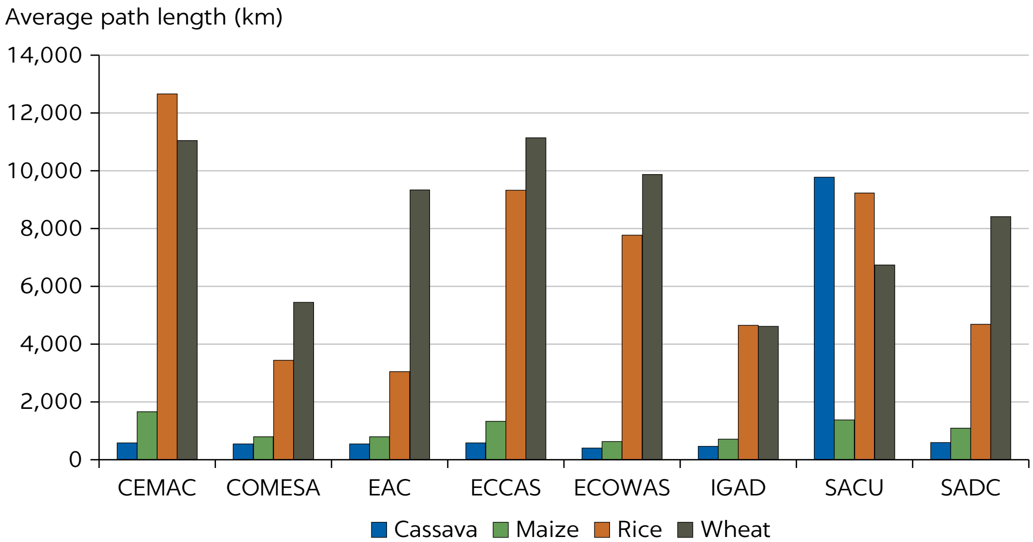
Food miles and trade costs within regional economic communities

The average distance over which food is shipped is shortest for locally produced and consumed commodities (cassava and maize) and longest for staples imported from overseas (rice and wheat). The average distances are shortest within the Intergovernmental Authority on Development (IGAD) and longest in Central Africa (refer to figure 5.4). The average path lengths reflect whether countries that belong to a REC produce a crop. ECOWAS has short average path lengths for cassava and maize, for example, because both crops are grown locally in West Africa.

The RECs also display different patterns with respect to the costs of transport, especially the efficiency of processes at the borders and the time it takes to cross international boundaries of countries in different RECs and, in many instances, even within the same REC. On the basis of simulations using the food flow model, transport costs are highest for cassava, followed by maize, rice, and wheat. This pattern is consistent with the aggregate pattern shown in figure 5.5, which shows that transport costs are highest for commodities traded the least, such as cassava and maize. Rice and wheat, which are often imported from overseas, have longer path lengths but lower unit transport costs.

FIGURE 5.4

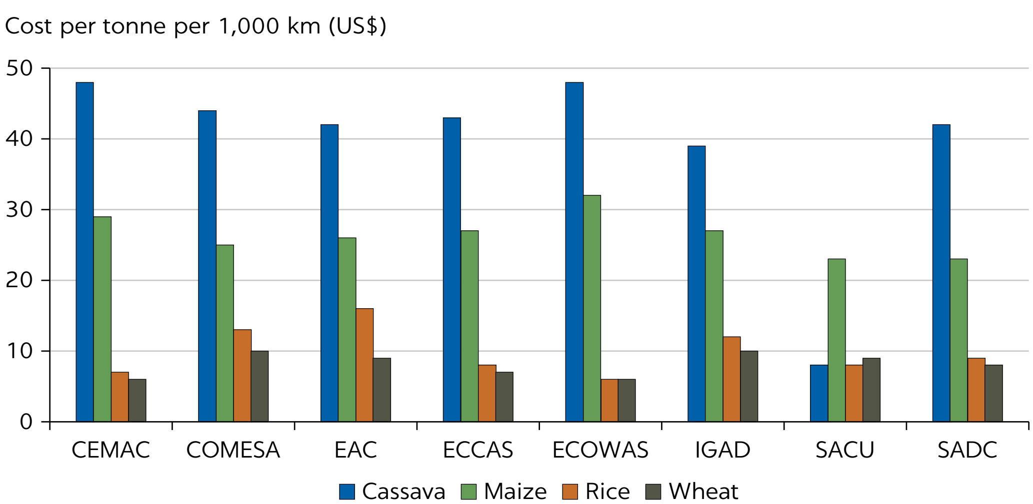
Average path length from producer to consumer of cassava, maize, rice, and wheat, by regional economic community, 2022



Source: Original figure for this publication, based on model outputs.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SACU = Southern African Customs Union; SADC = Southern African Development Community.

FIGURE 5.5

Estimated transport costs of cassava, maize, rice, and wheat, by regional economic community, 2022



Source: Original figure for this publication, based on model outputs.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SACU = Southern African Customs Union; SADC = Southern African Development Community.

The Central Africa region, especially CEMAC, has high transport costs per kilometer for cassava and maize, which are heavily consumed in the region. Poor transport infrastructure is a major contributor to these costs.

In general, short path lengths contribute to higher transport costs per kilometer, primarily because crops are transported by small trucks. In contrast, overseas shipments are transported by ship. The poor condition of the transport infrastructure in some countries contributes to higher transport costs. The costs of crossing borders contribute significantly to trade costs within RECs.

Problems at the border

A large share of food trade in Africa is over land. Corridor-based programs could improve regional trade (as discussed in chapter 4), but such programs tend to be commodity agnostic. To overlay transport networks and food exchanges, the food model was used to assign food flows across the network, to estimate the volumes of food that cross borders in Sub-Saharan Africa. The simulation identified the most important border crossing points (BCPs) and the associated corridors for food trade (refer to map 5.1 and table 5.4). The results can be used to prioritize border posts and corridors by their importance to food trade in general or for specific commodities, countries, or subnational units within a country.

The additional costs reflect the increase in costs should there be a disruption to the identified crossing point.

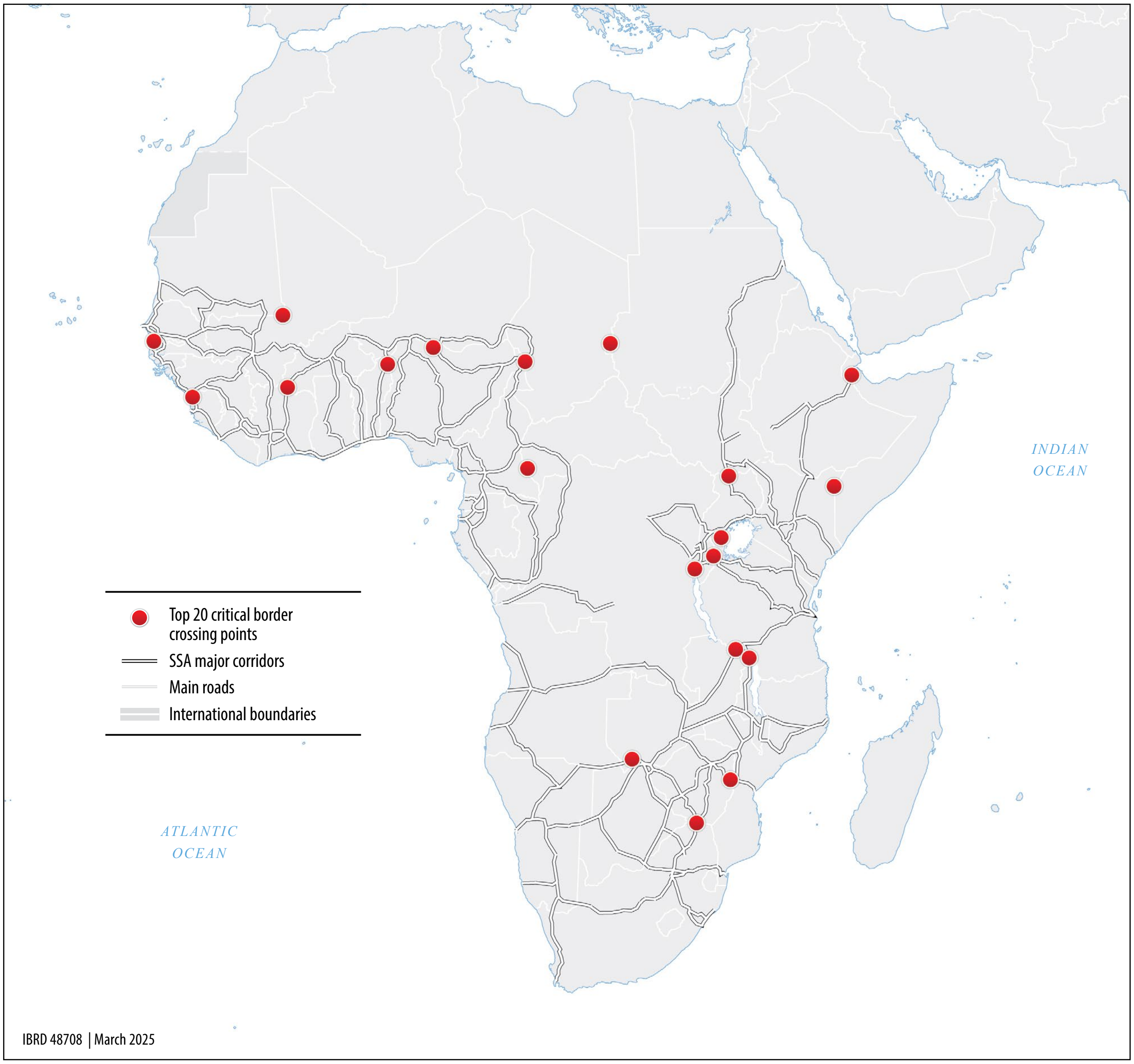
Critical BCPs are in all subregions, often along corridors that connect to ports. For example, two BCPs (Mwenda-Chembe and Mokambo) are important for access to food in the Democratic Republic of Congo, which experiences significant transport stress. In some countries, such as Nigeria and Zimbabwe, a few border crossings are critical. In others, such as Cameroon and Djibouti, a single crossing point is the most critical.

The results suggest that for specific countries, agricultural trade with other countries in the same REC is handled at a few points. The condition of and performance at BCPs can be a major determinant of costs.

Using the model, a 25 percent reduction in time to cross borders would result in a 13–18 percent reduction in shipments of intra-African trade and a 7–8 percent reduction in time for imported commodities. These reductions in time would have an impact on lead times to trade and, therefore, the generalized cost of trading.

MAP 5.1

Top 20 critical border crossing points in Sub-Saharan Africa, 2023



Source: Original map for this publication, based on model outputs.
Note: SSA = Sub-Saharan Africa.

Nontariff trade measures and the cost of food trade

Many NTMs yield important benefits for food trade, including in Africa, where serious pests have resulted in loss of access to food resources. Kansiime, Rwomushana, and Mugambi (2023) estimate that fall armyworms result in maize losses across Sub-Saharan Africa of more than $9 billion per year. NTMs are crucial in reducing the spread and impact of pests and diseases and protecting populations from major food safety incidents and contaminants. In this way, NTMs contribute to food security.

TABLE 5.4 Twenty most important border crossing points in Sub-Saharan Africa for food flow

COUNTRIES	LOCATION	ADDITIONAL TRANSPORT COSTS (US$ PER YEAR, MILLIONS)	FOOD FLOW (KCAL/YEAR, BILLIONS)
Zambia-Congo, Dem. Rep.	Mwenda-Chembe	37	1,500
Zambia-Congo, Dem. Rep.	Mokambo	37	1,500
South Africa-Mozambique	Ressano Garcia	26	10,300
Nigeria-Cameroon	Awa-Ekok	14	7,100
Nigeria-Cameroon	Achan	12	7,600
Zimbabwe-Mozambique	Forbes	12	3,700
Ethiopia-Djibouti	Guelile	8	5,200
Malawi-Mozambique	Muloza-Milange	6	1,500
Liberia-Guinea	Ganta	5	1,200
Kenya-Somalia	Gerille	5	900
Cameroon-Central African Republic	Gamboula	4	600
Malawi-Mozambique	Zobue	4	600
Nigeria-Niger	Baba Mutum	4	700
Zambia-Zimbabwe	Chirundu	3	1,200
Cameroon-Congo, Rep.	Souanke-Ntam	3	200
Central African Republic-Congo, Rep.	Mboulou	3	600
Rwanda-Tanzania	Rusumo	2	1,400
Guinea-Mali	Kouremale	2	1,000
Tanzania-Kenya	Taveta	2	1,100
Senegal-Mali	Kidira-Diboli	2	600

Source: Original table for this publication, based on model outputs.
Note: kcal = kilocalories.

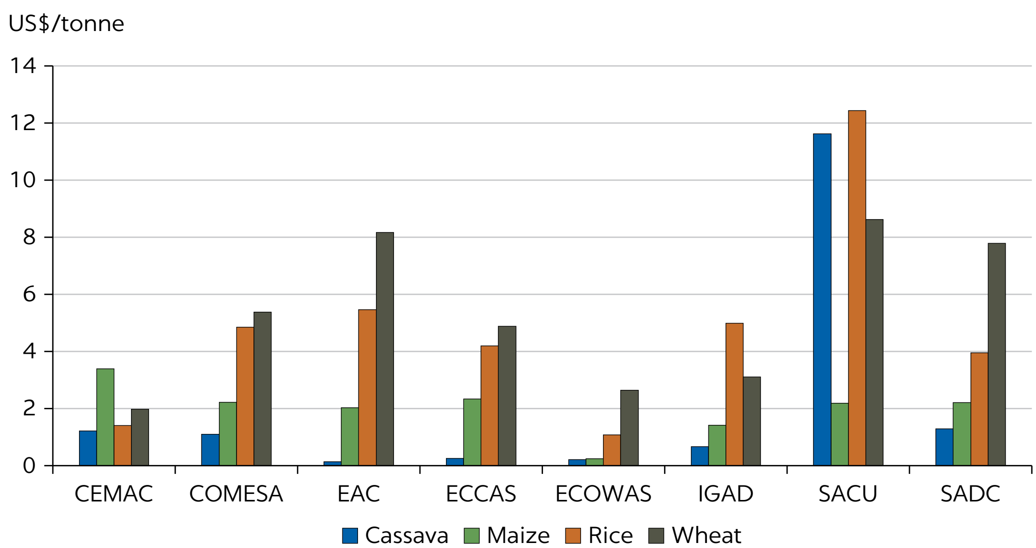
The challenge in Africa is not that NTMs exist but that they are poorly developed and implemented and therefore become barriers to trade. Bonuedi, Kamasa, and Opoku (2020) use a panel data set encompassing 45 African countries from 2006 to 2015 to examine the impact of trade facilitation on food security outcomes. They find that suboptimal trade facilitation is a significant impediment to food security on the continent. The report finds a correlation between ineffective trade facilitation and increased undernourishment, deeper food deficits, diminished dietary energy supply adequacy, and reduced access to sanitation facilities. It posits that heightened documentation demands and extended times to clear exports and imports substantially compromise food availability and access. The implications are clear: Reducing delays associated with documentary and border compliance is critical to enhancing food security in Africa.

The World Bank (Echandi, Maliszewska, and Steenbergen 2020) maintains that for the AfCFTA agreement to positively contribute to economic growth and trade diversification, and to food consumption across the continent, it is necessary to reduce the costs associated with NTMs. Echandi, Maliszewska, and Steenbergen (2020) conclude that reducing NTMs has a larger positive impact than further reductions in tariffs. These authors recommend that governments focus on reducing or eliminating measures that hinder or limit the flow of goods across borders and invest in efforts that facilitate cross-border trade and eliminate unnecessary red tape. They conclude that reducing NTBs—such as onerous at-the-border documentary requirements, protracted export and import times, and elevated real trade costs—can significantly improve food security outcomes. The impact of NTBs on the efficiency and costs of transport was tested using the food flow model (refer to figure 5.6).

The results show variation in NTBs and transport costs across RECs, pointing to region-specific issues. Some of the patterns are contrary to expectations based on regional trade policies. For instance, SACU, a customs union, has a much higher incidence of NTBs than other RECs. The main challenge appears to lie in the limited capacity at BCPs and in ports, which causes significant delays. Mozambique is not an SACU member, but its ports are vital for handling maize, rice, and wheat intended for SACU countries, even though South Africa and Namibia (both SACU members) have well-developed ports. Those ports are optimized for and prioritize commodities other than food. The World Bank (2018) advocates for cross-sectoral collaboration to effectively tackle NTBs.

FIGURE 5.6

Estimated average cost associated with nontariff barriers on food staples, by regional economic community, 2022



Source: Original figure for this publication, based on model outputs.
Note: CEMAC = Central African Economic and Monetary Community; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SACU = Southern African Customs Union; SADC = Southern African Development Community.

Within the EAC and CEMAC, NTBs are high for rice and wheat, which are often traded across borders. NTBs continue to impose significant trade costs on the regions, particularly for cross-border trade. Box 5.1 summarizes the regulatory barriers faced in the CEMAC region and how they could be addressed.

Box 5.1

Regulatory barriers to food trade in the Central African Economic and Monetary Community region

The Central African Economic and Monetary Community (CEMAC) includes six countries: Cameroon, the Central African Republic, Chad, the Republic of Congo, Equatorial Guinea, and Gabon. Agriculture plays a significant role in the economies of these countries, providing employment and income for a large portion of the population. However, trade in agriculture faces several bottlenecks that hinder its growth and potential.

Gaskell et al. (2018) reach several conclusions about barriers to trade within the region:

- Intermediation costs, including market access costs, are the most significant cost driver, accounting for 42 percent of the final consumer price.
- Transport costs and harassment of transporters and traders account for about a third of the final price.
- Border crossing costs make up roughly 7 percent of the consumer price.
- Improving conditions along a trade corridor is more effective than targeting a single problem across multiple corridors.
- Investments in market infrastructure, market management, trade information systems, and transport infrastructure are needed to reduce trade costs and improve regional agricultural trade.

In addition to transport infrastructure challenges, significant nontariff barriers (NTBs) persist within CEMAC, including phytosanitary regulations, additional documentation requirements, and occasional border delays. On average, NTBs add $0.80 per tonne to the cost of cassava, $4.30 to the cost of maize, $13.10 to the cost of rice, and $16.60 to the cost of wheat. These costs stem from requirements such as certifications and customs procedures that delay goods at border crossings.

Regulatory barriers pose significant challenges to agricultural trade in the CEMAC region. For example, traders often face lengthy and costly customs clearance processes, which can cause perishable goods to spoil before reaching their destination. The lack of harmonized standards and certifications also means that agricultural products need to undergo multiple inspections and approvals, further delaying trade and increasing costs.

Market information gaps also hinder agricultural trade in the CEMAC region. Information asymmetry can lead to market inefficiencies, with farmers either overproducing or underproducing certain crops, resulting in both price volatility and income instability. The absence of reliable market information also makes it difficult for traders to identify profitable market opportunities and plan their logistics effectively.

continued

Box 5.1 Regulatory barriers to food trade in the Central African Economic and Monetary Community region, *continued*

Several measures could be implemented to address these bottlenecks and enhance agricultural trade in the CEMAC region. Regulatory harmonization is essential to facilitate smoother trade flows. Simplifying and harmonizing regulations across borders can reduce the complexity and cost of trading agricultural products. It involves streamlining customs procedures, reducing NTBs, and adopting common standards and certifications. Implementing a single-window system for customs clearance can expedite the process and reduce delays.

Developing robust market information systems is also vital. Such systems can provide real-time data on prices, demand, and supply, helping farmers make better production and marketing decisions. Establishing agricultural market information platforms can enable farmers to access up-to-date market information through mobile phones and other digital devices.

Implementing trade policy reforms that reduce tariffs and other trade barriers can open new markets for agricultural products and enhance competitiveness. These reforms can create a more conducive environment for agricultural trade, ultimately contributing to increased trade and economic growth in the CEMAC region.

SUMMARY

AfCFTA's coming into force in 2021 was a significant milestone in the endeavor for trade integration on the continent. The AfCFTA aims to create a single market for goods and services across the continent, promoting seamless intra-African trade by lowering barriers. This interconnected system supports a more resilient food distribution network, enabling African countries to meet regional demands more effectively and reduce dependency on imports from outside the continent.

However, the experience with similar efforts through RECs has pointed to both opportunities and hurdles that need to be addressed if the continental ideal is to be realized. The RECs have been at the forefront of defining and promoting transport corridors that carry much of the interstate trade. Many such corridors are operational, albeit to varying degrees of efficiency. Many of the inefficiencies on the corridors are due to poorly defined and implemented NTMs that end up being NTBs and are a particular impediment to trade, especially trade in agricultural commodities. This chapter estimates the contribution to costs of such NTBs and finds that they are significant in terms of monetary cost, but also in terms of the time it would take to meet the requirements.

It is important to harmonize NTMs and to minimize, if not eliminate, NTBs if food is to be more efficiently distributed across the continent.

NTMs should be closely aligned with trade facilitation objectives to expedite the transport of legitimate trade. International instruments, such as the World Trade Organization's Trade Facilitation Agreement—which promotes basing sanitary phytosanitary standards and technical barriers to trade rules and regulations on harmonization, enhanced transparency, stakeholder consultation, and the application of regulatory impact assessments—can be useful foundations for the modernization of practices at the border.

NOTES

1. See World Bank, DataBank, https://databank.worldbank.org/source/escap-world-bank-international-trade-costs.
2. An eighth REC—the Intergovernmental Authority on Development (IGAD)—was created in 1996. It has eight member states (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda). All these countries are members of one or more of the other seven RECs. IGAD does not yet play a central role in intercountry trade.

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6 Local Access to Food

ABSTRACT

This chapter investigates the role of local access and distribution in ensuring food security, particularly in low-income countries.

KEY FINDINGS AND MESSAGES

- High domestic transport costs significantly raise food prices, especially in regions far from production zones or ports. In Tanzania, for example, transport costs of up to $182 per tonne limit farmers' ability to sell their goods, increasing food prices for consumers. Reducing these costs is critical to ensuring affordable and accessible food for all.
- Inadequate domestic infrastructure severely restricts the flow of food within countries. Improving local infrastructure is key to stabilizing prices and ensuring the efficient distribution of food.
- Although some countries in Africa produce sufficient food at the national level, localized deficits—especially in staples such as rice and wheat—require better internal distribution networks. About one-fifth of African countries face rice shortages, and more than one-quarter struggle with wheat deficits. Improving domestic access to food through stronger distribution systems would help reduce reliance on imports and improve the availability of food.
- The resilience of domestic transport networks is key to efficient food distribution. Strengthening key domestic links, such as the road from Zambia to the port of Beira in Mozambique, would reduce transport costs and enhance food accessibility within countries. Investing in these networks would help ensure that food reaches communities quickly and efficiently, improving overall food security.

ROLE AND IMPACT OF RURAL TRANSPORT AND ACCESS ON FOOD SECURITY

International trade plays a crucial role in supplying essential goods, but it is the local systems that dictate the effectiveness of food distribution and accessibility. The interplay of rural infrastructure, market access, and local governance forms the backbone of food security, determining whether nutritious food reaches those in need.

In low-income countries, the poor quality of rural infrastructure—roads, transportation networks, and storage facilities—limits farmers' ability to transport their produce to markets and consumers' ability to access affordable food. The presence of functioning markets and fair pricing mechanisms is essential for connecting producers with consumers, ensuring that food is not only available but also accessible. Local governance, characterized by effective policies and community engagement, plays a pivotal role in creating an environment conducive to thriving local food systems.

Reducing transport costs, improving market accessibility, and supporting the supply chain can increase agricultural production, reduce food waste, and improve livelihoods for rural communities. Careful planning, targeting of investments, and complementary policy interventions are crucial for maximizing the impact of transport infrastructure on food security.

Several actions are needed to maximize the impact of rural roads:

- *Allocate transport infrastructure in a way that enhances access, reduces food waste, and enables rapid movement of food supplies during crises (Fajgelbaum and Schaal 2019)*. Roads are often constructed in areas with higher agricultural potential or economic activity, which can skew the perceived benefits of road development. Careful targeting of infrastructure investments is crucial to avoid the misallocation of resources.
- *Complement roads investments with support for rural markets.* Kebede (2024) finds that rural road infrastructure in Ethiopia is crucial in promoting market integration and facilitating a transition from subsistence farming to market-based farming. Nagesso, Ayele, and Nigussie (2019) find that households in Ethiopia with access to all-weather roads and agricultural extension services were significantly more likely to report food security than those without access. Their study also reveals that access to other infrastructure, such as protected water sources, information and communications technology, and health centers, is correlated with food security, although the association was not as strong as with roads and agricultural extension services.

- *Support supply chain management infrastructure.* Transportation infrastructure investments are critical to reduce waste and improve food accessibility and affordability, enhancing food security (Zakaree 2022).
- *Enhance access at scale.* The Pradhan Mantri Gram Sadak Yojana rural roads program in India has funded the construction of more than 100,000 roads to 200,000 villages. It shows the potential of expansive rural access programs to reduce transportation costs and facilitate access to markets (Asher and Novosad 2020).

FOOD DISTRIBUTION

African countries may not produce enough to meet all their food needs, but the volume of trade with overseas partners could be lower than it is. Clear patterns emerge from the analysis of the food balance of countries in Sub-Saharan Africa (refer to figure 6.1). For cassava (refer to panel a), the top producers, such as the Democratic Republic of Congo, Ghana, and Nigeria, have large surpluses, whereas the smallest producers have very small shortfalls. A similar pattern, although of a smaller magnitude, emerges for maize (refer to panel b), where the top 10 producers have relatively large surpluses and the bottom 10 countries have small or negative balances. However, the patterns are very different for rice (refer to panel c) and particularly for wheat (refer to panel d), for which very few countries have surpluses; those that do have surpluses have them only in small amounts, and most countries, as shown for the bottom 10 in each case, have large trade deficits.

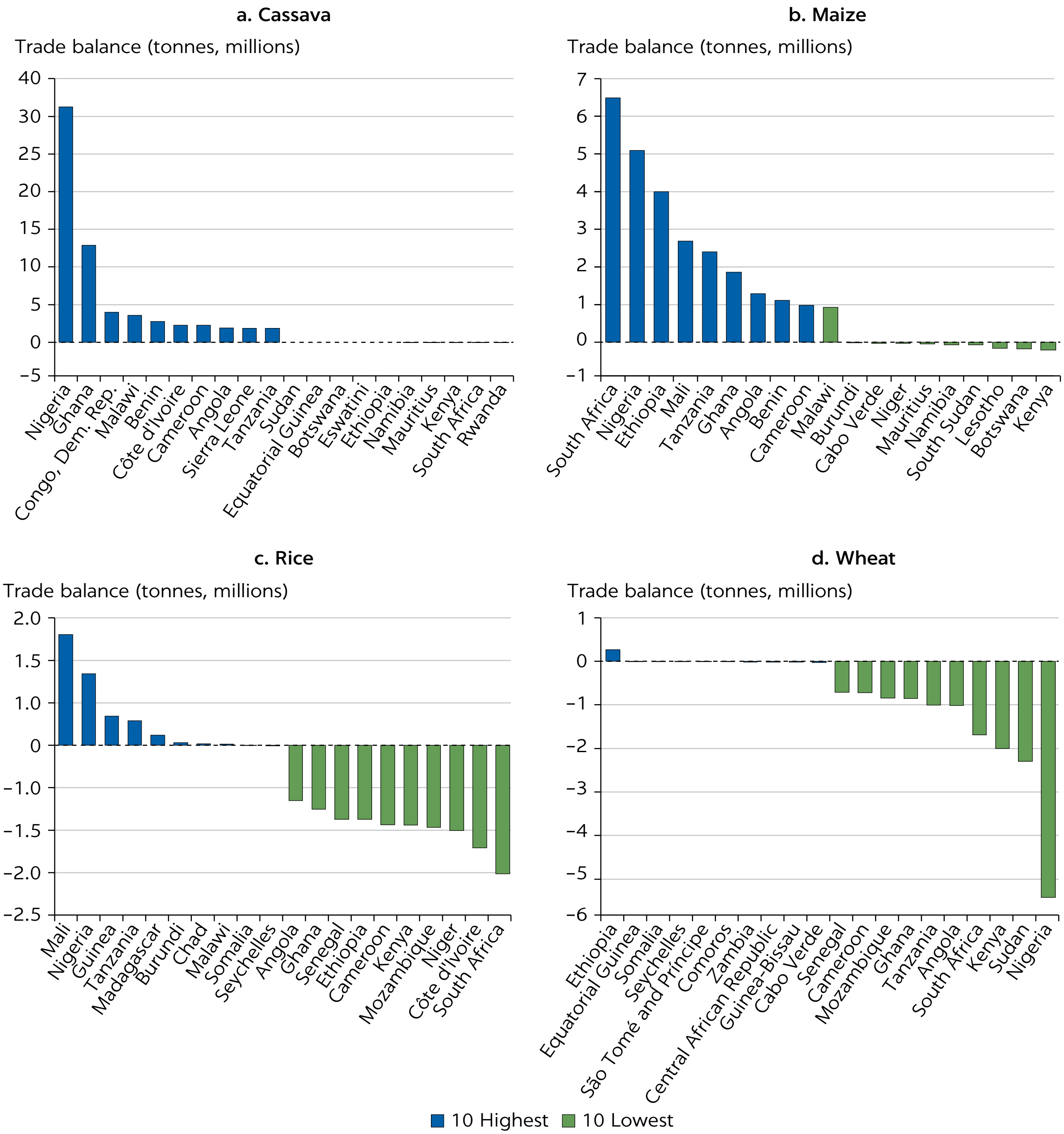
At the aggregate level, no countries in Sub-Saharan Africa have deficits of cassava and maize (refer to table 6.1). Almost one-quarter of countries run deficits in rice and wheat. The majority produce enough rice and wheat for their own consumption, and some produce surpluses, which could be traded.

The question is, What prevents greater intercountry exchanges of food commodities on the continent?

One factor is the weak food distribution system. National data mask the significant number of subnational units (traffic analysis zones) that face food deficits: A total of 5 percent of traffic zones face deficits in maize, and 11 percent face deficits in cassava, rice, and wheat (refer to table 6.1 and figure 6.2). The patterns confirm the presence of significant frictions that hamper the flow of commodities between and within countries.

FIGURE 6.1

Trade balance for cassava, maize, wheat, and rice in Sub-Saharan Africa, by country, 2022



Source: Original figures for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data/TCL).

TABLE 6.1 Trade balances in Sub-Saharan Africa for cassava, maize, rice, and wheat, 2022

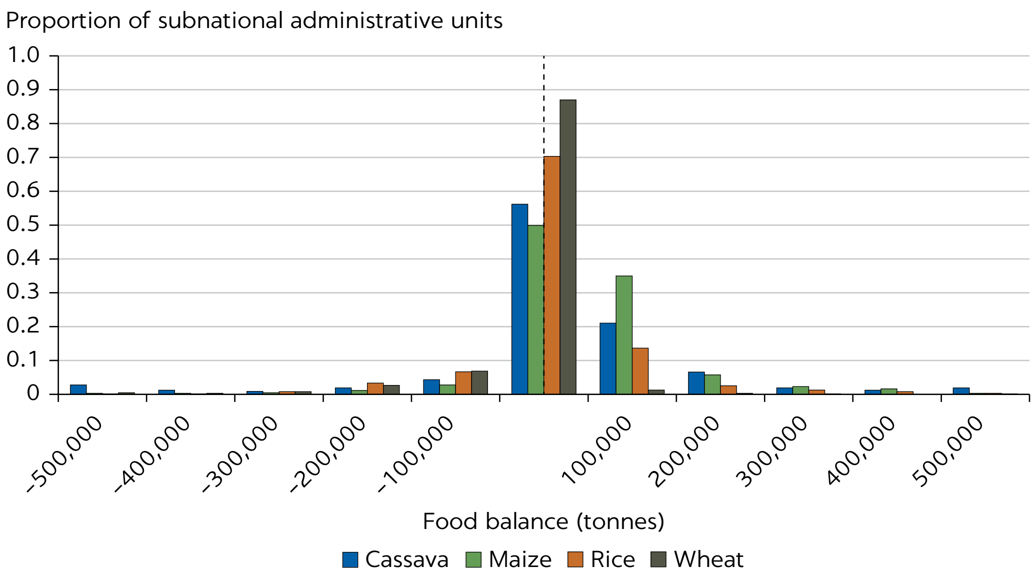
% of countries

STATUS	CASSAVA	MAIZE	RICE	WHEAT
National level				
Deficit	0	0	22	28
Zero to trade	39	44	61	70
Surplus	61	56	16	2
Subnational level				
Deficit	11	5	11	11
Zero to trade	56	50	70	87
Surplus	33	45	19	2

Source: Original table for this publication, based on model outputs.
Note: Subnational level = traffic zone.

FIGURE 6.2

Distribution of food balances for cassava, maize, rice, and wheat in Sub-Saharan Africa, by traffic zone, 2022



Source: Original figure for this publication, based on data from FAO Food Balance Sheets (https://www.fao.org/faostat/en/#data).

A comparison of the food balances at both country and subnational scales sheds more light on the incidence of food insecurity across and within countries in Sub-Saharan Africa (refer to table 6.2). In table 6.2, a negative value indicates that the number of subnational units exceeds the proportion of countries. For instance, for cassava, the proportion of subnational units is 11 percent greater than that of countries with deficits of the crop. The picture is different for wheat, where the proportion of countries with

TABLE 6.2 Differences between incidence of food insecurity at the country and subnational levels in Sub-Saharan Africa, 2022
Percent

STATUS	CASSAVA	MAIZE	RICE	WHEAT
Deficit	−11	−5	11	17
Surplus	29	11	−2	0
Balanced	−18	−5	−9	−17

Source: Original table for this publication, based on model outputs.
Note: A negative value indicates that a greater percentage of subnational units are food insecure compared with the proportion of countries and vice versa.

deficits is 17 percent greater than the proportion of subnational units with deficits. The data therefore show that a larger proportion of subnational units than countries have deficits in cassava and maize; for rice and wheat, the share of countries with deficits is larger than the share of subnational units. These results point to a problem with the distribution of commodities within individual countries, in which a country produces enough of a commodity, but it cannot be transferred from areas of surplus to those of deficit. Regarding imported commodities, the results point to high deficits across countries, but few districts face such deficits. These problems could be addressed or minimized with a more efficient connectivity between territories.

TRANSPORT COSTS WITHIN COUNTRIES

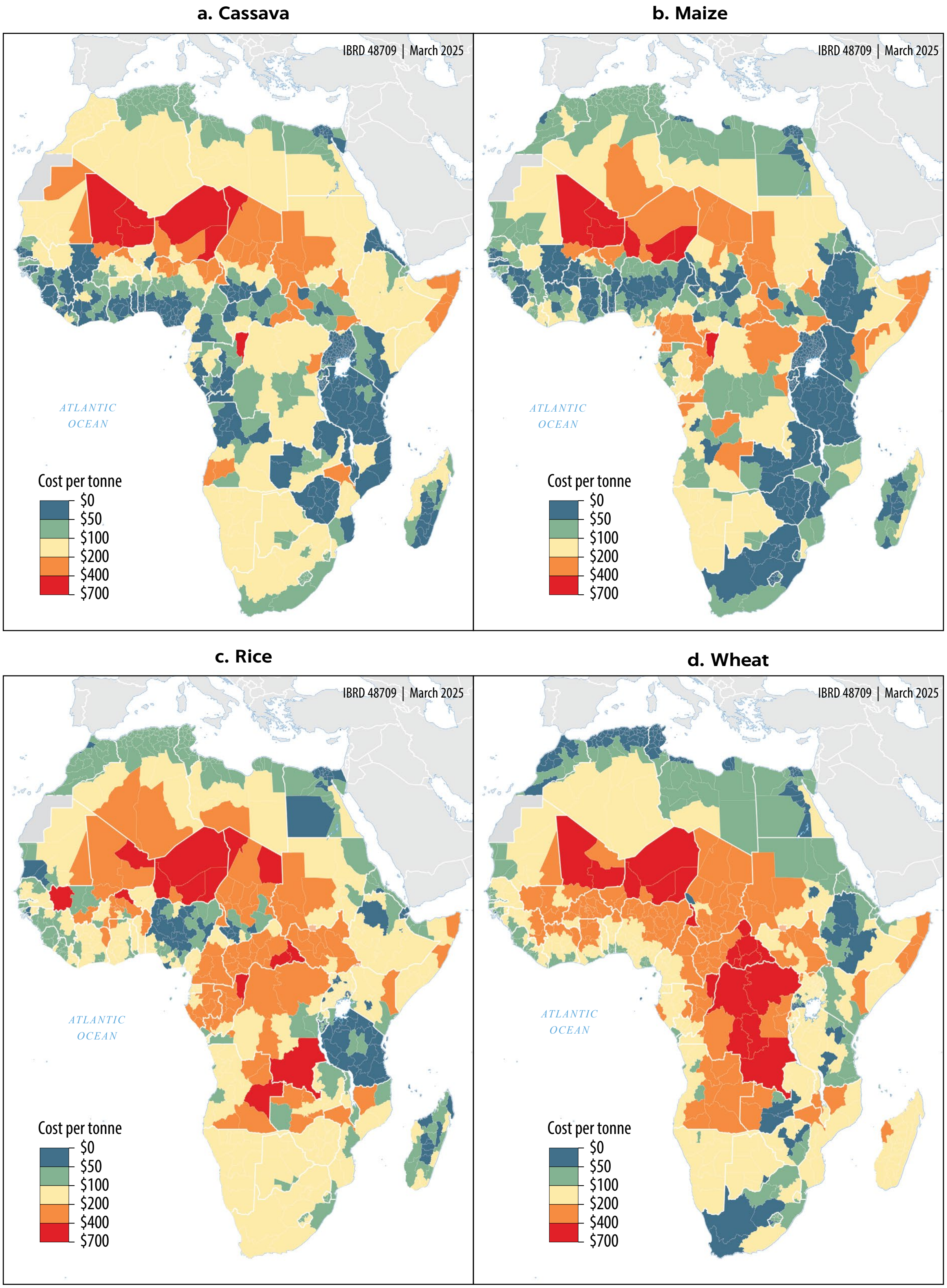
Transport costs often vary widely within countries. In Cameroon, Ethiopia, and Zimbabwe, for example, distance from key agricultural areas raises the cost of moving goods (refer to map 6.1).

In Cameroon, maize is grown primarily in the northern regions, and the two largest cities, Douala and Yaoundé, are in the south. The long distance between these production areas and urban markets significantly drives up transport costs, because goods must traverse the country's challenging terrain and poor infrastructure. Supplying population centers in the south is difficult, even though maize is abundantly produced in the north. Similar situations prevail in Ethiopia and Zimbabwe.

For wheat, regions with access to coastal ports enjoy significantly lower transport costs because of the ease of maritime shipping and proximity to international trade routes. Coastal areas, particularly in countries with well-developed port infrastructure, can efficiently import wheat. Transport costs begin to rise sharply as one moves further inland, because overland transport is the primary mode of moving goods.

MAP 6.1

Cost of transporting cassava, maize, rice, and wheat to consumers in Africa, by traffic analysis zone, average 2016–22



Source: Original maps for this publication, based on model outputs.

Transport costs for wheat are relatively low in areas where it is produced locally, such as Oromia, in Ethiopia; Njombe, in Tanzania; Lusaka, in Zambia; and Mashonaland East, in Zimbabwe. Local production reduces the cost of wheat distribution in the immediate area, benefiting both producers and consumers.

Nearby zones do not always share in the benefits of these production hubs, however. Despite their proximity, regions adjacent to these production zones often face higher transport costs. This discrepancy can be attributed to several factors. One possibility is the inefficiency or high cost of transportation within the national network, which makes internal distribution more expensive, even when wheat is produced nearby. Poor road conditions, limited transport capacity, and logistical inefficiencies hinder the movement of wheat, driving up costs for neighboring regions.

Another factor could be the limited surplus production in these wheat-producing zones. Although they may have enough output to meet local demand, their production levels may not be high enough to significantly reduce the need for wheat imports in the rest of the country. As a result, neighboring areas may still rely on more expensive international imports or distant production zones to meet their wheat needs, which increases transport costs.

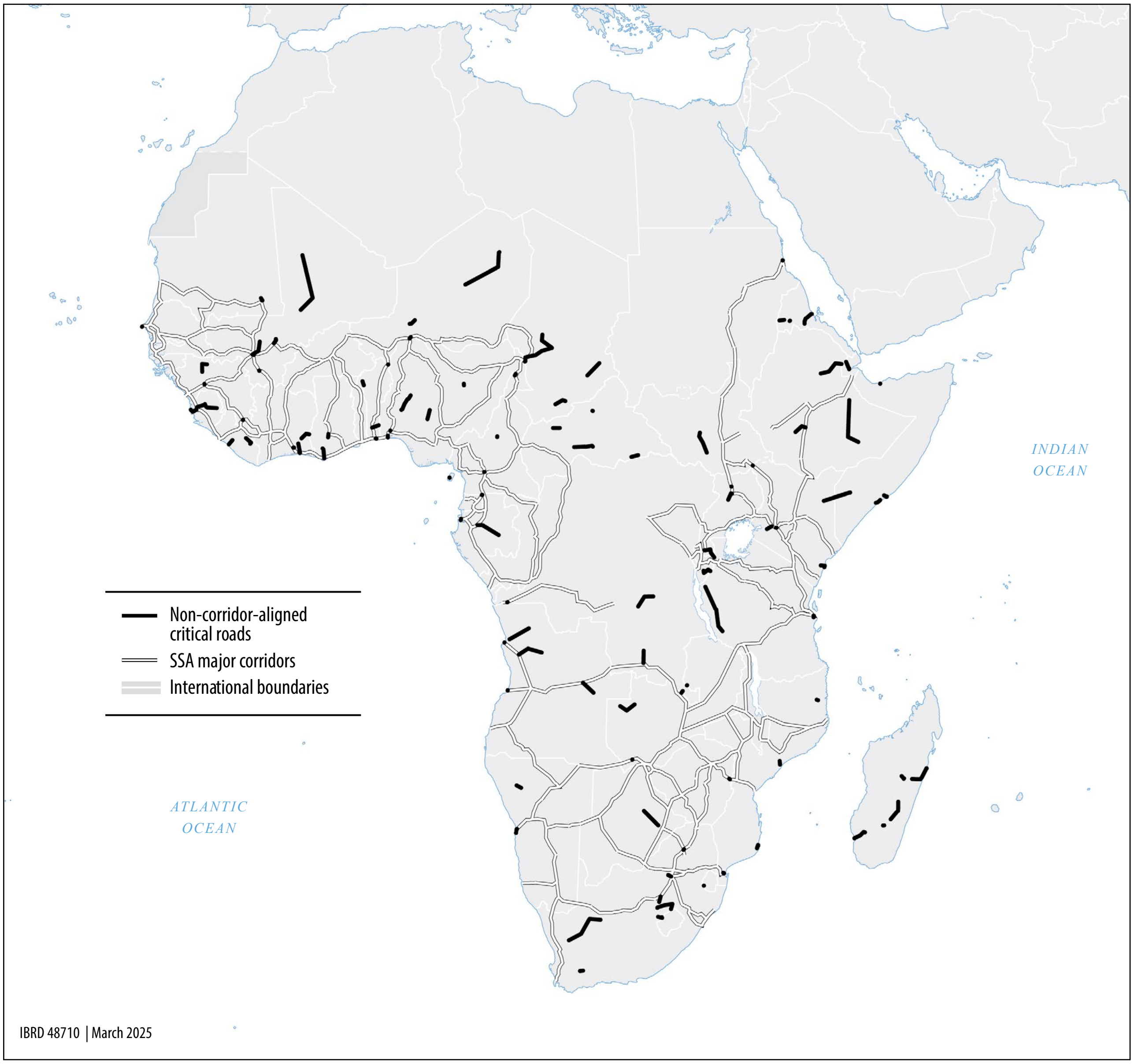
Prioritizing elements of transport networks

As established on the basis of the literature, the placement of transport infrastructure is important for food flows and therefore food security. The resilience of the transport networks is also important for critical links within the network. Critical links are those that handle flows between food deficit and surplus areas, including flows in transit between such zones. Both functions are particularly important in Sub-Saharan Africa, where the geography is diverse, distances are long, and economic densities are low.

The model identifies transport network links that are critical for food security (refer to map 6.2). Most of them connect to existing corridors. This finding is important because it shows the continuing influence of the network of corridors in terms of how food flows are channeled as well as the importance of considering the wider network when building transport infrastructure for agriculture and especially food security. Network approaches entail areawide solutions and the identification of links that connect subnetworks that may otherwise be isolated. Investment in transport infrastructure, such as roads, bridges, and storage facilities, is crucial for creating a seamless supply chain that can respond efficiently to market demands and emergencies. Improved connectivity also facilitates the rapid movement of food during crises. Network connectivity in transport is not just about physical infrastructure but also about creating an enabling environment for economic growth, poverty reduction, and sustainable development.

MAP 6.2

Critical secondary road transport links in Sub-Saharan Africa, 2022



Source: Original map for this publication, based on model outputs.

A neglected dimension of food access is the availability and cost of transport services. Transport prices are a function of several variables, including the degree of competition in service markets. The seminal report of Teravaninthorn and Raballand (2009) finds that the price shippers pay in Sub-Saharan Africa is significantly higher than the price shippers pay elsewhere primarily because of market regulations and the structure of transport markets. Even when infrastructure is built to the same standard, inefficient market dynamics, particularly in Central and West Africa, can result in inefficiencies that affect trade.

Transport services and cost of access to food

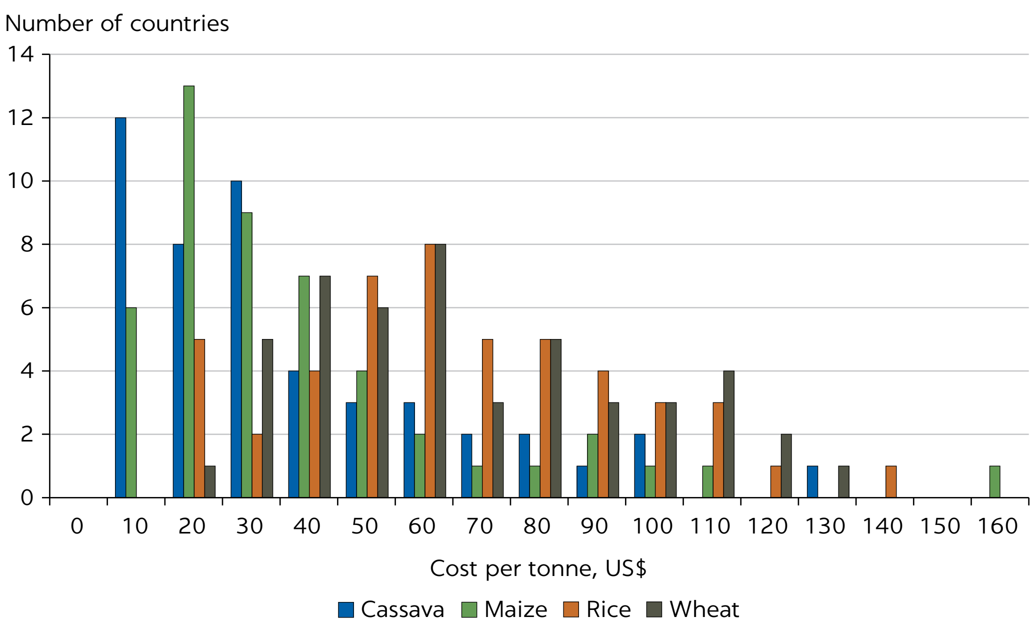
The link between transport prices and food security in Africa is multifaceted, involving several interacting variables. They include distance, the quality and availability of road infrastructure, seasonal rain patterns, conflict, economic geography, and border frictions that affect the ability of foreign shippers to access the market. One critical but often overlooked factor is the cost of transportation. High transport prices can significantly affect food security by increasing the cost of food, reducing market accessibility, and affecting the overall efficiency of food distribution systems.

Using the model, the costs per tonne of shipping the staple commodities range from $10 to more than $160 (refer to figure 6.3). Cassava and maize generally have lower transport costs ($10–$50 per tonne); rice and wheat show a wider distribution of transport costs, with higher costs exceeding $100 per tonne in some countries. These disparities in transport costs across different crops and regions can significantly affect food prices and accessibility, particularly for imported commodities, such as wheat.

The Rural Access Index measures the proportion of the rural population living within 2 kilometers of an all-season road. It reveals the accessibility of rural areas to markets and services.[1] Improved access via rural roads can enhance farmers' ability to obtain inputs and sell their produce, thereby increasing productivity.

FIGURE 6.3

Distribution of countries in Sub-Saharan Africa by cost of transporting cassava, maize, rice, and wheat, 2022



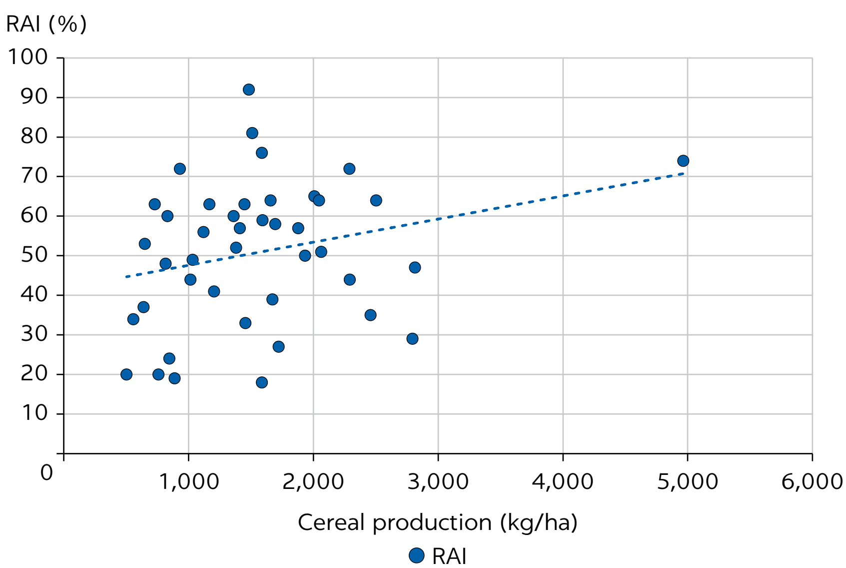
Source: Original figure for this publication, based on model outputs.

Figure 6.4 shows the correlation between agricultural production and rural access in Sub-Saharan Africa. Other factors must be considered in interpreting the results, including degree of urbanization and level of income. Although better access can lead to increased food production, the initial conditions of the area—such as existing agricultural practices and market access—also determine outcomes. Understanding this dynamic is essential for effective policy making aimed at enhancing food security and rural development.

Improving the connectivity of rural areas reduces poverty, which enhances the ability of the poor population to cope with shocks to the food system. Dorosh et al. (2010) provide evidence that investments in road infrastructure can significantly enhance agricultural productivity and output in Sub-Saharan Africa. Their findings highlight the importance of considering the impacts of road connectivity on both agricultural production and the broader rural economy, including household behavior and migration patterns. The impacts are attributed to the agricultural sector's large share of gross domestic product in most Sub-Saharan countries, the concentration of poverty in rural areas, and the high transaction costs associated with selling agricultural inputs and outputs because of limited road infrastructure and long travel times. They find that the elasticity of crop production increases as the size of the nearest city increases, suggesting a greater concentration of production in regions surrounding large cities. The elasticities of travel time on crop production are also higher for low-input crop production systems than for high-input and

FIGURE 6.4

Correlation between the Rural Access Index and cereal production per hectare in Sub-Saharan Africa, 2024



Source: Original figure for this publication, based on World Bank data (https://databank.worldbank.org and https://rai.azavea.com).
Note: RAI = Rural Access Index.

irrigated systems, indicating that the location of production may be driven more by proximity to markets for low-input technologies. Better road connectivity makes high-input production more profitable, leading to an increase in its share of production. This shift is driven by both direct and indirect channels, with roads increasing crop production through access to larger markets and intermediate inputs, as well as facilitating the adoption of high-input and high-yield crop production. For these and other reasons, scaling up rural access often makes sense (refer to box 6.1).

Box 6.1

Improving rural connectivity: A rural access and mobility program in Nigeria

There is considerable evidence of the efficacy of programmatic approaches to improving rural access and connectivity. The Pradhan Mantri Gram Sadak Yojana rural roads program in India is an example of such an approach. It has constructed more than 100,000 roads to 200,000 villages, significantly increasing transportation services and facilitating access to markets (Asher and Novosad 2020); similar programmatic approaches have shown positive outcomes in China (Zhou et al. 2021). Investments in rural road infrastructure have been linked to significant improvements in agricultural productivity and output. These investments have reduced transportation costs, increased market access, and facilitated the adoption of modern farming technologies.

In Africa, the World Bank supported efforts by the government of Nigeria to implement a Rural Access and Mobility Program (RAMP) in Nigeria. The program was implemented in two phases from 2008 to 2018 and, at a total cost of $303 million, was financed by the government of Nigeria with support from the International Development Association and Agence Française de Développement. The program's primary objective was to improve transport conditions and bring sustained access to the rural population by rehabilitating and maintaining key rural transport infrastructure in a sustainable manner. This objective was closely tied to enhancing agricultural productivity and improving the livelihoods of rural communities by providing better access to markets and services.

RAMP interventions included rehabilitating and upgrading rural roads to all-season standards, ensuring that rural communities had reliable access to markets, schools, and health care facilities, and establishing community-based maintenance systems to ensure the sustainability of the rehabilitated roads. It also included annual mechanized maintenance to address more significant road maintenance needs.

RAMP-2, which was implemented between 2012 and 2018 at a cost of $243 million, achieved several significant outcomes that directly contributed to food security. It brought 1.5 million people within 2 kilometers of an all-season road, significantly improving access to markets and services. By reducing transport costs and average transport time, it led to a 31 percent increase in the volume of agricultural produce transported. The project contributed to greater food security and improved nutrition for rural communities by facilitating better access to agricultural markets and services. With improved roads, farmers could transport their produce to markets more quickly, ensuring that fresh food was available to consumers.

continued

Box 6.1 Improving rural connectivity: A rural access and mobility program in Nigeria, *continued*

RAMP points to the potential of scaling up rural access for food security. Doing so requires integrating rural road development and maintenance with broader agricultural development programs and involving communities to empower them to take ownership of road maintenance, which leads to better-maintained roads and more sustainable outcomes.

SUMMARY

Rural transport is critical for food security in Africa, because high transport costs due to long distances and poor infrastructure negatively affect food affordability and accessibility. Farmers struggle to transport produce to markets, leading to food waste and reduced income, and consumers in remote areas have limited access to affordable food. Better market access encourages farmers to produce more, increasing food availability and minimizing spoilage during transportation. Despite substantial food production, inefficiencies in distribution and reliance on imports highlight the need for strategic investments in transport infrastructure, storage facilities, and market integration to enhance food security. Addressing these challenges through improved rural roads and efficient transport services can boost productivity, reduce food waste, and improve living standards for farmers and consumers alike.

NOTE

1. The index is an indicator for Sustainable Development Goal Indicator 9.1.1, which measures the proportion of the rural population who live within 2 kilometers of an all-season road.

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7 Inadequate Food Storage and Poor Food Handling Practices

ABSTRACT

This chapter delves into postharvest losses in Africa, which are substantial. It highlights how inadequate storage and poor handling of agricultural commodities are linked to deficiencies in transport and logistics connectivity.

KEY FINDINGS AND MESSAGES

- One of the major weaknesses of Africa's food systems is the incidence and magnitude of losses across supply chains, caused in part by poor handling and delays during transportation from farm to market and in storage. Storage is an integral element of agricultural supply chains, used to mitigate postharvest losses, improve or maintain product quality, and enhance market access for farmers and consumers.
- Adequate storage also provides economic benefits and improves market access for farmers. With proper storage, farmers can store their produce and sell it when market conditions are favorable rather than immediately after harvest, when prices are typically lower.
- Storage facilities also contribute to food security by ensuring a steady supply of food products throughout the year regardless of seasonal fluctuations in production. This benefit is particularly important in regions where production is limited to specific seasons of the year or is prone to climatic fluctuations and other disruptions. Local storage facilities reduce the need for government intervention in price support and procurement activities, lowering food security investments.

- As much as 40 percent of perishables and 20–25 percent of cereals are lost postharvest in Sub-Saharan Africa. These losses are driven largely by inadequate storage, poor transport infrastructure, and inefficient logistics.
- Sub-Saharan Africa's storage capacity is less than 20 percent of its food production. Countries such as Ethiopia that rely on both domestic production and imports face persistent food shortages partly because of inadequate storage and logistical bottlenecks. Investing in better transport systems would enhance the use of existing storage facilities and reduce food losses in transit.
- Strategic grain reserves play a critical role in managing food security during crises, but their effectiveness depends on robust transport and logistics connectivity, the cost of capital, and effective information systems.

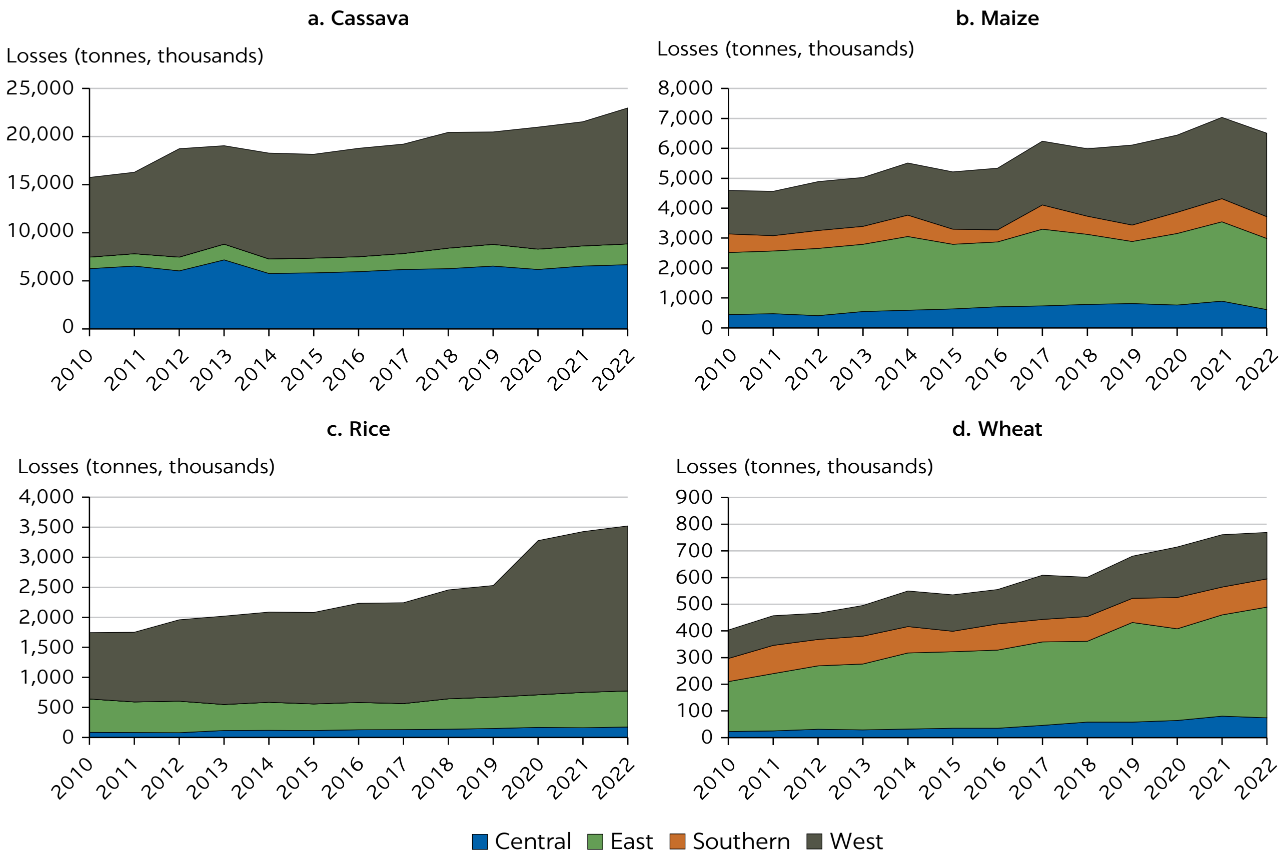
FOOD LOSS ACROSS AGRICULTURE SUPPLY CHAINS IN AFRICA

One of the most visible symptoms of poor supply chain management, especially storage of agricultural commodities, is the high incidence of postharvest losses. On the basis of an analysis of the food loss situation in Burkina Faso, the Democratic Republic of Congo, and Uganda, Totobesola et al. (2022) find large losses and advocate for a paradigm shift in how African countries consider storage and other points of loss along agricultural supply chains. A recent assessment by Rutta (2024) estimates that postharvest losses in Sub-Saharan Africa are around 20 percent for cereals, 25 percent for rice and maize, and as much as 40 percent for perishable crops, such as fruits and vegetables. In 2012, the African Postharvest Losses Information System estimated that physical losses for grain before processing translated to approximately $1.6 billion a year in East and Southern Africa alone (Brenton 2012). Losses in Sub-Saharan Africa stem from various factors, mainly inadequate storage, poor handling practices, and pest infestations (World Bank 2009).

Despite recognition of the problem, the quantity of food lost in Sub-Saharan Africa continues to increase (refer to figure 7.1).[1] Analysis estimates that the quantity of cassava, maize, rice, and wheat lost each year rose by 50 percent between 2010 and 2022, from 22.5 million to 33.8 million tonnes, equivalent to 30 percent of imports of those commodities. Affognon et al. (2015) have noted that lost quantities understate the severity of the food loss problem, because quality degradation reduces the value of food, potentially reducing farmers' incomes by more than the quantity losses.

FIGURE 7.1

Estimates of quantities of postharvest losses of cassava, maize, rice, and wheat in Sub-Saharan Africa, 2010–22



Source: Original figures for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).

Table 7.1 provides estimates from the literature of the perishability of the four commodities studied. The values—which range from a quarter to more than half of the value of commodities that could be lost because of spoilage—underscore the importance of storage to food security.

Given the seasonal patterns of rain-fed production prevalent across much of Africa, storage plays an important role in the functioning of food systems. Public grain stocks are most effective in the short term, especially for bridging the time needed to import food and targeting support to help ensure the most vulnerable people have food to eat in times of market shocks.

Sub-Saharan Africa has a limited ability to build and maintain cereal inventories, with many countries lacking basic elements of public storage infrastructure, such as silos and warehouses. Many developing countries, especially in

Sub-Saharan Africa, have set up strategic grain reserves that store food staples that can be managed to stabilize food prices and mitigate the impacts of food crises (refer to figure 7.2). Some researchers caution that strategic storage can be more costly than alternative policies, such as targeted transfers or subsidies, which directly offset high prices for specific groups of people.

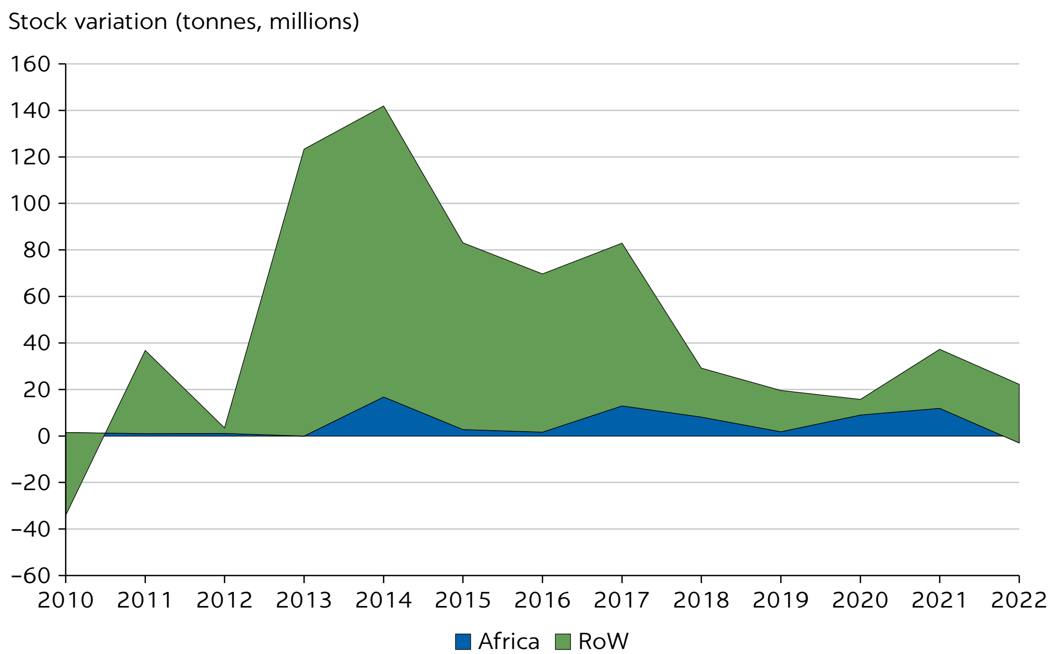
TABLE 7.1 Perishability and storage of cassava, maize, rice, and wheat in Sub-Saharan Africa

COMMODITY	PERISHABILITY	SPOILAGE	SOURCE
Cassava	If untreated, less than two days.	A total of 44 percent but can be ±28 percent	Affognon et al. 2015; Tomlins et al. 2021
Maize	Can be stored for up to two years depending on the quality of the storage.	Up to 27 percent weight loss in storage (postharvest loss, mean = 25 percent)	Affognon et al. 2015; Mvumi and Stathers 2020
Rice	Under good conditions, can be stored for more than one year (even up to 30 years).	In 2018, 48 percent postharvest loss of expected total production in Sub-Saharan Africa	Affognon et al. 2015; Ndindeng et al. 2021; Rice Knowledge Bank 2025.
Wheat	Can be stored for up to a year.	Up to 55 percent: 15 percent in the field, 13–20 percent during processing, and 15–25 percent during storage	Dessalegn et al. 2014; Manandhar, Milindi, and Shah 2018.

Source: Original table for this publication.

FIGURE 7.2

Cereal stocks in Sub-Saharan Africa and rest of world, 2010–22



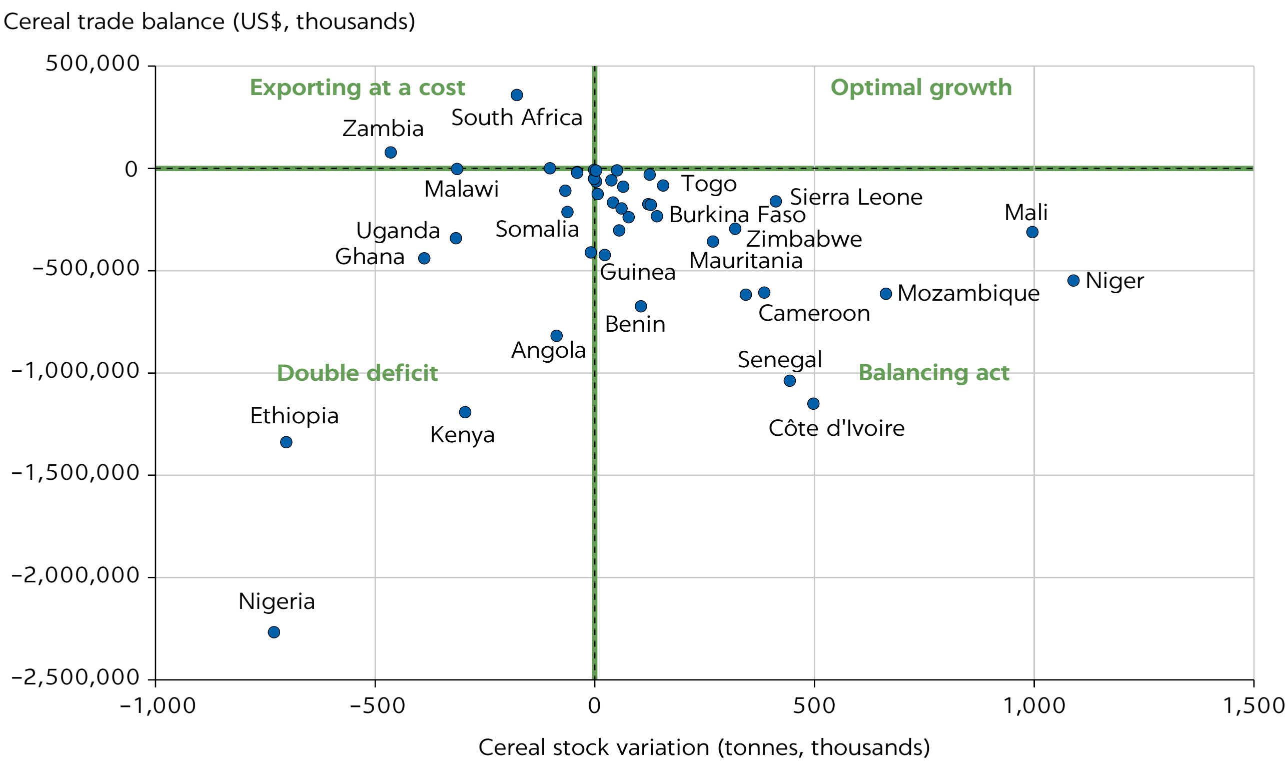
Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).
Note: RoW = rest of world.

Figure 7.3 shows the relationship between variation in cereal stocks and the cereal trade balance for various African countries in 2022. Countries can be distinguished in four ways on the basis of their balances and changes in cereal stocks:

- *Double deficit*. Some countries—including Ethiopia, Ghana, Kenya, Malawi, Nigeria, Uganda, and Zambia—experienced both a negative trade balance and a reduction in cereal stocks, indicating potential strain on food security. Ethiopia, Kenya, Malawi, and Nigeria are on the list of food insecurity hotspots; Zambia is not, but it still faces dual challenges that exacerbate food insecurity.
- *Balancing act*. Some countries—including Cameroon, Côte d'Ivoire, Mali, Niger, Senegal, and Sierra Leone—have negative trade balances but have increased their cereal stocks. A positive stock variation can help mitigate the impact of high imports on food security, underscoring the importance of effective stock management.

FIGURE 7.3

Typology of cereal trade balances and stock variations in Sub-Saharan Africa, 2022



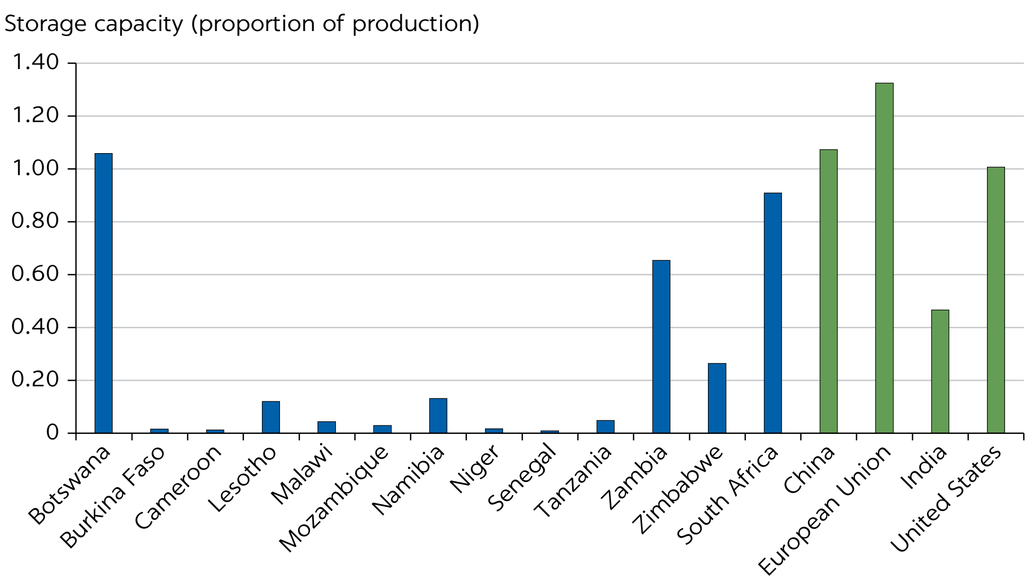
Source: Original figure for this publication, based on data from International Trade Centre, Trade Map (https://www.trademap.org/Index.aspx) and FAOSTAT (https://www.fao.org/faostat/en/#data).

- *Exporting at a cost*. South Africa is an outlier, with a positive trade balance but a reduction in cereal stocks. It has the largest storage capacity on the continent and an effective grain stock management program.
- *Optimal growth*. Mozambique increased its cereal stocks despite a negative trade balance, indicating effective stock management or increased production. This highlights the potential for growth and stability in the cereal market, even in the face of trade deficits.

Interest in storage facilities in Africa reflects the elevated vulnerability of the continent to droughts, other climate-related disasters, and armed conflict. The provision of relief supplies is often managed through strategic reserves (Ahmed, Abdelsalam, and Siddig 2012). However, the limited data available suggest that countries in Sub-Saharan Africa have very limited grain storage capacity. In higher-income regions, storage capacity tends to exceed annual production (refer to figure 7.4). In contrast, this report estimates that storage capacity for the 12 countries for which data could be compiled is equivalent to less than 20 percent of total annual food production and less than 50 percent of the volume of food imports (refer to figure 7.4) (Admin 2024; Agro-Marketing and Trade Agency n.d.; Business in Cameroon 2020; Chemonics International 2017; Club of Mozambique 2001; Lynton-Evans 1997; Inter-Réseaux Développement Rural 2011; Mhagama 2020; Raji 2022; Reidy 2023).

FIGURE 7.4

Estimated food storage capacity in selected regions and countries, 2022



Sources: Original figure for this publication, based on various sources, including International Trade Centre, Trade Map (https://www.trademap.org/Index.aspx) and FAOSTAT (https://www.fao.org/faostat/en/#data).

ETHIOPIA: A CASE STUDY ON NATIONAL STORAGE FOR FOOD SECURITY

Ethiopia's economy depends largely on agriculture, the source of livelihood for most of the population. On the basis of data from FAOSTAT in 2019, the country produced 31.6 million tonnes of cereal crops and imported about 1.5 million tonnes of various food products. Despite the volume of production and imports, Ethiopia struggles with food shortages. More than 21.4 million of the country's 127 million people needed humanitarian assistance in 2024 (Humanitarian Action 2024).

Institutions and objectives

Because of recurring food crises, Ethiopia has since the 1950s had policies for maintaining grain reserves (Mulugeta 2018; Rashid and Lemma 2011). Table 7.2 summarizes key institutions and objectives over time to maintain such reserves and respond to food emergencies. The first dedicated agency was the Emergency Food Security Reserve Administration (EFSRA), which was established in the aftermath of the 1973–74 famine to manage food reserves and address structural deficits, production shocks, and infrastructural bottlenecks. In 2013, the agency evolved into the Strategic Food Reserve Agency, focusing on better management of food reserves and strategic stockholding; more recently, some of its original functions were folded into the National Disaster Risk Management Commission (NDRMC).

TABLE 7.2 Evolution of food price stabilization and market-related organizations in Ethiopia

PERIOD AND INSTITUTION	OBJECTIVES
1950–1970s: EGMB	• Control prices • Manage export licensing for oilseeds and pulses and quality control • Supervise marketing intelligence • Regulate domestic and export purchases and sales
1973–74: RRC	• Manage emergencies
1974–76: AMC (EGMB became AMC)	• Manage all aspects of grain marketing • Procure grain for public distribution and price stabilization • Set wholesale prices • Buy and sell inputs • Set restrictions on private grain trade and interregional grain movement • Determine the days on which local markets are to be held • Ration grain to urban consumers • Manage the import and export of cereals, agricultural products, and marketing of inputs
1982: Food Security Unit or Emergency Food Security Reserve Administration under RRC	• Manage emergencies • Maintain adequate reserve to be used in case of disasters, structural deficits, production shocks, and infrastructural bottlenecks
1992: EGTE (AMC restructured as EGTE)	• Stabilize producer and consumer prices • Maintain buffer stock for market stabilization
1992: EFSRA (autonomous agency)	• Provide emergency loans to relief and rehabilitation agencies • Ensure smooth operation of relief agencies' efforts during temporary shortages

continued

TABLE 7.2 Evolution of food price stabilization and market-related organizations in Ethiopia, *continued*

PERIOD AND INSTITUTION	OBJECTIVES
1993: DPPC (RRC became DPPC)	• Coordinate food and nonfood emergency responses
2007: EFSRA (reforms introduced)	• Strengthen national preparedness to address food gaps in times of natural and manmade disasters on time
2013: SFRA (EFSRA became SFRA)	• Establish national preparedness capacity to address food gaps arising from disasters in a timely manner • Provide emergency loans to relief and rehabilitation agencies • Encourage grain production and protect farmers' income by providing them with a floor price in case of market failure • Distribute grain during periods of market volatility and high inflation to help consumers access food in local markets at affordable prices • Export grain to generate foreign currency
2015: Ethiopian Trading Businesses Corporation (amalgamation of the EGTE, Ethiopian Commercial Enterprise, Procurement Service Enterprise, and Ethiopian Vegetable and Fruits Share Company)	• Create market opportunities for farmers and commodity processors • Stabilize grain and commodities prices and protect consumers from unfair prices • Export grain, to generate foreign currency
2015: NDRMC (DPPC became NDRMC)	• Enhance the coordination of emergency preparedness • Strengthen government ownership of disaster prevention • Improve rapid response to disasters and emergencies
2018: SFRA mandate transferred to NDRMC	• To establish a comprehensive and coordinated disaster risk management system across the country, focusing on prevention, preparedness, response, and recovery measures through policy formulation, monitoring, coordination, and capacity-building efforts
2021: Warehouse Receipts System	• Enable individuals to store their goods, particularly standardized agricultural products, in warehouses and to borrow money upon delivery of the warehouse receipt as collateral • Establish a valid contract between the bailee (who receives goods) and the bailor (who delivers the goods) and properly direct and administer the system • To create an organized and efficient marketing system for agricultural products

Source: Original table for this publication.
Note: AMC = Agriculture Marketing Corporation; DPPC = Disaster Preparedness and Prevention Commission; EFSRA = Emergency Food Security Reserve Administration; EGMB = Ethiopian Grain Marketing Board; EGTE = Ethiopian Grain Trade Enterprise; NDRMC = National Disaster Risk Management Commission; RRC = Relief and Rehabilitation Commission; SFRA = Strategic Food Reserve Agency.

In its different forms, the NDRMC and its predecessors are the result of various reforms over time, starting in 1992, when EFSRA was established as an autonomous agency to provide emergency loans to relief and rehabilitation agencies. Initially, its objective was to maintain a rotating stock of cereals and facilitate the operations of relief agencies when responding to emergencies by making cereals available (Häberli 2013; Rashid and Lemma 2011). In 2004/05, for example, the stockpile was increased to an amount considered sufficient to serve at least 95 percent of the food-insecure population for a period of four months (Rashid, Dorosh, and Alemu 2018). The threshold was established to reduce delays in distribution when emergencies occur and provide adequate lead time for the government and nongovernmental organizations (NGOs) to import cereals to replenish the stockpile. In emergencies, NDRMC releases cereals on the basis of promissory notes from donors or the government ensuring replenishment within an agreed-on period. Upon donor confirmation, both NGOs (such as the World Food Programme) and governments borrow cereals for distribution, repaying them once the grain is secured from other sources. This process is designed to maintain consistent quantities and quality of food through regular rotation.

Storage infrastructure

There are three main layers to food storage infrastructure in Ethiopia, as is typical in many other countries in Africa—namely, household, community, and central government. The flow of commodities between these layers is described in box 7.1 for the case of wheat.

- *Household*. Most food produced in Ethiopia, as in many other low-income economies, is stored on farms. Storage facilities at this level are built using locally available resources, such as mud, wood, wheat straw, cow dung, and sometimes bricks. Generally, households in Ethiopia keep 65 percent of the grain they produce for home consumption and sell the rest in the market (Bachewe et al. 2018). However, the volume sold varies greatly by commodity and depends on the level of harvest, household wealth status, and expected market price.
- *Community*. Above the household level, communities or traders store produce in small warehouses of varying capacity. The facilities are made of corrugated iron, hollow blocks, small silos, bricks, or temporary shades (Gabriel and Hundie 2004). In some cases, millers also store produce.
- *Central government*. Most of the large stocks of produce are stored in government facilities. Vital agricultural commodities and staples, such as cereals, oilseeds, coffee, and other nonperishable agricultural products, as well as fertilizers, are stored in warehouses owned or operated by the public sector (World Bank 2017). The federal government in Ethiopia operates approximately 873 warehouses either through ownership or by leasing them from the private sector. These warehouses play a crucial role in the country's food security infrastructure, serving as vital hubs for storing essential food commodities, and overall in supporting the agricultural sector, providing essential infrastructure for preserving and managing agricultural commodities.

Box 7.1

Wheat value chain in Ethiopia

Smallholder farmers dominate the wheat farming landscape in Ethiopia, using traditional farming techniques to manage their plots. As of 2022, the total number of wheat farmers was estimated at 6–6.5 million, with the majority located in the Oromia and Amhara regions. Smallholder farmers are responsible for the entire cultivation process, including land preparation, sowing, crop health management, and harvesting. Although these farmers primarily drive wheat production, a small fraction of wheat is produced on large commercial farms, which account for 3–5 percent of total cultivated land.

The wheat value chain in Ethiopia begins, as with other grain crops, with the supply of essential inputs, such as seeds, fertilizer, pesticides, and agricultural equipment. Seeds are distributed by the government as well as by private companies and nongovernmental organizations. Generally, the distribution of seeds remains predominantly informal, with a significant portion of the seed trade occurring through farmer-to-farmer exchanges.

Village collectors often serve as the initial point of sale, purchasing wheat directly from farmers and aggregating small quantities into larger volumes suitable for wholesale markets. Wholesalers play a crucial role in the value chain by buying wheat in bulk from these collectors and, at times, directly from the farmers themselves. They then sell the wheat to processors and retailers or engage in exporting. Additionally, wholesalers are responsible for much of the wheat storage, providing a buffer against market fluctuations.

Wheat passes through multiple marketing channels that may involve direct sales from producers to consumers or more complex routes involving numerous intermediaries. Each channel adds certain values, whether through storage (time), transformation (form), or transportation (place), ultimately affecting the final product's cost and accessibility. The retailers, such as grocery stores, supermarkets, and local market stalls that purchase flour and other wheat-based products from processors or wholesalers, resell the flour to the public. Restaurants and bakeries also purchase wheat flour to produce bread, pasta, and other dishes for consumption and sell it as value-added product to the public.

Currently, Ethiopia has more than 600 small and large flour mills, with a total production capacity of between 3 million to 4.2 million tonnes of wheat flour a year. It is estimated that a third of these mills are in and around the country's capital, Addis Ababa. Millers access their wheat supply either through government distribution of the imported subsidized wheat, at much lower prices than prevailing open market rates, or the domestic market, which has a much higher price for the commodity. In addition to local production, the country also imports wheat in bulk to compensate for growing local consumption. In 2022, Ethiopia imported $1.07 billion in wheat from Argentina, India, Romania, Ukraine, and the United States, becoming the 21st largest importer of wheat in the world. The imported grain arrives mainly through the port of Djibouti, and, to a much lesser extent, and mainly wheat imported through the World Food Programme, through the port of Berbera, in Somaliland. All the imported grain is transferred to 50-kilogram bags at the port facilities and loaded manually onto trucks, a time-consuming and labor-intensive process. From the bagging area, the trucks then proceed to Ethiopia, usually directly to the warehouse the wheat has been assigned to. If a decision is made to transport the grain for import or export using the railway,

continued

Box 7.1 Wheat value chain in Ethiopia, *continued*

it needs to be bagged at the quayside, loaded onto a truck, and then loaded into the freight wagons.

In recent years, the government of Ethiopia has been working to increase wheat production and reduce imports. As a result of these efforts, the country started exporting wheat. In 2022, Ethiopia exported $279,000 worth of wheat to Israel, Morocco, the Netherlands, and the United States, making it one of 116 exporters of wheat in the world (OEC n.d.).

In addition to the warehouses managed by the federal government, Ethiopia also benefits from additional storage facilities owned or operated by NGOs. Notably, three main humanitarian organizations—the World Food Programme, the Catholic Relief Society, and the International Rescue Committee—play pivotal roles in emergency food distribution across the country. Combined, the warehouses operated by these organizations have a cumulative capacity of 978,880 metric tonnes, further expanding the country's food storage capacity.

Overall, Ethiopia has an estimated food storage capacity of 3,960,991.56 tonnes at the federal level, spread throughout the country (refer to table 7.3). However, the purpose of the warehouses operated by the government and those by humanitarian organizations varies greatly. On the one hand, the government organizations store cereals primarily to stabilize the local market and conduct integrated business activities as well as to ensure accountability and efficiency in the grain market. On the other hand, the humanitarian organizations and the NDRMC use warehouses to store cereals specifically for emergency food assistance security. This strategic allocation of resources allows for efficient management and distribution of food supplies during times of crisis.

Map 7.1 shows the locations of storage facilities in Ethiopia relative to the transport network, specifically roads. Three-quarters of the storage facilities are situated within 5 kilometers of the nearest trunk road. In fact, road transport is the dominant mode of transport for both passengers and freight. It accounts for more than 95 percent of total domestic passenger and cargo traffic, despite the country's limited road network, small transport vehicle fleet, and low coverage of road transport services. However, road transport is also quite costly and often does not have adequate capacity, especially when the demand for commodity shipments is high.

TABLE 7.3 Subnational food storage capacity operated by the Ethiopian government, 2024

	FEDERALLY OPERATED STORAGE CAPACITY (TONNES)						
REGION	ETBC	ECX	EABC	NDRMC	EDR	TOTAL GOVERNMENT	TOTAL NGO
Addis Ababa	170,500	300,000	12,000	—	—	482,500	11,766
Afar	—	—	—	—	—	—	33,000
Amhara	187,200	59,397	34,600	120,000	—	401,197	101,590
Benishangul-Gumuz	—	35,965	—	—	—	35,965	11,262
Dire Dawa	50,500	58,000	—	25,000	8,000	141,500	170,074
Gambela	—	—	—	—	—	—	9,300
Oromia	448,400	863,370	34,500	135,000	29,590	1,510,860	348,711
SNNP	—	277,500	—	40,000	—	317,500	74,662
Somali	—	—	—	40,000	2,590	42,590	73,696
Tigray	—	10,000	—	40,000	—	50,000	144,819
Total	856,600	1,604,231	81,100	400,000	40,180	2,982,111	978,880

Sources: Original table for this publication, based on data from the Government of Ethiopia, Ethiopia Logistics Master Plan diagnostic survey, 2024 (unpublished), and Ethiopian Storage assessment data from Logistics Cluster, Logistics Capacity Assessment tool (https://dlca.logcluster.org/ethiopia).
Note: — = no recorded capacity; EABC = Ethiopian Agricultural Businesses Corporation; ECX = Ethiopia Commodity Exchange; EDR = Ethiopia Djibouti Railway; ETBC = Ethiopia Trade Business Corporation; NDRMC = National Disaster Risk Management Commission; NGO = nongovernmental organization; SNNP = Southern Nations, Nationalities, and Peoples Region.

Rail transport is available on the main Ethiopia-Djibouti corridor and has some associated storage facilities for cereals, but it is not extensively used for grain shipments, except in exceptional circumstances. This is despite the railway operator having its own grain storage infrastructure in Ethiopia, albeit of limited capacity.

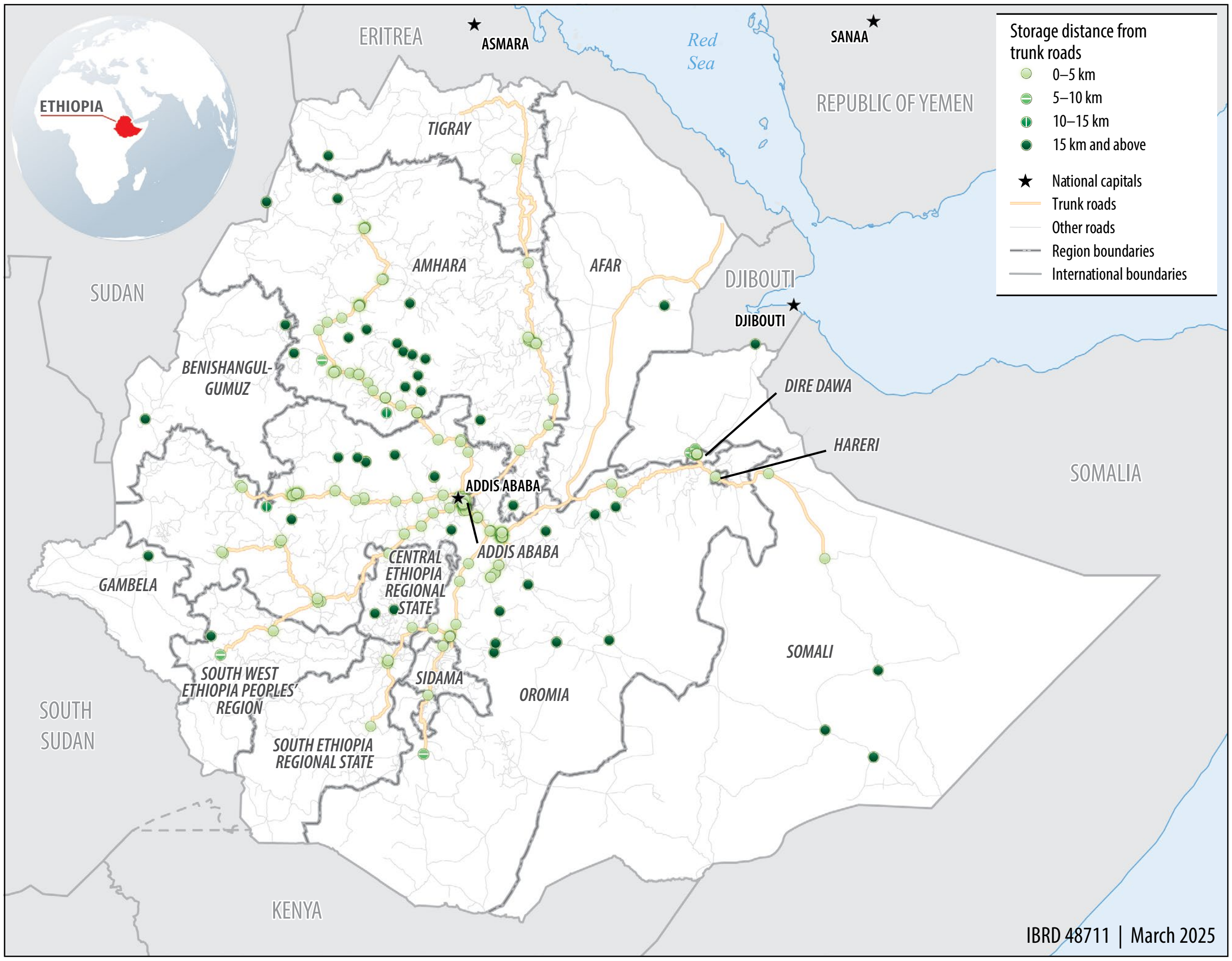
REGIONAL APPROACH TO ENHANCING FOOD STORAGE IN WEST AFRICA

Ethiopia is an example of a country that adopted a national approach to maintaining strategic grain reserves. Some groups of countries have also considered regional solutions. One of the prominent examples is the Association of Southeast Asian Nations (ASEAN), which in 1979 established the Rice Reserve System by partnering with China, Japan, and the Republic of Korea to form the ASEAN Plus Three Emergency Rice Reserve, which aims to help member countries overcome food shortages after natural and humanitarian crises. The system has been underused and criticized for a lack of effective activation mechanisms.

A regional approach to maintaining strategic reserves of food has been part of the agricultural policy of the Economic Community of West African States (ECOWAS) since 2012. The initiative was in response to the region's structural

MAP 7.1

Food storage locations and distance from trunk roads, Ethiopia, 2024



Source: Original figure for this publication, based on data from various sources.

food and nutritional insecurity, which had been exacerbated by cyclical shocks, such as climatic variability, locust attacks, and socioeconomic changes (World Bank and FAO 2021). The operationalization of the regional system began in 2015 with the support of the G-20, the European Union, and technical partners, including the Agence Française de Développement and the Spanish Agency for International Development Cooperation.

The primary objectives of ECOWAS's food reserve system are twofold: first, to cope with shocks and, second, to support the structuring of agricultural value chains and the regulation of food markets. It is a layered approach conceived of as lines of defense, starting at the local level at the bottom of the pyramid and narrowing to international assistance through central governments, when needed (refer to figure 7.5).

FIGURE 7.5

Lines of defense in ECOWAS's food reserve system

Source: Original figure for this publication, based on World Bank and FAO 2021.
Note: Defense starts at the local level and involves cascading layers of government, depending on the geographic scope of the required response. ECOWAS = Economic Community of West African States; RFSR = Regional Food Security Reserve; UN = United Nations.

MANAGEMENT OF THE RESERVE

Stocks held by the participating ECOWAS countries are an important component of the regional food reserve system, serving as the second line of defense. The countries have storage policies, governance schemes, types of intervention instruments, and the level of sovereignty over stock operations, all of which were considered when defining the size of the regional reserve. Some countries have well-developed and stabilized storage instruments, but others are still in the process of developing their national storage policies. The governance of these stocks varies, with some countries having physical stocks, financial reserves, or a combination of both.

One of the key commitments within the regional storage strategy is the pooling of 5 percent of national stocks to meet the needs of countries facing food crises. This pooling can be done in three ways:

- Contribution of 5 percent of the national physical food security reserve, the national financial food security reserve, or both

- Voluntary mobilization of national food security stocks and financial assistance to other countries in case of a food crisis
- A combination of the above two options.

The RFSR serves as the third line of defense. It aims to respond effectively to food crises in the region and has three specific objectives:

- Complementing the efforts of member states to provide rapid and diversified food and nutritional assistance
- Expressing regional solidarity with affected member states and populations through transparent, equitable, and predictable mechanisms
- Contributing to food sovereignty and the political, economic, and trade integration of West Africa.

The RFSR is composed of two instruments: a physical stock and a financial reserve. The physical stock is stored in subareas of countries grouped according to diets, main production basins, and the intensity of food risk.

The RFSR is triggered in response to a food crisis based on a request from an ECOWAS member country. The request must include information on the food and nutrition situation, assistance needs, national stock status, and the modalities of replenishment. The Reserve Management Committee then decides on the mobilization of the RFSR based on specific trigger criteria.

Since its inception, the ECOWAS regional grain reserve initiative has significantly increased the storage capacity for grains in the region, enabling ECOWAS to maintain a buffer stock of grains that can be quickly mobilized during emergencies. This has been crucial in improving food security, because the grain reserves have been used during food shortages to provide emergency food supplies to affected populations, thereby preventing hunger and malnutrition. Additionally, by releasing grains from the reserves during periods of high food prices, ECOWAS has stabilized food prices in the region, helping to protect vulnerable populations from the adverse effects of food price volatility. The initiative has also strengthened the capacity of national and regional institutions to manage and operate grain reserves, improving the overall efficiency and effectiveness of the grain reserve system.

However, despite these achievements, the ECOWAS regional grain reserve initiative faces several challenges, including secure sustainable funding for the operation and the considerable costs of maintenance of the grain reserves. The transportation and distribution of grains across the region can be difficult because of poor infrastructure and the logistical constraints of transferring grains between countries, potentially delaying the delivery of emergency food supplies to affected populations. Also climate-related shocks disrupt agricultural production and increase demand for emergency food supplies. Political instability and weak institutions in some member countries impede the implementation of the initiative.

SUMMARY

This chapter makes a case for food storage as an element of supply chain infrastructure and management. Investing in food storage infrastructure in Africa is essential to reduce food losses, manage supply chain complexities, and mitigate price and supply volatility. Although there are challenges associated with food storage, the experiences of Ethiopia and ECOWAS highlight viable options for improving food security across the continent.

- First, food losses in Africa are alarmingly high, primarily because of inadequate storage infrastructure and poor food handling practices. Proper storage facilities can significantly reduce these losses, ensuring that more food reaches consumers and less is wasted.
- Second, Africa's food supply chains are notably long, with extended lead times from production to consumption. This necessitates maintaining a minimum amount of stock in storage to buffer against delays and ensure a steady supply of food. Without adequate storage, any disruption in the supply chain can lead to severe shortages, exacerbating food insecurity.
- Third, price and supply volatility further underscore the need for robust food storage systems. Fluctuations in food prices and supply can be mitigated by having reserves in storage, providing a buffer that stabilizes markets and ensures consistent availability of food products. This is crucial for both consumers and producers because it helps maintain economic stability and predictability.

However, storing food is not without its complexities and risks. Effective food storage requires careful management to prevent spoilage, pest infestations, and other issues that can compromise food quality and safety. This necessitates investment in modern storage technologies and training for those involved in food handling and storage. Also, it costs money to keep stocks, with associated financial risks.

NOTE

1. Recent World Bank projects supporting grain storage facilities include the Bangladesh Modern Food Storage Facilities Project (P120583), which aims to increase grain reserves and improve storage efficiency by constructing modern silos and distributing household silos to vulnerable groups, and the Mexico Grain Storage and Information for Agricultural Competitiveness Project (P160570), which invested in grain storage infrastructure, including the upgrading of existing facilities and the building of new ones, and supported capacity building and training for operators.

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8 Diagnosis of and Recommendations for Improving Transport for Food

ABSTRACT

This chapter distills the main insights from the analysis from this report and proposes measures to strengthen the resilience of food systems through transport interventions.

KEY FINDINGS AND MESSAGES

- Africa's agricultural supply chains are long and inefficient, increasing food prices and reducing access. Locally grown crops, including maize and cassava, face high transport costs, while imported items, among them rice and wheat, suffer from weak infrastructure and fragmented markets. Improving rural road networks and transport systems can enhance food distribution and reduce these inefficiencies.
- Food takes too long to reach markets, especially in deficit regions. Long lead times raise costs, increase spoilage, and reduce food insecurity. Enhancing transport infrastructure and local storage capacities could shorten delays, enabling faster food delivery during crises or shortages.
- Significant amounts of food—as much as 40 percent of perishables and 25 percent of cereals—are lost because of poor handling and storage and weak logistics. Investments in modern storage and better transport infrastructure are crucial to reduce waste, improve food quality, and ensure affordable food access.
- Intra-African trade faces high transport costs and nontariff barriers (NTBs), making it more expensive to trade within the continent than with global markets. Improved regional transport corridors and streamlined regulations would reduce these costs, promote regional trade, and strengthen Africa's food security.

- Africa's transport networks are vulnerable to climate disruptions. Building climate-resilient infrastructure and alternative routes is essential to protect food flows during extreme weather events.
- There is no one-size-fits-all solution. Interventions must be based on what and how countries produce and trade and the specifics of their transport networks. In some cases, strengthening rural roads and national transport networks will improve market access, reduce postharvest losses, and enhance food security, particularly in remote areas; in other instances, more attention needs to be paid to seaports and international and regional connectivity.

TRANSPORT'S ROLE IN FOOD SECURITY AND RESILIENCE

Transport is an integral element of each stage of the food supply chain. Its importance is often most apparent when there are disruptions to the food system, as happened during the coronavirus disease 2019 pandemic (COVID-19), in the immediate aftermath of the Russian Federation's invasion of Ukraine in 2022, and during the prolonged drought in the Horn of Africa.

Poor transport systems can lead to higher food prices and limit the ability of vulnerable populations to access nutritious food. The efficiency of transport also affects the time in transit and the environment in which food is transported, which affect food quality and safety. Transport and trade are two of the levers governments use to maintain the stability of food systems. Transport systems contribute to stability and resilience by facilitating the timely distribution of food during periods of scarcity or disruption, such as after natural disasters or during seasonal shortages.

This chapter distills the main findings of the role of transport in enhancing food security and identifies opportunities for a new generation of food-security-sensitive operations in some of the most vulnerable countries and in countries that can play a greater role in supplying global markets and affecting each of the segments of the supply chain at the local, national, regional, and international scales. It starts with the importance of properly diagnosing current or potential food flows.

MAIN VULNERABILITIES THREATENING FOOD SECURITY

When designing transport interventions to enhance food security, it is crucial to begin with a proper commodity-sensitive diagnostic. This step ensures that the interventions are tailored to the needs and characteristics of the commodities that need to be transported.

Different food commodities have different logistical requirements, based on their flow patterns. Staple cereals, such as rice and maize, need dry, well-ventilated storage and transport conditions to avoid moisture and pest infestation; fresh produce requires cold chains and speed. A commodity-sensitive diagnostic helps identify these needs, allowing for the design of transport systems that cater to the unique requirements of each type of food. This targeted approach minimizes losses and ensures that food reaches its destination in optimal condition, with minimal loss of quantity or quality.

Understanding the supply chain dynamics of different commodities is essential for identifying critical bottlenecks and inefficiencies. A diagnostic that considers the entire supply chain—from production and processing to distribution and retail—can pinpoint where delays, high costs, or losses occur. This comprehensive understanding enables the design of interventions that address specific issues, improving the efficiency and reliability of the food supply chain. It also contributes to developing and strengthening sustainable and resilient food trade, transport, and logistics systems in general.

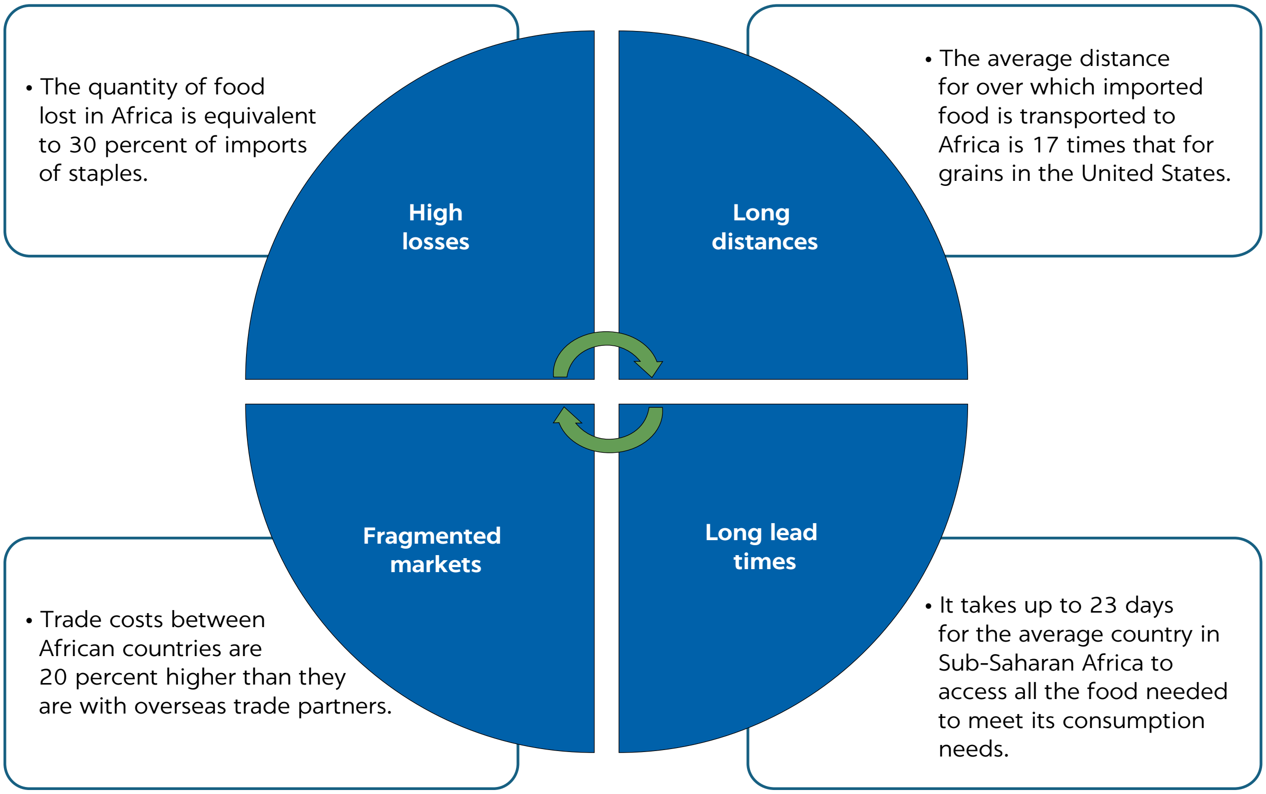
A commodity-sensitive diagnostic can reveal the socioeconomic and environmental impacts of transport interventions. Different commodities have varying levels of importance to local economies and communities. For example, improving the transport of staple foods can directly affect food security and livelihoods in both rural and urban areas, whereas enhancing the logistics of export-oriented crops can boost national economies.

The environmental footprint of transporting different commodities also varies on the basis of distance, transport mode, and perishability. Wheat and rice, which for Africa are primarily imported via long maritime routes, have higher carbon footprints; maize, although locally grown, suffers from inefficient road transport, contributing to emissions. Cassava, grown and consumed locally, has a lower transport footprint but faces challenges because of its perishability and a reliance on small, inefficient vehicles. To reduce impacts, such solutions as improving infrastructure, boosting local production, and adopting sustainable transport technologies are essential.

The detailed modeling of food flows in Sub-Saharan Africa provides five insights that are important for a new generation of food-security-sensitive transport interventions. Four of them are reflected in figure 8.1. The fifth insight, on vulnerabilities, is specific to the transport sector and reflects aspects of the other four.

FIGURE 8.1

Summary of findings on transport and food security in Sub-Saharan Africa



Source: Original figure for this publication.

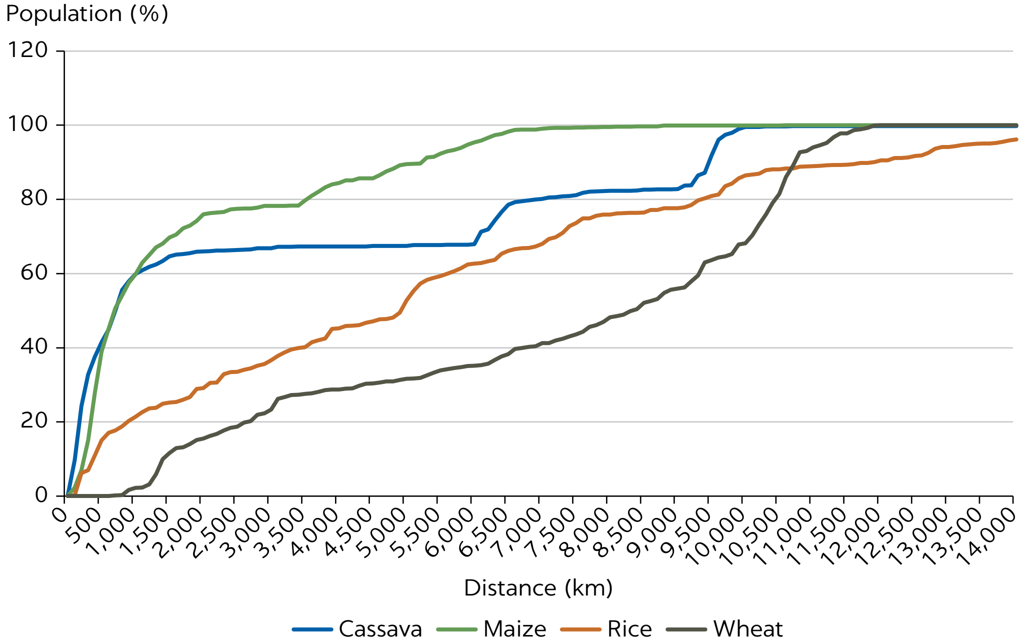
Long distances of agricultural commodity supply chains

Supply chains in Africa are long and fragmented (refer to figure 8.2). It takes up to 10,000 and 12,000 kilometers to access 100 percent of the rice and wheat, respectively, needed to meet demand in Africa. Besides long distances, costs of accessing food are increased by inadequate infrastructure, weak market integration, informal services, weak institutions and regulations, limited sources of capital, low levels of technology, high costs, and climate and political risks.

By mapping commodity supply chains, it is possible to identify specific points of weakness as well as opportunities to strengthen supply chains. For instance, many rural areas in Africa have inadequate road infrastructure, making transporting goods to urban markets difficult. In addition, some regions face the risk of disruption of transport links because of climate change or political unrest. In such cases, more robust transport and storage solutions can ensure stability of food systems. Understanding such vulnerabilities allows for better targeting of interventions.

FIGURE 8.2

Population and transport distances in Sub-Saharan Africa, 2023



Source: Original figure for this publication, based on model outputs.
Note: Figure shows cumulative population.

Understanding the topology of commodity supply chains can help identify opportunities for value addition and economic development. By understanding the flow of goods, stakeholders can pinpoint where investments in processing facilities or market infrastructure could create jobs and increase incomes for local communities.

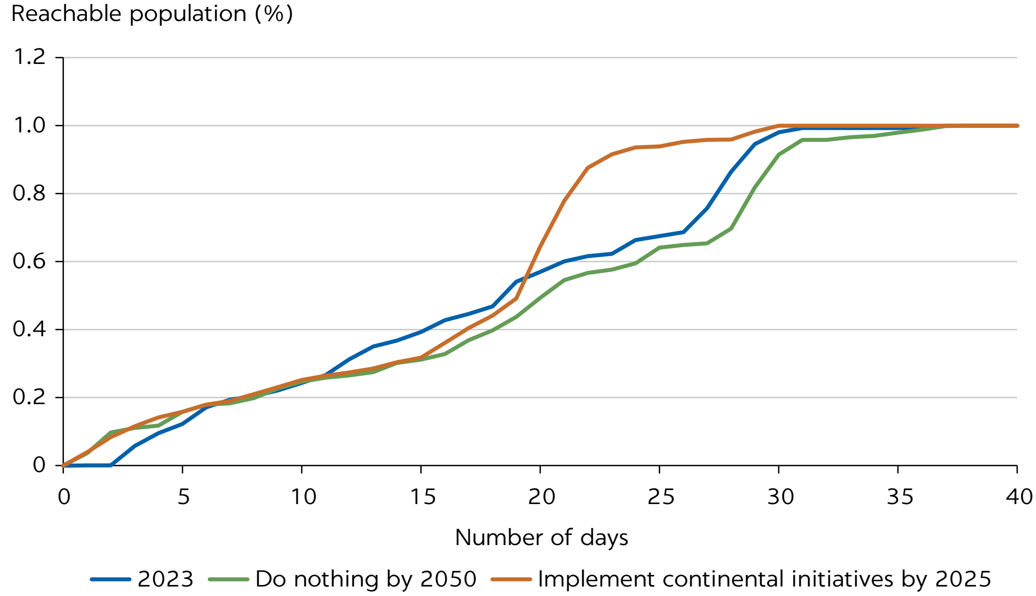
Long lead times for food shipments

Shipping food in Africa takes a long time. In many places with food deficits, it takes at least five days for more than 80 percent of food to arrive from its source. Long lead times require advance planning or the maintenance of adequate inventories in local storage facilities. Short of that, communities suffer food deprivation. Without proper storage, food insecurity becomes an urgent logistics operation, often at much higher costs. If the various initiatives to improve transport infrastructure in Africa are implemented, the model outputs suggest that there would be a marked reduction in time needed to transport commodities such as wheat, which are largely imported from outside the continent (refer to figure 8.3). The proportion of people with access to wheat within 25 days would increase from 60 percent in 2023 to approximately 95 percent by 2050.

Supply chains are also highly unreliable. Several factors contribute to delays, including inadequate infrastructure, inefficient logistics, and

FIGURE 8.3

Impact of African continental initiatives on wheat delivery



Source: Original figure for this publication, based on model outputs.
Note: Figure shows cumulative population.

regulatory hurdles. Road networks are poor, with many rural areas lacking paved roads, making transportation slow and difficult, especially during the rainy season, when roads can become impassable.

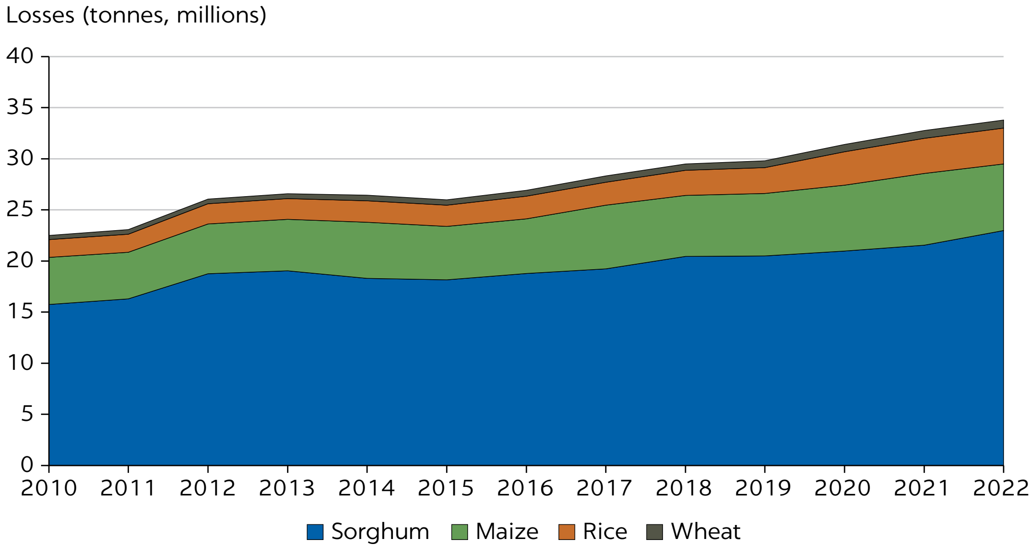
High food losses

Long distances and transport times contribute to the high incidence of food loss and waste in Sub-Saharan Africa. About 20 percent of all cereals and, more specifically, 25 percent of rice and maize and as much as 40 percent of perishable crops are lost postharvest (refer to figure 8.4) These losses are primarily attributable to inadequate storage, poor handling practices, and pest infestations. Food loss contributes to food insecurity by reducing the availability of food, increasing prices, and making basic staples unaffordable for low-income households. Storage is crucial in mitigating postharvest losses and ensuring a steady supply of food throughout the year.

Outside urban areas, demand for food is spread over very large areas across much of Sub-Saharan Africa, eliminating opportunities for economies of scale that are important for moving low-value, high-volume commodities. As a result, trucks often travel empty or partly loaded, reducing efficiency and increasing costs. Central locations could be used to consolidate commodities into larger volumes that can be handled and transported at scale and with lower unit costs.

FIGURE 8.4

Cereal food loss in Sub-Saharan Africa, 2010–22



Source: Original figure for this publication, based on data from FAOSTAT (https://www.fao.org/faostat/en/#data).

Highly fragmented agricultural markets

As shown in chapter 5, the costs of trade in agricultural products between African countries are much higher than between African countries and external partners. High costs lead to a fragmentation of agricultural markets, with many African countries better integrated with overseas trading partners than with other countries on the continent. The low level of intra-Africa trade reflects both historical trade links with colonial powers and the lack of reliability of potential continental trade partners, many of which have fluctuating production volumes. High trade costs in agricultural product also explain the low trade intensity of food. Using a cross-country analysis, Xu (2015) shows that agricultural trade costs are at least twice as large as manufacturing trade costs.

Transport costs per tonne range widely in Sub-Saharan Africa, averaging $23 for maize, $21 for cassava, $48 for rice, and $59 for wheat. Considering the distance over which commodities are shipped, transport costs for intra-Africa trade are 8–25 percent higher than the costs of intercontinental trade.

These high costs reflect several factors, including high transport prices, regulatory barriers, and the use of restrictive policies and procedures, especially at the border. Transport prices are high because of poor infrastructure, high vehicle operating costs (fuel, tires, maintenance), and limited competition in transport services markets in some countries, especially in rural areas. The fact that many operators are informal and offer poor-quality, unreliable services also raises costs.

Increased use of rail facilities could significantly reduce transport costs. Many railway facilities in Sub-Saharan Africa are underused. Although tracks and associated trackside infrastructure are in place, locomotives and rolling stock needed for a viable rail service are often unavailable because of mismanagement and a lack of investment by the mostly state-owned and -operated rail entities. Because of the poor state of rail transport, local and international freight in Sub-Saharan Africa goes by road when rail would be a cheaper and more applicable option.

Several countries—including the Republic of Congo, Democratic Republic of Congo, Equatorial Guinea, Mauritania, Somalia, and Zambia—have very high food transport costs. One of the major cost drivers is the high cost of crossing borders because of procedures that can be time-consuming and inconsistent, leading to unpredictable crossing times and complicating the movement of agricultural commodities. NTBs are common for agricultural products in Africa. Their prevalence—and that of nontariff trade measures, some of which have legitimate purposes—suppress trade between countries in Sub-Saharan Africa. If the impact of NTBs were halved, the costs of intra-Africa trade could be comparable with those of intercontinental trade for the two imported crop types (rice and wheat).

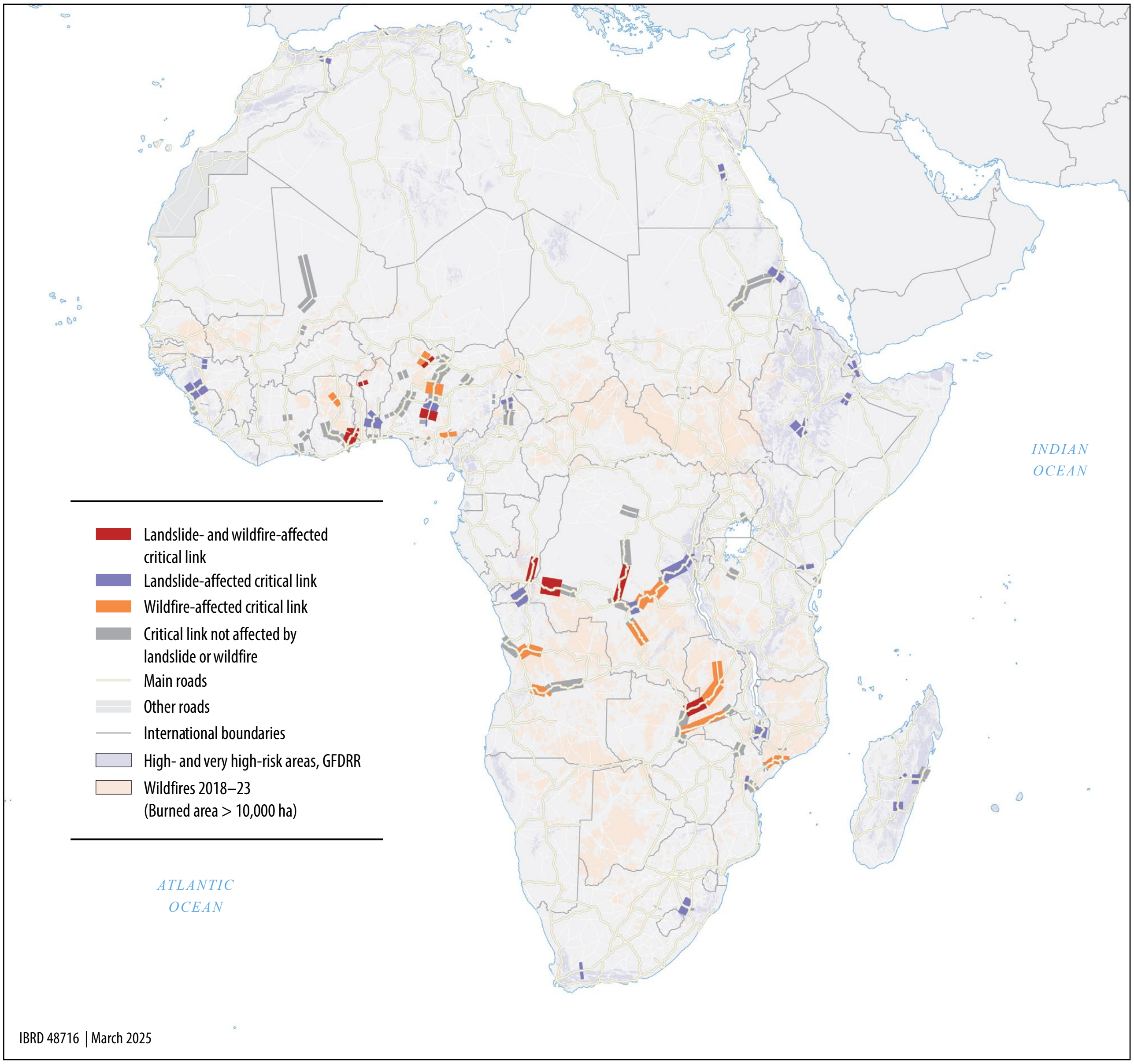
Vulnerability of critical transport links to climate change

The lack of resilient storage and transport infrastructure can exacerbate food insecurity, given the vulnerability of agricultural supply chains to climate shocks. A 2022 study by the International Monetary Fund shows that the vulnerability of food production, quality, and distribution to climate change in Sub-Saharan Africa reflects a lack of agricultural resilience (Salgado Baptista et al. 2022). Reliance on rain-fed crop production prevails across Sub-Saharan Africa. In addition, the poor storage capacity of households and warehouses results in significant food loss. The continent's roads, bridges, train tracks, and ports are easily damaged or destroyed by severe weather conditions. Reliance on imported food is vulnerable to weather events in other parts of the world.

Many elements of the transport system, including road links, border crossing points, and ports, are vulnerable to climate change (refer to map 8.1). In the event of a disruption, the availability of alternative routes to facilities is key. Detour costs in several countries would be very high. The Democratic Republic of Congo and Nigeria are the most vulnerable in terms of absolute detour costs; the Democratic Republic of Congo, Djibouti, Equatorial Guinea, Guinea-Bissau, Mali, South Sudan, and Zambia are the most vulnerable on a population-adjusted basis. The Republic of Congo and Somalia have high transport cost burdens and poor local access to surplus production; the Democratic Republic of Congo and Equatorial Guinea face high costs in the event of climate-related network disruption.

MAP 8.1

Exposure to natural risks among road links that are critical for food flows in Sub-Saharan Africa, 2022



Sources: Original map for this publication, based on model outputs and data from the World Bank Global Facility for Disaster Reduction and Recovery (https://www.gfdrr.org/en) and Global Wildfire Information System (https://gwis.jrc.ec.europa.eu/).
Note: Line widths denote total annual calorie flow of food on a link. GFDRR = Global Facility for Disaster Reduction and Recovery, a multidonor partnership that supports low- and middle-income countries to understand, manage, and reduce their risks from natural hazards and climate change.

Disruptions to transport networks can severely affect food security, particularly in countries with high detour costs and those heavily reliant on specific links. These findings are relevant to the prioritization of transport network elements and how different countries should invest in strengthening their transport infrastructure and improving network resilience. Options include diversifying transport routes, improving road maintenance, and enhancing border crossing efficiency. Collaboration by neighboring countries is also crucial for addressing shared vulnerabilities. Joint investments in critical links can benefit partner countries and improve regional food security.

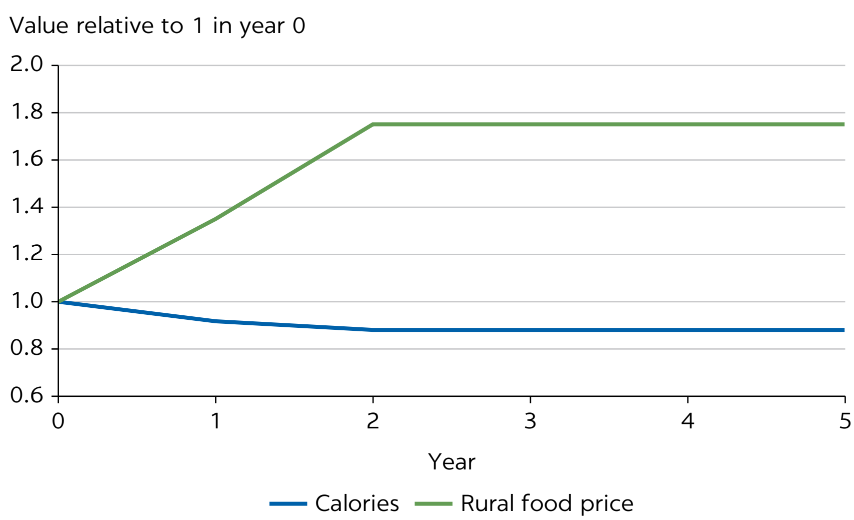
Reducing transport costs and tariffs can help countries recover from shocks to the food system. Figure 8.5 illustrates the impacts of climate shocks on food consumption and prices over time. The trends show that all other factors being constant, a climate shock will reduce caloric intake while prices will increase. Under such circumstances, lower transport costs support a slightly faster rebound from climate shocks than reductions in tariffs (Salgado Baptista et al. 2022). Efficient transportation networks facilitate the delivery of emergency supplies, support the rebuilding of affected areas, and maintain economic stability by reducing delays and losses. Investing in strategic transport elements is, therefore, an important preparedness measure that countries should pursue.

RECOMMENDATIONS

Optimizing the role of transport in strengthening food systems requires strategic interventions across various segments of the commodity supply chain. These interventions can be categorized into four areas: international connectivity, regional integration, domestic network connectivity, and access to local markets. Each scale offers distinct opportunities and challenges, necessitating a comprehensive and multiscalar approach to ensure effective and sustainable outcomes.

FIGURE 8.5

Impact of climate shock on rural food consumption and food prices in Sub-Saharan Africa



Source: Adapted from Salgado Baptista et al. 2022.

Fostering international network connectivity

Many African countries rely heavily on imports to meet their food needs. At both the international and the regional scales, improving transport infrastructure and logistics is crucial for facilitating cross-border trade and regional integration.

Seaports are critical nodes in African countries' food systems. A small number of ports account for a significant percentage of Sub-Saharan Africa's food imports. Many ports in Africa lack the infrastructure needed to efficiently load and unload agricultural commodities. As a result, ships lie idle at anchor awaiting services, incurring substantial demurrage charges.

Some ports have poor connectivity because they are not always on frequent itineraries. In addition, port operations are often hampered by elaborate customs and other border procedures, which contribute to delays, additional storage costs, and transport costs, all of which raise food prices.

The concentration of food imports at a few ports, as identified in chapter 4, leaves some countries and regions particularly vulnerable to disruptions in their international connections. Small size, sparse populations, and long distances to source markets make these countries particularly susceptible to natural hazards, such as cyclones and flooding. Damage to transport assets, particularly ports, connecting roads, railway lines, and bridges, can cut off critical supplies.

Specific actions are recommended to enhance the international connectivity of African countries:

- *Identify the causes of shipping delays at specific gateway ports.* These causes may include the lack of docking facilities, inadequate cargo handling and storage facilities, inability to manage adverse weather conditions, and degradation of the port marine environment (e.g., through siltation and erosion). The analysis should be used to inform improvements in physical port facilities, including handling equipment and systems.
- *Assess the criticality of ports in Africa and those of overseas trading partners.* The resilience of supply chain relationships and infrastructure is particularly important for food security, especially in the face of large-scale disasters. Natural disasters can cause extensive damage to transport infrastructure, leading to lengthy periods during which a port, terminal, or wharf is offline for handling critical food consignments. Countries should prepare for such an eventuality by identifying alternative ports and making plans for using them in case of an emergency (Akakura and Ono 2014; Osawa et al. 2018).

- *Increase the role of the private sector in building, operating, and maintaining infrastructural facilities.* Private sector entities manage ports and physical infrastructure in many parts of the world. Such opportunities should be exploited more in Africa through well-designed public-private partnerships. Care must be taken to ensure that private operators are not provided with monopoly powers. Sound regulatory oversight by government authorities is essential to balance efficiency with public interest.
- *Improve packaging.* Lack of storage infrastructure and handling equipment requires the bagging of food for transportation by trucks. Most cereal products are packaged in individual 50-kilogram sacks, using technology that is outdated and requires additional labor to load and unload vehicles. With modern methods of packaging—for example, by using augers and conveyers—ports would become more efficient and help to reduce costs.

Increasing regional integration

Cross-border trade faces several challenges, including weak and complex regulatory frameworks, high transaction costs, and infrastructure deficits. Although the costs of trade in agricultural commodities tend to be higher than those for other commodities (Xu 2015), they are particularly high between African countries. Improving trade facilitation measures—by, for example, reducing documentation requirements and border delays—can significantly enhance the efficiency of cross-border trade. Better regulatory practices can help streamline administrative processes, supporting the flows of food.

Three intervention points could enhance the efficiency of food flows within Africa. The first entry point is soft infrastructure, especially trade facilitation and border management. Initiatives such as the African Continental Free Trade Area are major pillars for the harmonization, if not standardization, of requirements and procedures that can promote smoother and more efficient trade flows. Harmonizing transport policies and regulations across countries would streamline customs procedures and reduce delays at borders. Working through regional economic communities could facilitate coordinated efforts to improve transport infrastructure and logistics. Joint investments and shared resources can lead to more robust and resilient cross-border transport networks.

The second entry point is developing and upgrading regional corridors critical for food flows. Developing cross-border transport infrastructure, such as roads, railways, and in some cases inland waterways, is important. Such connectivity improvements help reduce transport and transaction costs, making it easier and less expensive to move food from areas of surplus to areas of need. Some corridor improvements have already been made, including the link between northern Mozambique and Malawi and the link between northern Kenya and southern Ethiopia.

Trade along corridors is generated by cities and towns connected by these corridors. Building infrastructure for consolidating and distributing food through hubs in these economic centers could help improve food security. With proper design and provision of support services, it is possible to increase trade and reduce frictions that are often faced because of low scale and high unit costs.

A third entry point is increasing cross-border trade in agricultural commodities. The approach to regional integration should include designated trade corridors as well as links through smaller border crossing points that facilitate exchanges between border communities.

Strengthening domestic connectivity

Three sets of actions could strengthen food supply chains at the national scale.

Improving network planning

A comprehensive approach to strengthening local transport connectivity involves identifying vulnerable points in the transport network. Prioritizing routes with fewer vulnerabilities and strengthening critical links for disaster prevention can maintain connectivity and support food security. Incorporating disaster risk management in infrastructure projects and contingency planning is crucial, especially in regions prone to natural hazards. For instance, Colon, Hallegatte, and Rozenberg (2019) find that network-wide perspectives can help identify how disasters can affect populations that may not be directly impacted by an event. As such, community engagement and participation in planning and implementing recovery projects are essential for enhancing resilience and ensuring that infrastructure meets local needs.

Improving transport infrastructure and services that connect major agricultural production areas with markets can reduce costs and postharvest losses and improve market access for farmers. Assessments of the criticality of road and rail links based on their importance for trade, services, emergency functions, and food supply chains can be used to prioritize investments. Using multicriteria analysis to assess the impact of infrastructure segments on the economy and society can identify the most critical and vulnerable segments requiring immediate attention.

Leveraging storage

Some disruptions can have short-lived effects; others can have enduring impacts. The prioritization of logistics needs to reflect how long a food system can cope if certain components are not available and maintain the minimum level of inventory needed.

Resilience in agrifood systems is defined as the capacity to sustainably ensure food availability and access and maintain livelihoods in the face of disruptions. Because transport and logistics are crucial components of the food system, their resilience and ability to adapt to various risks are essential for maintaining continuous food flows and the overall resilience and sustainability of food systems.

The Ethiopia case study in chapter 7 shows the importance of national policies that support storage as part of a logistics solution for agriculture and food security. Establishing dedicated institutions or agencies to oversee logistics and storage can ensure sustained focus and investment in this often-neglected element of food systems. Public-private partnerships can mobilize resources and expertise to scale transport and storage, enhancing the resilience and efficiency of food supply chains.

Efficient logistics and supply chain management practices can optimize the movement of food commodities within the country. The use of technology for tracking and inventory management can enhance the efficiency of food distribution networks.

Improving transport services

The limited availability and weak performance of transport services are a major vulnerability of agriculture supply chains in Sub-Saharan Africa. The region faces unique challenges, including vast geographical distances.

One of the primary benefits of robust transport services is the reduction of postharvest losses. Poor road conditions, limited rail networks, and insufficient storage facilities contribute to these losses. Better transport services, including roads, railways, and ports, would ensure that more food reaches consumers and that farmers can access larger markets, increasing their income and incentivizing higher production levels.

Transport services are also vital for responding to food emergencies and ensuring food security during crises. During the 2011 drought in the Horn of Africa, the ability to quickly transport food aid was crucial in preventing widespread famine. Enhancing transport services would help countries build more resilient food systems capable of withstanding and recovering from shocks.

Increasing local access

Local transport networks are often the weakest link in the supply chain. Targeted interventions at the local, regional, and international levels can significantly enhance food availability and accessibility (World Bank 2024).

Scaling and maintaining rural road networks is crucial for connecting smallholder farmers to markets. Improved rural roads can reduce transportation costs, increase market access, and enable farmers to sell their produce at better prices. Public investments in rural roads have been shown to significantly improve food security and reduce poverty in a relatively short period of time.

The extent and strength of transport networks has heterogeneous impacts on different groups in society. Rural road development has a clear link to the welfare of rural households, particularly during severe droughts. Connecting rural communities to markets, especially in remote areas, also enhances resilience to shocks.

Community-based approaches, such as labor-based road construction and maintenance, can also create local employment opportunities. Involving communities in these projects can enhance the sustainability and effectiveness of transport interventions.

Enhancing first- and last-mile connectivity to higher-class transport infrastructure and markets can improve access to food for remote and underserved communities. Targeted solutions can be particularly effective in areas in which traditional transport infrastructure is lacking or impractical. Improving first- and last-mile connectivity—by, for example, building and maintaining rural roads, can help ensure that food reaches even the most remote households.

The need for an integrated approach is evident in the Sahel (Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal), which faces complex challenges (refer to box 8.1).

Box 8.1

Enhancing food security in the Sahel through a basins-of-integration approach

In the Sahel—Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal—several countries face high climate vulnerability and high food insecurity and are heavily dependent on imported food. The paucity of intraregional connectivity in the subregion exacerbates the triple crises of climate change, food security, and conflict and fragility. Disasters and conflict, in particular, can increase transport costs and multiply economic losses beyond those due to crop damage in the affected areas (Deninger et al. 2024; World Bank 2021).

Although significant investments in international connectivity have been made, they have not reduced transport costs across the region. Costs remain high for several reasons:

- The Sahel is highly vulnerable to climate threats, increased temperatures, flooding, and sandstorms, which disrupt rural logistics,

continued

Box 8.1 Enhancing food security in the Sahel through a basins-of-integration approach, *continued*

prevent local products from reaching consumers, and hinder the efficient distribution of agricultural inputs.

- Much of the region's transport infrastructure is inadequate and poorly maintained. Many rural areas are isolated and lack reliable connectivity to major markets, limiting farmers' access to larger markets and reducing their ability to sell their produce.
- The region faces significant logistics infrastructure challenges, including a lack of storage facilities, processing units, and distribution centers.
- Fragility, conflict, and violence exacerbate food insecurity by limiting access to markets and increasing the risk of supply chain disruptions.
- Inconsistent and outdated regulatory frameworks create barriers to efficient transport and logistics operations. They include informality and cartelization in transport services markets and issues related to trade facilitation, customs procedures, and nontariff measures, which delay the movement of goods and increase costs.

To address these challenges, the new World Bank strategy for a corridor in West and Central Africa prioritizes investments across value chains, particularly in the Lake Chad Basin, where efforts could increase agricultural production by 20 percent and fish production by as much as 40 percent and ensure that meat and dairy products cover the nutritional demand of almost the entire population. Supporting transportation infrastructure and services to ensure reliable, all-weather accessibility to production areas and markets is also crucial. Developing a cold supply chain for fish, meat, and dairy products would help reduce malnutrition and support economic growth.

The strategy prioritizes regional connectivity and unlocking the development potential of areas adjacent to backbone corridors. It seeks to lower fixed costs of transport, by increasing the number of trips per truck per year and reducing truck idle time during trips on corridors, enhance corridor safety and security, and improve access to agricultural markets to address food security in landlocked countries.

Source: World Bank 2024.

SUMMARY

Common messages can be taken from the role of transport in food security in Africa, but it is also clear that needs differ across and within countries and for different commodities. Proper diagnostics are an essential first step to understand the requirements for an optimal role of transport in strengthening food systems across various scales, from international connectivity to local market access, ensuring effective and sustainable outcomes. Such diagnostics should be used to maintain clear visibility of food shipments when designing transport for global, regional, and local connectivity.

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Food insecurity is a persistent global problem affecting hundreds of millions of people each year. *Transport Connectivity for Food Security in Africa: Strengthening Supply Chains* confirms the complexity of the problem and focuses on the transport dimension to its resolution. The book explores critical links between transport, logistics, and food security in Africa, with the goal of enhancing the resilience of food systems.

The book relies on a World Bank in-house Freight Flow and Transport Choice Model (FlowMax) to analyze the supply chains of key food commodities in Africa. It explores how transport deficiencies affect food production, distribution, and imports and, ultimately, food security. It is the first of its kind to answer six questions that are often asked in relation to food security on the continent:

1. Why does Africa have a "long food supply chain"?
2. How can regional economic blocks facilitate a more efficient exchange of food between countries?
3. What impedes the distribution of food within countries?
4. Does Africa have a transport infrastructure problem that impacts the food supply chain?
5. Do market distortions in transport services contribute to high costs of food in Africa?
6. What hampers investment in storage as one of the ingredients to the weaknesses of food supply chains on the continent?

Using the FlowMax model, the book identifies weaknesses and opportunities for improvement along the entire food supply chain, from local production and consumption to international linkages, aiming for more resilient food systems. Recommendations focus on fostering international network connectivity, increasing regional integration, strengthening domestic logistics, and improving access to markets.

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