Food and Agriculture Organization of the United Nations

2020

THE STATE OF AGRICULTURAL COMMODITY MARKETS

AGRICULTURAL MARKETS AND SUSTAINABLE DEVELOPMENT: GLOBAL VALUE CHAINS, SMALLHOLDER FARMERS AND DIGITAL INNOVATIONS

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VIET NAM. A woman selling tropical fruits in the old town of Hoi An city.

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THE STATE OF AGRICULTURAL COMMODITY MARKETS

AGRICULTURAL MARKETS AND SUSTAINABLE DEVELOPMENT: GLOBAL VALUE CHAINS, SMALLHOLDER FARMERS AND DIGITAL INNOVATIONS

Food and Agriculture Organization of the United Nations
Rome, 2020

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FOREWORD

The 2020 edition of *The State of Agricultural Commodity Markets* (SOCO 2020) comes out at a crucial juncture for the global economy and the global food systems, as we join our efforts to contain the global pandemic triggered by the spread of COVID-19.

The pandemic has clearly shown us that, in an interconnected world, diseases and the effects of measures taken to contain them spread rapidly over national borders. While the pandemic is not the central theme of this report, it highlights the close relationship between the production, consumption and trade of food. This fact underlines the importance of adopting an integrated approach to food systems and makes the release of SOCO 2020 even timelier.

I invite you to read this report carefully, as it contains important information on how markets can bring us closer to achieving the Sustainable Development Goals of Agenda 2030. SOCO 2020 provides novel data analysis for trade and markets around the world. It offers a detailed study of major global trends in agri-food markets to identify how to reap economic, environmental and social gains and spur development.

Trade in food and agriculture has more than doubled in real terms since 1995. Emerging and developing countries have become active participants in global markets, and they now account for about one-third of global trade. Technological advancements have made it possible to transform production and trade processes, which has in turn enabled global value chains in food and agriculture to emerge. SOCO 2020 estimates that about one-third of global agricultural and food exports are traded within a global value chain.

A central argument of this report is that well-functioning markets are key for development and economic growth. International trade can be a powerful instrument, and markets can be harnessed to foster sustainable economic, social and environmental outcomes. Global value chains can make it easier for developing countries to integrate into global markets. As they link our food markets closely, they also provide a mechanism to diffuse best practices to promote sustainable development.

But in this rapidly transforming market environment, we should leave no one behind. We need to redouble efforts to include smallholder farmers in modern food value chains, thus securing rural incomes and food security in both rural and urban areas. Smallholder farmers face many challenges that can undermine their attempts to farm and market their products effectively. Policies and mechanisms that support them in this regard will be indispensable to encourage their productivity and market participation.

Digital technologies can help markets to function better and can improve farmers' access to them. Innovations, such as food e-commerce, can benefit both farmers and consumers. However, to guarantee that the dividends of digital innovation are shared with the poorest, we must reduce the current digital divide. Nevertheless, it is difficult to foresee all the impacts that technological innovation could have on how we grow, process, trade and consume food. Today, we know that further usage of technology can help us achieve significant gains in this area. But it is worth noting that some of the risks involved in technology adoption are not yet fully understood. We have to strengthen our joint efforts and ensure that the digital revolution reinforces development.

SOCO 2020 makes it abundantly clear that we need to rely on markets as an integral part of the global food system. This is all the more important in the face of major disruptions, whether they come from COVID-19, locust outbreaks or climate change.

We all have a role to play in sustainable development and the eradication of hunger. FAO is here to support its Members and partners in this endeavor.

Qu Dongyu
FAO Director-General

METHODOLOGY

The preparation of *The State of Agricultural Commodity Markets 2020* began in June 2019. An Editorial Advisory Group comprised of FAO specialists and external experts was formed to support the writing team. The Editorial Advisory Group reviewed and provided advice on the analysis and drafts of the report.

A Technical Workshop on Global Value Chains was held at FAO Headquarters in Rome on 21–22 November 2019. The workshop brought together practitioners, academics and other interested stakeholders from various countries to present their research and discuss the following: the evolution of food and agricultural global value chains and how these have transformed food markets and trade; their impact in economic, social and environmental terms; and how policies can enhance their contribution towards sustainable development in food and agriculture. The workshop broadened the Organization's knowledge and views on these issues.

A group of experts produced nine background papers on a range of issues to inform the writing of this report. These included two modeling exercises: one to assess the impact of global value chains on agricultural productivity, and another using a global computable general equilibrium model to analyse the effects of trade policies on global value chain participation.

The first draft of the report was reviewed by the Editorial Advisory Group and discussed by the FAO Economic and Social Development Stream management team in May 2020. FAO experts from technical divisions across the Organization also reviewed the draft report. The Office of the Director General and the FAO Economic and Social Development Stream reviewed the final report. The content and findings of SOCO 2020 will be presented to the Committee on Commodity Problems (CCP) at its meeting in March 2021.

ACKNOWLEDGEMENTS

The State of Agricultural Commodity Markets 2020 (SOCO 2020) was prepared by a multidisciplinary team of the Food and Agriculture Organization of the United Nations (FAO) under the direction of Boubaker Ben-Belhassen, Director of FAO's Markets and Trade Division, and George Rapsomanikis, Senior Economist and Editor of SOCO 2020. Overall guidance was provided by Máximo Torero Cullen, FAO Chief Economist, and by the management team of the Economic and Social Development Stream.

RESEARCH AND WRITING TEAM

The research and writing team at the Markets and Trade Division was composed of: Andrea Zimmermann, Clarissa Roncato Baldin, Edona Dervisholli, Evgeniya Koroleva (data), Husam Attaallah (data), George Rapsomanikis and Rob Dellink.

EDITORIAL ADVISORY GROUP

The writing team received valuable comments and guidance from the SOCO 2020 Editorial Advisory Group: Boubaker Ben-Belhassen (Director, Markets and Trade Division, FAO), Carmel Cahill (former Deputy Director for Trade and Agriculture, OECD), David Blandford (Pennsylvania State University), Hope Michelson (University of Illinois), Jikun Huang (Peking University), Johan Swinnen (University of Leuven), Luca Salvatici (Roma Tre University), and Máximo Torero Cullen (Chief Economist, Economic and Social Development Stream, FAO).

CONTRIBUTORS

The following authors contributed with technical background papers for this report: Edona Dervisholli (FAO), Eva-Marie Meemken (Cornell University), Felix Baquedano (FAO Consultant), Ivan Đurić (Leibniz Institute of Agricultural Development in Transition Economies – IAMO), Hope Michelson (University of Illinois), Jikun Huang (Peking University), Johan Swinnen (University of Leuven), Leslie C. Verteramo (Cornell University,) Luca Salvatici (Roma Tre University), Miguel I. Gómez (Cornell University), Pierluigi Montalbano (University of Rome, La Sapienza), Rob Dellink (FAO) and Silvia Nenci (Roma Tre University).

ADDITIONAL CONTRIBUTIONS

The writing of this report was informed by the International Workshop on Global Value Chains, which took place on 21–22 November 2019 in Rome. The following experts presented their research and work at the workshop: Carlo Altomonte (Bocconi University), Davide Del Prete (FAO), Edona Dervisholli (FAO), Koen Deconinck (OECD), Luca Salvatici (Roma Tre University), Marie-Agnès Jouanjean (OECD), Pierluigi Montalbano (University of Rome, La Sapienza), Rob Dellink (FAO), Silvia Nenci (Roma Tre University) and Sunghun Lim (University of Minnesota).

From FAO, inputs were provided by Anna Lartey, Davide Del Prete, Elena Ilie, Nancy Aburto, and Siobhan Kelly.

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ABBREVIATIONS AND ACRONYMS

ACRE
Agriculture and Climate Risk Enterprise

AFCFTA
African Continental Free Trade Area

AFDB
African Development Bank

BMI
Body Mass Index

CGE
Computable General Equilibrium

COVID-19
Novel coronavirus disease

DLT
Distributed Ledger Technology

FAO
Food and Agriculture Organization of the United Nations

FDI
Foreign Direct Investment

GATT
General Agreement on Tariffs and Trade

GDP
Gross domestic product

GVC
Global value chain

HS
Harmonized Commodity Description and Coding System of the World Customs Organization

ICT
Information and communications technology

IFAD
International Fund for Agricultural Development

ILO
International Labour Organization

IPPC
International Plant Protection Convention

ISO
International Organization for Standardization

MRL
Maximum residue limit

NCD
Noncommunicable disease

NGO
Non-governmental organization

NTMs
Non-tariff measures

OECD
Organisation for Economic Co-operation and Development

OIE
World Organization for Animal Health

RTA
Regional Trade Agreement

R&D
Research and development

RSPO
Roundtable on Sustainable Palm Oil

SDGs
Sustainable Development Goals

SIM
Subscriber Identification Module

SME
Small and medium-sized enterprises

SMS
Short message service

SPS
Sanitary and phytosanitary

TBTs
Technical barriers to trade

TFA
Trade Facilitation Agreement

UNDP
United Nations Development Programme

WFP
World Food Programme

WHO
World Health Organization

WTO
World Trade Organization

EXECUTIVE SUMMARY

TRADE, MARKETS AND SUSTAINABLE DEVELOPMENT

Trade and markets lie at the heart of the development process. In food and agriculture, markets expand consumers' choices and create incentives for farmers. Markets thereby enable the optimal allocation of resources and provide the avenues which link agriculture with other sectors of the economy. This makes markets crucial for the structural transformation of the economy. How trade and markets contribute to sustainable development is the subject matter of this 2020 edition of *The State of Agricultural Commodity Markets* (SOCO).

The role of well-functioning markets in driving economic growth is significant; however, the market mechanism cannot guarantee the provision of a range of social and environmental benefits that are central to sustainable development. In some instances, markets may fail to reconcile the interests of individuals with those of society as a whole, but also with the needs of future generations, which are embedded in the 2030 Agenda for Sustainable Development.

The 2030 Agenda and its 17 Sustainable Development Goals (SDGs) aim at a better and more sustainable future for all. They address the global challenges we face, including ending poverty and hunger and restoring and sustainably managing natural resources. The SDGs integrate the three dimensions of sustainable development – economic, social and environmental – with closely interwoven targets.

Agriculture is central to the 2030 Agenda. Its linkages with food security, economic growth, employment and poverty eradication, the environment and natural resource management, and nutrition and health are reflected in most of the SDGs. Markets identify these linkages. This report discusses policies and institutions that can promote economic growth and also harness agricultural and food markets to contribute towards sustainable outcomes – economic, social and environmental.

SOCO 2020 explores the evolution of trade and markets and examines their roles in growth and sustainable development. It looks specifically at the emergence of global value chains in food and agriculture; the extent to which smallholder farmers in developing countries participate in value chains; and, the transformative impacts of digital technology on markets.

THE EVOLUTION OF TRADE AND MARKETS

Since 1995, international trade in food and agriculture more than doubled in real terms to amount to USD 1.5 trillion in 2018. Emerging economies and developing countries are increasingly participating in global agricultural and food markets; their exports have grown to more than one-third of the world total.

This growth in trade is the result of several drivers. Lower transport costs have made it cheaper to trade. Trade policies and the decline in import tariffs – resulting from the World Trade Organization (WTO) Agreement on Agriculture that entered into force in January 1995 and many bilateral and regional trade agreements – have also been key drivers in promoting trade in food and agriculture.

These drivers, together with increases in income in both developed and developing countries, have fueled trade expansion in food and agriculture. Income growth is also associated with demographic trends, such as urbanization, which all bring about new lifestyles and changes

in diets, thereby affecting trade and markets. As countries develop, people consume less staple foods and more meat, dairy products, and fruit and vegetables. These changes in diets are reflected on international trade patterns.

Urbanization is occurring at a more rapid pace in the developing world than it did, for example, in Europe and has affected domestic food markets. Consumers' preferences for convenience, food quality and safety are strengthening the vertical coordination of food value chains. In countries in Asia and Latin America and the Caribbean, sales of leading supermarket chains increased up to tenfold between the beginning of the century and 2018. In sub-Saharan Africa, urban consumers are also more likely to shop in supermarkets, and they spend a higher share of their income eating out.

At the same time, advances in digital technology have improved communication between people and are having a profound impact on economies and societies. Better communication brings about cultural proximity which, in turn, affects consumers' preferences for food. Also, as farmers and firms find it easier to communicate, they can better coordinate their operations across borders and become part of global value chains. This report estimates that about one-third of trade in food and agriculture takes place within global value chains and crosses borders at least twice, as primary commodities are initially exported to be processed into food products, which, in turn, are re-exported.

The evolution of international trade and agri-food global value chains were interrupted by the financial crisis in 2008. Since then, the slowdown of the global economy, and especially in emerging economies, has affected trade and global value chains. In the first part of 2020, markets, both domestic and global, have been once more facing significant challenges due to the outbreak of COVID-19 and to the restrictions on people's movement and international travel that were imposed to contain its spread. The pandemic and its impact on the global economy are expected to affect trade considerably. The WTO suggested that world merchandise trade would plummet by 13–32 percent due to the COVID-19 pandemic disrupting economic activities.

Governments and the private sector are attaching high priority to keeping food value chains alive and functioning amid movement restrictions. Efforts are being made to link food production areas with urban centres through special channels (following safety measures, such as testing, physical distancing and other hygienic practices) to accelerate the delivery of perishable and nutritious foods to affected populations. At the global level, policy-makers in many major food exporting countries committed not to impose restrictive trade measures, such as export bans, to ensure that trade could continue to move food and agricultural products from surplus to deficit regions, thus promoting food security globally.

THE CONTRIBUTION OF AGRICULTURAL AND FOOD GLOBAL VALUE CHAINS TO ECONOMIC GROWTH

Global value chains (GVCs) have become an important part of food and agricultural trade. GVCs unbundle the production process into stages in different countries to achieve efficiency gains. This allows farmers and firms in developing countries to overcome limitations arising from the lack of well-developed and export-orientated domestic food sectors. People have more options to join global markets and can better leverage their comparative

advantage at any stage of the value chain they choose.

For developing countries, GVCs can be a significant avenue to growth. Being closely coordinated, GVCs can sharpen the effects of international trade on growth – technology and knowledge spillovers that can increase productivity, improve employment opportunities and raise incomes. Research undertaken for SOCO 2020 suggests that, on average and in the short term, a 10 percent increase in agriculture's GVC participation can result in an increase of around 1.2 percent in labour productivity. This immediate impact also translates into sustained long-term positive effects on productivity, which can bring about important benefits to developing countries.

Increased GVC participation can have positive and negative environmental outcomes. On the one hand, GVCs foster growth; on the other, they may not necessarily result in better management of natural resources. For example, there are concerns that increased crop production for exports, a result of trade openness, contributes to deforestation. However, GVCs that are coherent with sustainable development objectives, for example those that adhere to regulation and standards, can spread sustainable technologies and practices. At the same time, they can promote productivity and income growth across countries. An active effort needs to be made to add sustainability to trade.

Trade policies are crucial. As GVCs run across countries, products cross borders multiple times and are subject to tariffs at each of them. Fewer and lower trade barriers can help promote GVCs. For developing countries, this is important. Lowering import tariffs along a GVC can increase imports of inputs and intermediate products. This, in turn, can stimulate production and exports, resulting in considerable gains in productivity, employment and incomes.

Opening global markets and promoting GVCs can create important spillover effects by transferring technology and know-how. But, to translate these into lasting gains, complementary policies are necessary to underpin competitiveness, such as measures that improve governance and infrastructure, upgrade skills, and remove rigidities from labour markets. However, there are concerns about the short-term effects of opening trade, especially the impacts on income distribution and inequality.

Regional trade agreements can also be instrumental in promoting GVC trade. Lower tariffs between signatories can promote vertical coordination and value chains. Coverage of many economic sectors by such agreements can strengthen their effect on agri-food GVCs, as a significant share of agri-food exports' value originates from other sectors besides food or agriculture. For example, globally, about 38 percent of the value added in food exports originates from imported services.

Regional trade agreements can also contain clauses on competition policy, or standards harmonization, resulting in policy reform and high levels of integration between the signatories. Although many view these agreements as building blocks of a global trading system, increased emphasis on regional trade should also be complemented by promoting multilateral trade to contribute to economic growth in countries, such as those located in sub-Saharan Africa, that trade mostly with global rather than regional partners.

THE IMPACT OF COVID-19 ON AGRICULTURAL AND FOOD TRADE AND GLOBAL VALUE CHAINS

The financial crisis of 2008 and the consequent economic slowdown stalled the evolution of agri-food GVCs, and the COVID-19 pandemic is expected to disrupt their potential in global trade and growth further. GVCs foster trade linkages that act as channels of technology and knowledge diffusion during periods of economic growth; similarly, they can transmit economic shocks and their impacts. As firms address the trade-off between efficiency and resilience to the economic slowdown, they may pursue a process of localization of food production by reshoring activities for foods that allow it.

Such strategies could significantly undermine efficiency gains that are associated with comparative advantage and could increase domestic food prices – which is undesirable in times of declining incomes. Relying on food and agriculture from domestic and multiple sources across the world is a form of resilience against food insecurity and economic downturns. Global shocks like the 2008 financial crisis and the COVID-19 pandemic require international collaboration and coordination rather than measures that promote self-sufficiency in food, especially when impacts are not occurring in all countries at the same time. Therefore, trade provides an efficient avenue to better manage risks arising from a shock and to increase resilience. In the context of COVID-19, efforts to minimize the disruption of GVCs and promote agricultural and food trade can generate both short- and long-term benefits.

INTEGRATING SMALLHOLDER FARMERS INTO VALUE CHAINS FOR SUSTAINABLE DEVELOPMENT

The relationship between trade and growth is complex, and the effect of globalization on the distribution of income across and within countries has been under debate for a long time. As trade expands, all countries gain, and many experience fast rates of growth. However, at the same time, the gap between low-income developing countries and the developed and emerging economies can widen. Some analysts suggest that the forces of globalization do not benefit those who cannot compete globally.

In agriculture, for example, a major issue is how to integrate smallholder farmers into markets, both global and domestic, and include them in the development process. In developing countries, nearly all farmers sell to and buy from markets. But markets function poorly, and the costs of transactions are high. Many smallholder farmers have low rates of commercialization. For many, markets, such as those for insurance and credit, fail to function and are entirely missing. This has important implications for food security, livelihoods and development.

The emergence of GVCs, with their stringent requirements in terms of food quality and safety, can further marginalize smallholders. Broad policies are necessary to create an environment that enables markets to flourish – for example, improved rural infrastructure and services, education and productive technology. In addition to these policies, inclusive business models, such as contract farming, driven by the private sector and supported by governments and the civil society, can help farmers integrate into modern and more complex value chains.

Innovative solutions also include multifaceted programmes that simultaneously address the multiple constraints farmers face in marketing, technology and finance. For example, contract farming schemes can obviate market failures related to price risk, access to productive inputs and credit, and access to technology and knowledge. These can improve productivity, raise commercialization rates, increase incomes and reduce poverty. Although contract farming can improve access to value chains and generate benefits for many smallholders, its effects can be highly diverse.

Contract schemes may exclude farmers with very small landholdings, failing to address inequality issues fully. They can also be subject to reversals and may collapse frequently. There is a high rate of exit, as farmers move in and out of contracts, possibly because farmers have difficulty in meeting quality requirements or because participation was not profitable compared to alternative activities. If markets and value chains are to contribute to development, sustained participation is necessary. The positive effects of contract farming on farmers will be larger if participation is continuous, as investments on productive assets, technologies and knowledge take time to generate benefits.

Increases in commercialization and trade can improve incomes and livelihoods but, at the same time, may lead to undesirable environmental outcomes. Intensification in agricultural production for exports, stimulated by trade openness and globalization, could result in water pollution, increased greenhouse gas emissions and biodiversity loss. These impose costs to society as a whole in terms of, for example, low water quality, global warming and declines in crop pollination.

Governments have a range of policy tools to address such costs. For example, taxes can make markets take into account various environmental costs to society. Public policies apart, certain arrangements can leverage markets to align private aspirations with public ones; those arrangements can thereby contribute towards sustainable development, especially in the context of global value chains. Value chains combined with sustainability certification schemes can develop markets for food produced sustainably.

Sustainability standards are gaining importance in global markets, especially for high-value products with established links to global value chains. Growing consumer demand for sustainability certified products has resulted in increases in the share of agricultural land under sustainability certification. About one-quarter of the global coffee and cocoa areas are certified through sustainability standards developed by non-governmental organizations and the private sector. The market provides information in terms of prices. Harnessing the market mechanism to also provide information on how food is produced and on the benefits this brings to the environment and society, can address the trade-offs between economic, social and environmental objectives.

THE TRANSFORMATIVE IMPACT OF DIGITAL TECHNOLOGIES ON MARKETS

Digital technologies are rapidly transforming all stages of the value chain from the farm to the table. Their adoption is improving efficiency, creating new jobs, generating new income streams and saving resources. However, digital technologies can be disruptive, modifying or displacing value chain activities and products.

EXECUTIVE SUMMARY

At the farm level, digital technology applications help address market failures and facilitate the integration of farmers in value chains by driving down information and transaction costs. Improvements in information and communications technology have also underpinned the development of global value chains, effectively linking farmers to traders and consumers across regions and countries. In 2020, the COVID-19 pandemic revealed the potential of digital technologies in improving the functioning of food markets. Estimates suggest that in the People's Republic of China, the share of the online market increased from 11 to 38 percent of total food retail purchases in February 2020.

Despite the rapid diffusion of digital technologies during the last three decades, a digital divide exists between countries, between urban and rural areas, and between men and women. On average, in rural Africa, only 10 percent of households have access to the internet. In order to include everyone in the digital economy, effective public private partnerships, good regulations to crowd in the private sector, and policy coherence are needed to improve digital infrastructure and skills in rural areas of developing countries.

From text messages through mobile phones' Short Messaging Service (SMS) to e-commerce platforms and distributed ledger technologies, digital applications reduce transaction costs, improve the flow of information and promote efficient matching between farmers, traders and consumers. This leads to increased market access and better outcomes in terms of income and welfare. Digital platform initiatives reviewed in this report, such as e-Choupal in India, Esoko in Africa and Taobao villages in the Peoples' Republic of China, demonstrate how digital technologies can improve the functioning of markets.

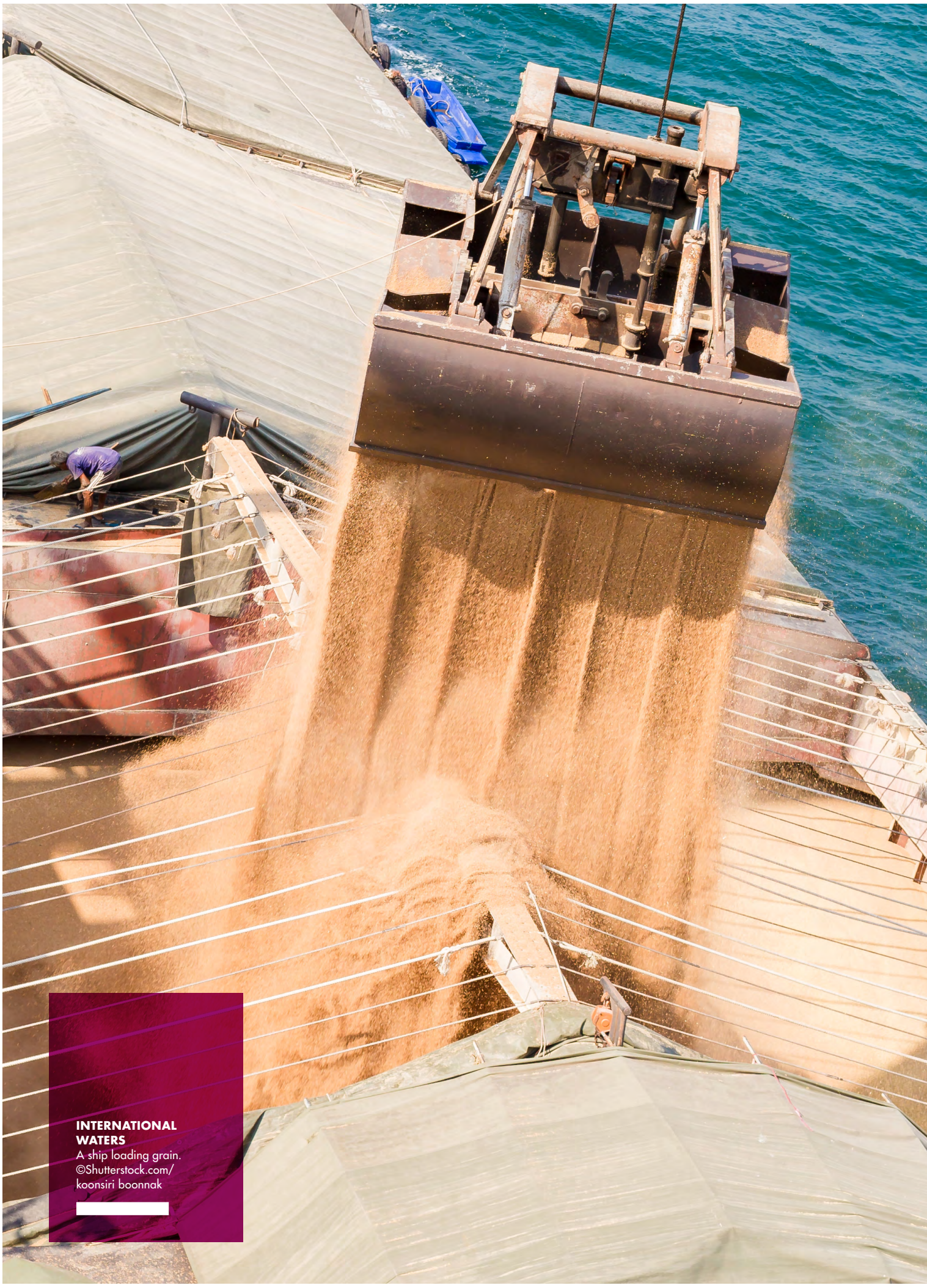
Access to credit and insurance is also being revolutionized. Digital innovations in earth observation, satellite rainfall estimations and remote sensing, combined with *in situ* data and blockchain technology, can support weather index-based insurance programmes at lower costs. This can help in reaching millions of smallholder farmers, many of whom were previously considered uninsurable.

The transformational impacts of digital innovations can support a range of market outcomes. Digital technology applications for agricultural and food markets can generate significant economic, social and environmental benefits and accelerate progress towards achieving the SDGs. For example, digital technologies promote financial inclusion as they allow financial institutions to enter rural markets without establishing a costly physical presence. E-commerce platforms incite educated youth and women to remain in or return to rural areas. This can transform rural areas into more attractive places to live and work. Blockchain technology can build trust and promote transparency and thus increase the traceability of food throughout the value chain. This can support the implementation of sustainability standards and labelling that provide information to consumers on environmental and social dimensions of production.

At the same time, digital technologies also entail risks and challenges. For example, issues related to the ownership and use of data collected through digital technologies on-farm have raised

huge concerns. Addressing these issues can further promote digital technology adoption. Technology also affects the factors of production and their value, such as the demand for labour and wages. Digital technologies could also lead to deviations from competitive outcomes in markets, affecting prices or quantities and, therefore, welfare.

The potential of technology to impact agricultural and food markets needs to be further analysed. The issues mentioned above point to the necessity for enhanced collaboration between all stakeholders. They will also require a consensus on best practices that can shape a regulatory framework which will maximize the benefits of digital technology for food and agriculture and minimize the associated risks.



INTERNATIONAL WATERS
A ship loading grain.
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koonsiri boonnak

PART 1
TRENDS IN AGRICULTURAL AND FOOD MARKETS

PART 1 focuses on how trade and markets have evolved since the beginning of the new millennium. It examines how economic growth and urbanization, as well as technological improvements and policies, have led to changes in agricultural and food trade, its patterns and composition. Many countries along their development path experience progressive dietary shifts and changing consumer preferences for food. These are mirrored on trade and markets that undergo a continuous transformation and which are also affected by crises, such as the 2008 financial crisis and the COVID-19 pandemic.

PART 1

TRENDS IN AGRICULTURAL AND FOOD MARKETS

KEY MESSAGES

1 Since 1995, international trade in food and agriculture has more than doubled in real terms but its growth rate has been slower since the 2008 financial crisis. Developing countries and emerging economies are increasingly participating in global markets, and their exports make up more than one-third of global agri-food trade.

2 Trade patterns are driven by economic growth, urbanization, technological progress and trade policies. These trends also bring about substantive changes in lifestyles, affect diets, and transform domestic and global markets and value chains.

3 Changes in the agricultural and food markets of emerging economies and developing countries are rapid and pronounced. This underscores a process that closely links development with the continuing transformation of food and agriculture.

4 The impact of the COVID-19 pandemic and the restrictions on movement and partial border closures imposed in the beginning of 2020 to contain its spread, affected the global economy through the trade and investment linkages that were developed over the last two decades.

KEY ACTIONS

➔ Increased awareness of developments in global agricultural and food markets and a systematic understanding of trade policies are crucial for addressing challenges related to the transformation process, financial shocks, natural disasters and health-related crises, such as the COVID-19 pandemic.

➔ The transformation of food and agriculture affects everyone and in different ways. It has effects on farms and value chains, incomes and jobs, diets and nutritional status, the environment and society as a whole. Policy-makers should identify how these impacts are linked to be able to design and implement effective measures and promote sustainable development.

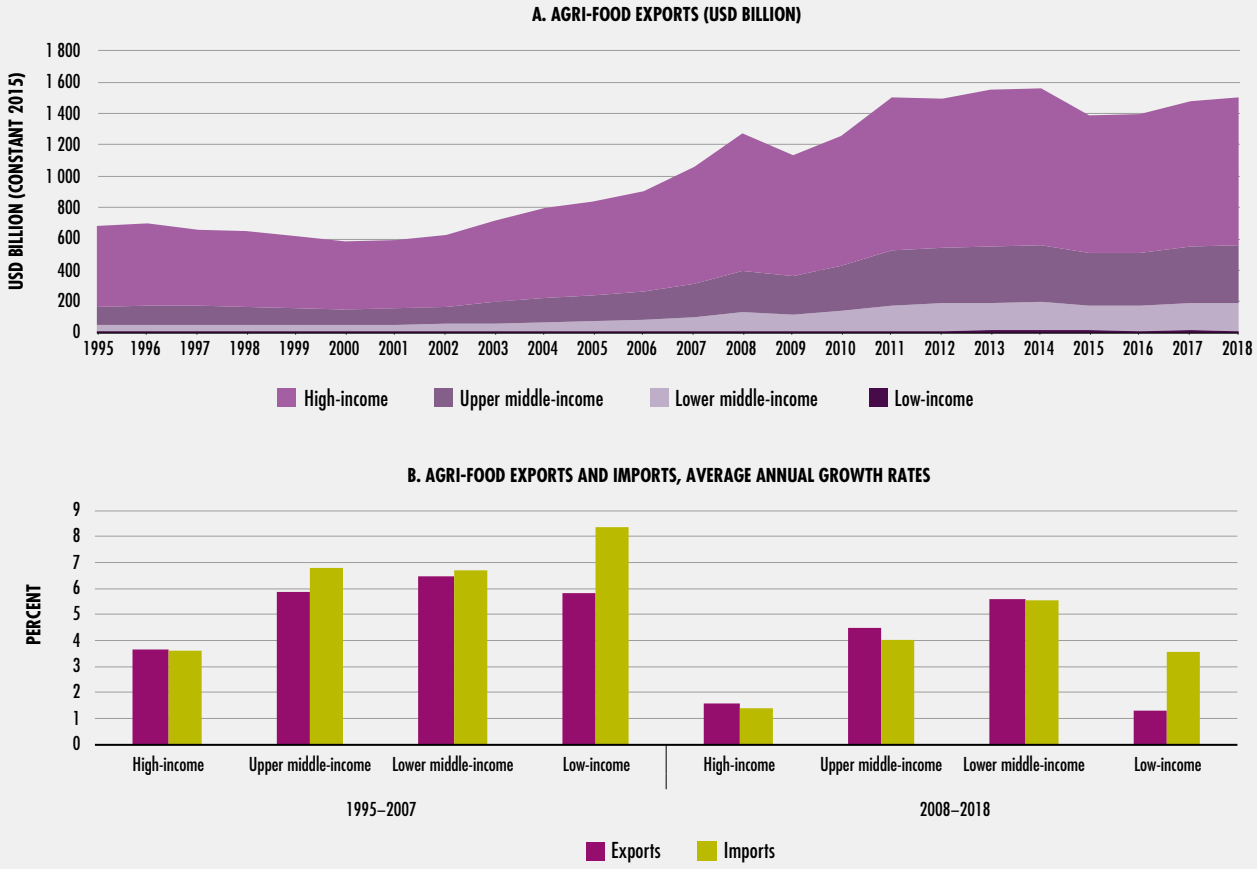
➔ Disruptive effects on food value chains due to the COVID-19 pandemic require enhanced international cooperation and market transparency, as well as measures that facilitate the movement of food without compromising food safety and workers' health, including the establishment of trade corridors and the temporary re-evaluation of technical trade barriers.

RECENT TRENDS IN AGRICULTURAL AND FOOD TRADE

Since the beginning of the twenty-first century, global trade in agricultural commodities and food (agri-food) has evolved significantly.[a] It has

a Agri-food trade includes agricultural commodities and food based on chapters 01–24 of the Harmonized Commodity Description and Coding System (HS) of the World Customs Organization. It largely corresponds with the definition of trade in food of the WTO World Trade Statistical Review by including fish, but excluding forestry and a number of non-food raw materials. >>

FIGURE 1.1
EVOLUTION OF AGRI-FOOD TRADE, 1995–2018 (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



NOTE: All calculations are based on values of trade at 2015 prices. Country income groups are based on the classification of the World Bank.
The calculations in Panel B are based on three-year averages of values of trade at 2015 prices.
SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

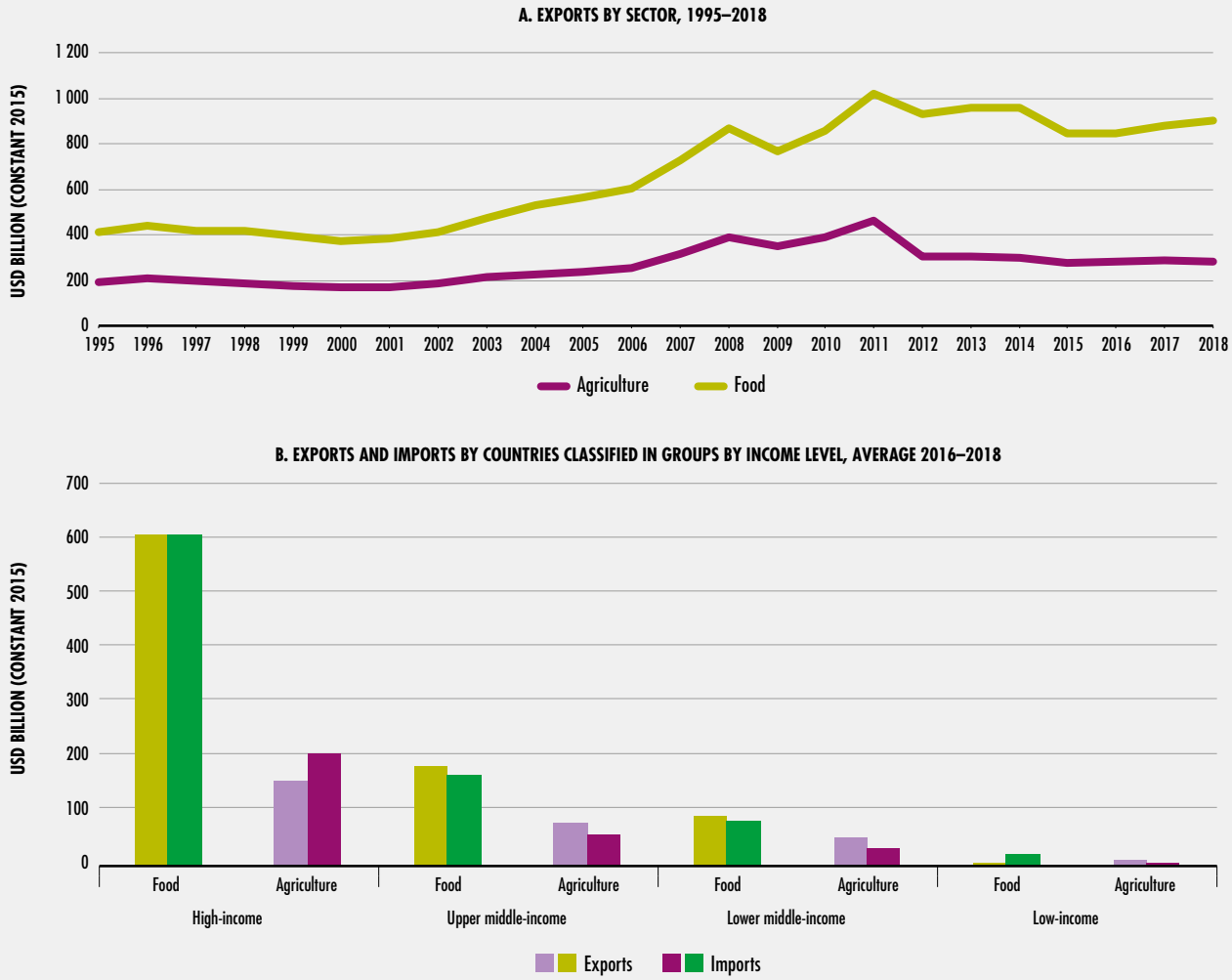
more than doubled in real value between 1995 and 2018, rising from USD 680 billion in 1995 to USD 1.5 trillion in 2018 (measured in 2015 prices, Figure 1.1). The share of agri-food trade in total merchandise trade averaged at 7.5 percent over this period.

The growing trend peaked with the food price crisis in 2007–2008 and was abruptly interrupted by the financial crisis in 2008 and the global recession that followed. Although trade recovered in 2010 and 2011 and commodity prices surged again, the slowdown in the global economy, especially in emerging economies such as the People's Republic of China, affected both trade and commodity prices significantly.[1] Since 2014, the decline in the value of agri-food trade has been mainly due to falling commodity prices and exchange rate fluctuations,[2,3] with growth rates partly rebounding between 2016 and 2018.

While high-income countries account for most of agri-food trade in value terms, emerging economies and developing countries increasingly participate in global markets (Figure 1.1, Panel A). Since the beginning of the new millennium, upper and lower middle-income countries together have increased their share in global agri-food exports from about 25 percent in 2001 to 36 percent in 2018. During the same period, the share of low-income countries in total agri-food trade remained almost unchanged at around 1.1 percent.

>> Export values include transportation and insurance costs within the exporting country (free on board); import values include the cost of transportation and insurance from the border of the exporting country to the border of the importing country (cost, insurance and freight). Trade is measured in gross terms, i.e. in total value traded, rather than in value added terms. Trade in value added is explored in Part 2, in the context of value chain analysis.

FIGURE 1.2
TRADE IN FOOD AND AGRICULTURAL COMMODITIES



NOTE: Agriculture includes unprocessed agricultural commodities; food includes all products that have undergone some processing. Unlike agri-food trade in Figure 1.1, the data presented in this figure do not include fresh fish and seafood.
SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

From 2008 onwards, with the slowdown of the global economy, growth of agri-food exports and imports has been sluggish as compared to 1995–2007, especially in high-income countries, whose economies were relatively more affected by the financial crisis (Figure 1.1, Panel B). Low-income countries, many of which export to high-income countries' markets, were also affected through the slowdown in demand in these markets and declining commodity prices. Exports and imports of upper and lower middle-income countries continued growing rapidly between 2009 and 2011 and have only stalled since then.

Throughout the period 1995–2018, high-income countries as a group showed higher agri-food imports than exports, while the group of upper and lower middle-income countries was in a net exporting position. Imports of the group of low-income countries were slightly higher than their exports between 1995 and 2000, followed by a significant deepening of their net importing position until 2011, which has stabilized since then.

Trade in agricultural commodities and food

The larger part of agri-food trade is made up of trade in processed products from the food sector (Figure 1.2). Between 1995 and 2000, the share of food in total agri-food exports remained stable, exhibiting an increase thereafter, from around 70 percent in 2000 to 76 percent in 2018 »

BOX 1.1
REGIONAL AGRI-FOOD TRADE

Countries can be more oriented towards trading within their region or trading globally, and the strength of this orientation can vary by sector and commodity (Figure 1.3).

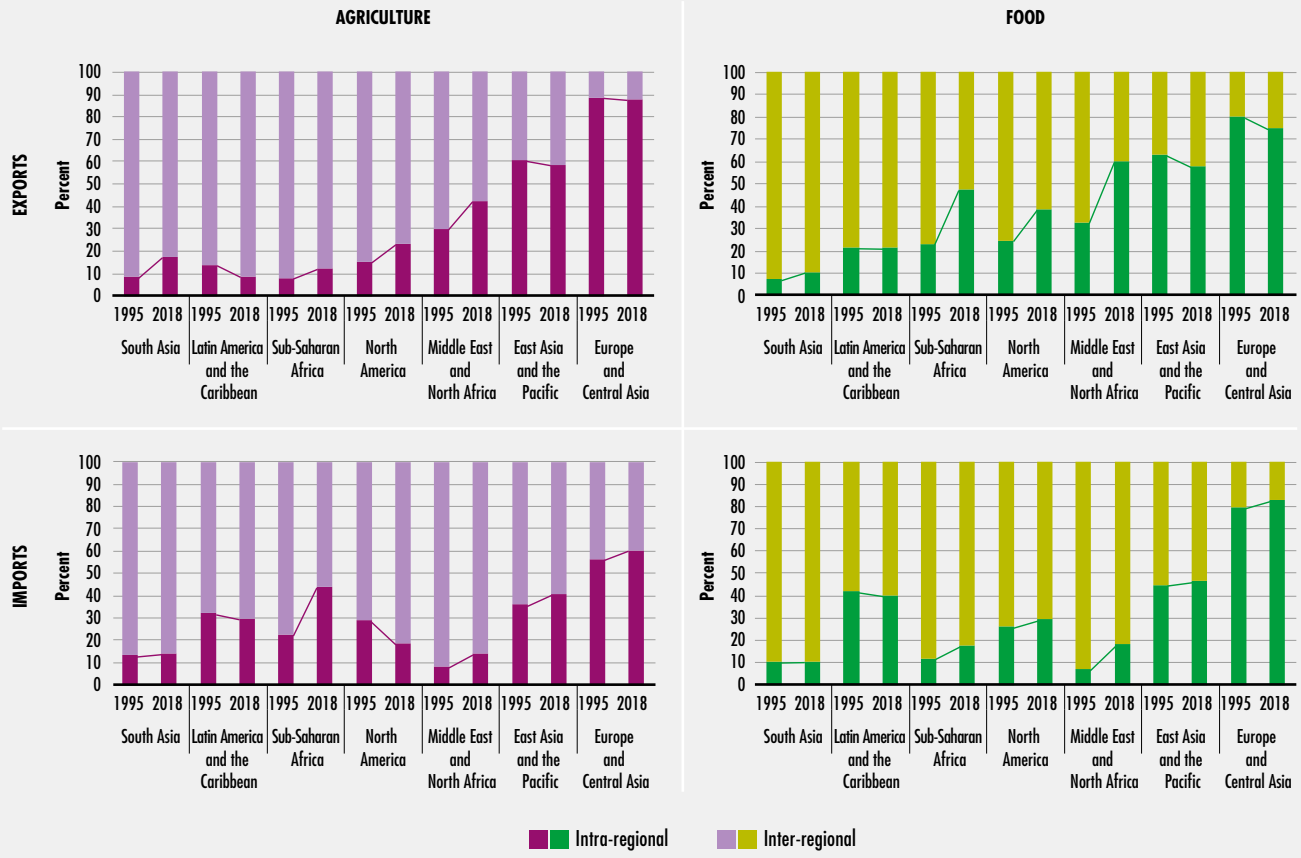
The majority of agricultural commodities are not traded within the region they are produced but exported to other regions. Approximately 90 percent of exports of agricultural commodities from sub-Saharan Africa and Latin America and the Caribbean are destined for other regions, where they often serve as inputs in the food industry (see Part 2). Only in East Asia and the Pacific and in Europe and Central Asia, most of the agricultural exports remain within the region.

Food is traded more often intra-regionally than agricultural commodities, suggesting that food processing facilities are, in general, located close to the consumers. Only in East Asia and the Pacific, intra-regional food exports are about the same as the intra-regional exports of agricultural commodities (60 percent). In South Asia and in Europe and Central Asia, the shares of intra-regional trade of food (10 percent in South Asia and 75 percent in Europe and Central Asia) are lower than those of agricultural commodities (approximately 15 percent in South Asia and 90 percent in Europe and Central Asia).

The general geographic pattern, however, holds across the two sectors. Some regions invest heavily in intra-regional trade (East Asia and the Pacific and Europe and Central Asia), and others tend to export globally (such as South Asia and Latin America and the Caribbean).

In some regions, there is a much stronger differentiation. Sub-Saharan Africa, for example, exports agricultural commodities to other regions, but

FIGURE 1.3
SHARES OF INTRA-REGIONAL AND INTER-REGIONAL TRADE



NOTE: The calculations are based on three-year averages of values of trade at 2015 prices.

SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

BOX 1.1
(CONTINUED)

exports of food are relatively more pronounced within the region.

In both sectors, food and agriculture, the share of intra-regional exports in total exports increased over time (1995–2018) in four of the seven regions (South Asia, sub-Saharan Africa, North America, and the Middle East and North Africa). This share decreased in Latin America and the Caribbean, East Asia, and Europe and Central Asia.

In Latin America and the Caribbean and in sub-Saharan Africa, the share of intra-regional imports of agricultural commodities is higher than that of intra-regional exports, while the other regions tend to source agricultural commodities more globally compared to the regional distribution of their exports. The same is true for food imports (except for Latin America and the Caribbean and for Europe and Central Asia). In most of the regions, the share of intra-regional imports increased over time.

Reflecting the general slowdown of growth in agri-food trade, growth of both intra-regional and inter-regional trade was much faster in the period 1995–2007 than in 2008–2018.

Significant potential for increasing intra-African trade is likely to come from the full implementation of the African Continental Free Trade Area (AfCFTA), with agri-food trade being projected to increase between 20 and 30 percent in 2040 compared to a baseline without the AfCFTA (see also Box 2.6 on the role of regional trade agreements).[4,5]

SOURCES: ECA. 2018; ECA & TradeMark East Africa. 2020.[4,5]

» (Figure 1.2, Panel A). During the 1995–2018 period, food exports grew faster at an average annual rate of 3.4 percent, while those of agricultural commodities increased at an average annual rate of 1.9 percent.

Globally, most food is traded by high-income countries, which account for an equal share of food exports and imports. All country income groups import, on average, more food products relative to imports of agricultural commodities (Figure 1.2, Panel B). Upper and lower middle-income countries export more food than they import, pointing out to a well-developed and export-orientated processing industry, on average. Low-income countries' exports are characterized by a larger share of agricultural commodities, as they specialize in the production of raw materials and their food industry is relatively less developed.

There are pronounced differences in the export orientations of countries. While countries in Europe and Central Asia, and East Asia and the Pacific tend to trade with other countries in the same region, countries in South Asia, Latin America and the Caribbean, sub-Saharan Africa, North America, and the Middle East and North Africa are more globally oriented in their trade (see Box 1.1).

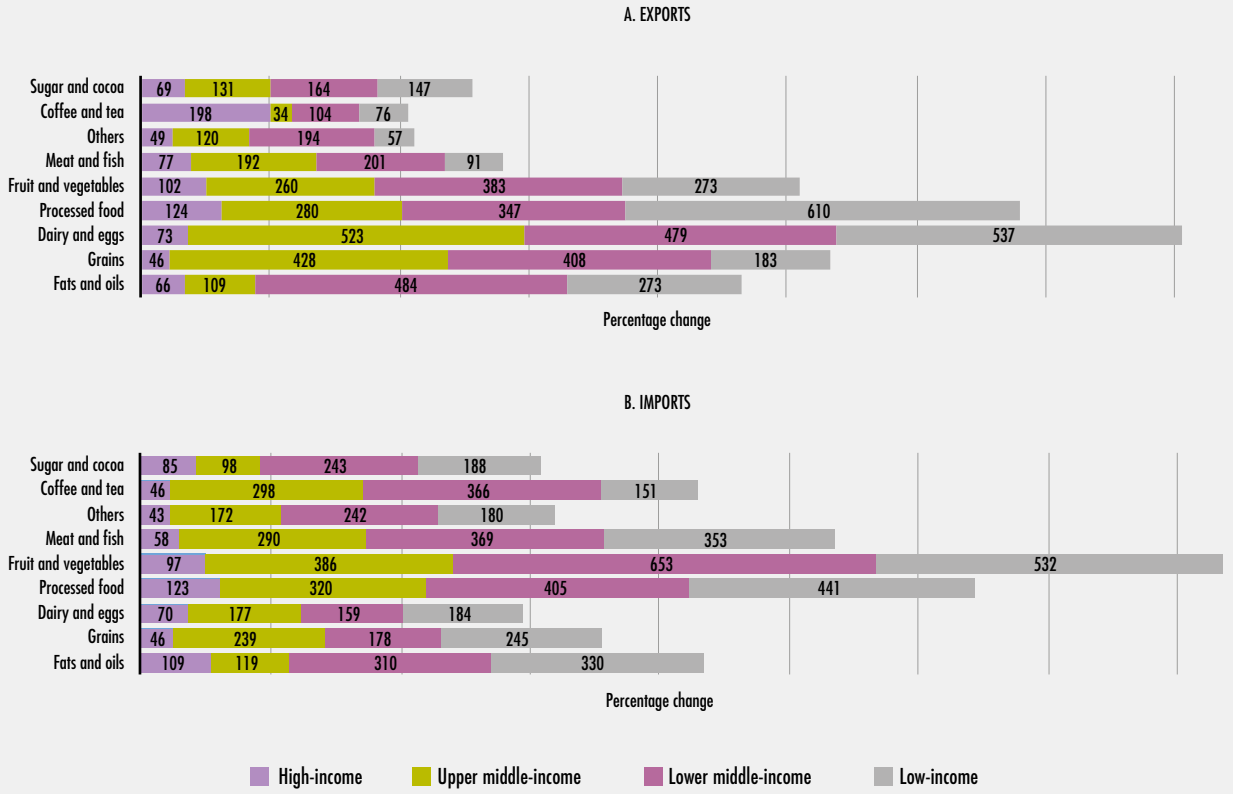
Trade by food aggregates

Between 1995 and 2018, trade increased across all foods.[b] While the change in exports and imports of all foods was relatively small in high-income countries, middle- and low-income countries significantly increased both exports and imports in all food aggregates (Figure 1.4, Panel A).

Starting from low levels, exports in middle- and low-income countries increased especially in the aggregates of fruit and vegetables (a fourfold increase in lower middle-income countries and a threefold increase in low-income countries); processed food (a threefold increase in lower middle-income countries and a sixfold increase in low-income countries); dairy and eggs (where

b Nine food aggregates are considered: (1) sugar and cocoa; (2) meat and fish; (3) fruit and vegetables; (4) coffee and tea; (5) processed food; (6) dairy and eggs; (7) grains; (8) fats and oils; and (9) others. The food aggregates are based on HS chapters 01–24. All aggregates also include preparations that reflect some processing. The aggregate processed food comprises preparations of cereals including pasta and bread, preparations of fruit and vegetables including jams, sauces, ice cream and beverages. Detailed definitions are given in the Annex.

FIGURE 1.4
CHANGE IN EXPORTS AND IMPORTS BY FOOD AGGREGATE, 1995–2018 (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



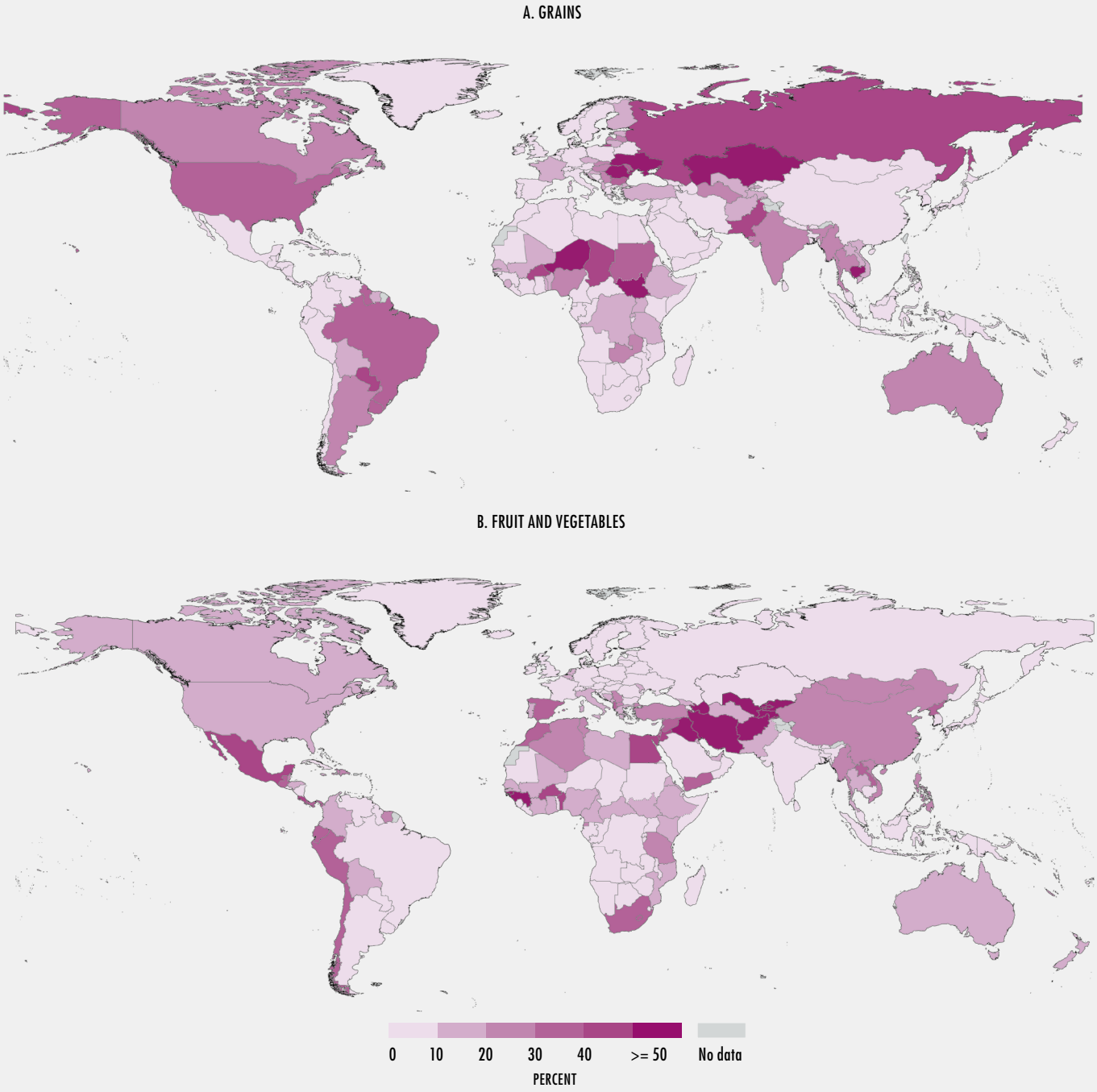
NOTE: The calculations are based on three-year averages of values of trade at 2015 prices. For illustration purposes, the percentage change from 1995 to 2018 per country income group is shown in one bar by food aggregate. The percentage changes within food aggregates cannot be added up.
SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

exports grew around five times across low- and middle-income countries); and fats and oils (approximately a fivefold increase in lower middle-income countries and a threefold increase in low-income countries). Upper middle-income countries significantly increased their exports of dairy and eggs and of grains (by more than five and four times between 1995 and 2018, respectively).

Following Bennett's law – which proposes that as incomes rise, people eat relatively fewer starchy staple foods and more nutrient-dense meats, oils, sugars, fruit and vegetables[6] – low- and middle-income countries significantly increased their imports of higher value products such as meat and fish, fruit and vegetables, and processed food (Figure 1.4, Panel B).

Which foods countries trade depends on a multitude of factors, including their comparative advantage in production and consumer preferences. In agriculture, the product-mix is often determined by resource endowments and natural conditions such as climate. Many grains, for example, are mainly produced in temperate zones, while a large variety of fruit and vegetables can be produced in warmer climates. Trade shifts products from surplus to deficit regions, which is reflected in regional trade patterns. Countries which have »

FIGURE 1.5
SHARE OF EXPORTS OF SELECTED FOOD AGGREGATES IN TOTAL AGRI-FOOD EXPORTS, AVERAGE 2016–2018



SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

» a comparative advantage in the production of grains also feature relatively higher shares of these products in their exports. Countries where conditions favour the production of fruit and vegetables are characterized by higher shares of these products in their total exports (Figure 1.5). Equivalently, countries which are comparatively less advantaged in the production of cereals or fruits are more dependent on imports of these products (Figure 1.6).

Trade patterns emerging along differences in comparative advantage are also reflected at the country level (Figure 1.7). Brazil, for example, an emerging economy (upper middle-income) and major agricultural exporter, almost quadrupled its exports (in real terms) since 1995. Brazil saw a particularly strong increase in its exports of grains, meat and fish, and sugar and cocoa. At the same time, Brazil's imports remained almost unchanged.

Viet Nam, a lower middle-income country, increased both exports and imports since the beginning of this century. Among the food aggregates that exhibited a major increase in exports are meat and fish, and fruit and vegetables. Imports of grains and fruit and vegetables also increased (Figure 1.7).

Nepal – a landlocked low-income country – is characterized by difficult conditions for agricultural production and low integration in global markets, mainly due to its location in the Himalayas. However, since 1995, Nepal has slowly increased the value of its exports, as well as changed their composition (Figure 1.7). Although fats and oils made up a large part of exports in the late 1990s, improved processing capacity in the new millennium helped to significantly increase exports of processed food and tea and spices. Food imports increased from almost a negligible level in 1995 to more than USD 1 billion in 2018 (measured in 2015 prices), consisting mainly of grains, fruit and vegetables, and processed food.

Uganda, also a landlocked low-income country, shows a different growth path in terms of trade. The country is one of the ten biggest coffee producers globally, and coffee makes up around 35 percent of its total agri-food exports. Between 1995 and 2018, besides an increase in coffee exports, Uganda managed to also significantly increase its exports of grains, sugar and cocoa, and fruit and vegetables. During the same period, Uganda increased its imports of fats and oils, grains, and processed food (Figure 1.7). ■

DRIVERS OF GLOBAL TRADE

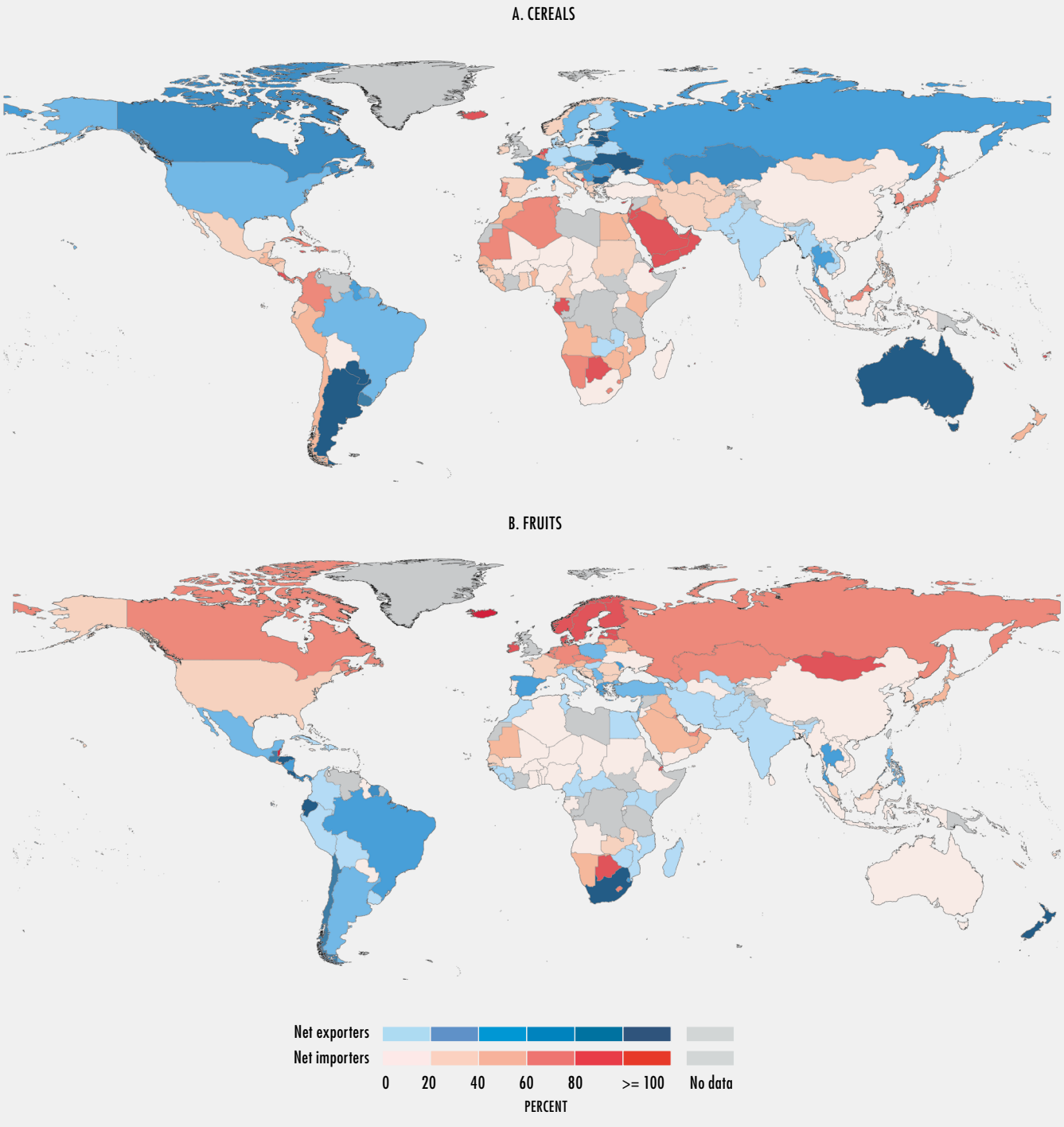
International trade gives rise to a globalized economy and, by connecting food demand and supply across the world, allows countries to expand their markets. Together with agro-climatic conditions, how much and what countries trade are shaped by four main drivers which are closely related and, at the same time, also identify economic development. Rising incomes, population growth and demographic changes, technological advances, and policies all drive the growth and composition of international trade.

Population growth and demographic changes together with rising incomes affect overall food demand and dietary patterns, which in turn lead to adaptations in production, markets and trade, facilitated by technology. The globalization process is characterized by increasingly open markets, promoted through reductions in trade policy barriers, but also by technological progress, which results in lower transport costs, improved communication and thus increased commercialization. All of these drivers affect food supply, demand and trade simultaneously and through various channels.

Income growth

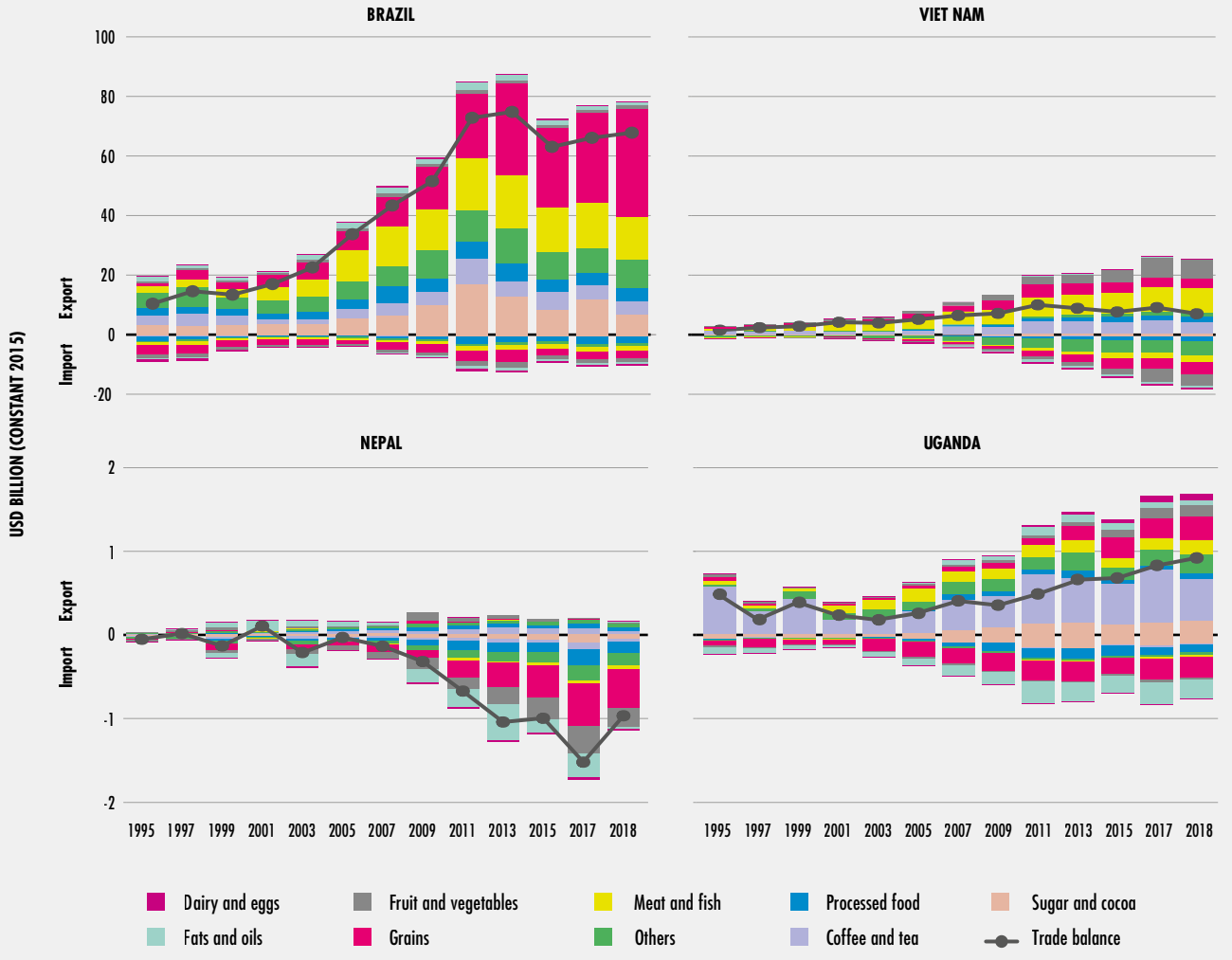
In general, trade is affected by income and, at the same time, can be one of the determinants of economic growth as it promotes efficiency gains and technology spillovers. Nevertheless, the relationship between trade and income is controversial. Between 1995 and 2018 – a period characterized by increasingly open markets and more trade – income growth across countries suggests that globalization only partly promoted convergence. Income growth rates in lower and upper middle-income countries were much higher than those of the high-income countries, indicating that during the period 1995–2018 these »

FIGURE 1.6
IMPORT DEPENDENCY FOR SELECTED FOOD AGGREGATES, AVERAGE 2015–2017



NOTE: Import dependency denotes the share of available domestic food supply that has been imported. Values in blue indicate that the country is a net exporter. The food aggregates are based on the classification of the FAO Food Balance Sheets. Detailed definitions are given in the Annex.
SOURCE: FAO calculations using FAOSTAT Food Balance Sheets (accessed February 2020; latest data available for 2017).

FIGURE 1.7
AGRICULTURAL EXPORTS AND IMPORTS: BRAZIL, VIET NAM, NEPAL AND UGANDA BY FOOD AGGREGATE

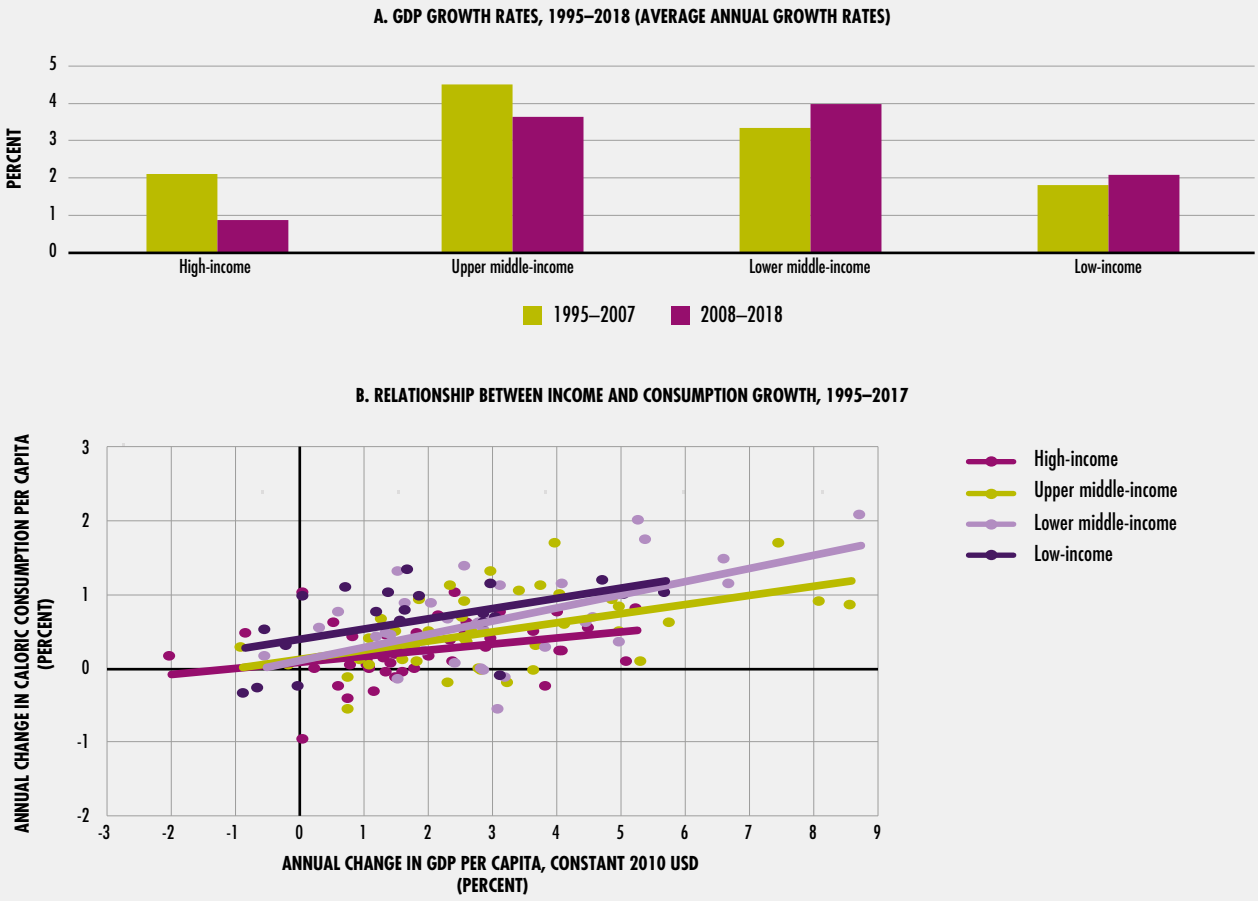


NOTE: Trade data for Nepal in 2018 are estimates inferred from the exports and imports reported by its trade partners.
SOURCE: FAO calculations using UN Comtrade data (accessed May 2020).

» country groups were catching up with advanced economies. However, income growth has been slow for low-income countries, suggesting a lack of convergence and an expanding income gap.

The 2008 financial crisis also affected income growth. High-income countries, with more leveraged financial systems and credit expansion, were disproportionally affected by the financial crisis and suffered larger downward revisions to their economic activity (Figure 1.8, Panel A).[7,8] Upper middle-income countries also experienced a slowdown in income growth between 2008 and 2018, but at a significantly lesser extent. At the same time, a broader set of developing countries, lower middle- and low-income countries with limited integration in global financial markets, were less affected by the 2008 crisis.[9] These income trends are also broadly reflected on agri-food trade (see Figure 1.1, Panel A).

FIGURE 1.8
INCOME DYNAMICS AND GROWTH IN FOOD CONSUMPTION (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



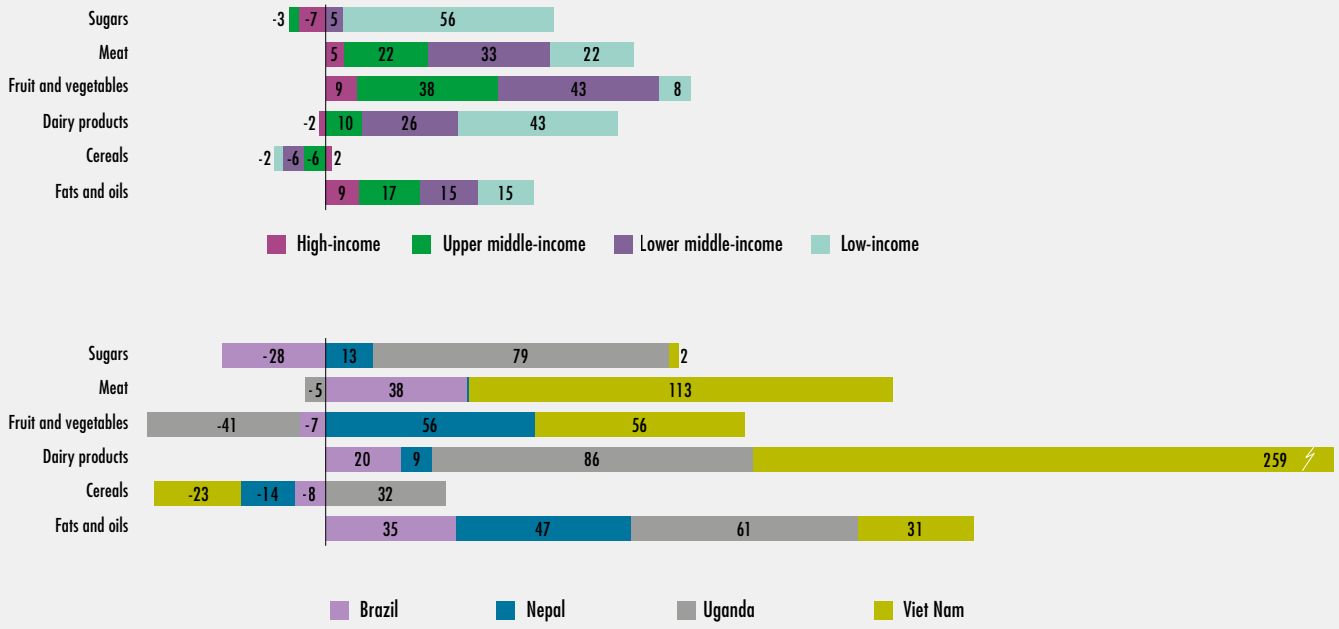
NOTE: Gross domestic product (GDP) growth rates for the periods 1995–2007 and 2008–2018 are calculated on the basis of GDP per capita in constant 2010 USD.
SOURCE: FAO calculations using World Development Indicators, World Bank (accessed February 2020) and FAOSTAT (accessed February 2020; latest data available for 2017).

Major socio-economic changes that are associated with income growth are paralleled by significant shifts in food consumption patterns[10] – a process described as the nutrition transition. At the early stages of the nutrition transition, income growth is associated with higher levels of food intake and a reduced incidence of food insecurity.[11] Diets, at this stage, are typically characterized by a relatively high share of starchy staples and a low variety of foods. This is followed by a stage of accelerated growth in caloric consumption accompanied by an increase in intake of protein and vitamins and minerals, all of which can lead to better nutrition and health outcomes. However, this change is often simultaneous to, or followed quickly by, a shift to diets with a higher share of fats, sugar and processed foods including highly processed foods. At the last stage of the nutrition transition, and as income rises further, the growth in caloric consumption per capita slows down, and diets shift to improved fat quality, a higher intake of fruit and vegetables, and an increase in whole grain consumption. Throughout the nutrition transition, the share of food in total household expenditure declines as income rises (as proposed by Engel's law).[c]

The nutrition transition is also reflected in Bennett's law; as people become wealthier, they

c The relationship between the share of food in total expenditure and income was named after the statistician Ernst Engel (1821–1896).

FIGURE 1.9
AVERAGE CHANGE IN THE SHARE OF CALORIES AVAILABLE FOR CONSUMPTION PER CAPITA BY MAIN FOOD AGGREGATES, 1995–2017 (PERCENT)



NOTE: Calculations are based on FAO Food Balance Sheets for which the methodology changed during the period under examination. The data can, therefore, provide only an indication of the change in dietary patterns. The calculations are based on three-year averages. The food aggregates are based on the classification of the FAO Food Balance Sheets. Detailed definitions are given in the Annex. For illustration purposes, the percentage change from 1995 to 2017 per country income group is shown in one bar by food aggregate. The percentage changes within a food aggregate cannot be added up. The bar showing the percentage change of the share of calories available for consumption from dairy products in Viet Nam, was truncated to fit the figure width.
SOURCE: FAO calculations using FAOSTAT Food Balance Sheets (accessed February 2020; latest data available for 2017).

switch from simple starchy plant-dominated diets to more varied foods that include a broader range of fruit and vegetables and animal-sourced protein.[6]

The aggregate data clearly reflect the stages of the nutrition transition (Figure 1.8, Panel B). In low-income countries, increasing incomes per capita are associated with rising caloric consumption per capita. With accelerating income growth, this effect becomes stronger in the lower middle-income countries. In upper middle-income countries, the effect is already slowing down, and in high-income countries, income growth is only weakly associated with growth in caloric consumption.

Dietary changes in line with Bennett's law can also be observed at the aggregate level. With increasing incomes, the share of cereals in per capita food consumption declined in low- and middle-income countries between 1995 and 2017 (Figure 1.9, upper Panel). High-income countries appear to have completed the nutrition transition with almost no change in cereals consumption.

However, the intake of sugars, as a share of the daily diet, increased by more than half in low-income countries, compared to a 5 percent increase in lower middle-income countries. High- and upper middle-income countries exhibited a slight decline in sugar intake. The consumption of fruit and vegetables, »

CHILE
A woman shopping at a grocery store.
©iStock.com/ Hispanolistic

» meat, and fats and oils increased in all country income groups, especially in upper and lower middle-income countries. Low-income countries saw a strong increase in the consumption of dairy products.

Similar dietary shifts have been observed in Asia along with rapid economic growth, urbanization and globalization during the period 1961–2011.[12,13] More recently, in sub-Saharan Africa, economic growth has brought about changes in food consumption, away from cereals, roots and tubers and towards fish, meat, eggs, dairy products, fruit and vegetables, along with a general shift to more processed foods.[14]

While changing consumption patterns along the nutrition transition are evident at this aggregate level, there is more heterogeneity at the national level where diet evolution also depends on preferences, the distribution of income and the level of development (Figure 1.9, lower Panel). For example, in emerging economies such as Brazil and many developing countries including Nepal and Viet Nam, income growth resulted in significant declines in the share of cereals in per capita food consumption. However, in Uganda, the share of cereals in per capita food consumption increased; there, unlike other countries in the region in which maize dominates diets, staples consist of a variety of foods including cassava, sweet potatoes and matooke. In countries exhibiting accelerated economic growth such as Viet Nam, dietary shifts evolved faster.

Diets changed both at the urban and rural levels.[14,15] Nevertheless, the shift away from cereals to more energy-dense foods has been found to be greater at the urban level, although rural areas appear to be rapidly converging driven by income growth and food system changes.[15]

The linkages between average income and consumption may mask important trends in food demand that are related to the distribution of both income and calories between wealthy and poor population groups.

In fact, the emergence of a middle class in many developing countries has been identified as the most significant factor driving not only the demand for food but also its composition, leading to changes in food procurement systems (see Box 1.4 on vertical integration).[14,16,17,18]

The rise of an urban middle class in Africa, for example, resulted in an increase in calories consumed overall and a higher demand for processed foods, meat, fruit and vegetables.[14,16] Middle-class consumers are also more likely to shop in supermarkets, or other types of convenience stores, and spend a higher share of their income eating out.[10,16]

The dietary shifts spurred by income growth also affect trade. Increasing consumption of meat and fish, fruit and vegetables, and processed food are reflected in growing imports of these products, especially in emerging and developing economies (see Figure 1.4, Panel B).

At the time of writing this report, the outbreak of a novel coronavirus has been affecting global agri-food value chains, incomes and demand for food. The rapid spread of COVID-19 throughout the 2019–2020 winter forced hard choices on global policy-makers. As many countries implemented necessary social distancing practices in response to the pandemic, an unprecedented and multifaceted crisis unfolded.

Many countries faced multiple challenges in public health, the economy and food security, which interacted in complex ways.[19] The threat COVID-19 poses to food security due to income loss is a cause of great concern to the progress made in the reduction of the prevalence of undernourishment over recent decades. Box 1.2 discusses the immediate effects of the pandemic on global trade, value chains and food security.

Population growth and demographic changes

The interaction between population growth and demographic changes impacts food demand, trade and markets in important ways. While population growth drives the demand for and trade of food in terms of volume, demographic changes affect its composition.

Population growth is associated with increasing trade across countries. If the pace of population »

BOX 1.2
THE IMPACTS OF THE COVID-19 PANDEMIC ON GLOBAL TRADE, MARKETS AND FOOD SECURITY

The measures adopted in response to the COVID-19 pandemic are inevitably impacting all economic activities. In April 2020, the World Trade Organization (WTO) suggested that world merchandise trade would plummet by between 13 and 32 percent due to the COVID-19 pandemic disrupting economic activities.

In agriculture and food, primary production, processing, trade, logistics (both domestic and international), and final demand are being affected. The spread of COVID-19 has consequences for both domestic and international food markets, income and employment, as well as for food security and nutrition across the world.

IMPACTS ON FOOD VALUE CHAINS AND INTERNATIONAL TRADE

At the time of producing this report, movement restrictions and partial border closures implemented around the world to contain the pandemic were affecting food value chain logistics, disrupting the flow of agricultural inputs and outputs and agriculture-related services. Disruptions caused adverse impacts on the production and quality of food, on freshness and on safety and impeded food distribution at the wholesale and retail levels. The efficiency of agri-food logistics is critical, particularly in times of crisis. Based on the experience from Wuhan, People's Republic of China, governments can set up "green channels" to connect production areas with urban outbreak hotspots, removing logistical barriers and restrictions to accelerate the delivery of perishable and nutritious foods to affected populations (http://www.fao.org/policy-support/coronavirus-pandemic/en/).

For labour-intensive crops, such as fruit and vegetables, movement restrictions could result in labour shortages, as border closures affected the availability of seasonal migrant workers. Due to their perishable nature, fruit and vegetables are particularly vulnerable to disruptions in the value chain. Governments introduced schemes to substitute for migrants workers, highlighting the difficulty agriculture faced to keep value chains functioning. For example, in the United Kingdom of Great Britain and Northern Ireland, the "Pick for Britain" campaign (https://pickforbritain.org.uk) was set up to connect potential workers and employers in order to maintain the supply of fruit and vegetables. At the same time, eating habits at home are not like those at restaurants and cafes, the closure of which reduced the demand for a range of foods, putting farmers and distributors in financial difficulties.

Across the developing world, value chains tend to be more fragile and susceptible to disruptions than in developed countries. Agriculture in developing regions relies less on inputs but is labour-intensive, and restrictions in movement can have a significant impact. When this report was being drafted, the virus had not yet spread widely in countries where food insecurity is pervasive, most notably in sub-Saharan Africa. If it did, the outbreak could be expected to have similar effects to previous epidemic-induced shocks, such as the Ebola Virus Outbreak, which caused steep harvest reductions, made food prices spike and aggravated food insecurity.

Despite the uncertainties caused by the rapid spread of COVID-19 around the world, global food markets remained well balanced. Cereal stocks are expected to reach their third highest on record in the 2020–2021 season, and export availabilities for rice and soybean are adequate to meet the anticipated demand. In May 2020, FAO announced that world food commodity prices declined for the third month in a row, as the economic and logistical impacts of the COVID-19 pandemic resulted in significant contractions in demand for many commodities (see http://www.fao.org/news/story/en/item/1273914/icode/). Adhering to international guidelines on safe travel and trade corridors can help keep agri-food supply chains alive, mitigate food supply disruptions and promote food security.

While drafting this report, some countries were temporarily relaxing technical regulations for imports of specific food products to ensure their availability, without compromising food safety. For example, Indonesia temporarily suspended fortification and quality requirements for food staples (flour, cooking oil, sugar), and Switzerland relaxed food labelling requirements for six months to facilitate imports of certain food ingredients and packaging material for which shortages arose due to the pandemic. Temporary restrictions were imposed on the import of specific live animals and animal products, especially from highly affected areas.

BOX 1.2
(CONTINUED)

IMPACTS ON ACCESS TO FOOD

As economic activity slows down, access to food is expected to be negatively affected by unemployment and income reductions. Such impacts can be immediate for those who work in sectors that are directly affected by social distancing restrictions. Workers in low-wage and informal sectors are particularly vulnerable to income losses due to the pandemic.

Although the demand for food is inelastic with respect to income, there are marked differences across high- and low-income countries, as well as within countries. The extent to which the pandemic will affect food consumption will depend on many factors, including the availability of household savings, but the poor are left immediately exposed to food insecurity and will also be the most affected in the medium term. In addition to worsening food security overall, diet quality is also expected to deteriorate for the poor since foods with high nutritional value are also generally more costly (dairy, fruits, vegetables, eggs, fish and meat).

Governments moved to strengthen food safety nets and social protection mechanisms to maintain access to food. Specific government measures could also address the impact of income reductions through subsidies, tax breaks and transfers to those affected. These measures are indispensable to preserve the gains realized in the reduction of food insecurity levels over recent decades. How this abrupt decline in incomes and interruption in economic growth will affect demand for food, and particularly foods of higher value, remains to be observed once economic activity is somewhat restored.

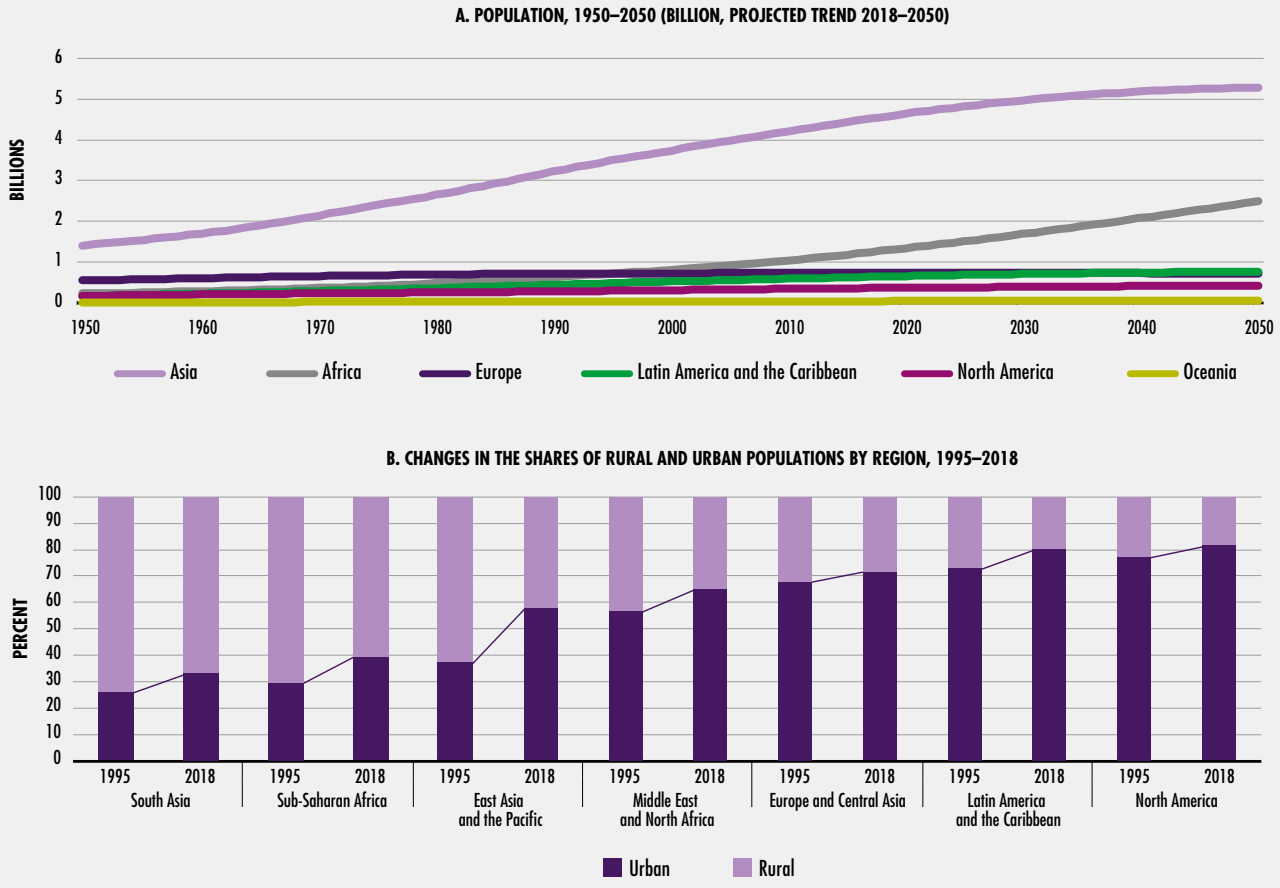
SOURCES: Adapted from contributions by FAO, the International Food Policy Research Institute (IFPRI) & the World Bank to World Economic Forum 'COVID-19, Trade & Food: Challenges, Scenarios & Recommendations', 18 April 2020; Torero. 2020; WTO Press Release 855; FAO. 2020; FAO. 7 May 2020; The Economist. 8 May 2020; Financial Times. 20 April 2020; Orfanos *et al.* 2017; Binkley. 2019; and WTO. 2020.[20,21,22,23,24,25,26,27,28]

» growth differs between regions, trade will likely move food from regions where population growth is slower to regions where it is relatively faster. For example, fast population growth in countries characterized by low agricultural productivity per capita, which may also be negatively affected by climate change, will lead to increased imports. Long-term population trends exhibit strong growth in Asia; while that growth has started slowing down, the population is projected to peak at 5.3 billion people around 2050 (Figure 1.10, Panel A). The population in Africa is projected to continue growing strongly up to 2.5 billion people in 2050, posing significant challenges to agriculture. Populations in Latin America and the Caribbean, North America and Oceania are projected to grow slowly, while those in Europe are likely to contract by 2050.

Urbanization is associated with considerable changes in lifestyle and is a key driver of changes in consumption patterns and the transformation of food systems. As societies become urbanized and consumers live farther away from where primary agricultural production takes place, the demand for food that can be easily stored and transported strengthens, which in turn gives rise to increased food processing.[29] Urban consumers also tend to have relatively higher incomes which strengthens demand for a wider variety of foods. Their lifestyles allow less time for food preparation, which results in higher consumption of processed foods and more frequent meals away from home.[30]

Urbanization is also linked with better modes of transportation and car ownership, access to refrigeration, and exposure to advertising.[17] These promote access to new and evolving retail channels for food and strengthen the demand for higher-value products, including fruit and vegetables and processed foods. Car ownership in urban Zambia, for example, significantly increases

FIGURE 1.10
POPULATION GROWTH AND DEMOGRAPHIC CHANGES



SOURCES: UN World Population Prospects 2019 (accessed April 2020); World Development Indicators, World Bank (accessed February 2020).

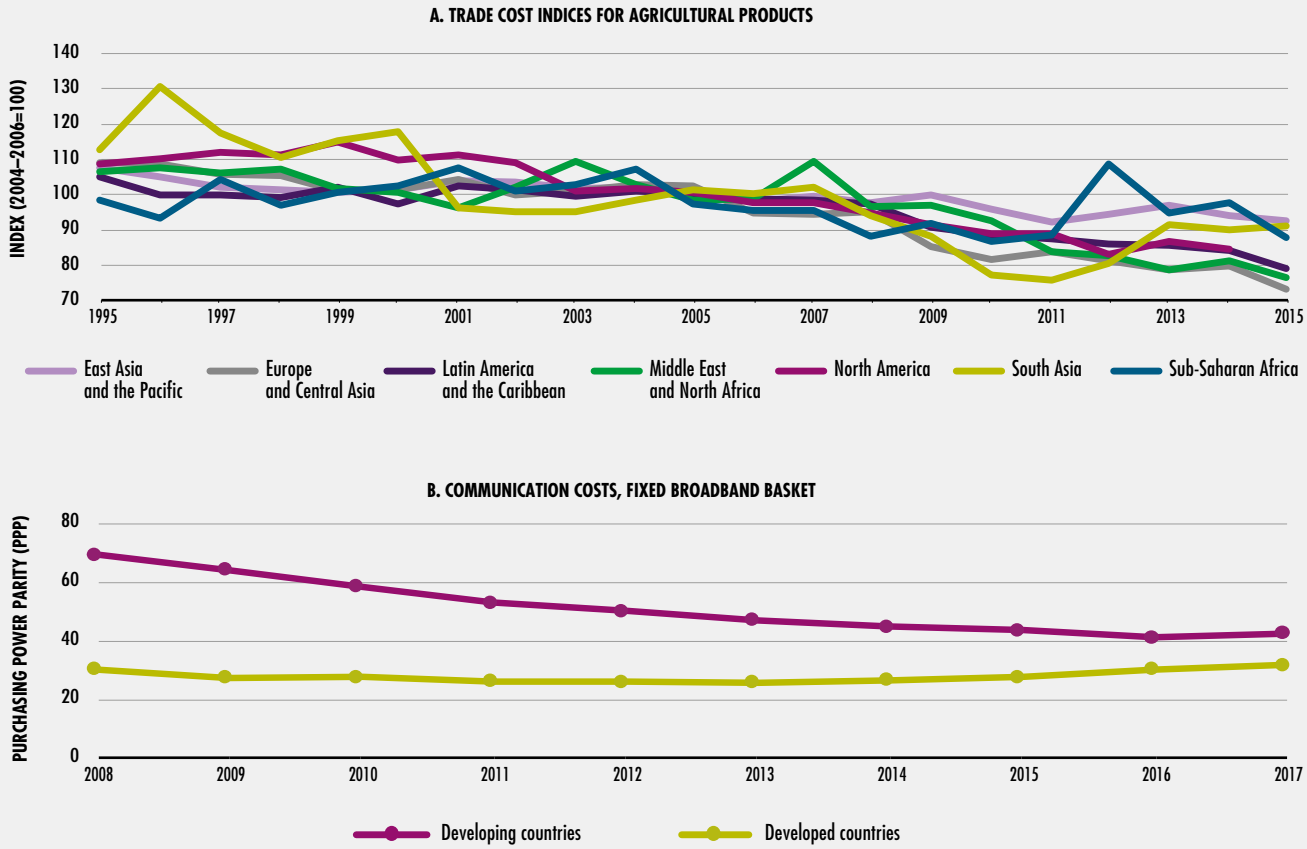
retail purchases in supermarkets, which tend to stock and sell relatively more processed foods.[16]

While North America, Latin America and the Caribbean, and Europe and Central Asia already have highly urbanized populations (Figure 1.10, Panel B), urbanization rates between 1995 and 2018 grew fastest in East Asia and the Pacific. In the relatively less urbanized regions of sub-Saharan Africa and South Asia, the share of urban population also increased, but at a relatively lower pace. Urbanization is occurring at a more rapid pace in the developing world than it did, for example, in the United States of America and Europe. It took nine decades for the share of the urban population in the total population to increase from 40 to 75 percent in the United States of America; however, this threshold was surpassed in less than three decades in Brazil and the Republic of Korea.[17]

Technological progress, trade costs and trade policies

Technological progress has led to improvements in infrastructure and logistics and thus lowered transportation costs. It has also contributed to declining communication costs, which

FIGURE 1.11
TRADE AND COMMUNICATION COSTS



NOTE: Panel A is based on a bilateral measure of trade costs including all costs involved in trading agricultural commodities with another country relative to those involved in trading them domestically. It captures a wide range of trade costs, including transportation costs and tariffs, but also not directly observable costs associated with language barriers and border procedures. Bilateral trade costs are inferred from observed patterns of trade and production across countries.[33,37] Trade costs are calculated as simple averages of exporters by region. For calculating the averages, only bilateral trade costs for three major importers were considered, one in the American continent (Mexico), one in Europe (Germany) and one in Asia (People's Republic of China). The purchasing power parity is a theoretical exchange rate, which is adjusted for the cost of living and inflation rates in different countries. In Panel B, it denotes the relative price that consumers in developing and developed regions pay for the same broadband basket (price of a monthly subscription to an entry level fixed broadband plan of 1 gigabyte).
SOURCES: FAO calculations using data on International Trade Costs from the ESCAP World Bank Trade Costs Dataset (accessed February 2020; latest data available for 2015) and data on communication costs from the International Telecommunication Union (ITU) (accessed April 2020; latest data available for 2017).

also influence trade and promote the global integration of value chains. By helping reduce inefficiencies in value chains, technological progress may also contribute to more sustainable food system outcomes.[31,32]

On average, trade costs, which are determined by transportation costs and changes in trade policy, declined for both manufactured[33] and agricultural products (see Figure 1.11, Panel A). Across the developing world, improvements in transport infrastructure led to lower trade costs, but often at a slower pace than the global average.[33] For example, between 1995 and 2015, in sub-Saharan Africa, trade costs for agricultural products declined by 11 percent, while those in

Europe and Central Asia showed a 33 percent reduction.[d]

The impact of trade costs on agricultural trade can be significant. A study analysing the effect of overall trade costs – including costs related to tariff and non-tariff policy barriers, freight, information, currency and legal and regulatory procedures – on agricultural trade, found that a 1 percent reduction in aggregate trade costs could increase global trade volumes by 2–2.5 percent.[34]

At the same time, technological progress has revolutionized communication by reducing its costs and facilitating trade (see also Part 4 for an in-depth discussion of digital technology impacts on markets). For example, analysis of the impact of communication costs on bilateral trade suggests that halving the importer's calling price leads to a 42.5 percent increase in aggregate bilateral trade.[31] Such impacts were shown to be one-third larger on trade in differentiated products – which requires better information and greater coordination between traders – than on trade in homogeneous products.

Indeed, digital technology improvements and the associated decline in communication costs are seen as a major driver of global value chains, making coordination across different production stages in different geographic locations possible.[35]

The internet is also having a significant effect on trade, allowing firms to communicate and market their products across borders with lower costs. Since the 1990s, the level of internet adoption has increased dramatically – today, it is estimated that around 54 percent of the global population have access to the internet (see Part 4). Higher internet adoption rates are also shown to have positive effects on trade – on average, a 10 percent increase in the exporter's internet adoption rate can bring about nearly a 2 percent increase in bilateral exports.[36]

There are marked differences in this effect depending on whether the internet is better adopted by the exporter or the importer. Nevertheless, high adoption rates by both trading partners can result in significant increases in the volume of trade but also in the number of products traded, as better communication can improve matching.

While costs for fixed broadband internet access have already been low in developed regions, they significantly declined between 2008 and 2017 in developing countries, contributing towards closing the digital gap across the world (Figure 1.11, Panel B). Nevertheless, although access to the internet is important for international trade, quality in terms of bandwidth and better speed is crucial. A study on the relative effects of internet subscriptions (reflecting the size of internet adoption) and bandwidth (reflecting its quality) suggests that a 1 percent increase in average data speed per subscription results in 0.5 percent increase in bilateral trade, while a similar increase in subscription rates brings about an increase of 0.3 percent.[38] Such a differentiated effect underlines the need to focus on improving the quality of digital infrastructure in the developing world, where bandwidth speed can be diverse across countries and subscriptions.

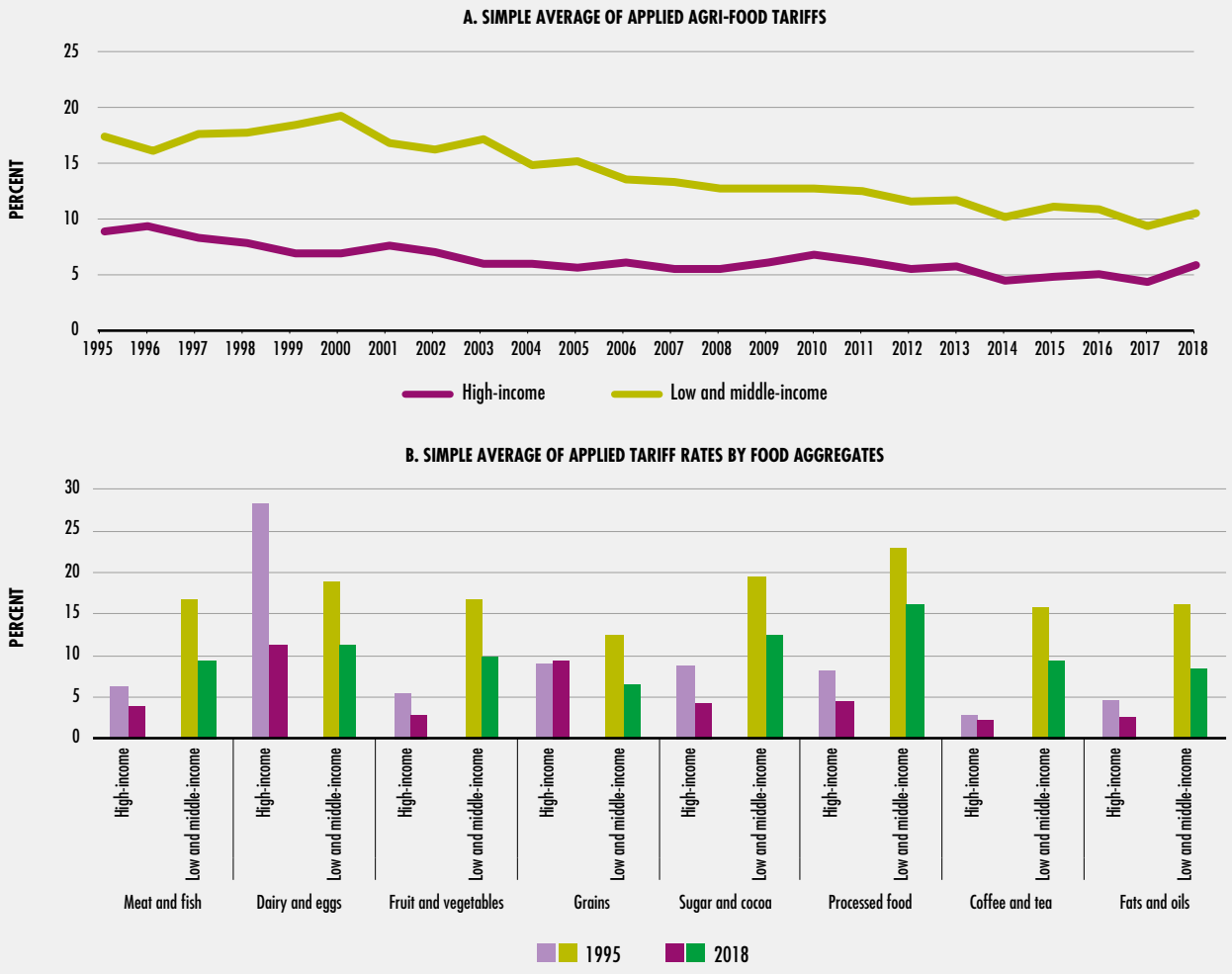
Declining trade costs also result from trade policies. A wave of opening to trade since the General Agreement on Tariffs and Trade (GATT) and the establishment of the WTO in 1995, as well as the proliferation of regional trade agreements, has reduced tariffs and trade-distorting domestic support, and improved the mutual recognition of non-tariff measures (NTMs).

Import tariffs applied to food and agricultural commodities decreased steadily in low- and middle-income countries from an average of around 17 percent in 1995 to approximately 10 percent in 2018 (Figure 1.12, Panel A). Average agricultural tariffs in high-income countries decreased from 9 percent in 1995 to 6 percent in 2018.[e]

d Regional trade costs are calculated as simple averages of costs faced by exporters in each region. For calculating the averages, only bilateral trade costs for three major importers were considered; in the American continent (Mexico), in Europe (Germany) and in Asia (People's Republic of China).

e Weighting tariffs with the actual value traded can draw a different pattern of protection. Tariff patterns depend also on the method of accounting for possible duties on quantities and quantity restrictions.

FIGURE 1.12
AGRICULTURAL APPLIED TARIFF RATES, 1995–2018 (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



NOTE: Low- and middle-income countries are classified as the aggregate of upper middle-, lower middle- and low-income countries.
The calculations in Panel B are based on three-year averages.
SOURCE: UNCTAD-TRAINS data accessed through World Integrated Trade Solution (accessed March 2020).

Tariffs can vary significantly across foods and agricultural commodities (Figure 1.12, Panel B). In high-income countries, average applied tariffs are relatively low on coffee and tea, fats and oils, and fruit and vegetables. However, on average, high-income countries impose considerably higher tariffs on imports of grains, dairy products and eggs. On average, low- and middle-income countries have much higher tariffs. They impose the highest tariffs on imports of processed food, followed by sugar and cocoa, and dairy and eggs. Tariffs in low- and middle-income countries are also relatively high on imports of fruit and vegetables, and meat and fish. For these countries, the lowest level of tariffs is imposed on grains.

Although the impact of digital technology on trade has led many observers to suggest that, in today's environment, trade policies are relatively unimportant, recent analysis suggests that tariffs do matter, especially in the context of global value chains.[39] Although fragmented and vertically coordinated production across different countries is often seen as a result of technological progress, tariff reductions have had a strong impact on the emergence of global value chains by significantly reducing the trade costs of products that cross borders multiple times during the production process.[40]

While tariff reductions have played a significant role in decreasing trade costs and stimulating agri-food trade, trade is also regulated by a myriad of NTMs. NTMs in agriculture include technical barriers to trade that reflect technical regulations and standards, and sanitary and phytosanitary (SPS) measures that ensure food safety.[41,42]

In fact, NTMs are much more important in agriculture than in most other sectors, and their effects on trade can be much stronger than those of tariffs.[43] SPS measures tend to be more stringent in high-income than in middle- and low-income countries.[44] However, the effects of NTMs on trade can be mixed; food standards can be trade-enhancing, as well as trade-impeding, depending on the measures, products and countries involved.[44,45,46]

The growth in high-value exports, such as fruit and vegetables, from developing countries has been accompanied by increasing attention to food safety standards – typically SPS measures – in the markets of developed economies.[47,48] While many food safety standards were initially imposed to meet the requirements in lucrative import markets, consumer awareness for food safety has also gained momentum in developing countries.[48,49] Food safety was, for example, identified as the most important sustainability attribute for rice consumers in Nigeria[50] and has become a societal issue that has received considerable attention in Viet Nam.[51]

Food standards can be public or private. Governments impose, for example, maximum residue limits (MRLs) on pesticides to denote the highest level of a pesticide residue legally tolerated in food. To minimize barriers to trade that might arise from divergent national regulations, global standard-setting bodies such as the Codex Alimentarius Joint FAO/WHO (World Health Organization) International Food Standards Programme aim at harmonizing standards at international level (see Box 1.3).

While many measures are enforced through public standards, increasingly globalized value chains have also led to a proliferation of private standards. These relate to product attributes such as quality grading, residue levels, traceability and branding, as well as process attributes such as organic production and animal welfare.[42]

Private standards often complement public regulation, for example, by referring to sustainability attributes such as environmental protection or ethical sourcing. Moreover, private standards may also fill the gap created by missing public regulation or enforce more stringent requirements than foreseen in national regulations. This is often the case for food safety and food quality standards, in particular when large retailers require a certain, constantly reliable quality of a product. In these cases, private standards could become a barrier to participation in global value chains for farmers and processors that cannot easily comply with them.[42,52] Standards and sustainability certification schemes are also discussed in the contexts of global value chains in Part 2, smallholder farmer integration in Part 3, and digital technology applications on traceability in Part 4.

In order to further reduce trade costs by simplifying and harmonizing customs procedures and export and import processes, the WTO Trade Facilitation Agreement (TFA) entered into force in 2017 (see Box 2.6 in Part 2). ■

AGRICULTURAL AND FOOD MARKETS TRANSFORMATION

The same trends that cause shifts in trade patterns and dietary habits lead to profound changes also in food markets and value chains. Urbanization, in particular, furthers dietary

BOX 1.3
TRADE, FOOD SAFETY AND THE CODEX ALIMENTARIUS

Governments apply food standards to protect public health and to ensure that food is safe and meets quality and labelling requirements. In a globalized world, food safety hazards can cross borders rapidly via agricultural commodities and food products at all stages of the food value chain.

As many countries developed their food laws and regulations independently, they often found different solutions to ensure that food was safe and met the quality expectations. Differing national requirements and regulations, however, make it difficult to trade food across borders. The use of international food standards worldwide helps protect consumers and reduce trade costs by making trade more transparent and efficient, allowing food to move more smoothly between markets.

Both the WTO SPS and Technical Barriers to Trade Agreements (see Part 2) strongly encourage WTO members to build on international standards, guidelines and recommendations as the basis for their national measures. The SPS Agreement explicitly recognizes three international standard-setting bodies, covering three different areas: the FAO/WHO Codex Alimentarius Commission for food safety standards; the World Organization for Animal Health (OIE) for animal health standards and diseases that can be transmitted from animals to humans (zoonoses); and the International Plant Protection Convention (IPPC) for plant health standards.

The Codex Alimentarius Commission was established by FAO and the WHO in 1963 as part of the Joint FAO/WHO International Food Standards Programme and is the single most important international reference point for food standards. Together with the WTO, it provides the institutional framework that governs the development and application of international food safety standards to ensure that food is safe and of expected quality and that it can be traded fairly.

The Codex Alimentarius is a compilation of harmonized international food standards, guidelines and codes of practice that are based on independent international risk assessments. Codex texts are developed through the joint input of independent experts and under the participation of 188 members representing over 99 percent of the world's population. The Codex Alimentarius includes provisions on the whole food safety spectrum including food hygiene, food additives, residues of pesticides and veterinary drugs, contaminants, labelling and reference values for nutrients, methods of analysis and sampling, and import and export inspection and certification.

SOURCES: Adapted from FAO & WTO. 2017; WHO & FAO. 2018.[41,53]

changes induced by income growth and spurs transformations in food value chains and the retail sector.

As people move to cities and consumers live farther away from where food is produced, food retail becomes more important. Urban, and increasingly also rural, food retail has evolved since the beginning of the twentieth century.[54] Traditionally, retail consisted of stalls in wet markets (traditional and roadside markets) and small stand-alone shops, such as grocery stores and local kiosks.[16,54] Supermarkets started to emerge in the 1920s–1940s in the United States of America and Western Europe and in the 1980s–1990s in many developing countries. Supermarkets initially only offered dry goods. Once procurement and storage improved, they also penetrated perishable food markets. Due to their ability to offer a great diversity of products through economies of scope, supermarkets have nearly fully captured food retail in developed countries and have acquired a rapidly growing share in developing countries.[54]

By 2018, sales of leading supermarket chains increased between twofold and sixfold in countries in Asia and in Latin America and the Caribbean, regions where supermarket sales were already relatively high in 2002. More than tenfold increases were reported for countries in which supermarkets started to appear only

around the beginning of the twenty-first century.[55]

A survey of 475 urban households in Lusaka, the capital of Zambia, showed that consumers used both traditional and different modern retailers. About 73 percent of households frequented supermarkets, with the use of these modern retailers increasing considerably from the lowest to the highest income population groups. Traditional wet markets were also frequented by 73 percent of the households with almost no difference between income population groups. The use of grocery stores and roadside markets, however, decreased with rising household income. While modern retailers were usually frequented once a week to make larger purchases, traditional retailers such as wet markets, but also smaller grocery stores, roadside markets and local kiosks, were attended several times during the week to buy additional foods. In this survey, on average, about 42 percent of household food expenditure was made for purchases from modern retailers.[16]

While urbanization is the main driver, changes in the food retail sector are shaped by many factors. In Ghana, an inventory of supermarkets and processed products in eight major urban centres showed only modest supermarket growth, despite rapid urbanization and increasing household incomes.[56] The share of supermarkets in a cross-section of 42 countries at all stages of development was found to also increase with income, openness to inward foreign direct investment and female labour force participation.[57]

Foreign direct investment (FDI) into retail, food processing, restaurants and fast food chains has risen rapidly since the 1980s, originating mainly from transnational food companies targeting markets in low- and middle-income countries. In fact, FDI appears to have proved more effective than trade in generating sales of processed foods in these countries.[58]

Motivated by rapidly expanding populations and less developed retail markets, investments of European grocery retailers in East Asia, for example, peaked in the late 1990s. However, this intense initial phase of investment in the region was followed by a phase of divestment. As a combination of increased regulation in these new markets, growing indigenous competition and firm-level reassessments of global activities, most of these retailers have now divested from individual markets or even exited the region. Most of the exits involved the acquisition of the operation by a local or regional operator, while others were transferred between developed country retailers.[59]

At the beginning of the new millennium, e-commerce started to emerge, adding to the transformation of the food retail sector.[10] E-commerce giants, such as Amazon and Alibaba, combined and extended the advantages of economies of scale and scope that previously supermarkets had had over traditional retail outlets. However, unlike supermarkets at that time, e-commerce businesses further reduce transaction costs of consumers by allowing ordering online and delivering the product to their home.

E-commerce's major drawback is that consumers have no direct observation of the food products. Recently, supermarket chains started adding e-commerce facilities and home-delivery, capitalizing on the fact that consumers are familiar with their products based on previous visits. At the same time, e-commerce firms moved to strategic alliances to include supermarkets in their platforms or add physical outlets to their portfolio, such as Amazon's acquisition of Whole Foods and Alibaba's of part of Auchan and RT Mart chains in the People's Republic of China.[54] Especially in Asian countries such as the People's Republic of China, Japan and the Republic of Korea, a phenomenal rise of e-commerce comprising grocery and meal delivery is observed.[60,61]

However, food e-commerce, while growing rapidly, remains small around the globe with the United States of America and the People's Republic of China experiencing the largest growth.[62,63,64] Although it is difficult to assess e-commerce penetration in food markets due to the lack of comprehensive data, available assessments indicate that the share of e-commerce in food and beverages sales is less than 1 percent of total food expenditures in Asia, Europe and

North America. This contrasts with the rate of penetration of e-commerce for other goods which averages 80 percent in the United States of America and almost 60 percent in the People's Republic of China.[63] The relative bulk of food items, their comparably low price per unit and the logistical challenges of the cold chain have so far prevented the emergence of food as a major category in online retailing.[10,62] These factors are expected to rein in further growth in the market share for food e-commerce, with supermarkets (and supermarket-like outlets) continuing to dominate and, particularly in Africa, expanding.

The transformation of food retail was paralleled by changes in the food service sector, such as shifts from small-scale independent restaurant outlets to fast-food restaurant and café chains. As with supermarkets, the transformation in food services was much faster in low- and middle-income countries than in the pioneering high-income countries. While product and process innovations were initially developed in high-income countries, they later diffused easily as multinational firms undertook FDI in search of profitable new markets. Local food services chains emerged and proliferated to serve lower income consumers and emerging middle-class markets. In the United States of America, the share of calories from food purchased to be consumed away from home was 17 percent in 1977 and 34 percent in 2011.[65,66] Gross sales of leading multinational food services companies in Asia tripled from 2008 to 2018.[55]

Economic growth, urbanization, technological progress and globalization shape dietary changes and affect agricultural production. Increasingly affluent consumers and growing demand for processed and higher quality food spur changes in retail and distribution sectors, as well as in food industries. These trends give rise to demand for more standardized, higher quality and larger amounts of agricultural production from farmers.

Along the development path, these transformations generally evolve over three stages and are driven by private firms seeking profits through innovations, based on new technologies, new business practices and new products.[55,67,68]

At the initial stage of the transformation, *traditional* value chains are short, with farmers often selling their produce directly to end-consumers or to small-scale traders and processors. Very little of the value added comes from off-farm activities such as processing or distribution. Markets are typically characterized by spot transactions without contracts and formal standards.[68]

With increasing urbanization, people move away from rural areas and primary agricultural production and with higher incomes demand more processed and higher quality food. In this *transitional* phase, many micro, small and medium-sized enterprises evolve in food retail, distribution and processing. In response to rising consumer awareness, public and private quality and safety standards emerge. Spot markets still dominate, but vertical integration and coordination through contracting begins to evolve (see Box 1.4).[55,68]

As value chains and market volumes expand, economies of scale and specialization in food retail and processing set in. Large retailers, such as supermarkets, rise and value chains become increasingly vertically integrated and coordinated, marking the change to *modern* value chains (see also Box 2.2 in Part 2). Consumers and the food industry increasingly demand quality and safety standards.[68,71]

While the transformation from traditional to modern value chains was initiated with the Industrial Revolution, and took almost a century in North America and Western Europe, in many developing regions it set in later and has been much faster.[17] This transformation process started in the 1980s in parts of East Asia (excluding the People's Republic of China) and larger countries in South America (such as Brazil); it continued in the 1990s in Central America and parts of South America (for example in Chile, Colombia and Mexico), parts of Southeast Asia and South Africa. In the 2000s, emerging economies in Asia (such as the People's Republic of China, India and Viet Nam) and other South American countries (including Peru and the Plurinational State of Bolivia) followed. The process also started in Southern Africa (Zambia), East Africa (Kenya) and West Africa (Ghana, Nigeria and Senegal) in the 2000s.[68]

BOX 1.4
VERTICAL INTEGRATION AND COORDINATION IN VALUE CHAINS

A typical modern food value chain includes several stages. First, input suppliers provide seed, fertilizers and other inputs to farmers who produce agricultural commodities that are either sold to wholesalers or become inputs to processors. From the processors, food reaches the consumer through several stages, including distributors, wholesalers and retailers (see Figure 1.13).

The multiple stages of a value chain to produce final food products may be controlled by one, a few or many firms or individuals.[55] Modern value chains are typically characterized by coordination between farmers and processors or traders, and between processors and retailers.[67] Firms can vertically integrate or coordinate through a variety of arrangements. These arrangements can be informal or contractual and involve intensive vertical coordination that can extend to common ownership. Value chain coordination can be initiated by downstream buyers, such as supermarkets and food processors, while others are initiated by upstream suppliers including farmers or farmer cooperatives. The arrangements can involve two collaborating parties at successive stages in the value chain or include more complex structures linking multiple stages in the chain based on multi-stakeholder agreements and partnerships.[55]

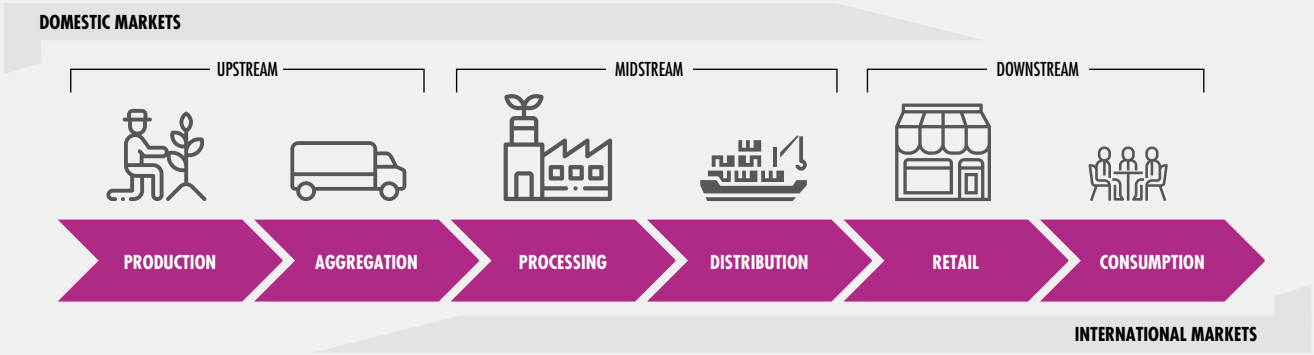
Procurement by the retail and processing sectors is prone to concentration and integration processes leading to fewer and larger firms along the value chain. These are seen as more efficient than smaller firms as they can leverage economies of scale and scope. Large-scale firms in different segments of the value chain may also facilitate each other's growth and evolve together. Supermarket chains, for example, tend to source from large distributors and processors to reduce transaction costs and ensure the compliance with private standards. When supermarket chains enter new countries, large logistic and wholesale multinationals as well as processors often follow.[68] At the same time, market concentration in food value chains raises concerns related to the emergence of market power (see Part 2 for a discussion on competition issues).

Supermarket chains in developing regions have been shifting away from sourcing products from traditional wholesalers and wholesale markets and rely, as much as possible, on specialized, dedicated wholesalers who assemble, grade and sort foods in compliance with the supermarket chain's standards. Current supermarket procurement systems in developing countries are often based on three pillars: (1) specialized procurement agents such as "specialized/dedicated wholesalers" and independent distribution agents; (2) centralized procurement through distribution centres owned by the supermarket chains; and (3) assured and consistent supply through "preferred suppliers", which can be farmers, farmer cooperatives or processors directly without other intermediaries (see Part 3 for arrangements that integrate farmers into value chains).[68,69,70]

The exact procurement system can vary from country to country. In some countries, wholesalers have also vertically integrated into retail and compete with supermarkets.[69] In Botswana, for example, the retail sector consists of retailers owned by wholesale groups; main supermarket chains which own distribution centres; and independent retailers. The vertically integrated wholesalers source their products from suppliers directly and/or from independent distribution agents. Supermarket chains source from their own distribution centres, from wholesalers, from independent distribution agents and/or from suppliers directly. In Zambia, however, independent retailers source from traders and wholesalers, whereas supermarket chains primarily source from suppliers directly.[69]

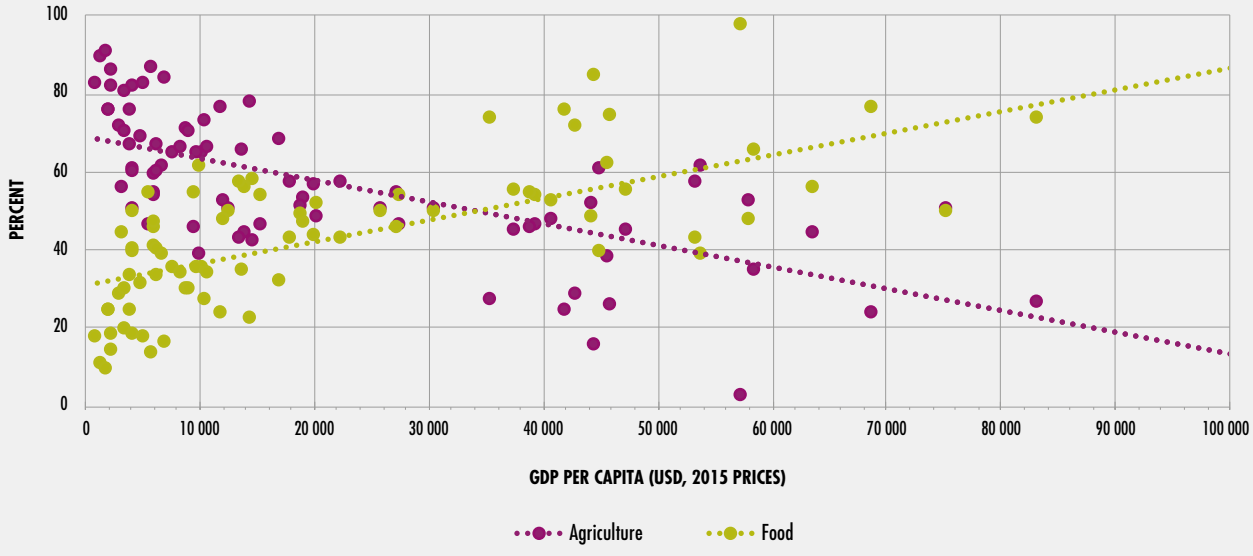
SOURCES: Adapted from Barrett *et al.* 2019; McCullough *et al.* 2008; Reardon *et al.* 2019; das Nair. 2018; Reardon *et al.* 2008.[55,67,68,69,70]

FIGURE 1.13
STYLIZED FOOD VALUE CHAIN



SOURCE: Elaborated by FAO.

FIGURE 1.14
SHARE OF VALUE ADDED OF AGRICULTURE AND OF FOOD IN TOTAL AGRI-FOOD VALUE ADDED BY INCOME, 2017



SOURCE: FAO calculations using FAOSTAT macro indicators (accessed April 2020; latest data available for 2017).

BOX 1.5
GLOBALIZATION, AGRI-FOOD TRADE AND NUTRITION

Improvements in productivity and international trade have increased the availability of food, lowered food prices and thus largely contributed to overall declining rates of undernutrition in the world. At the same time, improved availability of food, lower food prices, higher incomes and a more sedentary lifestyle are associated with drastically increasing rates of overweight and obesity worldwide.[73] While there is compelling evidence that income increases up to a certain point are associated with a higher Body Mass Index (BMI: kg/m²), overweight and obesity, empirical analyses investigating the impact of globalization effects and agri-food trade on nutritional outcomes find mixed results depending on the context and methods of analysis.[74]

GLOBALIZATION EFFECTS ON OVERWEIGHT AND OBESITY

While existing evidence does not clearly show associations between trade liberalization and the prevalence of diet-related noncommunicable diseases (NCDs; e.g. diabetes), the empirical literature points to a broad association with improved dietary quality and reductions in undernutrition.[74]

The economic integration between countries, measured as an index of trade and FDI flows and restrictions, is often shown to have no or a decreasing effect on the prevalence of overweight in the population.[72,75,76] However, FDI alone appears to be more clearly associated with increases in overweight and the prevalence of NCDs than with changes in undernutrition.[74]

Globalization has not only economic effects, but also socio-cultural impacts which affect consumer preferences and are associated with shifts in diets and different nutritional outcomes. Some global studies on the impact of globalization on overweight and obesity find that a closer social integration, measured by an index of personal international contacts, international information flows and cultural proximity,[77] is positively associated with obesity.[75,76] However, there is also evidence for the opposite. A study using a sample of over 160 countries spanning 24 years finds that socio-cultural aspects of globalization and access to information and communications technology (ICT) lower the share of overweight and obese young people aged 15–19, suggesting that knowledge about the benefits of physical activity and healthy diets might diffuse through ICT.[78]

The evidence available also suggests that the association between trade liberalization or globalization and nutritional outcomes might differ substantially across population sub-groups.[74]

For a dataset of up to 887 000 women in 56 low- and middle-income countries between 1991 and 2009, it was shown that both political and especially socio-cultural aspects of globalization are strongly positively related to the risk of being overweight, whereas this was less apparent for the effects of economic globalization. In fact, living in the most economically globalized quartile of countries seems to be associated with a 1 percentage point lower probability of being overweight.[75] However, another study covering about the same time period finds that an increase in trade openness was associated with increasing overweight and obesity prevalence in Brazil.[79]

AGRI-FOOD TRADE AND NUTRITIONAL OUTCOMES

The effects of agri-food trade on nutritional outcomes are mixed, as increasing agri-food trade is associated with rising imports of both foods necessary for a healthy diet and foods high in fat, sugar, salt and calories. However, empirical evidence is scarce, and more efforts are necessary to explore the linkages between trade and nutrition.

A study of 172 countries associated a 10 percent increase in average sugar and processed food imports with a very small (0.0002) increase in average BMI. The imports included a variety of foods from flour to confectionary to margarines but not dairy products or meats. This effect, though very small, was stronger when only countries with a high average BMI (above 25 kg/m²) were considered; a 10 percent increase in sugar and processed food imports was then associated with a 0.004 increase in average BMI.[80] Although the study suggests that trade may have an

BOX 1.5 (CONTINUED)

impact on BMI, the physiological importance of this small effect is not clear.

Agri-food trade was shown to have contributed to increasing the diversity of available foods in countries in Eastern Europe and Central Asia during their transition from a planned to a market-oriented economy. While trade openness was associated with a higher share of fats and oils available for consumption, an increased variety of fruit and vegetables available to consumers could be attributed to the reduction of agricultural trade costs, suggesting that different aspects of trade can be associated with different nutritional outcomes and warranting further and more detailed analysis.[81]

Thus, the data suggest a varied and complex effect of trade on the availability and accessibility of affordable food and subsequently nutritional outcomes.

SOURCES: de Soysa & de Soysa. 2018; FAO. 2018; Cuevas García-Dorado *et al.* 2019; Goryakin. 2015; Costa-Font & Mas. 2016; Dreher. 2006; Knutson & de Soysa. 2019; Miljkovic *et al.*2018; Lin *et al.* 2018; Krivonos & Kuhn. 2019.[72,73,74,75,76,77,78,79,80,81]

The pace of transformation differs by commodity, with grains value chains often transforming first, followed by animal products, and fresh fruit and vegetables, often leading to the co-existence of traditional, transitional and modern value chains in many developing countries.[17,68]

Along the transformation process, the share of value added from the food sector in total agri-food value added increases, while the share of value added from agriculture declines. In countries at the early stages of the transition, total agri-food value added is still dominated by agriculture (Figure 1.14). As average income per capita rises, the contribution of agriculture to total agri-food value added declines. At the same time, emerging industrialization and the development of a food processing and distribution sector result in increases in the share of food in total agri-food value added.[f]

The largest welfare impacts from trade and the transformation of agricultural and food markets are likely to accrue to food consumers. Productivity increases, in conjunction with more trade and competition, bring about increases in the availability of safe and nutritious food and drive its price down, resulting in improvements in access to food. For many people, this process results in improved food security and better diets, since it increases access to foods rich in micronutrients such as fruits, vegetables and animal-sourced foods.

At the same time, globalization, the rise of urban lifestyles, and the associated transformations in food production and food value chains are seen by some analysts as contributing factors in the shift towards less healthy diets, and in the increasing prevalence of overnutrition and obesity in many parts of the world (see Box 1.5).[11,15,16,72] In many low- and middle-income countries, overnutrition and obesity coexist with undernourishment and micronutrient deficiencies, denoting a "triple burden" of malnutrition.

Part 2 further explores the economic and health impacts of global value chains on consumers, as well as linkages with inequality and environmental impacts. The integration of smallholder farmers into modern markets and their inclusion in modern value chains is further discussed in Part 3. ■

f Structural transformation, that is the reallocation of economic activities away from agriculture to industry and services and its impacts on farmers, is further discussed in Part 3.

SERBIA
Orange juice bottles.
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PART 2
GLOBAL VALUE CHAINS IN FOOD AND AGRICULTURE

PART 2 analyses international trade data and looks at the emergence and evolution of agricultural and food global value chains (GVCs). It provides a framework to better understand GVCs and their effects on growth and development in food and agriculture. By allowing the separation of the production process in stages across different countries, GVCs are seen as an opportunity for developing countries to increase productivity. Trade policies and other measures that can promote GVC participation are discussed, as well as the implications of the COVID-19 pandemic on trade and GVCs evolution. The analysis also looks at mechanisms that can help GVCs address the trade-offs between economic and environmental objectives more effectively.

PART 2

GLOBAL VALUE CHAINS IN FOOD AND AGRICULTURE

KEY MESSAGES

1 Global value chains have emerged rapidly and are widespread in food and agriculture. About one-third of global agricultural and food exports are traded within global value chains.

2 Agri-food global value chains can be complex, running across many countries. But as production is separated in different stages, farmers and firms can more easily participate in the stage(s) where they can best leverage their comparative advantage.

3 Participation in global value chains can boost farmers' productivity by diffusing improved technologies and knowledge. But some smallholder farmers who lack the required skills and assets could be excluded from these modern markets.

4 Export restrictions in response to the COVID-19 pandemic can affect global food markets and hurt low-income food-importing developing countries. A shift from global value chains to localized production processes that could be triggered by the pandemic can also hinder productivity and resilience.

KEY ACTIONS

➔ Lower trade barriers can promote global value chains and contribute to growth in agriculture and the food industry. Every time products cross borders, they are subject to import tariffs, which escalate along global value chains and hinder value added creation.

➔ Trade policies that foster open markets should be complemented by measures that improve the capacity to compete in modern global value chains. These include investments in infrastructure, effective regulation and, most importantly, measures targeting the upgrade of skills for farmers and workers.

➔ Global value chains, when combined with sustainability certification schemes, can help align global efforts to address sustainability challenges. Harmonizing sustainability standards and certification across countries can facilitate their application to agri-food global value chains.

➔ Regional trade agreements can stimulate global value chain participation, as well as spur institutional and policy reform. But as many vulnerable countries continue to rely on global markets, international efforts should also promote multilateral trade.

➔ Increased awareness on the contribution of trade and global value chains to growth and food security is important in addressing the challenges posed by the COVID-19 pandemic. Policies that promote international trade add to efficiency gains and strengthen resilience to shocks.

EVOLUTION OF AGRICULTURAL AND FOOD GLOBAL VALUE CHAINS

Global value chains in agri-food markets

Since 1995, international trade in agricultural commodities and food more than doubled in real terms (see Figure 1.1 in Part 1). However, focusing on the value of trade measured through gross exports alone could mask important developments in global markets.

Over time, firms have increasingly used international trade to leverage specialization and comparative advantage by "unbundling" the production process into stages and identifying the least-cost location for each one. This resulted in production processes that run across borders, giving rise to global value chains (GVCs) – production chains that encompass at least three countries. GVCs have been a typical feature in manufacturing and services. Indeed, about half of global goods and services trade now takes place through GVCs.[1]

GVCs are present in food and agriculture. This report estimates that about one-third of agri-food exports are traded within GVCs. Seeds and fertilizers, primary agricultural commodities (such as grains), processed and intermediate products (such as soybean oil or milk powder), but also services and industrial inputs are exchanged between different stages of production that run across multiple countries.

Although relatively new as a topic of analysis, GVCs are based on the fundamental concepts of comparative advantage and specialization in production that have their origins in the classical economic theory of the eighteenth and nineteenth centuries.[2,3] Viewing international trade from a GVC perspective helps to understand how trade contributes to value added that is generated in a country. GVC analysis allows to decompose the value of gross exports into the value that has been imported – and then used in production for export purposes – and the value that is added or generated domestically (see Box 2.1 for further explanation of the key terminology and Box 2.2 for an example).

This emergence of GVCs is driven by declining transport costs and lower trade barriers, such as import tariffs, both of which gave rise to globalization. These trends have made the slicing and spreading of production processes across countries even more attractive. Technological advances and the rise of information and communications technology (ICT) have made coordination across countries cheaper, further promoting GVCs (see also the discussion on trade and communication costs in Part 1).

International trade can improve resource allocation and contribute to economic efficiency, boosting income growth and productivity in trading partners.[4,5,6] Furthermore, an emerging literature suggests that GVC-related trade has a stronger positive impact on productivity and income per capita compared to bilateral non-GVC trade.[7] Participation in GVCs may enable greater competitiveness, better inclusion in trade and investment flows, and improved access to technology and knowledge, all of which help to upgrade towards higher value-added activities.

Export-oriented agriculture, boosted by GVCs, can provide on-farm and off-farm job opportunities. Scaling up agricultural production increases jobs within the sector.

BOX 2.1
GLOBAL VALUE CHAINS: KEY TERMINOLOGY

Global value chain (GVC): Series of stages of production of a commodity or service (the value chain) that encompass at least three countries. GVC analysis focuses on value added – that is the amount by which the value of a traded product increases at each production stage located across countries.

Domestic value added (DVA): The value of exports that is created by domestic production factors, such as land and labour. Domestic value added contributes to gross domestic product (GDP) for each country.

Foreign value added (FVA): The value of exports that originates from imported inputs. For example, if fertilizers were imported to produce agricultural commodities for exports, in GVC analysis they are considered as foreign value added.

Domestic value added, foreign value added and "double-counted" trade flows (value that may arise when intermediate products cross borders multiple times, which does not contribute to either the exporter's or the importer's GDP) add up to gross exports.[8,9,10]

Backward linkages: The degree to which countries rely on imported inputs in the production of exported commodities. It is measured as the share of value of imported inputs in total exports. In GVC analysis, this share is calculated as the ratio of foreign value added in exports over the sum of foreign and domestic value added in exports.

Forward linkages: The extent to which exported commodities are used later in the value chain of another country to be further exported to a third country (or, less commonly, to be re-exported back to the home country). Forward linkages are measured as the value of intermediate exports sent indirectly through third countries to final destinations.

GVC participation: The sum of backward and forward GVC linkages. When measured in US dollars, it is the GVC participation level; the GVC participation rate is derived from this level by dividing by gross exports.

Upstream: A sector in a country that has many forward value chain linkages (either domestic or international).

Downstream: A sector in a country with mostly backward linkages (either domestic or international).

GVC-related trade: Trade that takes place within GVCs.

Bilateral non-GVC trade: In this report, bilateral non-GVC trade is used to define the exchange of goods and services between two countries outside of a GVC. For example, the export of an agricultural commodity to another country where it is processed and consumed is considered as bilateral non-GVC trade.

However, the enhanced production also implies increased demand for inputs, which can have a knock-on effect on employment in, for example, the seed and fertilizer industries, as well as in the relatively labour-intensive transport and commercial services sectors.

Developing countries, including sub-Saharan African countries, are also actively participating in agri-food GVCs.[11] GVCs can allow farmers and firms in developing countries to participate in and benefit from export activities, as it is easier to penetrate the global market when production slices are thinner and more specific. But the benefits of GVC participation are not automatic, and there is a large degree of heterogeneity. For example, although trade is expected to boost economic growth, many developing countries experienced an increase in inequality as they became more exposed to open markets, often due to the lack of complementary policies and investments and transferrable skills in sectors that were impacted the most by trade reforms.[12]

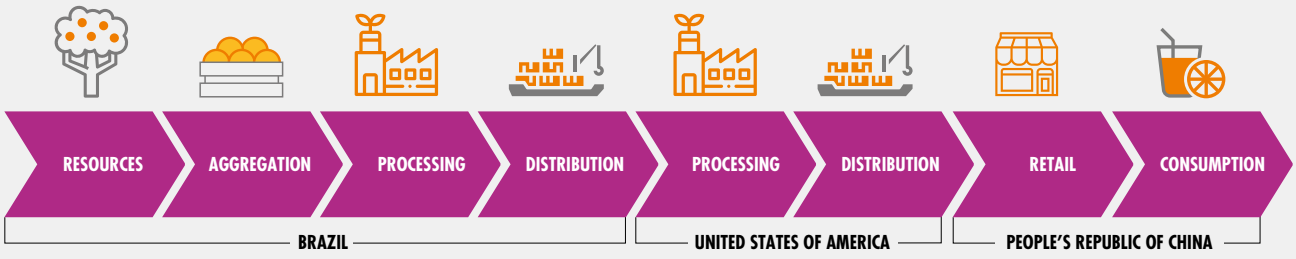
BOX 2.2
GLOBAL VALUE CHAIN IN ACTION: ORANGE JUICE – FROM THE TREE TO THE BOTTLE

Orange-based beverages are among the most popular around the world. Of all the oranges produced worldwide, 20 percent of the total is sold as a whole fruit, while the remainder is used for making extracts and juice. The leading orange producers in the world are Brazil (accounting for about 30 percent of the world's production) and the United States of America (accounting for about 10 percent of the world's production). Over 90 percent of the oranges produced in the United States of America go to juice making.

The illustration below displays that the companies involved in producing orange-based beverages compete with each other and are also complementary. Companies in Brazil focus on processing by crushing domestically produced oranges and exporting the juice extract for further processing and distribution. Companies in the United States of America import the juice extract from Brazil and process it together with the US-produced orange juice extract to produce orange juice-based soft drinks. These are partly consumed domestically and partly exported to other countries, for example the People's Republic of China.

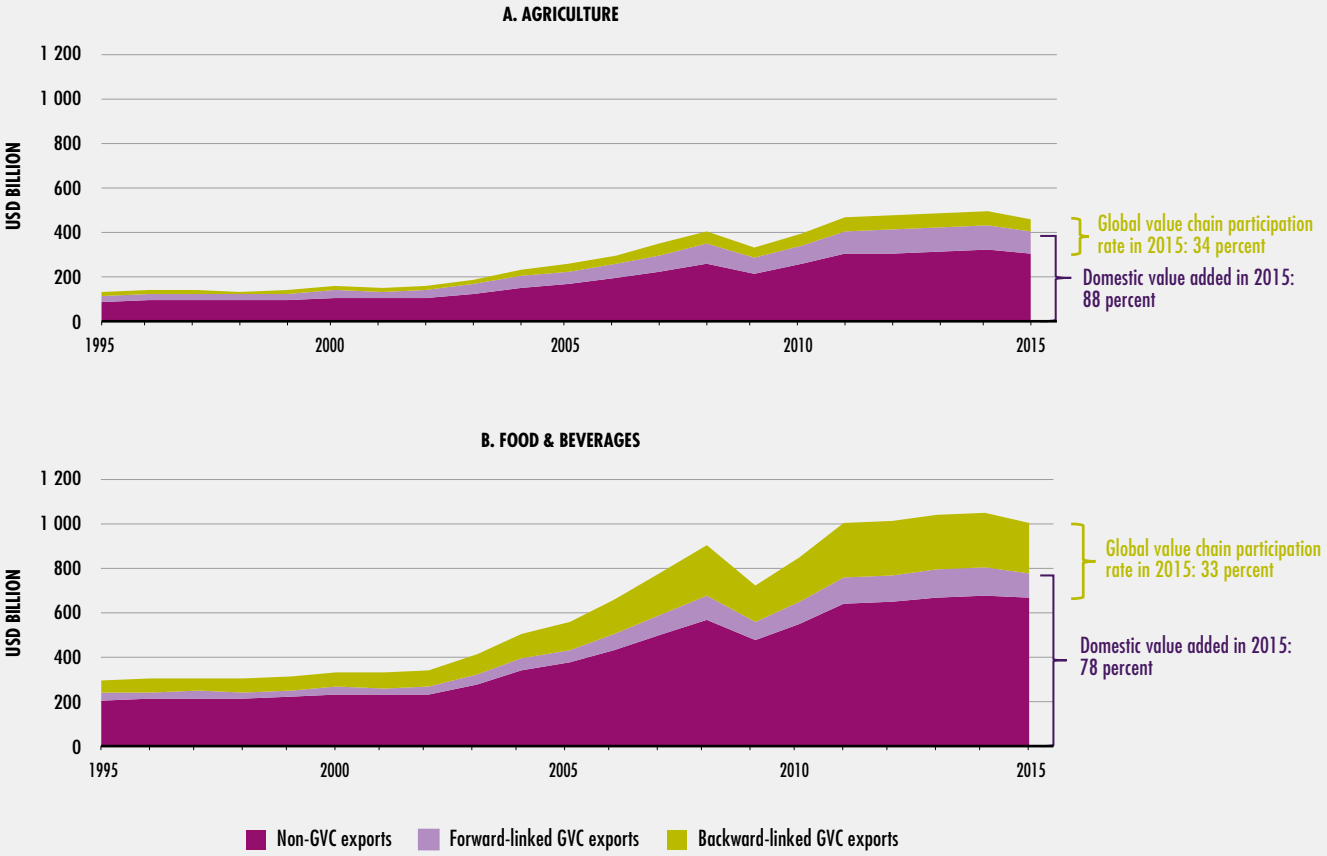
In the GVC of these orange-based drinks, the value of exports to the People's Republic of China is made up of value added from Brazil and the United States of America. For Brazil, the juice extract exports reflect domestic value added. For the United States of America, which imports the juice extract as an input, it reflects foreign value added. At the same time, the processing industry in the United States of America adds value to this input by further processing it – this reflects domestic value added for the United States of America. In this value chain, the forward linkages of GVC participation of the agriculture sector in Brazil are represented in the example by the exports of the processing industry in the United States of America to Peoples' Republic of China. The United States of America has backward linkages (imports of the juice extract from Brazil) and forward linkages (exports of orange drinks to the People's Republic of China). The total GVC participation level of the orange-based beverages sector in the United States of America is the sum of the foreign value added from Brazil (backward linkages), plus the value added generated in the United States of America that flows through to the People's Republic of China (forward linkages).

SOURCE: Azevedo & Chaddad. 2006.[13]



SOURCE: Elaborated by FAO.

FIGURE 2.1
GROSS EXPORTS AT GLOBAL LEVEL AND GVC PARTICIPATION, 1995–2015



NOTE: Backward-linked global value chain (GVC) exports is the sum of foreign value added (FVA) across countries, that is all value added that has already been part of exports earlier in the value chain; at the global level, this represent double-counted value added. Forward-linked GVC exports are exports that will later be re-exported, again aggregated across countries. Non-GVC exports are exports that do not flow through GVCs. Backward- and forward-linked exports add up to GVC participation; forward-linked exports and non-GVC related exports add up to domestic value added (DVA), aggregated across countries. The sum of the three elements equals gross exports. See Box 2.1 for definitions.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

Recent trends in agri-food GVCs

In manufacturing, GVC participation increased from around 45 percent in 1995 to above 50 percent in 2007 and retracted to just below 50 percent in 2015.[14,a] GVC participation rates in agriculture and food and beverages are lower but have followed a similar trend.

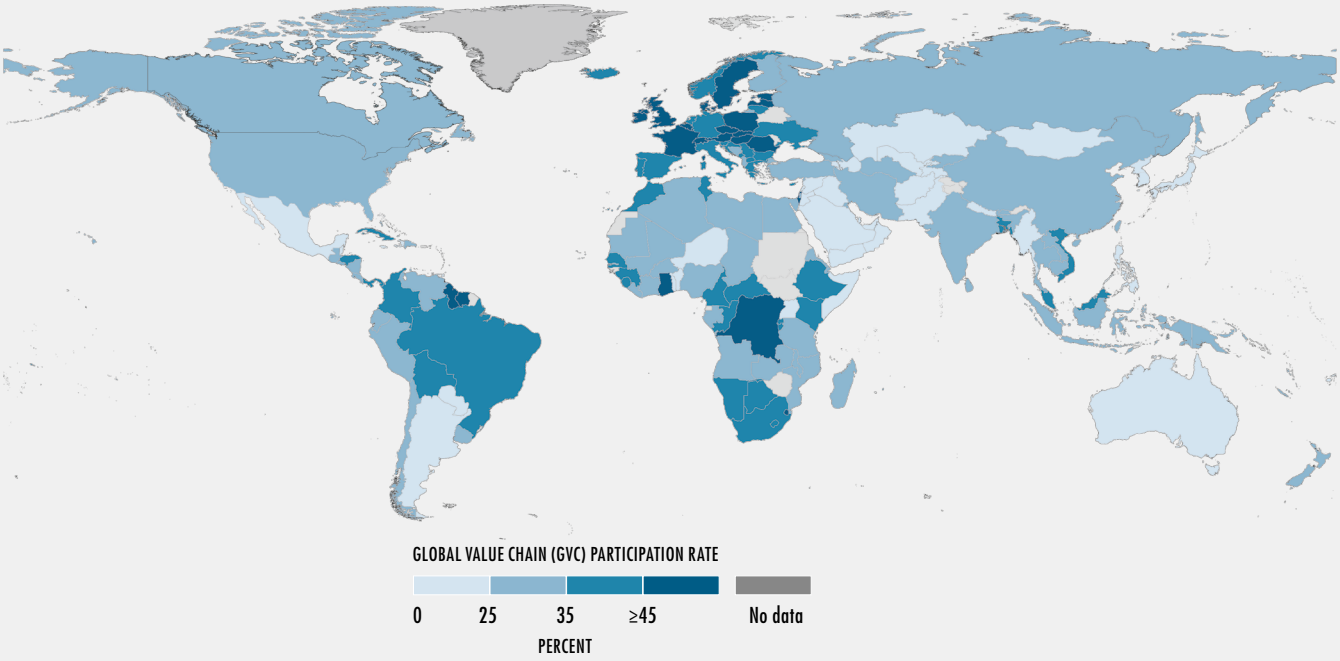
Viewing trade through a GVC lens allows the decomposition of gross exports into GVC-related trade (both backward and forward linkages) and bilateral non-GVC trade (Figure 2.1). Globally, average participation in agri-food GVCs peaked from around 30 percent in 1995 to above 35 percent in 2008, followed by a slight decline.[b] In 2015, about one-third of all agri-food value added that was exported was part of a value chain that involved at least three countries (34 percent in agriculture and 33 percent in food and beverages; see Figure 2.1, Panels A and B, respectively).

Agricultural commodities are a basic input in food and beverages but also in other sectors, and thus, GVC participation in agriculture is mostly through forward linkages (Figure 2.1,

a Domestic and foreign value added, and thus GVC participation rates, are calculated at the national level and then aggregated across countries. From a purely global perspective, foreign value added would by definition be zero.

b Multiregional input-output tables (MRIOs) can be used to calculate GVC participation by country and sector as they detail the economic flows of inputs between sectors and countries. In this report, the EORA MRIO is used. As globally consistent input-output tables are not available beyond 2015, the analysis in this report covers the period 1995–2015.[15] The dataset used in the calculations in this section comprises 181 countries for the period 1995–2015.[16]

FIGURE 2.2
GVC PARTICIPATION RATES IN AGRICULTURE IN 2015



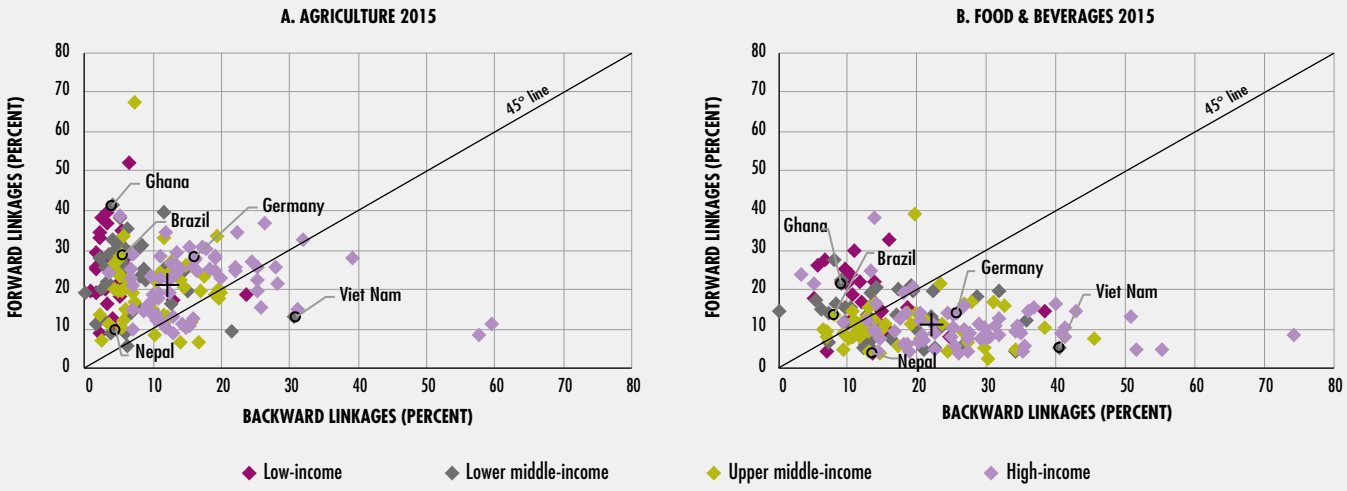
NOTES: GVC participation rates are the sum of backward and forward GVC linkages as ratio of gross exports. See Box 2.1 for definitions.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

Panel A). On average, a significant share of agricultural production is linked to GVCs through exports, leading to high forward linkages (22 percent of the value of gross exports). The backward linkages of agriculture reflect imports of inputs, such as seeds and fertilizers, as well as significant use of services in the production process (such as quality controls, logistics, storage and financial services). At the global level, as exports cross borders, these backward linkages give rise to double-counting of value added and make up a relatively small part – about 12 percent – of the total value of gross exports (at the country level, backward linkages reflect foreign value added; see Boxes 2.3 and 2.4). The larger part of the value of agriculture's exports, about 88 percent, reflects domestic value added, that is value generated by land and labour, production factors that are not traded internationally. A proportion of this domestic value added can become part of GVCs downstream through forward linkages.

The food and beverages sector (which includes all processed products) is more in the middle or at the end of the value chain. Globally, its GVC participation rate is comparable to that of agriculture (on average, 33 percent; see Figure 2.1, Panel B). However, food and beverages entail a larger share of backward linkages in production compared to agriculture (about 22 percent) and relatively fewer forward linkages (11 percent). This is because the sector uses domestic and imported agricultural commodities but also inputs from other sectors on a large scale. When these are imported, it leads to a significant level of foreign value added embedded in exports. Therefore, at the global level, a significant part of gross exports are backward-linked and thus double-counted. Part of the forward linkages of the food and beverages sector concerns exports of lightly processed products, such as orange juice extract, that can be used by the food industry of another country and processed further before they are re-exported (see Box 2.2 for an example).

Global exports of food and beverages are approximately twice as large as those of agricultural commodities, and, in absolute terms, the rapid increase in their value between 2002 and 2008 is remarkable (see also the discussion on the evolution of trade in Part 1). The increasing share of backward-linked GVC exports also shows that the trend in total gross exports is not all newly created value added.

FIGURE 2.3
FORWARD AND BACKWARD GVC LINKAGES IN 2015 (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



NOTE: GVC = Global value chain.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

GVC-related trade has increased even more rapidly than bilateral non-GVC trade, at least until the financial crisis in 2008, since which further integration in GVCs has stalled.[c] The effects of the financial crisis are clear in both agriculture and food and beverages GVCs with a three-staged impact: (i) GVC participation rates declined significantly in 2009; (ii) there was a rebound effect in 2010–2011; and (iii) GVC participation rates have stagnated since 2011. Furthermore, for both sectors, the shares of backward and forward linkages remained approximately unchanged over the 1995–2015 period. This suggests that changes in total GVC participation have been driven more by scale effects – that is increased trade through both backward and forward linkages – rather than by changes in the positioning of firms across the different value chains, which would imply that backward and forward linkages evolve differently.

The financial crisis and the slowdown in economic activity affected all trade. However, the decline in trade may be due in part to a structural change in the trade-GDP relationship. It may have resulted from a slowing pace of international vertical coordination due to the economic slowdown that is evident in the evolution of GVCs.[18]

GVC participation rates vary widely across countries (Figure 2.2 shows this for agriculture). Small countries tend to trade more and are thus more likely to be involved in GVCs.[d]

c Evidence on trends after 2015 is scarce, but the analysis in the World Investment Report 2019[17] seems to suggest that foreign value-added levels revert after 2015 to 2011–2013 levels, suggesting that the slowdown may be temporary, and the long-term trend is approximately flat. Nevertheless, the impact of COVID-19 pandemic may affect foreign value added trends.

d Some of the small countries heavily involved in GVCs are mainly European Union countries and are part of the Common Market of the European Union.[16]

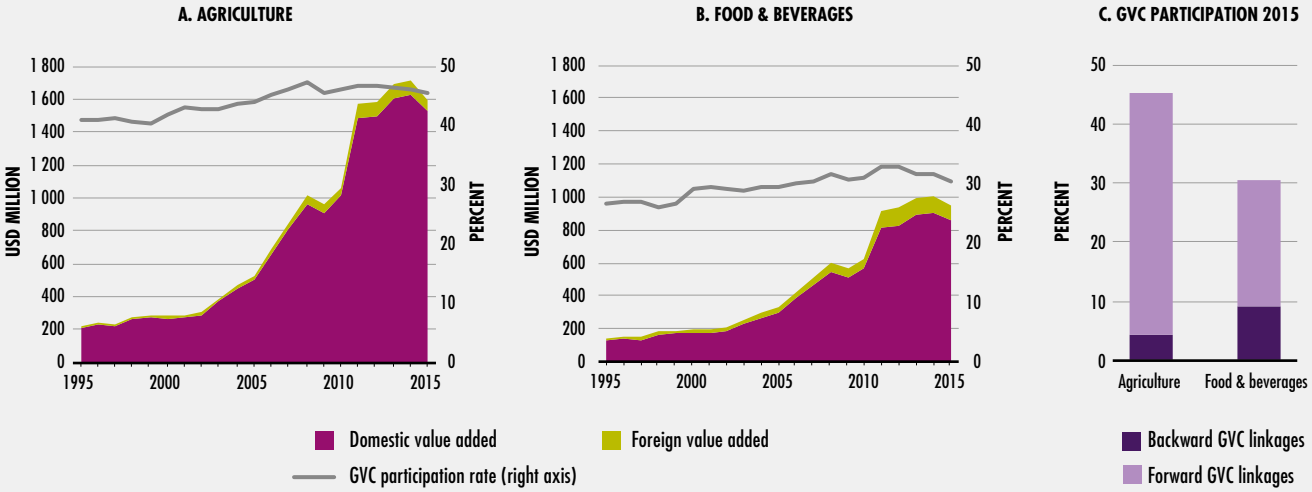
BOX 2.3
EXAMPLE OF A COUNTRY WITH UNEVEN GVC LINKAGES: GHANA

Ghana's GVC participation differs between agriculture and food and beverages. Agriculture is characterized by rapidly expanding export volumes and a high GVC participation, but the food and beverages industry is less developed (Figure 2.4, Panels A and B).

As Ghana exports mostly unprocessed cocoa, it has very high forward linkages from its agricultural sector to the rest of the world (Figure 2.4, Panel C); similarly, Ghana's food exports are largely lightly processed cocoa products and hence have low backward linkages to other economies. Together this leads to Ghana's status as a large exporter with strong GVC linkages in agriculture but with relatively weaker GVC linkages in food and beverages.

SOURCES: FAO analysis by Dellink *et al.* 2020; AfDB, OECD & UNDP. 2014.[16,20]

FIGURE 2.4
GROSS EXPORTS AND GVC PARTICIPATION IN GHANA



NOTE: GVC = Global value chain.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

This can also reflect that small countries are relatively more open to trade as their economies lack scale and tend to be less diversified.[19] The higher GVC participation rates of small countries imply a stronger reliance on imports – through backward GVC linkages – but also closer ties to the international markets – by means of forward GVC linkages.

In general, low-income countries tend to have low backward linkages, as they primarily specialize in producing and exporting agricultural commodities. Their forward linkages vary substantially, depending on a range of factors, including geography. Nepal, for example, has relatively low backward and forward linkages, as it mostly trades with India rather than with the global market

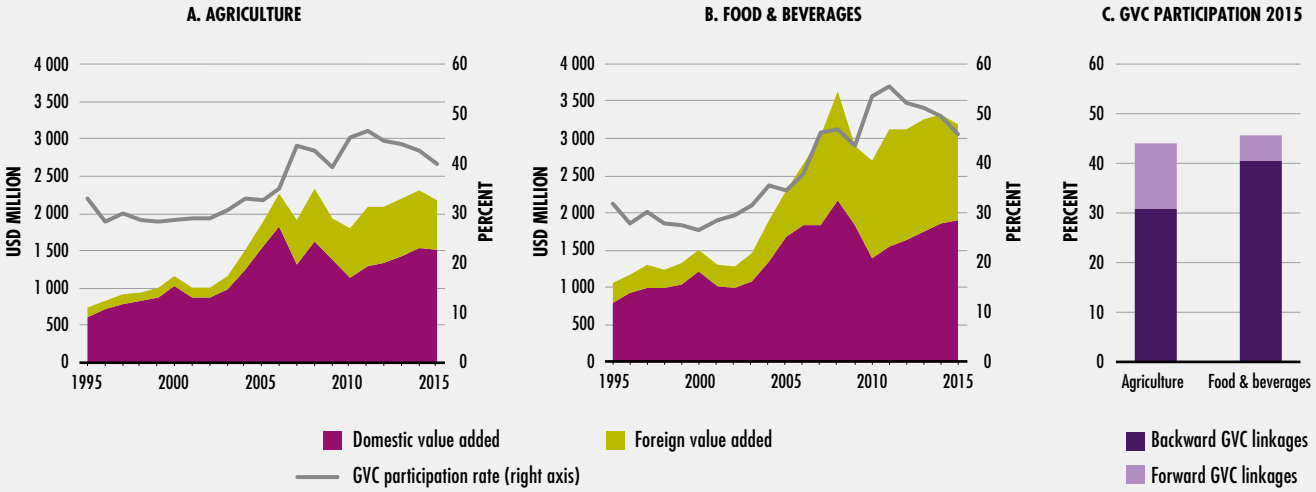
BOX 2.4
EXAMPLE OF A COUNTRY WITH STRONG GVC LINKAGES: VIET NAM

GVC participation in Viet Nam is quite extensive and exemplifies its international orientation, particularly of the food and beverage industry (Figure 2.5).

Trade liberalization and international economic integration have brought about significant contributions to export expansion, economic growth, employment creation and welfare improvement in Viet Nam, especially after 2000. Viet Nam benefited throughout the period from several bilateral trade agreements, its membership in the Association of Southeast Asian Nations (ASEAN) and the Free Trade Agreements that this regional trade bloc has signed. The country experienced persistently increasing participation rates in both sectors in the 2000s after the Asian crisis (Figure 2.5, Panels A and B). These positive impacts are, in large part, brought about by greater capital inflows. The extensive backward linkages in the food and beverages industry suggest that Viet Nam has specialized in processing imported basic inputs from its regional neighbours (Figure 2.4, Panel C).

SOURCES: FAO analysis by Dellink *et al.* 2020; Auffret. 2003; EU Commission. 2018.[16,21,22]

FIGURE 2.5
GROSS EXPORTS AND GVC PARTICIPATION IN VIET NAM



NOTE: GVC = Global value chain. Gross exports exclude fisheries; therefore, export volumes in this figure are lower than those reported in Part 1.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

(Figure 2.3). Middle-income countries can exhibit a range of GVC participation patterns.

Ghana, a lower middle-income country, enters GVCs with substantially higher forward GVC linkages (Figure 2.3 and Box 2.3). In contrast, in Viet Nam, another lower middle-income country, GVC participation is quite extensive, mainly through backward linkages (Figure 2.3 and Box 2.4).

In Brazil, an upper middle-income country, GVC participation rates remain below the global average for both agriculture and food and beverages. Its forward linkages are significantly lower than those of Ghana, as most trade is bilateral – for example, with the United States of America due to trade agreements – and not through GVCs (Figure 2.3).

Some high-income countries – mainly in Europe – enter agricultural GVCs combining high backward with high forward linkages. Germany, a high-income country, is an example of an economy with high export intensities and significant GVC participation. Other high-income countries tend to have more backward linkages but relatively fewer forward ones (Figure 2.3). ■

GVC PARTICIPATION AND ECONOMIC GROWTH

GVC participation and value added across economic sectors

The relationship between international trade and economic growth is complex. Nonetheless, there is widespread empirical evidence that, in the long term, trade promotes growth and development. In the short term, every country has a relative comparative advantage in some goods and services, and all countries could potentially gain when engaging in trade. In the long term, these efficiency gains together with technological spillovers and the transmission of knowledge, which are stimulated by trade, can generate dynamic benefits in terms of higher productivity and innovation, leading to economic growth. The relationship between trade and economic growth runs both ways, as at the same time, economic growth, by strengthening demand, also boosts international trade.

Emerging evidence shows that participation in value chains can be even more beneficial for growth and productivity than bilateral non-GVC trade.[7] Indeed, there is a positive association between growth in agri-food value added and growth in GVC participation, although this does not imply a causal relationship (Figure 2.6). In both sectors – agriculture and food and beverages – those countries that exhibit a higher average growth rate in value added tend to have higher growth in GVC participation levels.[e]

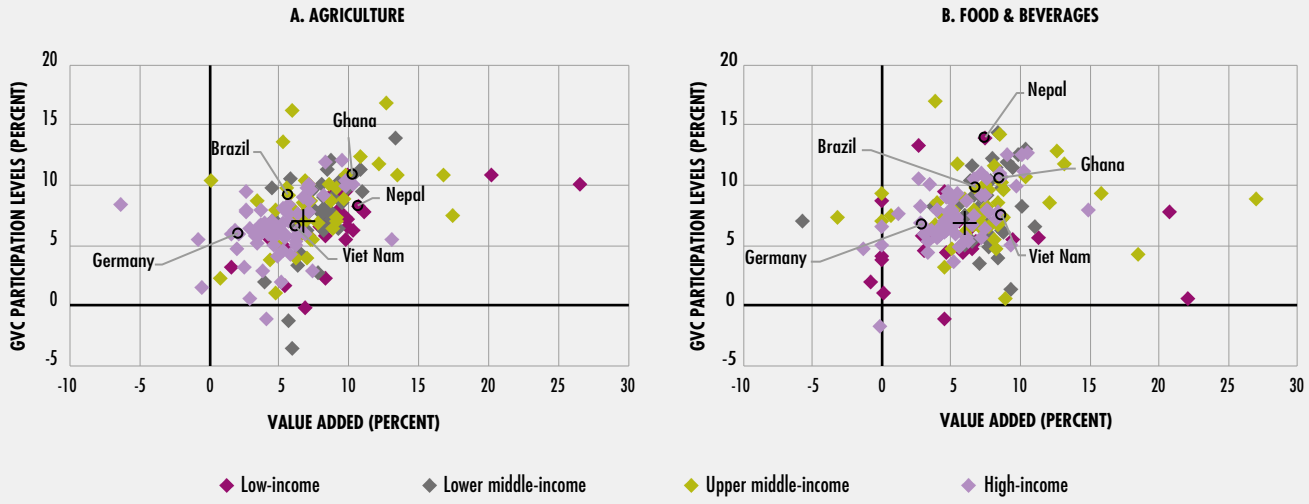
Nevertheless, several empirical studies, which are based on aggregated data from all economic sectors, have found significant causal effects of GVC participation on value added for middle- and high-income countries and negligible impacts for low-income countries. More specifically, the analysis suggests that increased backward linkages (through increased imports of foreign value added) have not led to economic growth in some low-income developing countries; these countries are characterized by low skill-sets and thus low capacity to learn and absorb knowledge to apply technological advances that otherwise could be diffused and promote growth.[23] This relationship between GVC participation and growth depends on capabilities to both adapt to production processes and innovate. For example, labour force education and skills, regulations that promote businesses, and investments in research and development all reflect a country's ability to enter GVCs effectively.

Most studies that analyse the impact of GVCs participation on economic growth consider the economy as a whole. Indeed, GVCs link economic activities over different sectors and across countries. Within a country, a significant share of the growth in value added in agriculture comes from its linkages to other economic sectors. Increased GVC exports by the food and beverages sector, and other sectors that use inputs from agriculture, can further promote agriculture's participation in global trade and create value added. GVCs also link economic sectors across countries. Globally, in food and beverages GVC exports, agriculture makes up 20 percent of the foreign value added.

In this way, GVCs, through technology and knowledge spillovers, can generate benefits for the whole economy and for other countries. Exports of agricultural commodities and food and beverages contain value added that is created by a range of economic sectors that supply inputs, such as fertilizers, energy and services. A significant part of foreign value added in agri-food exports, globally, is provided by the services sector – in 2015, for agriculture and food and beverages, services made up 42 percent and 38 percent of the foreign value added embedded in GVC exports, respectively.[16]

e This result does not extend to GVC participation *rates*, as sectoral growth leads to larger exports, which acts as the denominator in the calculation of GVC participation rates.

FIGURE 2.6
RELATIONSHIP BETWEEN GROWTH IN VALUE ADDED AND GROWTH IN GVC PARTICIPATION BETWEEN 1995 AND 2015 (COUNTRIES CLASSIFIED IN GROUPS BY INCOME LEVEL)



NOTE: Global value chain (GVC) participation reflects growth in participation levels, not rates. Value added reflects total sectoral value added in production. Growth rates reflect average annual growth rates between 1995 and 2015.
SOURCE: FAO analysis by Dellink *et al.* 2020.[16]

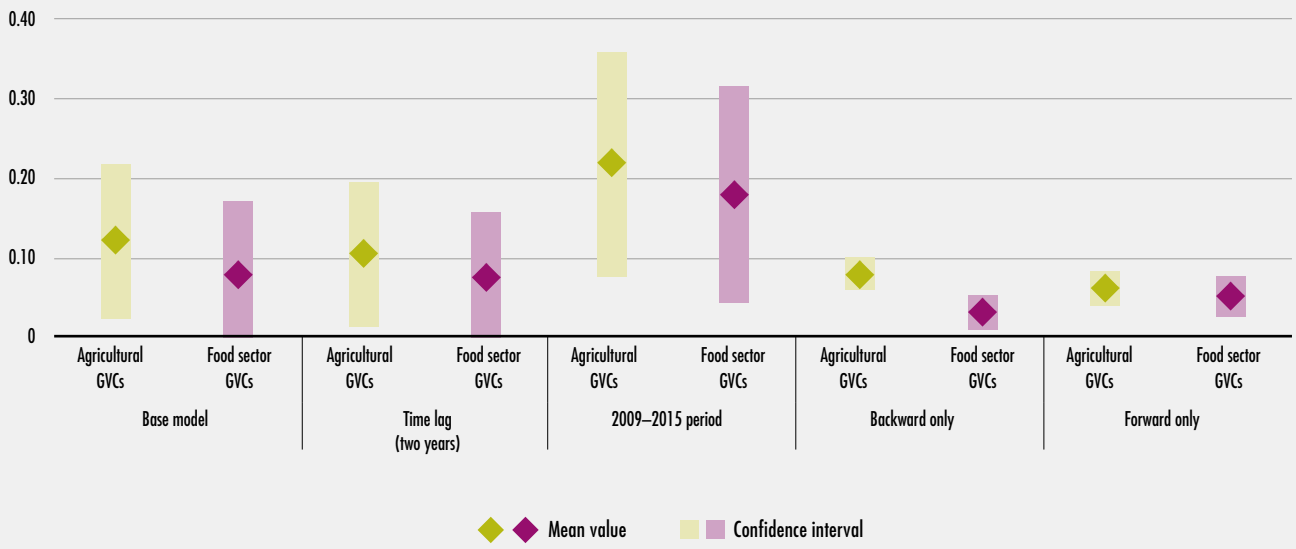
In addition, a significant share of imported inputs (on average, 22 percent in 2015) is provided by the chemicals and raw materials sector (which also includes petroleum). This large share partially reflects the globalization of the fertilizers and pesticides markets. The share of manufacturing (including machinery) in foreign value added is also sizable in both agriculture and food and beverages, amounting to 19 percent and 16 percent, respectively.

Such linkages also shape the strength of the relationship between GVC participation and economic growth together with the country's capacity to effectively absorb technology and knowledge. Factors such as the structure of the economy, geography, the size of the domestic market, the level of development, but also crucially government policy settings matter. The impact of increased GVC participation is likely to vary depending on policies that promote the mobility of production factors, especially labour, and on conditions that allow economic activity to expand, such as investments in human capital through better skills, improved infrastructure and effective regulation.

GVC participation and agricultural labour value added

Analysis also suggests that GVC trade results in increased labour value added or productivity per capita.[24] The main mechanism for this lies on how value chains unbundle the production process – allowing farms and firms to leverage additional options for comparative advantage – promoting stronger competition and better access to capital and knowledge. For example, with adequate skills, backward linkages can work as a channel for the transmission of improved technology leading to better farm practices and improved labour productivity.

FIGURE 2.7
EFFECT OF A 1 PERCENT CHANGE IN GVC PARTICIPATION ON AGRICULTURAL VALUE ADDED PER WORKER



NOTE: GVC = Global value chain.
SOURCE: Based on analysis provided by Montalbano & Nenci. 2020.[26]

GVCs can represent an opportunity for supporting the ongoing transformation of food and agriculture in developing countries and spurring a shift from a low productivity to a more commercialized and productive agricultural sector with stronger backward and forward linkages to the domestic economy and the global market.[25]

Empirical estimates using data on the GVC participation of 160 countries between 1995 and 2015 developed for this report establish a causal relationship between GVC participation and agricultural value added per worker; they also show that changes in GVC participation can have a significant impact on agricultural labour productivity measured by the value added per worker (see Figure 2.7).[f] Globally, on average, a 1 percent increase in *agriculture's* GVC participation results in an increase of around 0.12 percent in labour productivity in agriculture, measured by agricultural value added per worker.

Greater GVC participation of the *food and beverages* sector is also estimated to have a positive effect on agricultural value added per worker, with an average effect at around 0.08 percent. This is due to the strong links between agriculture and the food industry: agricultural commodities that are produced domestically and then processed and exported by the food and beverages sector through GVCs can raise productivity in agriculture.

The estimates also suggest that GVC participation can have sustained long-term impacts on labour productivity in agriculture. An increase of 1 percent in GVC participation continues to add to agricultural labour productivity even

f A detailed description of the methodology and empirical results is given in Montalbano and Nenci. 2020.[26]

after two years, although this long-term impact diminishes moderately as time passes – the effect of agricultural GVC participation weakens to 0.10 percent after two years.

Additional analysis for the shorter period of 2009 to 2015 provides evidence that the effect of GVC participation on agricultural labour productivity was not a temporary feature of the high-growth economic boom at the beginning of the century but remained during the period of much weaker growth after 2008. This suggests that, during times of fast growth, processors and retailers procure from many farms, but the least productive of these drop out of the global value chain when growth stagnates. This sorting process, where only the more productive farms remain connected to global markets, could result in a higher average impact on productivity (Figure 2.7).

Both backward and forward GVC linkages contribute significantly to labour productivity in agriculture and approximately add up to the effect of total GVC participation (see Figure 2.7). In other words, both sourcing more foreign inputs for producing for exports and providing more inputs to foreign partners for their exports tend to bring about economic benefits.[9] From a policy perspective, this implies that trade policies on both the import and export sides are critical. ■

POLICIES TO PROMOTE GVC PARTICIPATION

Over the past four decades, international trade negotiations in the General Agreement on Tariffs and Trade, and subsequently under the WTO, have contributed to opening up global markets. Import tariffs on agricultural commodities and food products have declined since the implementation of the WTO Agreement on Agriculture in 1995–1996 (see Figure 1.12, Part 1).

Many developing countries have initiated policy reforms to reduce trade barriers and engage in international trade.

Yet, despite these reforms, agri-food markets remain relatively highly protected compared to other economic sectors. Average tariffs on agricultural commodities and food are around three times higher than those imposed on other goods.[33] They are also higher in low- and middle-income countries than in high-income countries (see Figure 1.12, Part 1). In some developing countries, other trade-related costs are also substantial due to weak contract and regulatory enforcement, inadequate transport infrastructure and other distortions.[34,h]

Opening global markets can bring benefits to all trading partners and can create important spillover effects through the transmission of technology and the transfer of know-how. Opening markets is more likely to result in significant benefits if complemented by other policies that underpin competitiveness, such as measures that improve governance and infrastructure, upgrade skills, remove rigidities in labour markets and facilitate the reallocation of labour between sectors. However, there are concerns about the short-term effects of opening trade, especially the impacts on income distribution and inequality.[12,35,36]

To reap the benefits of GVC participation for economic growth, appropriate trade policies on both the import and export sides are critical. Opening to trade and removing market-distorting policies could enhance the unbundling of production processes internationally, and thereby promote GVC participation. Through various mechanisms, opening to trade stimulates economic activities in general and can facilitate food system transformation, including the emergence of a domestic food industry (see Part 1).

g As differences between regions are substantial, more detailed regional studies can shed light on these linkages. Empirical results from Southeast Asia suggest that foreign sourcing in the production of exports is a complement to, rather than a substitute for, the creation of domestic value added in exports.[27] The positive relationship between the use of imported inputs and increases in productivity growth for the economy as a whole, and specifically for agriculture, in developing countries is also found for Chilean manufacturing plants,[28] Hungary,[29] India,[30] Indonesia,[31] and Latin America and the Caribbean.[32]

h These also imply that the pass-through of costs and taxes to downstream firms and consumers is far from perfect, with a significant share of the trade costs being borne by farmers. Furthermore, implementing a tariff fails to achieve its intended results if the tariff revenue never materializes; correcting for the missing revenues dramatically changes the calculations of the benefits of tariff policy. More generally, in the presence of tariff evasion, attempts to target particular products through tariffs as a form of agricultural policy may be ineffective.

BOX 2.5
ANALYSING POLICIES TO PROMOTE GVC PARTICIPATION: EFFECTS BY POLICY MEASURE AND RETURNS TO LAND, LABOUR AND CAPITAL

A computable general equilibrium model – a model of the global economy including agriculture and the food sector – is used to simulate the effects of different policies on GVC participation. The simulation exercise considers a policy package that includes the removal of all import tariffs and export restrictions in all sectors of the economy, as well as the removal of domestic subsidies and taxes on agricultural commodities, food and beverages products, and land inputs. As the model is a stylized representation of the economies involved, these results should be interpreted with care: the mechanisms and direction of impacts matter more than the size of the effects.

The policy changes have immediate impacts on gross agri-food exports and through those on value added and GVCs. While the overall effects on GVC participation are positive, the impact can differ by region, policy measure and production factor.

PROJECTED EFFECTS ON GROSS EXPORTS BY POLICY MEASURE

From a GVC perspective, tariff and non-tariff barriers – including those to trade in services – are viewed as important instruments in determining domestic value added. However, the strength of the effects on agri-food GVCs can differ by measure and economic sector to which these measures are applied.

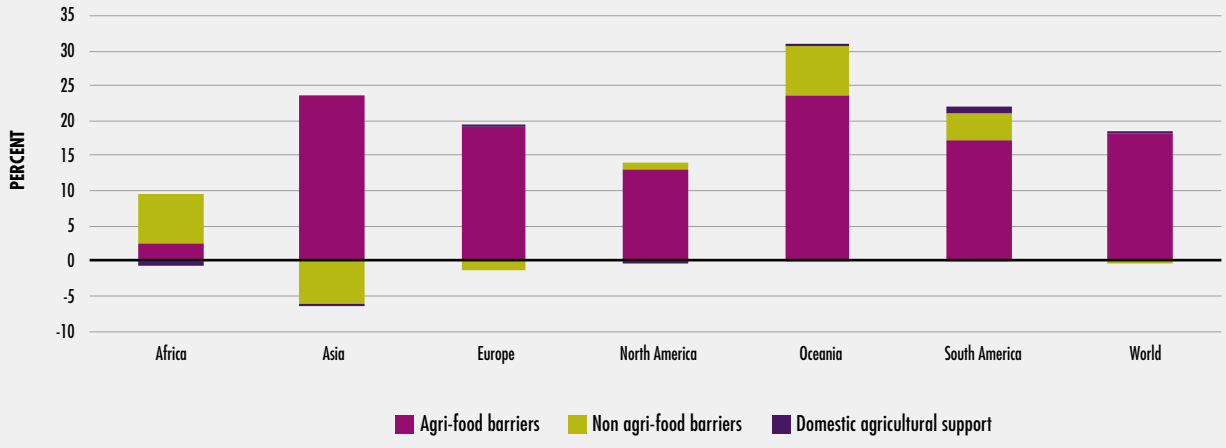
In most regions, phasing out trade barriers in agriculture and food and beverages is projected to be more important than reducing domestic support distortions. Removing trade barriers in sectors other than food and agriculture also brings about impacts on agri-food exports (see Figure 2.8).

Removing tariffs on agricultural commodities and food products across all countries and regions is projected to result in increases in agri-food exports. This also implies better opportunities for GVC participation in the form of foreign value added in production for exports (backward linkages), as well as increased exports of intermediate products for foreign processing and re-exporting (forward linkages).

The removal of domestic support to agriculture has little effect on agri-food exports compared to trade liberalization.

In contrast, removing trade barriers in sectors other than food and agriculture, leads to adjustments that benefit agri-food exports from some regions at the expense of exports from other parts of the world. For example, in Africa, phasing out non agri-food trade barriers has a positive effect on the economy of the region, through improved terms of trade that result in increases in the relative competitive position of exports of all sectors, including those from food

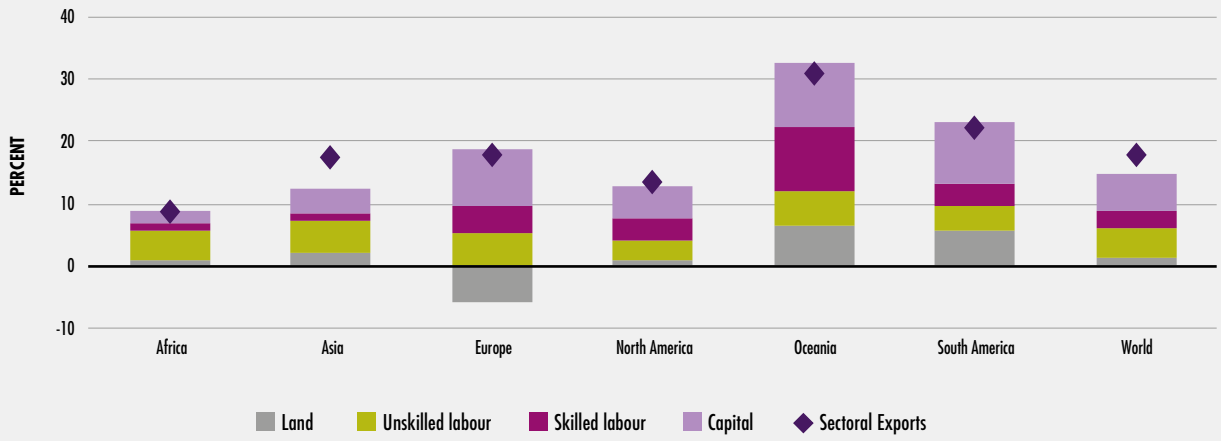
FIGURE 2.8
PROJECTED EFFECTS OF REMOVING DIFFERENT POLICY MEASURES ON GROSS AGRI-FOOD EXPORTS, PERCENT CHANGES



NOTE: The simulation scenario consists of removal of all (agri-food and other) tariffs, subsidies and taxes on agri-food outputs and land inputs. Exports reflect both domestic and foreign value added exported by the agri-food sectors.
SOURCE: Based on analysis provided by Salvatici. 2020.[37]

BOX 2.5
(CONTINUED)

FIGURE 2.9
PROJECTED EFFECTS OF OPENING TO TRADE ON EXPORTED AGRI-FOOD VALUE ADDED BY PRODUCTION FACTOR, PERCENT CHANGES



NOTE: The simulation scenario consists of removal of all (agri-food and other) tariffs, subsidies and taxes on agri-food outputs and land inputs. Sectoral exports reflect both domestic and foreign value added exported by the agri-food sectors.
SOURCE: Based on analysis provided by Salvatici. 2020.[37]

and agriculture. African agri-food exporters can thus reap a larger share of the global market *vis-à-vis* their competitors.* However, in Asia and Europe, this competitive position deteriorates, worsening export prospects for food and agriculture.

PROJECTED EFFECTS ON RETURNS BY PRODUCTION FACTOR

On average, trade and GVC participation can have a positive effect on agricultural income, both in terms of domestic value added and the share that accrues to labour.[38] Especially in developing countries, increased GVC participation could create more jobs for unskilled workers. Indeed, increased GVC participation through the removal of trade barriers and distortive policies is projected to lead to a relatively large increase in the demand for unskilled labour in regions where average income per capita is relatively low. In developed countries and regions, the results suggest that the benefits will accrue to both skilled and unskilled labour (Figure 2.9).** Nevertheless, a key question relates to when low-skilled farmers and agricultural workers can reap such benefits, as GVC-based trade tends to place stringent requirements on production that necessitate specific skills and capabilities.

Land and capital are generally also projected to increase their contribution to exported value added.*** The exception is Europe, where removing domestic taxes and subsidies related to land is projected to result in a decline in value added.****

* Oceania and South America also benefit from this realignment, but the effects of removing agri-food trade barriers dominate in these regions.

** Removing all trade barriers and distortive policies may also lead to increased employment outside the agri-food sector, especially in sectors that supply inputs to the agri-food sector. This effect can be significant.

*** The bars in Figure 2.9 reflect value added generated in the agri-food sector, regardless of whether this is exported by the sector itself or by another downstream sector. In contrast, the gross exports presented in Figure 2.8 – and represented as black markers in Figure 2.9 – reflect exports of domestic value added by the agri-food sector only, which contain value added created in the sector itself or in an upstream supplying sector. The difference between the two is relatively small in most regions: most of the value added is exported by the agri-food sector itself. In the simulation, the agri-food sectors in Asia and Europe, which face changes in their macroeconomic competitive position, show a lower increase in value added generated in the agri-food sector compared to value added exported by this sector. This implies that the agri-food sector relies more on value added generated in other sectors upstream, while the possibilities for embedding agri-food value added in downstream sectors are smaller than in other regions. Especially in Europe, these stronger backward linkages imply a boost to foreign value added.

**** This effect is related to how support provided to land use in Europe is calculated in the model, which may be an artefact of the GTAP database.

A computable general equilibrium (CGE) model simulation exercise developed for this report (see Box 2.5) suggests that the removal of trade barriers and trade-distorting domestic support could enhance the opportunities for GVC participation and, in turn, domestic value-added creation.[i] This is a hypothetical scenario to illustrate the impact of lowering trade barriers and removing distortive domestic policies on GVC participation.

Opening to trade and GVC participation

In agriculture and food and beverages, the removal of all trade barriers and market distortions is projected to increase GVC participation and value added through both backward and forward linkages in all regions.

In agriculture, opening to trade and removing distortive domestic measures specifically strengthens backward GVC linkages as countries increase imports of inputs to agriculture, such as seeds and fertilizers. This results in production increases and more exports that correspond to increased foreign value added. Domestic value added also increases but to a lesser extent. This effect is particularly strong in Africa and Europe (Figure 2.10, Panel A).[i]

In food and beverages, both domestic and foreign value added also increase across all regions, but, for some regions, backward linkages (through foreign value added) are not as important as domestic value added as in the case of agriculture (Figure 2.10, Panel B). This reflects different strategies to leverage the opening up of global trade. Some countries may increase GVC participation through increases in the use of domestic inputs, and therefore higher domestic value added. In other countries, the food and beverages sector may choose to expand exports by increasing imports of agricultural commodities, which reflect higher foreign value added.

Removing trade barriers also strengthens forward GVC linkages (Figure 2.10, Panels C and D). In agriculture, domestic value added is shown to increase more through GVC forward linkages – that is through exports of commodities that cross borders to be processed and further exported – rather than through bilateral non-GVC trade (exports that are directly consumed in the destination country).[k] In the food and beverages sector, domestic value added increases through both forward linkages in GVC trade and non-GVC exports. A key effect of removing trade barriers is the strengthening of linkages between agriculture and the food and beverages sector, across countries and through GVCs. In agriculture, forward linkages through exports of commodities for processing abroad are stimulated. This brings about significant gains to the food and beverages industry, which also benefits from increased sourcing of inputs from domestic agriculture.

Across regions, there are significant differences in the projected gains from opening to trade. This is because the model simulation results depend on the size of the shock (the initial import tariff level matters), the size of the global market for specific commodities (the sector matters), the size of the country (the size of the domestic economy matters), and the specific specialization and comparative advantage patterns of the country (the mix of exported commodities also matters). For example, North America has lower levels of tariff barriers and distortive measures compared to most other regions and thus is projected to gain less from removing them.

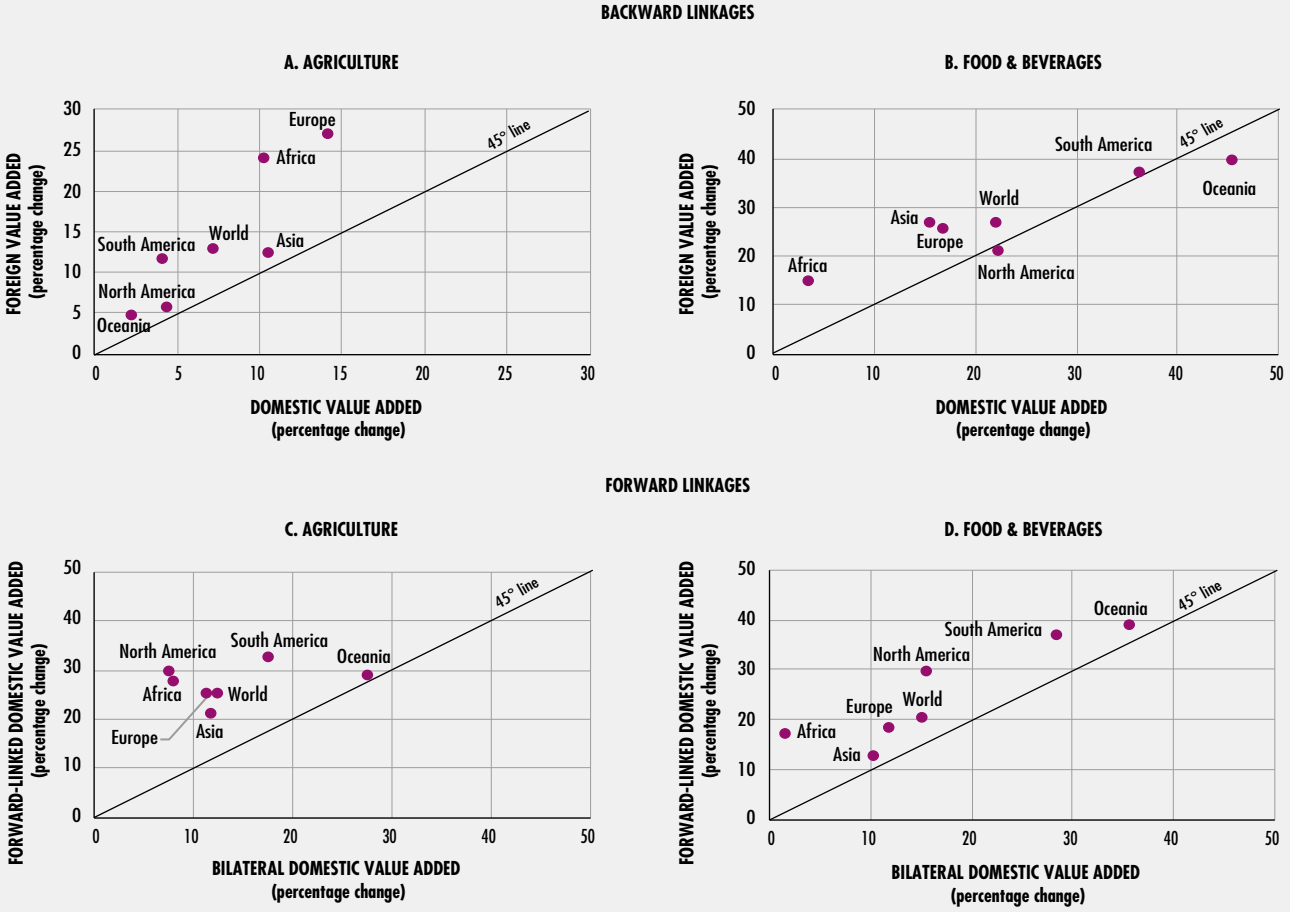
Furthermore, the dispersion of the gains depends on the change in the *relative* competitive position. Countries adapt to changes in the trade policy environment depending on how their economies are structured, their resources and how flexible they are in allocating

i This model is based on the GTAP dataset and not the EORA dataset used in the analysis of GVC participation earlier in this Part. Thus, there are some numerical differences. For example, for the trade policy analysis, the European Union is aggregated to one region, implying lower GVC participation rates for some European and African countries. The results presented here are expressed in deviations from the baseline.

j The Europe region encompasses countries that are part of the European Union and those that are not; the base year for the trade barriers is 2014.

k Bilateral exported value added consists of trade that is not linked to a GVC, as well as trade that is only linked to a GVC through backward linkages. In other words, it excludes all trade with forward GVC linkages.

FIGURE 2.10
PROJECTED EFFECTS OF OPENING TO TRADE ON GVC PARTICIPATION, PERCENT CHANGES



NOTE: The simulation scenario consists of removal of all (agri-food and other) tariffs, subsidies and taxes on agri-food outputs and land inputs. Sectoral exports reflect both domestic and foreign value added exported by the agri-food sectors. Domestic value added reflects value added generated in the agri-food sector for export purposes; foreign value added reflects value added embedded in agri-food exports with foreign origin.
SOURCE: Based on analysis provided by Salvatici. 2020.[37]

them. For example, in Africa, the potential availability of land means that the removal of import tariffs significantly promotes GVC backward linkages of agriculture and increases foreign value added through imports, which in turn also spurs domestic value added in exports. In contrast, agriculture in Oceania is projected to increase its exported domestic value added through a combination of forward linkages – including the expansion of exports by the downstream food and beverages sector – but additionally through non-GVC agricultural trade.[l] Results are also critically influenced by regional trade agreements (see Box 2.6).[39]

l As GVC participation rates are expressed as the ratio to gross exports, any increase in bilateral non-GVC exports implies a reduction in the GVC participation *rate*. GVC participation *levels* increase significantly in Oceania.

BOX 2.6
THE ROLE OF REGIONAL TRADE AGREEMENTS

Regional trade agreements (RTAs) create new trade relations and flows among the signatories and are likely to divert trade from non-signatories. They also promote vertical coordination in value chains across borders.[39] RTAs can increase GVC participation by strengthening both backward and forward linkages.[40] At the same time, the likelihood of joining an RTA is higher when countries are already linked through GVCs.[41]

As agricultural and food exports contain value added by a number of economic sectors, such as manufacturing, energy and services, and agri-food value added is embedded in the exports of downstream sectors, RTAs with wide sectoral coverage can be more effective in promoting trade between signatories through GVCs. For example, opening up trade in services among signatories could further increase agri-food GVC trade within the RTA. This can boost exports of agricultural and food value added, as well as promote increases of both domestic and foreign value added among signatories, strengthening backward GVC linkages. Furthermore, RTAs can stimulate exports of food products that embed agricultural inputs, creating forward agri-food GVC linkages.

The increase in value added traded through GVCs within the membership group – the trade creation effect – is likely to be partially offset by reduced value added exchanged from outside the Free Trade Agreement – the trade diversion effect – unless outside trade is firmly embedded in the GVC. These patterns vary substantially across countries and sectors. However, the benefits of RTAs are more pronounced when considering value added instead of gross exports, as the boost in embedded value-added exports due to the trade agreement is a major contributor to sectoral growth.

There are other benefits to RTAs that have spillover effects through GVCs. For example, trade through GVCs can spur institutional and policy reforms that reduce inefficiencies. The technology spillovers can also be sizable. These effects are especially strong when the RTA embeds facilitating elements, such as technical and financial assistance and access to knowledge, but they are hard to quantify.

The WTO also facilitates the reduction of trade costs through its Trade Facilitation Agreement (TFA) which aims at expediting the movement, release and clearance of goods, including goods in transit, and at improving customs cooperation. It is estimated that the full implementation of the TFA could reduce trade costs by 14 percent on average and increase global trade by up to USD 1 trillion per year, with the largest gains in the poorest countries. The Agreement also targets to improve transparency, increase possibilities to participate in global value chains, and reduce the scope for corruption.[42]

The TFA contains special and differential treatment provisions that allow least developed countries to request technical assistance and support for capacity building. The Trade Facilitation Agreement Facility (TFAF) has been created to help ensure developing and least developed countries are provided with the assistance needed to reap the full benefits of the TFA. This, in turn, is beneficial for developing countries as it would not only reduce both variable and fixed trade costs, but it would ease the burden for them to partake in GVCs.[43]

RTAs have a significant effect on whether value chains run across countries within the region or are global in the sense that link countries from different regions in the world. Some regions, especially Europe and Central Asia and East Asia, trade mostly in regional GVCs. Others, such as sub-Saharan Africa, South Asia, and Latin America and the Caribbean, rely more on the global trading system – and thus on global integration – for their GVC participation (see Box 1.1 in Part 1).[1] In recent years, it is not clear whether trade is becoming more regional or more "truly global", and economic crises, such as the one caused by the COVID-19 pandemic (see Box 2.7), tend to make governments wary of global trade. But a breakdown of multilateral trade negotiations could hinder the development of vulnerable countries, especially those in sub-Saharan Africa, that have trade links with global partners outside their region.

SOURCES: Dellink *et al.* 2020; Greenville *et al.* 2019; Fontagné & Santoni. 2018; WTO. 2015; Beverelli *et al.* 2015; Johnson & Noguera. 2017.[16,40,41,42,43,44]

BOX 2.7
TRADE POLICY RESPONSES TO THE COVID-19 PANDEMIC

In the spring of 2020, the COVID-19 pandemic and the restrictions on the movement of people to contain it had a severe impact on goods and services that rely on transport, especially ground and air freight, as well as on the availability of agricultural labour domestically and internationally. These factors induced overall disruptions in the logistics of the food value chains, both global and domestic, impeding the transportation of food and agricultural inputs (see also Box 1.2 in Part 1). At the time this report was being produced, sea freight had not been significantly affected – with port state authorities coordinating their actions to keep ports and maritime transport functioning. Nevertheless, disruptions to air freight – as worldwide flights declined by 70 percent between January and April 2020 – gave rise to challenges, especially for the trade of perishable foods such as fruits.[45]

Although the pandemic has, once more, triggered the debate on globalization, the restrictions on travel and movement may necessitate some short-term rebalancing between global and domestic value chains to ensure food availability, particularly for the most vulnerable population segments. In the long run, the economic impacts of the pandemic may lead to adjustments of trade patterns, which, similarly to the economic slowdown after the 2008 financial crisis, could affect global value chains. GVCs foster channels through which technology and knowledge are diffused. These same channels also transmit economic shocks and their impacts. Severing these channels to address the trade-off between efficiency and resilience to shocks should not form a long-run strategy. Shifting away from international trade and GVCs, could significantly undermine efficiency gains that are associated with comparative advantage and may result in increasing domestic food prices – an undesired outcome in times of declining incomes. The COVID-19 pandemic requires international collaboration and coordination rather than pursuing self-sufficiency in food. As impacts across the world are not occurring at the same time, international trade can help manage risks and contribute to resilience.

However, the most significant threat to food security comes from export bans. FAO, together with other international organizations such as the International Fund for Agricultural Development (IFAD), the World Food Programme (WFP), WHO, WTO and the World Bank, underlined both the need to keep value chains in food and agriculture functioning and the detrimental effect export restrictions could have on the global market. In the 2007–2008 food price crisis, panic-driven export bans and rapid escalation in food stock procurement through imports exacerbated price volatility. The results of these measures proved extremely damaging for low-income food-import dependent countries, as well as to the efforts of humanitarian organizations to procure supplies.

Global policy-makers responded. During the Meeting of G20 Agriculture Ministers on 21 April 2020, ministers committed to "guard against any unjustified restrictive measures that could lead to excessive food price volatility in international markets and threaten the food security and nutrition of large proportions of the world population, especially the most vulnerable living in environments of low food security". They also agreed to implement measures that are transparent and temporary and that do not result in disruptions to global food supply chains, in line with WTO rules.

Furthermore, the European Union and 21 other WTO members also pledged to ensure well-functioning global food supply chains and committed to open and predictable trade in agricultural and food products during the pandemic.

SOURCES: FAO, WHO & WTO. 2020; FAO, IFAD, World Bank & WFP. 2020; G20 Extraordinary Agriculture Ministers' Statement, April 2020; WTO. 2020.[46,47,48,49]

Trade policies and the transformation of the domestic agri-food sector

In most regions, removing trade barriers in agriculture is projected to result in a stronger expansion towards value added exported *indirectly*, through the domestic food and beverages sector (or other economic sectors that use agricultural inputs), than through *direct* exports of agricultural commodities (Figure 2.11, Panel A).[m] This implies that open markets could help stimulate GVC participation through the development of the domestic food industry (see also Box 2.8).

On average, in the food and beverages sector, open markets can stimulate expansion in both directions, but with a stronger impact on directly exported value added. The value added that is generated and exported by the food and beverages sector itself also reflects the more downstream nature of the sector (Figure 2.11, Panel B).

The effects for Oceania are large in percentage terms, but as the region makes up for less than 10 percent of global trade in both sectors, this increase masks low initial trade levels.

Trade policy and domestic support implications

Globally, open markets can spur economic activity and promote trade and GVC participation. Reducing trade barriers can lead to both more imports of inputs to agriculture and increased exports of agricultural commodities for processing in other countries. At the same time, the food and beverages sector can import more inputs from agriculture abroad and increase its exports for further processing and subsequently for final consumption in partner countries.

However, on average, a large part of agricultural production is projected to be used by the domestic food industry (see Figure 2.11, Panel A). This means that the food industry will export domestic value added from agriculture.

Thus, lowering trade barriers could imply a proliferation of global value chains, but also the potential for developing a domestic food industry. Such a path is in line with the interaction of economic growth and the transformation of value chains in food and agriculture (see Part 1). Along the development path, the food industry grows, while the relative contribution of agriculture to total agri-food value added declines (see Figure 1.14 in Part 1). The stronger linkages of agriculture to the domestic but also to foreign food industries can stimulate further labour productivity growth, thus adding to economic growth.

The analysis implies two complementary pathways to promoting economic growth in food and agriculture through GVC participation. Countries can enter vertically coordinated GVCs upstream and increase their agricultural commodity exports. This can result in increases in productivity through a range of avenues, including through improved technology and knowledge. Countries can also enter GVCs downstream through their food industry. However, if the domestic food industry is just emerging or is not yet fully developed, expanding domestic value added through primary exports to foreign processors can be combined with a gradual build-up of food processing capabilities, which can also indirectly export agriculture's value added.[n] This is the case in many African countries, for example.

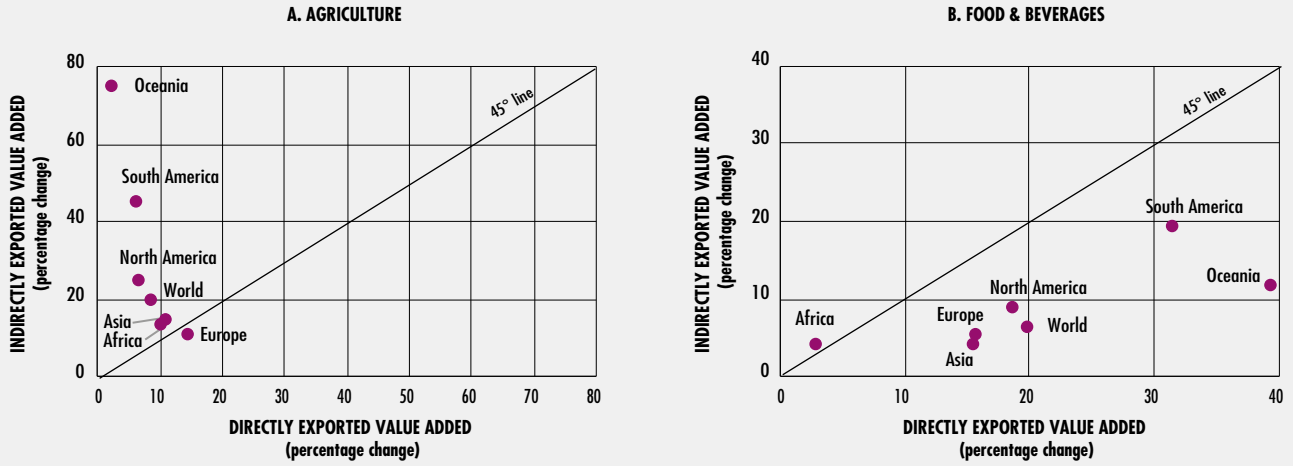
The share of trade that flows through GVCs, in conjunction with their effects on productivity and economic growth can strengthen the argument for lower trade barriers and open markets. As GVCs slice the production process across countries, they combine the comparative advantage of many firms across many countries and thus provide an important entry point to international trade. With GVCs where production stages are thinner and more specialized, it is easier to penetrate the global market.

Analysing trade through a GVC perspective also reveals that the costs implied by trade barriers

m This result depends crucially on the modelling assumption that both sectors, agriculture and food and beverages, remove their trade barriers; if the food and beverages sector is not liberalized, such a pathway would be much less attractive.

n For individual countries, there is a trade-off between these effects, that is an expansion in one direction can take place at the expense of the other.[37]

FIGURE 2.11
PROJECTED EFFECTS OF OPENING TO TRADE ON DIRECTLY AND INDIRECTLY EXPORTED AGRICULTURAL AND FOOD VALUE ADDED



NOTE: The simulation scenario consists of removal of all (agri-food and other) tariffs, subsidies and taxes on agri-food outputs and land inputs. Exported agri-food value added reflects all value added generated in the agri-food sector for export purposes, regardless of the exporting sector.
SOURCE: Based on analysis provided by Salvatici. 2020.[37]

can be high.[1,53] The increased fragmentation of production across borders means that tariffs are incurred multiple times along the value chain. As inputs and intermediate products cross borders many times, tariffs are being applied to the full value of exports, including on the amount in tariffs paid previously. This can have significant knock-on effects on all trading partners in the global value chain. In addition, uncertainty about trade policies can also be amplified through GVCs, as firms are more reluctant to make further investments in new or existing relationships with foreign suppliers.

As tariffs cascade through GVCs, this makes their impact larger and, when a commodity is exported to be processed and subsequently re-imported in the country of origin, detrimental. Furthermore, as GVCs strengthen the trade linkages between countries, domestic value added creation is affected not only by domestic trade measures, but also by policies of other countries. Tariffs imposed in the destination market can have ripple effects on the production activities which are linked to the GVC and which span across different countries.[54]

The benefits of tariff reductions are thus larger when a significant part of the agri-food trade takes place through GVCs. This can entail a shift in policy focus from import substitution policies and protection of the domestic producers through tariffs to providing incentives to increase domestic economic activity through enhanced exports and integration in the global market.[55,56] As an increasing share of global trade takes place among emerging and developing economies, and this share is projected to expand further, such a strategy can only be successful if implemented in as many countries as possible, rather than relying on increasing access to markets in developed countries alone.

GVCs, but also the evolution of food and agriculture more broadly, have led to »

BOX 2.8
EMERGING FOOD PROCESSING SECTORS IN DEVELOPING COUNTRIES

While research on agricultural development has traditionally focused on the sector's integration in global markets, transformations in the middle segments (processing, logistics and wholesale) of agri-food value chains in developing countries have until recently been studied less.[50]

Following trends in developed economies and fueled by domestic and international private sector-led investment, this transformation often started with a proliferation of small and medium-sized midstream enterprises and was followed by a process of consolidation and concentration. Today, midstream segments can form 30 to 40 percent of the value added in food value chains in developing countries.[50] For example, in Bangladesh, the People's Republic of China and India, the share of the midstream segments in total marketing margins in rice value chains was found to average around 32 percent, while it was estimated at 42 percent for potato value chains.[51]

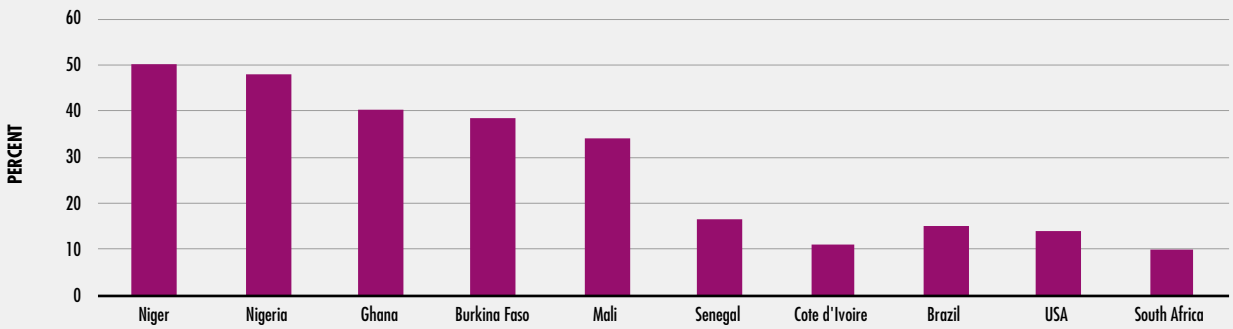
In West Africa, the food processing sector is the largest manufacturing sub-sector in terms of employment. It accounts for only 5 percent of employment in the total agri-food economy but represents an average of 30 percent of total secondary sector employment. In Niger and Nigeria, food processing accounts for almost 50 percent of all manufacturing activities (Figure 2.12), with many of these jobs being in micro, small and medium-sized enterprises in the informal economy.[52]

Due to its nature in the midstream, the food processing sector creates strong domestic and international forward and backward linkages with agriculture and other non-agriculture activities. However, while the demand for food processing activities is expected to grow further in many developing countries, the growth of large-scale industrial processors is often constrained by an unreliable supply of local raw materials of consistent quality, often resulting in reliance on imported commodity inputs.[52]

To improve the reliable and steady supply of agricultural commodities, food processors have started shifting from sourcing from spot markets to engaging in more formal contracts with farms. However, contract farming linked to processors seems to be emergent only in a few commodity categories (see Part 3). To ensure the quality of agricultural commodities, public food standards have been increasingly complemented by private standards (see Part 1).[50]

SOURCES: Reardon. 2015; Reardon. *et al.* 2012; Allen *et al.* 2018.[50,51,52]

FIGURE 2.12
IMPORTANCE OF FOOD PROCESSING FOR EMPLOYMENT – WEST AFRICA AND SELECTED COUNTRIES (SHARE IN TOTAL MANUFACTURING SECTOR LABOUR)



SOURCE: Allen *et al.* 2018.[52]

» increased requirements on technology, capital and labour skills for producing food and beverages (see Box 2.5). Linkages to GVCs can be facilitated by promoting the transformation and development of the domestic sectors. The development of competitive agriculture and food industry requires policies that provide incentives for the uptake of novel technologies, enhance skills and capabilities, and facilitate the cooperation between public and private actors.[38,55] At the same time, while open markets are generally conducive to economic growth, they may have various effects on environmental, social and health outcomes. Both positive and negative effects can be amplified through GVCs.

Domestic policy conditions need to be coherent with the trade policy framework to take advantage of the opportunities arising from increased GVC participation. Policy-makers should aim at creating an environment where both food and agriculture can best leverage their comparative advantage and be competitive in agri-food GVCs.[38] ■

GVC LINKS WITH SUSTAINABLE DEVELOPMENT: ENVIRONMENTAL, SOCIAL AND HEALTH OUTCOMES

The debate on the economic gains from trade is enriched by a discussion on its impacts on the environment, inequality, and, specifically for food trade, concerns about health and nutrition. International trade, as all economic activities, can support sustainable practices, encourage unsustainable ones, and generate a range of environmental and social outcomes (Box 2.9). Global value chains can strengthen the effects on sustainable outcomes, as they support closer links between the different actors than looser forms of trade do. On the one hand, both positive and negative effects can be amplified through GVCs, especially under open trade. On the other hand, knowledge and technology spillovers, that can be leveraged in GVCs, can address the trade-offs between the various economic, environmental and social objectives.

Trade, GVCs and the environment

Global value chains that are coherent with sustainable development objectives can spread sustainable technologies and practices and, at the same time, promote productivity and income growth across countries. Increased GVC participation can propagate the positive impacts of environmental regulations across borders and contribute to sustainable development. For example, export-oriented firms in a country may adhere more strongly to sustainability regulations and use cleaner technologies than typical domestic firms, either to ensure that public standards in the importing country are met or because of private standards imposed by the downstream partners in a GVC.

Trade policies that facilitate regulatory harmonization and uphold high sustainability standards throughout GVCs can prevent regulatory arbitrage by multinationals that can easily move parts of the production chain across borders. For example, the provisional terms of the new European Union–Mercosur trade agreement directly link tariff elimination to animal welfare standards.[57]

Global value chains can also play a key role in the international dissemination of sustainable technologies and practices. An essential part of the transition to sustainable development is the widespread uptake of more efficient and cleaner technologies. Open markets and GVC participation can boost such technological development globally and promote its diffusion across countries.[o] But when GVCs lock in specific trade patterns, they may hamper the uptake of clean technology.

o Countries sometimes have a tendency to block imports (including through local content requirements) of products with rapidly evolving technology (for example, solar power panels) to shield domestic innovators and thus boost domestic industry, aiming at reaping a first mover benefit for more advanced technology. Such protective policies are only effective when countries have support policies to ensure domestic technology development is boosted by these measures.[58]

BOX 2.9
GLOBAL VALUE CHAINS, PRIVATE SECTOR ACTION AND ENVIRONMENTAL OUTCOMES

Economic activities have environmental impacts that are usually not part of the cost calculations of producers. Such impacts are external to markets and create costs to society that are not accounted for in product prices. Traditionally, governments intervene to align market outcomes with collective interests, not least social and environmental well-being. Direct regulation, taxes and subsidies are tools used to ensure accounting for these effects. In recent decades, the private sector has progressively taken up the initiative to address social and environmental externalities in their businesses voluntarily.

Businesses and consumers are increasingly aware of the unprecedented level of connectivity between our economies, the environment and social well-being. For countries well-integrated into GVCs, economic incentives for business activity associated with environmental externalities may extend beyond national borders and authority. Illustrative of this dynamic is the increase in deforestation rates reported in the Brazilian Amazon throughout the early and mid-2000s.[62]

Throughout the 1990s, Brazil's cattle industry was isolated from regional and global markets due to sanitary concerns related to the presence of the foot-and-mouth disease in the domestic herd, while soybean cultivation was negligible due to the absence of varieties suitable to the local soil and weather conditions. In addition, suitable regional infrastructure was almost absent.[62] This changed due to technological progress in the beef and soybean industries, which facilitated production. At the same time, population and income growth increased the demand for beef and soybeans, both domestically and globally. The increased demand provided the fundamental economic incentives to producers, triggering large land-use changes and deforestation in the Amazon region.

Broad economic development also brought about the development of infrastructure. In the Brazilian Amazon, connecting isolated areas through road network expansion contributed to reduced transportation costs, greater market integration and increased land values and thus provided an additional incentive for deforestation.[63,64] At the same time, these forces made agriculture an important pillar of the Brazilian economy. The sector is well integrated into the global economy and commodity markets, which makes it sensitive to market forces and international calls for more sustainable production and lower deforestation rates.

The Soy Moratorium (SoyM) was a private sector response to mounting pressure from environmental groups and consumers over the environmental impacts of the soybean global value chain. The SoyM is a permanent commitment by the major soybean traders in Brazil not to commercialize soybeans produced in areas deforested after 2006 in the Brazilian Amazon. The SoyM is unique in that the private sector acted collectively to comply with government regulations (the Brazilian Forest Code establishes that 80 percent of native vegetation should be maintained over privately owned areas in the Amazon biome). Prior to the SoyM, nearly 30 percent of the soybean area expansion occurred through deforestation in the Amazon, falling to approximately 1 percent afterwards.[65] The SoyM provides a useful example of how international trade and markets can effectively address the trade-offs between economic and environmental objectives.

As global soybean demand remained strong in the years that followed, cultivation expanded into already deforested areas being used as pastureland at the time, and soon into the Cerrado biome. This woodland and savannah area falls under a different regulatory category that presently allows for private landowners to undertake significant changes in land cover and use. There remains a potential for expanding such initiatives into other value chains and biomes to halt deforestation leakage.[66]

Recently negotiated trade agreements have included extensive environmental provisions. In doing so, these agreements provide incentives to producers to adopt sustainable practices in order to gain and maintain access to new markets. Contemporary policy responses that go beyond exclusively national legislation and encompass global actors can provide economic incentives and support the achievement of national sustainable development objectives.

SOURCES: Nepstad *et al.* 2006; Miranda *et al.* 2019; Nascimento *et al.* 2019; Gibbs *et al.* 2015; Soterroni *et al.* 2019; FAO. 2016.[62,63,64,65,66,67]

Environmental supply chain management to reduce environmental impacts, pollution and waste is especially relevant in the age of global value chains.[59,60] This includes green logistics management with reductions in emissions, waste and pollution from logistics activities; sustainable transport options through alternative transport modes and more sustainably refrigerated trucks; and reduced packaging and use of recycled packaging materials. Due to the global nature of many value chains, international coordination is essential, as is attention to environmental impacts that cannot easily be attributed to a country, such as those from international shipping and aviation.[61]

Private standards can also be an effective tool to make GVCs more sustainable. There are clear environmental and social benefits to adherence to the requirements of sustainability certification schemes (see below and Part 3).[68] The share of agricultural production affected by sustainability standards is growing rapidly; as of 2015, more than 50 million hectares were certified as organic, and the sustainability certified areas of cotton, bananas, cocoa and tea more than doubled between 2011 and 2015.

Trade, GVCs and inequality

The sharp increase in developing countries' participation in trade and the emergence of global value chains coincided with a significant decline in extreme poverty worldwide.[69] Open markets are often seen as a tool for growth, but they are not a mechanism to reduce inequality.[70] Indeed, as globalization progressed, inequalities in wealth and income widened within many countries.[72]

A recent analysis of the impacts of eliminating tariffs on agricultural products across 54 low- and middle-income countries pointed to increases in both income and inequality.[71] The results suggest that, on average, liberalizing agricultural trade would increase household incomes. At the same time, eliminating import tariffs was found to have highly heterogeneous impacts across countries, and within countries across households. In 37 out of the 54 countries, the top 20 percent of the richest households would gain more from liberalization than the bottom 20 percent, thus exacerbating relative inequality even when all household groups gain in absolute terms.

For example, in Viet Nam, the income of richer households increased, on average, by 2.7 percent, while that of the poorer ones by 1 percent. Such differential impacts depend on household characteristics, such as different consumption patterns and income structures, but also call for complementary policies and actions.

The impacts of increased agricultural trade through GVCs on inequality may be more pronounced, as the associated new technologies and innovative processes require higher skills. GVC-based trade may therefore, to some extent, undercut the opportunities of developing countries to reap comparative advantage that is based on low-skilled labour.[72] In the past, a number of economies in Southeast Asia experienced rapid growth and a shift to low-cost export-orientated manufacturing by leveraging regional and global value chains and low-skilled labour; this led to increased productivity and higher wages, leading these countries to a middle-income status. Recent evidence from analysing manufacturing-related GVCs across 58 countries suggests that although GVC participation led to productivity increases, it did not result in employment growth.[73] This could be related to the fact that manufacturing has become increasingly capital-intensive.

When the focus is on agriculture rather than manufacturing, the requirements on capital and high labour skills are perhaps mitigated. But even agri-food GVCs put a premium on skilled labour, farm size and access to credit. Not all farmers in developing countries have the skills and means required to adopt the farming practices, standards and logistic targets set by downstream GVC partners.

If access to GVCs is only feasible for higher-skilled and large-scale farmers, relative social inequality may increase, despite increases in average income. Agricultural commercialization that is

sometimes induced by GVCs may marginalize poor smallholder farmers that cannot meet stringent requirements, even if average agricultural productivity is increased and those that do participate in GVCs reap economic gains. Given these distributional concerns, it is essential to address the market failures that prevent poor farmers from access to lucrative markets (see Part 3 for a discussion on farmers' participation in value chains).

Inequalities may be diminished by taking an inclusive growth perspective in policies and with focused attention to ensuring no-one is left behind. For example, the European Union's initiative on Value Chain Analysis for Development (VCA4D) uses a systematic framework that focuses on economic and environmental impacts, but also on social aspects that promote inclusive growth, such as child welfare, gender issues, land and water rights and social capital. VCA4D provides decision-makers with evidence-based information that relates to sustainable development strategies specific to global value chains.[p]

In general, access to water and energy gives people – and especially women who tend to spend more time gathering water and fuel – the opportunity to use their time productively rather than on addressing basic needs. Ensuring that all children have access to education and adults to lifelong learning is essential. The high skill requirements associated with GVCs and with sustainable production methods can be a major stimulus for improving the linkages between educational goals and decent work objectives. More modern production technology that is often required for integration in GVCs can also make food and agriculture more appealing for educated younger generations to remain in rural areas and contribute to vibrant rural economies.

Trade, GVCs, food security and nutrition

Generally, GVCs could be a significant source of socio-upgrading opportunities.[74] Participation in agri-food GVCs can improve the food security of smallholder farmers by promoting productivity, which in turn can increase rural incomes, reduce rural poverty and foster pro-growth opportunities (see also Part 3).[75] Positive spillovers, especially through productivity increases, on domestic food markets can also contribute towards food security for all.[76,77] Such gains can enable people to buy more food (thus increasing energy intake), to buy more diverse foods (thus increasing dietary diversity and possibly quality), or to invest in sanitation and healthcare (which are crucial determinants of nutritional outcomes, especially in children).[78] The trade-offs involved are, however, complex, and there are significant differences across regions and between markets.

When specific actions are taken, global value chains could also help contribute towards reducing malnutrition. Interventions may include fortifying processed food with specific micronutrients (such as folic acid and iron) that may otherwise be lost in food processing or that more generally are not consumed regularly or in sufficient quantities by the poorest. Well-functioning GVCs based on improved cold chain technology can allow more trade of fruit and vegetables, that would otherwise spoil during transport. They can thus increase diet diversity for consumers in countries that do not have a comparative advantage in the production of fruit and vegetables. Lastly, packaging and nutritional labelling could also lead to enhanced demand for more nutritious foods and possibly reduce the demand for energy-dense foods.

However, the increased availability of processed foods has led to concerns about the contribution of trade and GVCs to overnutrition and obesity. Urbanization and changing lifestyles, as well as the increased prevalence of households where both women and men have paid jobs, have resulted in greater consumption of processed foods. Evidence from Mexico points to significant increases in the share of

p See Value Chain Analysis for Development available at https://europa.eu/capacity4dev/value-chain-analysis-for-development-vca4d-

energy consumed from highly processed foods in urban households with higher income, with a highly educated family head, and in which both men and women participate in the labour market.[79]

Several intervention priorities have been identified to reverse the obesity epidemic and noncommunicable diseases associated with the consumption of specific processed foods, including those high in saturated fats, salt and sugar. Proposed measures include taxation, regulation of food advertising, promotion of healthier food such as fruit and vegetables, improved labelling of processed foods and using healthier ingredients in processed foods.[80,q] There is evidence that policies aiming at reducing the consumption of sugar-sweetened beverages have been successful in a number of countries (see Box 2.10). However, there is scope for governments to work together with businesses in addressing the unintended consequences of actions on obesity. ■

GLOBAL VALUE CHAINS, STANDARDS AND COMPETITION ISSUES

The transformation of agricultural and food markets is the result of a combination of factors such as higher incomes, urbanization and the nutrition transition. It spurred a high penetration of supermarkets at the retail level and the introduction of stringent food quality and safety standards. The demand for differentiated products and the implementation of public and private standards across countries result in increasingly complex global value chains. At the same time, the proliferation of GVCs, especially the fragmentation of production processes across countries, requires strong vertical coordination and governance within the chains that often raise concerns over containing market power if national competition policies differ.

q Such interventions could imply additional costs for actors along the value chain, which may in turn affect GVCs. If the regulations stem from downstream, GVC partners may be able to adopt them through better coordination throughout the chain.

Standards and GVC access

Technical standards

There are many reasons why certification and standards are used throughout the various stages of GVCs. Governments use public regulations and standards to ensure the health, safety, and environmental and social quality of the agricultural commodities and food that enter their markets. These standards are regulated by WTO Agreements, such as the Technical Barriers to Trade (TBT) Agreement and the Sanitary and Phytosanitary (SPS) Agreement. The TBT Agreement covers product standards, technical regulations and conformity assessment procedures, and provides disciplines to ensure that imported products are treated equally with "like products" of national origin. The SPS Agreement serves to guarantee food safety and animal and plant health regulations.

Since along a GVC, the stringency of public standards differs across countries, standards are also imposed by private firms to ensure that they will be able to sell their final product in a given market. Downstream retail firms need mid- and upstream producers to adhere to the standards of the country where final consumption takes place.

Compliance with private standards may also be required to ensure that inputs can be used for the intended purpose in the downstream stages of the value chain. For instance, wheat protein content determines its suitability for a variety of purposes. Private standards may also be used by firms – typically vertically integrated – as a marketing tool.[87] They sometimes allow firms to differentiate products and increase market shares. The complexity in production processes associated with GVCs, as well as corporate branding and marketing strategies, has increased interest in third-party certification schemes to provide assurance of the compliance with private standards along the value chains.

A key challenge in certification schemes is traceability – the ability to track any food product through all stages of production, processing, and distribution within and across countries. Data systems can be used to improve traceability and independent conformity »

BOX 2.10
POLICIES AIMED AT REDUCING THE PREVALENCE OF OVERWEIGHT AND OBESITY: TAXES IN MEXICO AND LABELLING IN CHILE

Sugar-sweetened beverages consumption has rapidly increased across the globe and has been linked to increased weight gain, glucose dysregulation, and development of noncommunicable diseases such as type 2 diabetes. Public policies are increasingly being used to reduce consumption of these beverages and prevent continued increases in obesity and related diseases.[81]

In Mexico, obesity has emerged as a serious public health problem across all age groups in recent years. The prevalence of overweight and obesity in Mexico among children is 33 percent. The prevalence of overweight and obese adults is about 70 percent, while the prevalence of obesity alone in adults is about 35 percent.[82]

About 70 percent of the sugar intake of Mexicans comes from sugar-sweetened beverages. Reducing the amount of sugar-sweetened beverage consumption became a natural starting point for policies to reduce overweight and obesity in the country.[83]

In response, in 2013, the Mexican government approved an excise tax on sugar-sweetened beverages and a sales tax on certain energy-dense foods with the goal of reducing the prevalence of overweight and obesity in the country. The excise tax on sugar-sweetened beverages came into effect on 1 January 2014, with intense opposition from the Mexican food and beverage manufacturers. This tax consisted of one Mexican peso per litre of sugar-sweetened beverage, which corresponds to approximately a 10 percent tax. The policy stipulated that the excise tax was going to be adjusted annually based on the inflation index.

A recent study carried out a detailed assessment of this policy intervention, intended to alleviate overnutrition and its adverse health consequences. The study found that although this tax was placed on beverage manufacturers, the tax burden was almost entirely passed on to consumers. The study estimated that the excise tax on sugar-sweetened beverages in Mexico resulted in a reduction in sugar-sweetened beverage consumption by 6 percent in the months after the tax was effective. In December 2014, after one year of implementation, the reduction in consumption was estimated at 12 percent. Poor households had the largest decrease in consumption of sugar-sweetened beverages by 17.4 percent. At the same time, the study found that consumption of non-sweetened beverages increased by 4 percent in that year.

In Chile, concerns about the prevalence of overweight and obesity, especially among children, gave rise to policy action. In 2016, nearly 25 percent of all first-grade primary school students in Chile were considered obese.[84] In response, in 2016, the government implemented the Law of Food Labelling and Advertising, a set of policies aimed at preventing further increases in the prevalence of obesity, including marketing restrictions on foods and beverages high in energy, sugar, sodium, and saturated fat content (such as banning sales of such foods and beverages in schools) and a national mandatory front-of-package warning-label system. These measures resulted in a reduction in the purchases of sugar-sweetened beverages by 24 percent.

After the successful Mexican experience taxing sugar-sweetened beverages to reduce consumption, other countries facing challenges to curb overweight and obesity trends have implemented similar policies. For instance, in 2017, six cities in the United States of America implemented taxation schemes on sugar-sweetened beverages. Countries such as Saudi Arabia and the United Arab Emirates have implemented the highest taxes on sugar-sweetened beverages to date. Similarly, many countries are actively implementing measures such as the front-of-package warning-label, including Peru, Uruguay, and Ecuador, while other countries are considering the Chilean labelling law as a model for their own legislation.[84]

SOURCES: Adapted from Gómez *et al.* 2020; Taillie *et al.* 2020.[85,86]

» assessments. For example, traceability systems are critical in seafood certification schemes, with approximately half of the systems requiring chain of custody standards to ensure tracking processes.[r,88] Digital technology applications on markets, including blockchain, can greatly enhance the traceability capacity of the value chain (see Part 4 for a discussion on digital applications to traceability).

At the farm level, analyses have found that compliance with private standards can have positive effects on productivity, exports and employment. In Kenya, for instance, incomes increased after farmers adopted the quality standards demanded by their international buyers, and these firms supported better traceability of the product throughout the entire supplier network.[89] The empirical evidence remains mixed, and many smallholder farmers may not have the capacity to supply food complying with stringent standards (see Part 3 for a discussion on compliance with private standards within the context of contract farming).[76–78]

Voluntary sustainability certification schemes

Sustainability certification schemes and standards comprise voluntary norms adopted by businesses; they aim to address non-economic dimensions of sustainability and can promote social and environmental outcomes. Such voluntary sustainability standards specify requirements for production methods in terms of, for example: the respect for basic human rights; workers health and safety; paying farmers a fair price for their produce; and various farm practices that can better manage natural resources and reduce negative environmental impacts.

Examples of widely known sustainability certification schemes include Fairtrade (set by a non-governmental organization) and the Roundtable on Sustainable Palm Oil (RSPO, a multi-stakeholder initiative).[s]

Private certification bodies have mainly developed standards for organic farming, but governments also establish national standards and regulations on the labelling of imported organic products. Private companies also set internal sustainability standards and goals in their value chains and business practices. Standard-specific rules can vary in terms of their details and stringency, but almost all sustainability certification schemes address the trade-offs between social, environmental and economic dimensions (see Part 3).

Sustainability standards are gaining importance in global markets, especially for high-value products with established links to global value chains. Growing consumer demand for sustainability certified products has resulted in increases in the share of agricultural land under sustainability certification. A relatively large share of tropical commodities cultivated in developing countries, such as coffee, cocoa, tea, palm oil and cotton, is certified. In 2015, over 50 million hectares were certified as organic, representing 1.1 percent of agricultural land worldwide. The RSPO-certified palm oil accounts for 0.07 percent of the global agricultural area. About one-quarter of the global coffee and cocoa areas are certified through standards developed by both non-governmental organizations (NGOs) and the private sector.[68]

GVCs, with their effective vertical coordination mechanisms, hold significant opportunities to apply sustainability standards and align global markets with sustainable development outcomes. The proliferation of certification schemes is in part a response to increased consumer awareness over sustainability concerns, particularly in high-income countries, but increasingly also in emerging and developing countries. For example, a label or certification of standard-compliant production by Fairtrade, Organic or Rainforest Alliance addresses environmental and social concerns; it provides information to consumers to make decisions responsibly on what to buy in accordance with their preferences and social beliefs. There are several issues of concern for consumers, including food safety, environmental sustainability, and social norms

r The chain of custody reflects the implementation of standards on all stages in the value chain, from primary production on a certified farm through to final consumption, including all processing, transformation, manufacturing and storing stages, where the progress of the product to the following stage in the value chain involves a change of ownership.

s See https://www.fairtrade.net and https://rspo.org

such as child labour, gender equality and producers' welfare. [93]

Standards and challenges to access GVCs

Certification schemes and standards in international markets can deliver positive impacts but also present challenges for small-scale processors and farmers, who often lack the technical and financial capacity needed to comply with complex and stringent requirements. This can induce retailers and firms downstream to reduce sourcing from small-scale suppliers. Transaction costs for monitoring compliance with standards may be very high in the case of sourcing from smallholder farmers.[93]

In many developing countries, other obstacles can threaten production that is compatible with international standards, including weak regulatory institutions, poorly designed and implemented sanitary and phytosanitary regulations, and inadequate transportation, power and water infrastructure.[94] Consequently, the inclusion of smallholder farmers in value chains that have sustainable certification may only be feasible with external support from development programmes, public-private partnerships, non-governmental organizations, or collective action.

The cost of uncoordinated standards across countries can be amplified within GVCs, much more so than in bilateral non-GVC trade, as compliance needs to be coordinated at each stage of production and for each market ultimately supplied. Compliance can require firms to make costly investments in duplicate production processes, specific packaging and labelling or to undertake multiple certification processes for the same product. These compliance costs are particularly acute for small and medium-sized enterprises (SMEs) and smallholder farmers and are a major obstacle to their GVC participation.[95]

Policies to facilitate and support compliance with international standards and to harmonize standards and certification can foster growth in GVC participation. International regulatory cooperation and the convergence of quality and safety standards may alleviate the burden of compliance and enhance firms' participation in global markets (see Part 1).[25] International initiatives for sustainable business practices, such as the United Nations Global Compact, can also be crucial for addressing sustainable development issues. However, their voluntary nature may, to some extent, hamper progress when trade-offs between economic, social and environmental objectives reflect significant asymmetries between private and public gains.

Market power, competition and the distribution of GVC benefits

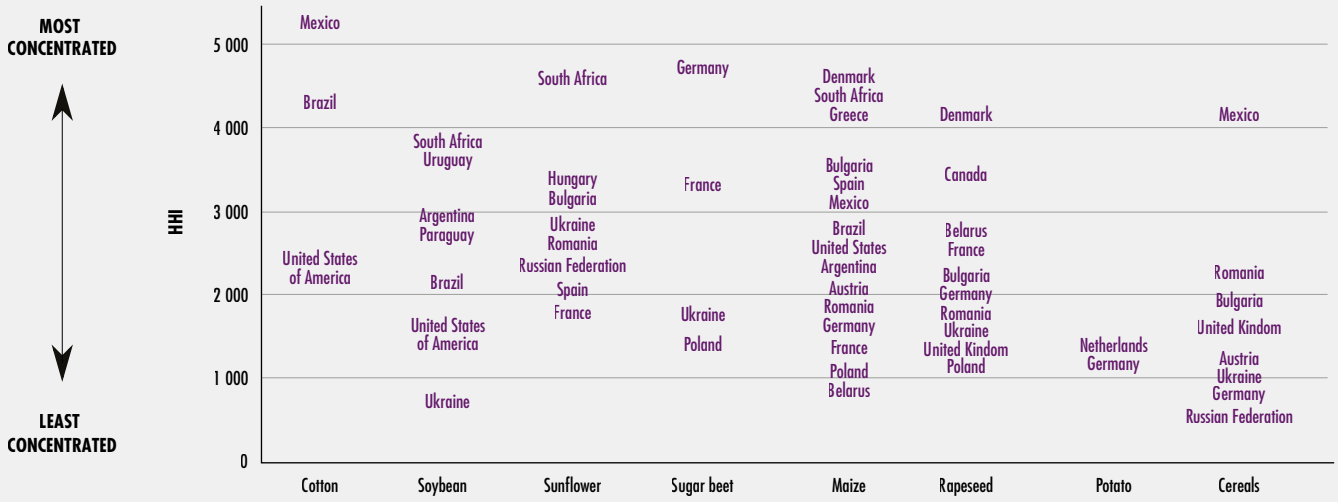
The transformation of agricultural and food markets in recent decades has also brought significant changes in market structures and market power for the various actors.[96] The dominance of supermarkets in food retailing and the importance of a relatively small number of large multinational food companies has also contributed to increased vertical coordination in the agri-food value chain and has enhanced emphasis on GVCs (see the discussion on vertical integration in Box 1.4 in Part 1).

There is clear evidence of market concentration, especially in seeds,[97] fertilizers,[98] the international commodity trading sector,[99] and food processing and retailing. Other parts of the agri-food sector are characterized by a large number of suppliers.[100] Figure 2.13 illustrates how market concentration can vary widely across crops and regions by examining the market for seeds.

To some extent, market concentration and market power can be driven by the existence of a natural monopoly or oligopoly, especially when scarce natural resources are used, such as in the case of fertilizer production. Another driver is the research and development (R&D) intensity of the sector. For example, high R&D investments in the seeds and biotechnology industries could create entry barriers that could hamper competition.

Often in GVCs, market power can be linked to innovations that create a local and

FIGURE 2.13
THE DEGREE OF SEED MARKET CONCENTRATION VARIES BY CROP AND REGION



NOTES: HHI is the Hirschman-Herfindahl Index, a common measure of market concentration that is defined as the sum of squared market shares. If a single firm has a monopoly, the HHI would be 10 000; if the market is equally divided between 100 firms, the HHI would be 100.
SOURCE: OECD. 2018.[97]

temporary monopoly generating excess profits. For example, packaged mixed vegetable salads, introduced through specific requirements by the innovator to upstream suppliers and processors, is seen as conferring some market power in the short term, at least until other competing firms enter the market.[101] Therefore, value chain innovations and product differentiation often give rise to market power in particular locations, and temporarily until competitors arise.

Traditionally, market concentration in value chains has been linked to collusive behaviour and market power. This increases prices for consumers (due to oligopoly rents) and lowers it for farmers (due to oligopsony rents), reducing welfare for both, and transferring gains to the large food processing companies and food retailers.[102] Nevertheless, market concentration does not necessarily lead to collusion or imperfect competition. Empirical evidence of market power abuse in agricultural and food markets remains scarce, despite high market concentration in parts of the value chains that are dominated by few firms which rely on vertical coordination.[103,104]

To some extent, this may reflect the difficulty and complexity of identifying market power. Anecdotal evidence points out that some of the more powerful firms unilaterally impose contract conditions and may practice "unfair" business.[105] But "unfairness" is also difficult to identify and may include a refusal to have a written contract, excessive transfer of costs and risks between transaction parties, or frequent changes in prices. Regulation by competition authorities is hindered by difficulties to prove perceived unfair trading practices, but formalising transactions along the value chain through contracts may overcome some of these issues (see Part 3).

In general, the literature does not support the claim of systematic market power abuse.[106] For example, the penetration of food markets in emerging and developing economies by large food and retail companies from developed countries has boosted GVC participation rates, but there is no clear evidence that it has induced large-scale market power abuse. The effects of market power along the value chain could also be positive. For example, there is evidence that increasing concentration and market power of the downstream buyers could potentially help overcome local market and government failures in rural areas where upstream suppliers are located, as they may alleviate structural market barriers through reduced transaction costs and improved contract clarity.[107] ■

MALAYSIA
A woman selling fresh vegetables at market.
©iStock.com/
simongurney

PART 3
FARMERS AND VALUE CHAINS: BUSINESS MODELS FOR SUSTAINABLE GROWTH

PART 3 shifts the analysis from the global level to the farm household. Smallholder farmers face a number of constraints that determine their participation in markets and value chains. These constraints also affect their aspirations for better livelihoods. The discussion places the farm within the process of development to look at markets and market behaviour. Business models such as contract farming and value chains that integrate sustainability certification schemes are examined. These can help address the constraints farmers face, include them in markets and contribute to economic, environmental and social outcomes.

PART 3

FARMERS AND VALUE CHAINS: BUSINESS MODELS FOR SUSTAINABLE GROWTH

KEY MESSAGES

1 Well-functioning markets are key for agricultural growth and lie at the heart of the development process. They provide a mechanism through which farmers can integrate into the economy, and they offer opportunities for income growth and better livelihoods.

2 In many developing countries, farmers face significant constraints to access markets. For women, these constraints are even higher. Stringent requirements in modern food value chains could further isolate smallholder farmers from the market mechanism.

3 Increasing farmers' participation in markets and value chains expands their choices. Markets allow farmers to better decide on how and what to produce and how to invest in their farms, their families and themselves. This can lead to livelihood improvements in agriculture or in other economic sectors.

KEY ACTIONS

➔ Government policies are crucial to underpinning market participation. They should target rural areas with measures to improve health and education services, upgrade infrastructure and foster labour markets, supporting an enabling environment that is conducive to business.

➔ Inclusive business models, such as contract farming, can address the constraints farmers face in entering markets and value chains. In developing countries, such an approach can be facilitated by effective farmers' groups and requires multifaceted and coordinated actions by the government, the private sector and civil society.

➔ Agricultural and food markets can be harnessed to deliver sustainable development outcomes. Promoting and widely applying voluntary sustainability certification schemes can address trade-offs between economic, environmental and social objectives.

SUSTAINABLE AGRICULTURAL DEVELOPMENT AND MARKETS

Markets lie at the heart of the development process, allocating activities and resources where they are most productive. In food and agriculture, well-functioning markets and trade are vital to improving the livelihoods of millions of people and can provide additional benefits, such as contributing to food security by ensuring that food moves from surplus to deficit areas.

The development process is characterized by the structural transformation of the economy. It is

the path towards higher incomes and poverty eradication, but also the expansion of opportunities for better living standards and the ability of people to choose among different livelihoods.

Although earlier analyses viewed agriculture as a traditional low-productivity sector that had to provide labour and other resources to fast-growing modern sectors, no country has been able to achieve a transition out of poverty without a dynamic agricultural and food sector.[1] At the same time, agriculture's growth depends crucially on how productivity and employment evolve in manufacturing and services. Structural transformation integrates the growth paths of all sectors of an economy, and this process depends on well-functioning markets (see Box 3.1 for a discussion on the role of markets in development).

As markets form an important part of the structural transformation process, farmers' participation in market-based exchange is key for sustainable development and poverty eradication. Ensuring that the poor are connected to well-functioning markets links them better to the development process.

In a broad sense, access to markets contributes to development not only through generating economic growth but also by providing opportunities to farmers to use their income-earning capability to improve their lives. Inclusion in markets and leveraging all of their roles and effects for expanding social development depend significantly on the government and the arrangements for education, health, credit, energy and water access, competition, and other policies.[a,2]

a Amartya Sen, the 1998 Nobel Prize Laureate in Economics, underlined the broad importance of access to markets in development, assessing their contributions and limitations in promoting individual freedoms. In his work, lack of access to markets can be a source of unfreedom.

From a narrower perspective, agricultural market-based exchange generates benefits through the production and sale of products in which farmers are specialized and have a comparative advantage. This creates income which can be used to buy other goods and services, including food that other producers may be able to provide at lower cost. In the long term, markets can also bring sustained effects. As ideas are also exchanged through market transactions, better technologies are diffused, productivity increases, and farmers and their families build their productive assets and invest in education, health and their livelihoods.[3]

Increasingly, procurement is characterized by a shift from traditional spot markets, where farmers and traders meet at the farm-gate, towards sophisticated, global vertically integrated value chains where contracts specify the timing, scale and quality parameters of the transaction (see also Parts 1 and 2 for a discussion on the evolution of agri-food trade and markets and the emergence of global value chains). In developing countries, both traditional and modern value chains are present, with the latter mostly meeting urban demand for food. International trade is also increasingly taking place through global value chains. ■

MARKET PARTICIPATION IN THE CONTEXT OF DEVELOPING COUNTRIES

Within this progressively transforming market environment, international trade has increased significantly, and sophisticated value chains, both global and domestic, link farmers with consumers, giving rise to better opportunities.

BOX 3.1

HOW WELL-FUNCTIONING MARKETS CONTRIBUTE TO DEVELOPMENT

Broadly, structural transformation can be initiated by increases in the productivity of labour, followed by increases in income, which can stimulate demand, create employment and spur economic growth. Improved technologies, investment in education and skills, and well-functioning markets for labour, capital and products are key to this development process.

In agriculture, productivity increases mean that fewer people can produce more food. People start leaving agriculture in search of better economic opportunities in cities. With well-functioning labour markets, workers move from agriculture to other sectors of the economy, such as manufacturing and services, to find employment. Their savings provide capital fueling growth. Societies urbanize, and rural households diversify their income sources by obtaining better-paid work in the non-farm rural sector that also bridges agriculture with the rest of the economy.

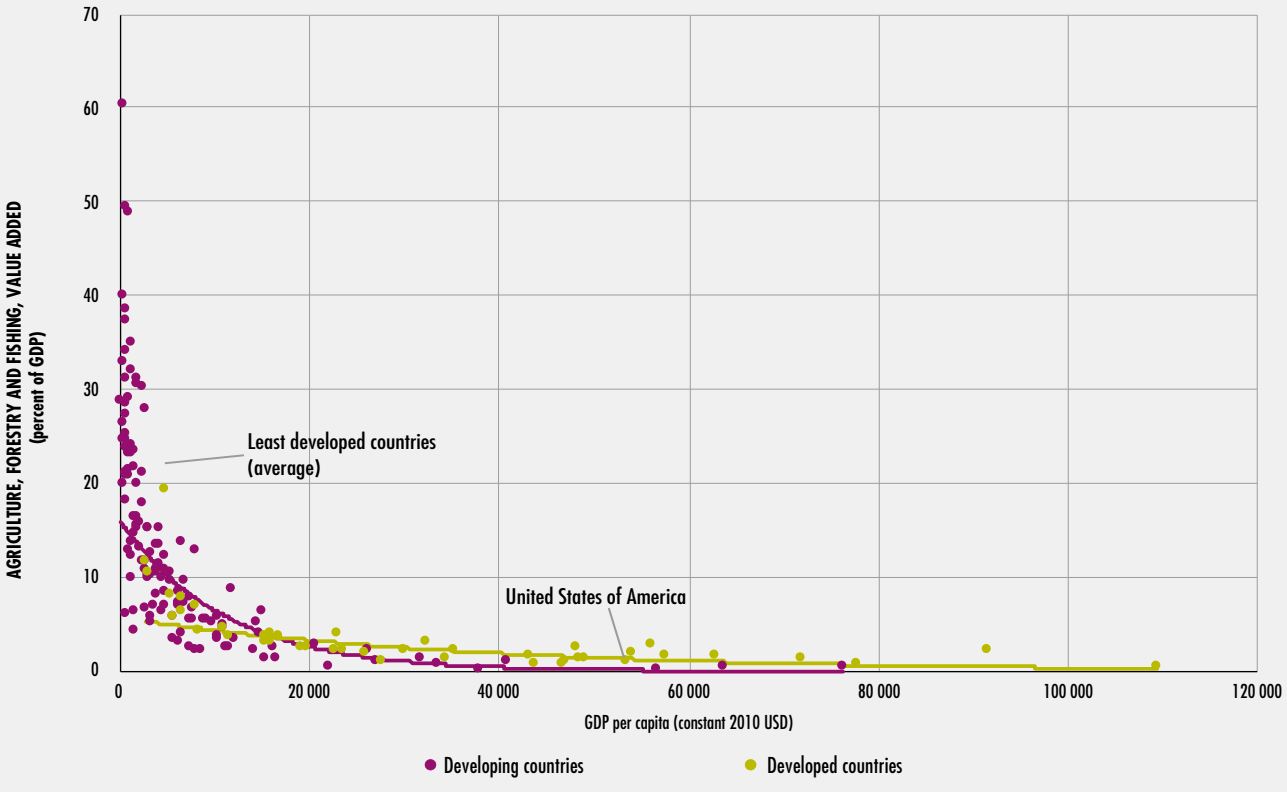
Product markets also link agriculture with other economic sectors. Forward linkages are identified with agricultural output markets, as agriculture (1) provides low-cost food to workers, underpinning productivity growth in the broader economy; (2) supplies inputs to the food and manufacturing sectors; and (3) markets exports to earn foreign exchange that is necessary to import capital goods that add to economic growth. There are also important backward linkages through markets for inputs for agricultural production such as seed, labour, machinery, agrochemicals and, increasingly, services. Through these linkages, agriculture can be an engine of economic growth early in the development process and a major force for poverty reduction.

Along this path to structural transformation, agriculture's relative importance in the economy declines as per capita incomes increase (Figure 3.1). As people become progressively richer, they consume more manufactures and services, while the demand for food rises at a lower rate. The final stage of structural transformation is an economy where GDP per capita is relatively high and agriculture contributes towards a small part of the GDP. For example, in 2017 in the United States of America, agriculture contributed around 0.9 percent of GDP, compared to an average of 21.4 percent in the least developed economies. At this final stage of transformation in the United States of America – which was probably achieved in the 1980s – agriculture became fully integrated with other sectors through well-functioning markets, with the productivity of labour across sectors becoming equal.

SOURCE: Timmer & Selvin. 2008.[1]

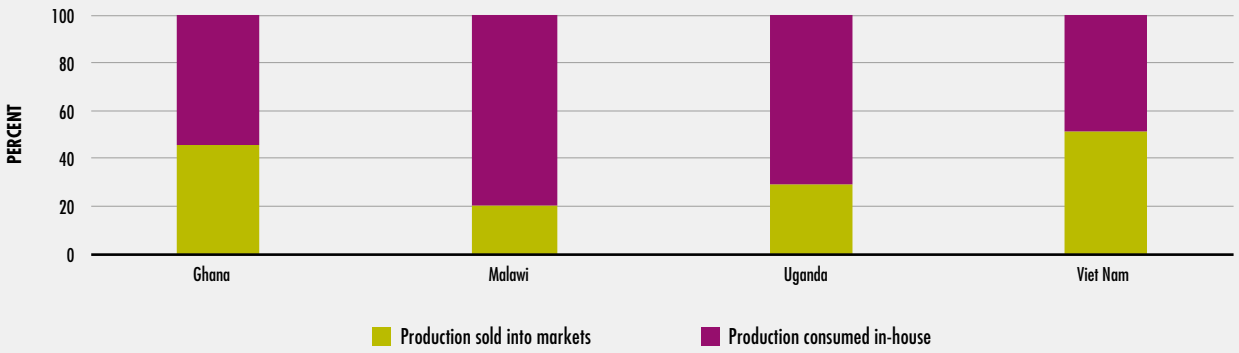
FIGURE 3.1

STRUCTURAL TRANSFORMATION ACROSS COUNTRIES: GDP SHARE OF AGRICULTURE AND GDP PER CAPITA, 2017



SOURCE: World Development Indicators, World Bank (accessed March 2020).

FIGURE 3.2
MARKET PARTICIPATION: AVERAGE SHARE OF HOUSEHOLD PRODUCTION SOLD IN MARKETS IN GHANA, MALAWI, UGANDA AND VIET NAM



SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family farming/data sources/dataportrait/farm size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

Yet, many farmers in developing countries, especially smallholders, remain marginalized and excluded from the development process, having access to traditional or informal markets that function poorly or only very locally.

In many developing countries, and especially in Africa, top-down interventions and liberalizing markets and trade in the 1980s proved ineffective in integrating many farmers into markets and improving their livelihoods. In many cases, this was due to market failures that constrain farmers from responding to price incentives, pointing out the need for a range of policies and public investments that could address specific constraints and inequities and complement market liberalization.[b]

Currently, in developing countries, a range of value chains link farmers to both formal and informal markets. Some value chains are being developed to meet the demand of higher-income urban consumers through supermarkets (see Part 1). At the same time, global value chains offer significant opportunities for farmers in developing countries to participate in the international market based on their comparative advantage, rather than having to only rely on domestic processing industries that may be still less competitive (see Part 2).

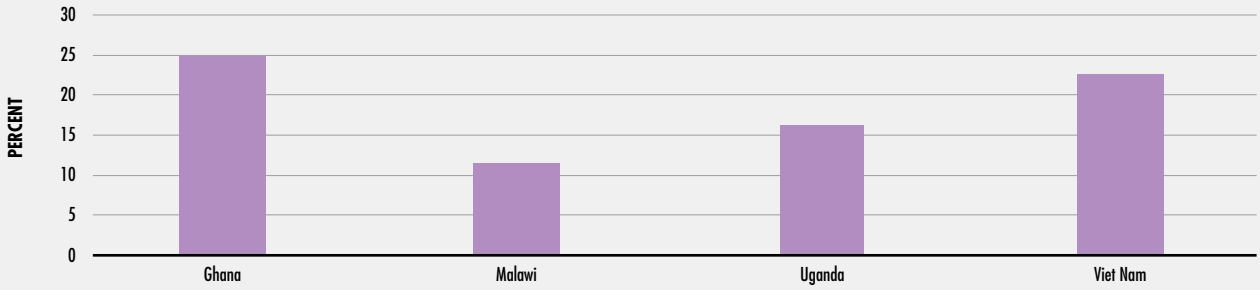
However, not everyone can link to global value chains, especially when enabling conditions for market access are not met. Often, in developing countries, smallholder farmers sell to small and local markets, informal vendors and lower-income population groups. Indeed, most farmers sell into markets, but, on average, their participation in terms of how much of their production is commercialized is not high.

This does not mean that households are entirely isolated from markets. Most farmers in developing countries participate in markets, both formal and informal, but their sale volumes are small. Few of them are net-sellers.

Household survey data showcase farmers in developing countries who sell only a part of their production, and this part can often be small. For example, in Ghana, farmers sell, on average, about 46 percent of their crop production (in value terms), retaining more than half for in-household consumption (Figure 3.2). In Malawi and Uganda, farmers participate in agricultural markets selling about 21 percent and 30 percent of their crop production, respectively. In the more commercialized agriculture of Viet Nam, the data suggest that, in 2008, the average proportion of household production sold in markets was 52 percent.

b In the 1980s, the Washington Consensus emphasized the role of market forces in the economy as the main mechanism for resource allocation and recommended reducing the role of the public sector. In some countries, especially in Africa, these top-down policies performed poorly and resulted in slow economic growth and rising inequality. This effect was especially pronounced in agriculture, with the withdrawal of the state affecting investments in public goods, such as research and development and productive infrastructure.

FIGURE 3.3
AVERAGE HOUSEHOLD SALES REVENUE OVER TOTAL HOUSEHOLD INCOME IN GHANA, MALAWI, UGANDA AND VIET NAM, PERCENT



SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

These thin market-based transactions do not add much to the household's liquidity which is crucial to lifting smallholder farmers out of semi-subsistence (Figure 3.3). For many farm households, a large part of income is made up of the value of production retained in-house for consumption, wages often earned in informal labour off-farm markets, remittances and transfers. Farm households rely on these earnings to supplement their own food production, and many are net-buyers in the food markets.

Market participation and transaction costs

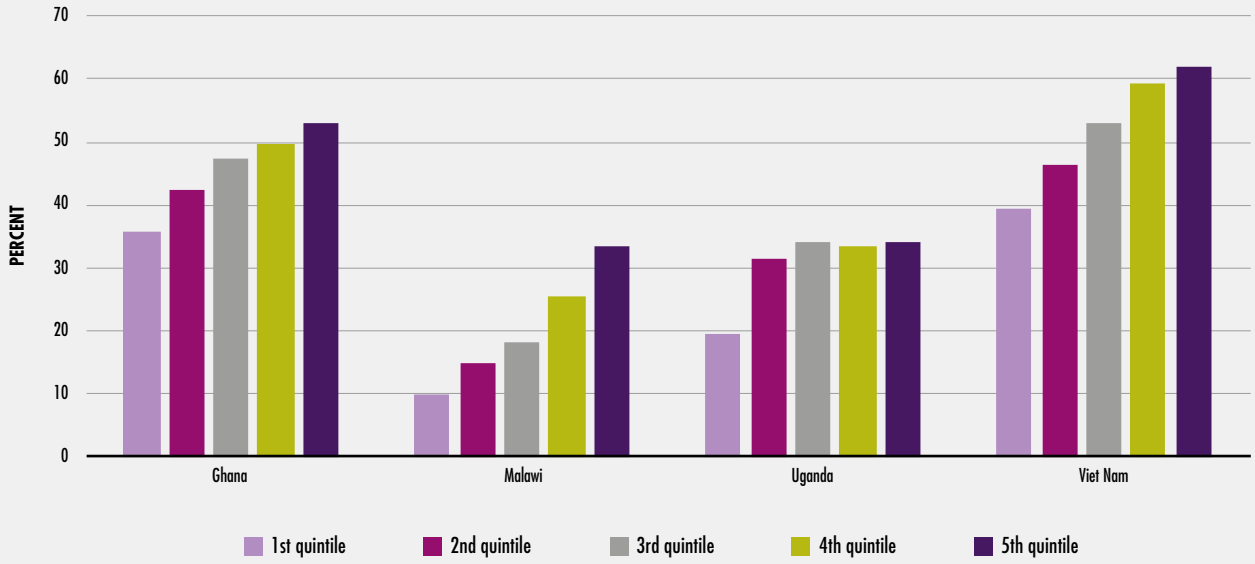
The high costs of market-based transactions largely explain the low rates of market participation in developing countries. For example, many farmers may have limited opportunities to participate in markets due to poor infrastructure and limited road accessibility that translate into high transport costs. These variable transaction costs add to the price farmers pay for inputs and lower the price they receive for their products. As farmers are geographically dispersed, and their supply is both small and inconsistent, private traders either do not source from them or require high margins. Distance and the quality of transport infrastructure give rise to a range of different commercialization rates across farmers, which is not reflected by looking at the average picture as in Figure 3.2. For example, farmers located near cities and towns are, in general, characterized by higher market participation relative to farms that are distant from markets.

In rural areas, information is also costly, and farmers may not be able to access details on buyers, markets and price levels. Search costs relating to finding a trader, bargaining, negotiating and agreeing on a transaction are high. These costs are fixed in the sense that once farmers acquire the necessary information, they can sell any quantity without adding much to these costs. Smallholders, who lack scale in production and sales, may be unable to overcome these fixed costs. Often it is the larger and well-endowed farmers that make up most of the supply in markets, especially for staple foods.[4]

Nevertheless, for commodities such as coffee and cocoa or vegetables, smallholders can have significant market and global value chain participation rates.

Household survey data suggests that there is a positive relationship between the proportion of household production that is

FIGURE 3.4
SHARE OF HOUSEHOLD PRODUCTION SOLD IN MARKETS ACROSS THE FARM SIZE DISTRIBUTION IN GHANA, MALAWI, UGANDA AND VIET NAM, QUINTILES



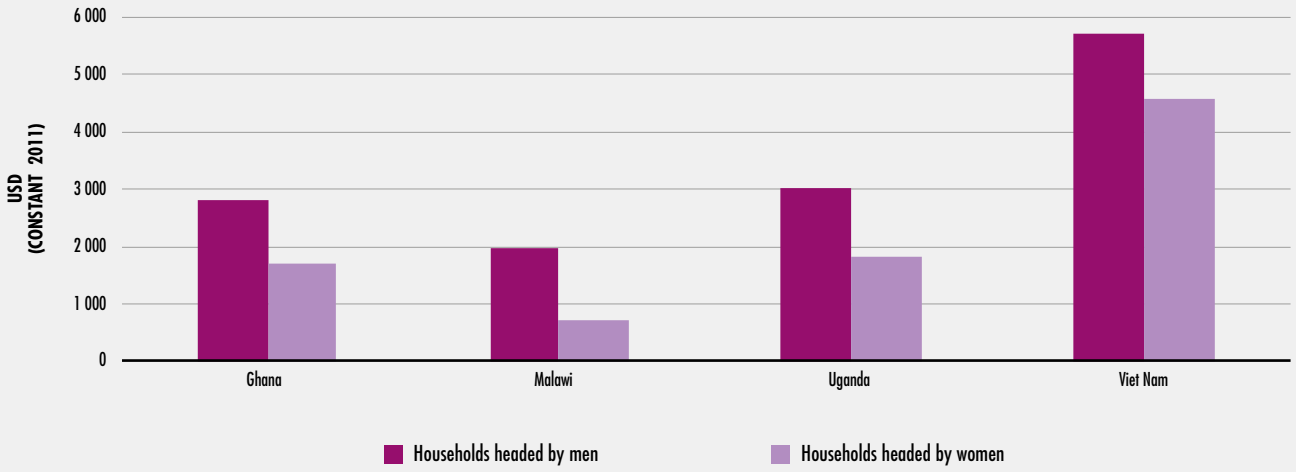
SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

sold in the markets and farm size (Figure 3.4). For example, in Ghana, small farms at the bottom of the farm size distribution with a farm size up to 0.4 hectares sell 35 percent of their production in markets. For larger farms, at the top 20 percent of the farm size distribution, with a size of more than 6.2 hectares, the rate of market participation is over 50 percent. In Viet Nam, market participation rates follow a similar pattern but are significantly higher for all farm sizes, indicating that farmers in the country face lower transaction costs compared with farm households in Malawi and Uganda.

High transaction and search costs in developing countries result in thin product and input markets. They also result in systemic market failures – price instability and missing markets for credit and insurance. For example, in the context of a developing economy, farms face considerable difficulties in accessing credit, as banks are often reluctant to lend to them due to poor collateral and lack of information. Lack of access to insurance limits farmers' ability to mitigate production risks and hinders on-farm investment. Such market failures can create poverty traps characterized by a cycle of low investment, low productivity and low incomes, especially for smallholder farmers.

There are also other constraints which can isolate farms from modern markets. Sales through modern value chains, such as supermarkets, require from farmers an ability to provide continuity of supply and to meet demanding food safety and quality requirements. Lack of information on quality standards, limited access to technology and low managerial and logistic skills make it difficult for many smallholder

FIGURE 3.5
AVERAGE TOTAL HOUSEHOLD INCOME BY GENDER OF HOUSEHOLD HEAD (USD, VALUED AT 2011 PRICES)



SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family farming/data sources/dataportrait/farm size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

farmers in developing countries to supply modern value chains.[5]

For example, pesticide residues inspections on imports in the European Union in 2013 resulted in 10 percent of the beans and peas that arrived at its ports being rejected. In the same year, Kenya's USD 930 million horticulture export industry experienced a 50 percent decline in total exports. Kenyan smallholder farmers, who reportedly produced about 80 percent of these exports, were significantly affected.[6]

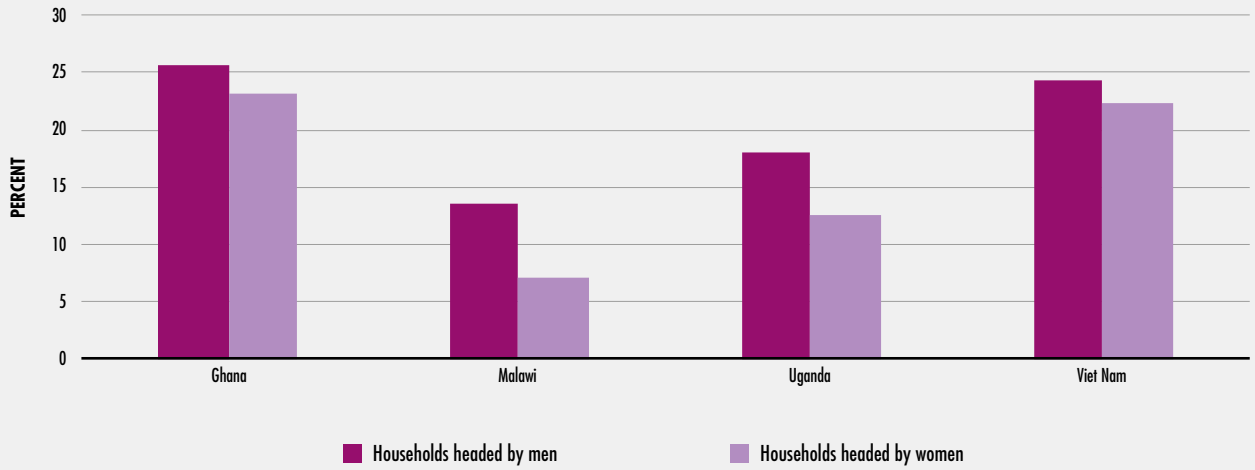
There are also success stories. In Ethiopia, the value chain for teff – the most important staple in the country – is transforming. Lower processing costs and increasing demand for convenience and quality has resulted in increases in market participation and improved farm-level productivity in areas that are well linked with urban centres.[7]

Across farms, access to markets is far from uniform as transaction costs give rise to a broad range of market participation rates. For many farmers in developing countries, decisions on production and exchange strategies are constrained because markets are missing or do not function well.

The most important implication of these constraints for growth and development is that a whole set of decisions at the farm household are not separable from each other. For example, when markets do not function well, the decision of what and how much to produce cannot be separated from the decision of what and how much to consume. Missing markets mean that farmers may choose to diversify their production to mirror their diets, rather than pursuing efficiency-increasing specialization strategies and relying on markets for their consumption.[8]

Women farmers face even greater disadvantages than their male counterparts, as they have less access to assets and social capital, and gender adds to the factors that determine the wide range of market participation rates in developing

FIGURE 3.6
AVERAGE HOUSEHOLD SALES REVENUE OVER TOTAL HOUSEHOLD INCOME BY GENDER OF HOUSEHOLD HEAD, PERCENT



SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family farming/data sources/dataportrait/farm size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

countries. Households headed by women generate significantly less income than those headed by men (see Figure 3.5). In many countries, households headed by women participate in markets to a significantly lesser extent compared with households headed by men (see Figure 3.6).

Decisions on how to allocate labour across on- and off-farm activities also depend on markets. Off-farm employment can complement farm income and provide an important risk management tool by diversifying income sources. Lack of well-paid employment – which can also be associated with low education levels – results in farmers assessing the cost of their labour as being very low. And as they are faced with such a low "shadow wage", farmers tend to supply more family labour on-farm. The smaller the farm, the greater the labour intensity, giving rise to an inverse relationship between yield per hectare and farm size – which is often observed but not entirely understood. Small farms tend to achieve higher yields per hectare than larger farms but significantly lower productivity per worker and thus relatively lower incomes per capita.[9]

Technology adoption rates can also be related to missing markets. Farmers who are integrated into markets are more likely to adopt new technologies than those who are characterized by low market participation. Households with limited access to markets have weak incentives to adopt new technologies and to increase productivity, as they face only their own demand, which becomes quickly satisfied with small increases in production. Farms that are well integrated into markets face an aggregate demand for commodities, and their behaviour towards technology adoption is in line with the returns they expect from selling more produce.[3]

In the context of developing markets, a myriad of decisions, including on how to meet social objectives such as investments in education and health, are affected by poorly functioning markets. Lack of insurance and credit markets in the face of adverse weather conditions can

significantly influence critical investments in the education of children. In Côte d'Ivoire, for example, rural households facing adverse rainfall shocks tend to reduce school enrollment rates by between 30 and 50 percent.[10] In Honduras, children from rural households that have limited access to credit markets attain lower educational outcomes. Such negative impacts appeared to heighten with weather shocks identified with Hurricane Mitch.[11]

Farm size, markets and structural transformation

Agriculture is one of the main economic occupations in the world. In essence, more than 600 million farms provide income and employment for billions of people, while producing food and raw materials for a growing and increasingly affluent population. About 90 percent of these farms are estimated to rely predominantly on family labour, occupying 70–80 percent of global farmland and producing about 80 percent of the world's food in value terms. Most of these family labour farms are small – about 70 percent of the 600 million farms worldwide are equal to or smaller than one hectare and operate 7 percent of total agricultural land.[12]

Family labour farms remain the dominant mode of agricultural production, even in high-income countries. This is because family members – being self-motivated – can carry out location-specific tasks, such as planting, fertilizing and weeding, without supervision and therefore at a lower cost compared to hired labour.[13] Thus, along the structural transformation process, as people exit agriculture, farm sizes evolve driven by changes in rural population growth, technology improvements and rural-to-urban migration.[14]

Evidence from agricultural censuses indicates that, between 1960 and 2000, the average farm size declined across low- and lower middle-income countries, while it exhibited increases in high-income countries.[12]

On average, across Asia, as population growth decelerates (see Part 1) and the movement of people out of agriculture continues, rural population growth is expected to slow down by mid-century.[15] Already, urbanization translates into average farm sizes stabilizing or even increasing. For example, household survey data suggests that, since 1992, average farm sizes in Viet Nam have increased from 0.16 to 0.54 hectares.[c,16]

Currently, Africa remains mostly rural, with about 40 percent of its population living in urban areas. Its rural population increased more than threefold between 1950 and 2018, from 196 million to 740 million, and although urbanization will continue, it is projected that more than 1 billion people will continue to live in the rural areas of Africa by 2050.[15]

Slow productivity growth in manufacturing and services could also contribute towards low rates of structural transformation and declining farm sizes in the future.[d,17] On average, farm sizes in African countries exhibit a declining trend. For example, household survey data suggests that in Malawi, between 2004 and 2011, the average farm size declined from 1.08 to 0.67 hectares (Figure 3.7).

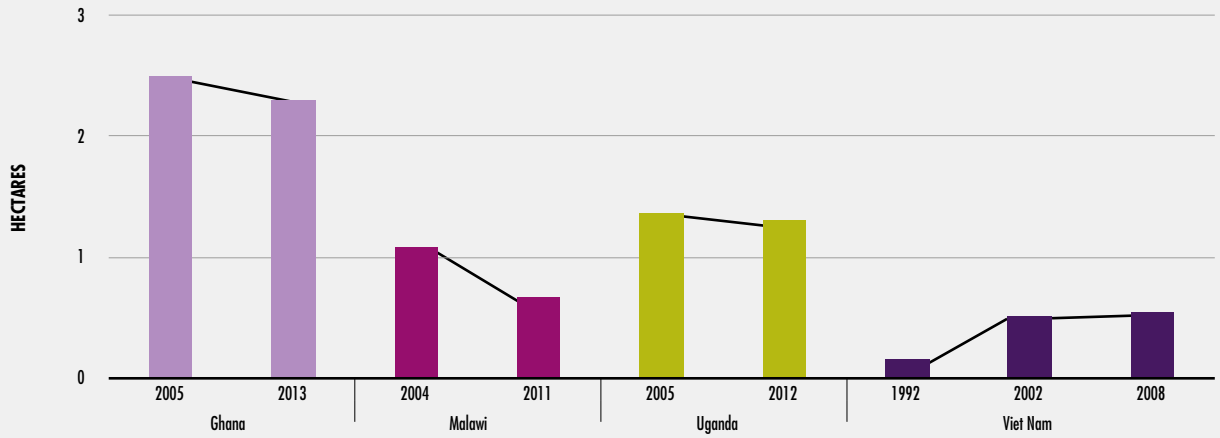
Declining farm sizes may have significant implications for market participation, especially in the context of modern food markets and global value chains, where access entails substantial fixed costs in terms of information. Assets, especially land, together with access to transport infrastructure, can be strongly associated with market participation.

Low market participation can hinder the development process and can also have negative implications for poverty eradication and food security for a large part of the population. Indeed, increasing the commercialization of small farms can increase income and reduce poverty. For example, in Kenya, a study of a

c In Viet Nam, de-collectivization was initiated in the late 1980s, and in 1993 a new land law was introduced recognizing official land titles and allowing land transactions. At that time, the land remained the property of the state, but rights to land were extended (typically from 15 to 20 years for annual crop-land) and could be legally transferred and exchanged, mortgaged, and inherited.

d Recent research suggests that, in the case of Africa, economic growth and structural transformation may not be sustained due to low productivity in the non-agricultural sectors of the economy.

FIGURE 3.7
EVOLUTION OF AVERAGE FARM SIZE, HECTARES



SOURCE: Smallholder DataPortrait, FAO (available at http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/).
The data were compiled from Living Standards Measurement Studies (Ghana 2013, Malawi, 2011, Uganda 2012, Viet Nam 2008).

sample of farm households which on average sell about 44 percent of their output, suggests that an increase of 10 percentage points in market participation results in a 17 percent increase in mean income per capita and reduces the prevalence of poverty among households by 16 percent.[18]

Positive effects of market participation were also identified in addressing deprivations in education, health and nutrition, and living standards, suggesting that market participation results in increases in human capital and capabilities that are key in including household members in the development process. At the same time, although markets can contribute to poverty reduction, increased market participation could lead to increased inequality, as gains in per capita income tend to be larger for relatively well-endowed and wealthier households than for poor ones.

Well-functioning markets can facilitate the process of structural transformation. However, the heterogeneity that characterizes agriculture and farms, but also the value chains and the agri-food enterprises within and across countries, will necessitate multifaceted actions (see Box 3.2 for a discussion on rural small and medium-sized enterprises).

Focusing on how to promote productivity per capita, integrate into markets and ignite growth in the sector is crucial for development, but, at the same time, the process of structural transformation entails different livelihood strategies for farm households within or even outside agriculture. Such strategies take into account several factors, including commercialization, which depends on farm size, transaction costs and the ability to meet the demand for food by urban consumers, but also on education, diversified skills and health that shape the ability of a household to transition entirely out of agriculture to other sectors of the economy.

In developing countries, policy prescriptions should address many challenges of integrating farmers into the process of economic growth. For example, social protection mechanisms reduce vulnerability, extreme poverty and deprivation but can also have positive impacts on »

BOX 3.2
RURAL SMALL AND MEDIUM-SIZED ENTERPRISES (SMEs) IN FOOD AND AGRICULTURE

DEFINING MICRO, SMALL AND MEDIUM-SIZED ENTERPRISES IN THE AGRI-FOOD SECTOR

The majority of agro-enterprises operating in rural areas in developing economies are self-employed and offer services to local farm households or traders that transport farm products from the farm-gate to the processor or town markets. Such firms are defined as micro enterprises. Enterprise size is estimated based on the number of employees: 1–4 employees for a micro enterprise; 5–9 for a very small enterprise, 10–49 for a small enterprise and 50–259 for a medium-sized enterprise. However, the International Labour Organization (ILO) indicates that the most commonly used benchmark is fewer than 10 or 50 employees for small firms and fewer than 100 or 250 employees for medium-sized firms.[20,21]

Enterprise size based on a number of employees can only be measured relative to the structure and characteristics of the industry within which the firm is operating and therefore "a one size classification does not fit all".[22] In addition, formality can also be used to rank the size of a firm, especially in agriculture and agriculture-related sectors, where estimates suggest that 80 percent of all enterprises in developing economies are informal firms, thereby falling into the micro enterprise category described above. Moreover, categorizing firms needs to take into consideration the country contexts and state of development. For example, there are fewer enterprises in the agri-food sector in developing countries, relative to comparable agriculture-related enterprises in emerging economies or developed countries, where registered companies can offer sustained employment. Differences across enterprises also arise due to the type of the agricultural commodity, its importance for the local market and the intended market of the agri-food product.

BARRIERS TO GROWTH FACING SMALL AND MEDIUM-SIZED ENTERPRISES

Unlike firms in services and manufacturing, agricultural firms, and particularly small enterprises, are embedded in the rural agricultural fabric of a country.[23] Many small enterprises comprise actors that create rural livelihoods for themselves, their families and the wider community in often poorly functioning business-enabling and regulatory environments. In doing so, they create important "close-to-farm" market outlets for farmers, various off-farm income-generating opportunities for rural poor people, while they can also account for 30–40 percent of the total value added in the chain.[24] As such, micro and small agricultural firms play an important role in rural communities' economies and in rural transformation.[25]

Across developing countries, in the food staples sector where lead firms are absent, traders and primary processors are equally small, fragmented and not coordinated along value chains.[26] These actors typically face many of the same constraints, which include a lack of access to tailored financial instruments, absence of support services and poor infrastructure imposing high transaction costs.[27] Small enterprises also experience a multitude of challenges inherent to being small, resulting from a lack of economies of scale and limited internal resource bases. These are all factors that hinder small agro-enterprises, including small food processors, from responding to an increasingly urbanized market.[28,29] Compared to medium-sized and large enterprises, small firms also, from the start-up phase, face "small firm level" disadvantages, due to informality and to lack of finance, electricity, adequate human capital, information, financial resources and strategic planning capacities.[30]

Locational disadvantages impede the growth of small enterprises in rural locations. This is particularly the case for difficulties related to infrastructure, such as access to the national electricity grid or to public institutional support. Secondary rural towns and villages have smaller, more diffuse pockets of demand, which result in small, localized production. In addition, compared to food companies in urban areas, rural agribusinesses' locational disadvantages include a lack of access to formal retailers offering regular contracts for higher volumes; higher transport costs due to less competition between trucking companies; and less variety of commercial banking services and products available compared to cities. Combined with important resource constraints and inadequate infrastructure, locational disadvantages prevent rural players from penetrating urban markets, ultimately making the agribusiness sector miss out on the opportunity to generate rural employment and to reduce migration to urban cities.[31]

Furthermore, small firms pay a proportionally higher cost for a poor business environment compared to large firms, are more exposed to external threats

BOX 3.2
(CONTINUED)

and face constraints that arise due to an unlevel playing field.[32] It is reiterated throughout the literature on SMEs that smaller firms face "greater financial, legal and corruption constraints compared to large firms".[32] Other studies also suggest that firm size matters, and when doing business with smaller firms, there are more reported obstacles than with larger firms,[33,34] especially in relation to "financing, taxes and regulation, inflation, corruption, street crime and anti-competitive prices".[35]

The challenges faced by small firms, thus, seem to justify the need to implement special programmes, reforms or regulatory frameworks supporting SMEs. Initiatives can, for instance, include "a simplified tax regime or differential labour regulations for SMEs, as well as programmes that facilitate access to credit and a set of subsidies and services aimed at supporting SMEs in different aspects of their activities".[36]

SOURCE: Adapted from Ilie, Kelly & Fall (forthcoming).[23]

» market participation, as they enable households to manage risks better and engage in agricultural production.[19] A range of interventions – both broad-brush and specific – will require investments to address market failures and many dimensions of development. Market-oriented farm households will directly benefit from improved transport and communication infrastructure that lower transaction costs and give rise to markets for products, inputs and financial services. Participating in these markets can promote investments, productivity and income growth but will also allow the households to diversify their income sources in the non-farm sectors.

Other households can leverage labour market linkages and public investments in education to build assets and upgrade their skills to transition out of agriculture and into different sectors of the economy. A significant challenge for policy-makers relates to semi-subsistence households that may be poor and geographically isolated, with unclear property rights and little productive assets. For these households, conventional markets may not work, and the options for improving livelihoods become limited. ■

CONTRACT FARMING

The Green Revolution – driven by technology improvements targeting small farms in the 1960s and 1970s – witnessed governments undertaking a role in addressing transaction costs and coordinating markets (through, for example, marketing boards) at a considerable fiscal cost. Subsequent market liberalization policies tended to underplay market failures and the need for complementary actions to enhance the coordination of market participants. Since then, the transformation of food systems has shifted the focus on how private sector coordination mechanisms can promote access to modern value chains and include farmers in the process of economic growth.

Among such coordination systems, contract farming presents an institutional solution to address transaction costs and market failures across commodities, inputs, credit, insurance and information.[37] Contract farming arrangements are increasingly seen as a means to include smallholder farmers in remunerative markets for added-value foods that are shaped by urbanization and income growth. Contract farming can also integrate these farmers into markets for export commodities that are driven by the expansion of global agri-food value chains.

Contract farming can be defined as a forward agreement between farmers and processing and/or marketing firms for the production and supply of agricultural commodities, often at predetermined prices. The arrangements can also involve the purchasing firms' pursuing a degree of vertical coordination through, for example, the supply of inputs and the provision of technical advice. Broadly, the contract binds the farmer to deliver a specific commodity in quantities and at quality standards determined by the purchaser and requires the firm to provide the farmer with either inputs or technical know-how and purchase the commodity.[38]

Contracts can take a range of forms with varying terms, requirements and conditions. As an institution, contract farming can link farmers to consumers through sophisticated supply chains that add value to food by transport, grading, marketing and processing, ensuring that food meets specific quality and safety requirements.

In many developing countries, firms are not able to entirely bypass smallholder farmers, either because they dominate the agricultural sector or because firms need to secure a continuous supply of commodities to cover their fixed costs. Often, sourcing locally can be attractive relative to imports because it minimizes the impact of currency depreciation. As economic growth results in an expanding middle class, traceability and food safety issues become increasingly important and contract farming provides a measure of vertical coordination and control over farming methods, use of agricultural inputs, volumes supplied, and quality and safety standards. At the same time, contract farming arrangements can link developing countries' farmers to global value chains and export markets, spurring growth (see Part 2).

For farmers, this form of vertical coordination – with contracts including the provision of inputs, such as seeds and fertilizers, technical assistance, credit and insurance, and a guaranteed price at harvest – addresses a number of constraints, such as price risk and the lack of access to markets, credit and information. Today, such new coordination systems may involve not only agribusinesses and individual farmers but combinations of government agencies, civil society, farmer groups, banks, digital technology and mobile telephone companies (see also the discussion in Part 4 on digital technology applications and market failures).

Empirical evidence on contract farming

The impact of contract farming on small farms in developing countries has been a topic of interest and analysis since the 1970s. Most studies utilize household-level data and focus on the average effects of contracting on outcomes, including crop yields, food security, assets, incomes and poverty status.

To estimate the impact of contract farming on farmers, researchers rely on household datasets, which include several variables such as farm size, demographic characteristics of the household, assets and income. These datasets include both households that participate in contract farming, as well as households that do not, with the objective that comparisons between these two groups can indicate the average impact of contract farming on productivity, income and welfare, and other outcomes.[e]

In practice, the results of such studies provide an indication of the average effects of contract farming. It is difficult to disentangle the specific outcomes of the various components of contracts that include predetermined minimum farm-gate prices, provision of inputs, technical support, credit and other services, which also may vary within and across household samples (see Figure 3.8 and Table 3.1).

Madagascar case studies: various crops

In Madagascar, contract arrangements with 1 200 farm households covering different crops across six regions with different agro-ecological

e In the empirical analysis of contract farming, the non-random selection of participants and non-participants in contract farming can easily lead to biased conclusions. For this reason, researchers employ methods that include instrumental variables techniques, panel data analysis and matching estimators. These methodological challenges and the limited availability of high-quality data result in a few studies on the welfare effects of contract farming. In this report we review a number of studies that properly address the non-random selection of participants, in addition to studies based on randomized control trials. We select these studies to showcase the impact of various contract schemes that include different components in different countries, a range of value chains (export, supermarket, or processing), and on different commodities (including high-value and staple foods).

FIGURE 3.8
CONTRACT FARMING INCENTIVES SETS

SOURCE: Elaborated by FAO.

conditions, generated significant positive impacts on participants' total household incomes.[39] On average, a 10 percent increase in the likelihood of participating in contract farming was estimated to bring a 6 percent increase in total household income (for more details on the Madagascar study, see Table 3.1).

A subsequent analysis of the same sample of households in Madagascar also suggests that participation in contract farming promotes food security by reducing the duration of a household's hungry season – that is the period during which one or more household members have less than three meals per day. This hungry season, which lasts between 3.3 and 3.7 months, coincides with the period before harvest when households – contracted or not – receive cash from selling their produce. Extra income from contract farming reduces the hungry season by about eight days on average, and households that participated in contract farming schemes were found to be about 18 percent more likely to have a short hungry season.[40]

Across these households, participation in contract farming was found to depend on several characteristics. For example, female-headed households were 45 percent less likely to secure contracts with purchasing firms, reflecting the constraints women face in entering markets.[41] Farmers' experience was also viewed as an important factor for contract farming participation with every additional year of agricultural experience relating to an increase of 1.2 percent in the likelihood of participation, suggesting that meeting the various contract requirements requires managerial and technical skills.

TABLE 3.1
CONTRACT FARMING STUDIES REVIEWED IN THIS REPORT

Country, study and sample	Products covered by contracts	Contract components	Impact
MADAGASCAR *Bellemare (2012) & Bellemare and Novak (2017)* Sample consists of 1 200 farmers in six regions (Alaotra-Mangoro, Analamanga, Anosy, Diana, Itasy and Vakinankaratra)	Green beans, snow peas and leeks for processing and export; rice, maize and barley	Price paid by purchasing firms is predetermined as part of the contract in most cases; majority of contracts include the provision of inputs (seeds, pesticides, fertilizers)	A 10 percent increase in the likelihood of participating in contract farming brings about a 6 percent increase in total household income. Participation in contract farming reduces the duration of a household's hungry season by about eight days on average. Participating households are about 18 percent more likely to see their hungry season end at any time
SENEGAL *Warning and Key (2002)* Sample comprises 26 households located in Passy near the primary road connecting the capitals of Senegal and Gambia	Peanuts	Purchasing firm provides training, seeds, fertilizers and agro-chemicals; agricultural practices are monitored throughout the season to verify that contract requirements are met; at harvest, farmers pay the value of inputs plus 13 percent interest	Participation results in 29 percent increase in household gross agricultural income
VIET NAM *Wang, Moustier and Loc (2014)* Sample is made up of 137 farmers that are members of cooperatives in peri-urban Hanoi	Vegetables	A variety of value chain arrangements in the context of certification related to conditions of soil and water and compliance with restrictions on the use of chemicals; these included selling to collectors in spot markets; directly to consumers; and to supermarkets or dedicated wholesalers through contracts	On average, participation in value chains results in an approximately 37 percent increase in household income
PEOPLE'S REPUBLIC OF CHINA *Miyata, Minot and Hu (2009)* Sample consists of 162 farmers in Shandong Province	Green onions and apples	A range of contract types including guaranteed prices, market prices plus premium, seeds and pesticides, spraying services to ensure pesticides residue levels, and quality and safety standards monitoring	Contract farming can result in household income per capita increases of 22 percent (for apple growers) and 45 percent (for green onions growers)
NICARAGUA *Michelson (2013)* Sample comprises 862 households across 73 municipalities out of a total of 153 municipalities in the country	Fruit and vegetables	Specified quantity and quality of products, minimum prices agreed by purchasing firms; NGOs assisted farmers with credit, irrigation and technical advice	Participation in contract farming is estimated to result in a 16 percent increase in household productive assets
VIET NAM *Saenger, Torero and Qaim (2014)* Sample is made up of 402 dairy farmers located near Ho-Chi-Minh City, Viet Nam	Dairy	Price premia for quality (fat and solids), pre-finance of inputs, technical training; an independent agency to verify product quality and enforce contract enforcement	Contract arrangements and the provision of third-party contract enforcement had a positive impact on input use, output levels and quality (quantity of milk fat and total solids). This led to higher revenue and also higher household welfare for specific subgroups of the sample

TABLE 3.1
(CONTINUED)

Country, study and sample	Products covered by contracts	Contract components	Impact
SENEGAL *Bernard, Hidrobo, Port, and Rawat (2019)* Sample is made up of 4 existing milk routes using 376 container level data, 320 concessions-level data, and 428 household level data located in Northern Senegal	Dairy	Fixed price per litre, access to inputs at discount cost; contract arrangements include a nutrition-based incentive to promote milk deliveries and ensure adequate supply for contractor	Significant impacts on the frequency and amount of milk delivered, especially during the dry season; greater impacts on milk deliveries when contracts are managed by women
BENIN *Maertens and Velde (2017)* Sample consists of 396 households in Savalou, located in the centre of the country	Rice	Specified quantity, time of delivery, quality specifications, impurity and humidity thresholds; other modalities include a predetermined fixed price; improved seeds, fertilizers and herbicides provided by purchasing firm on credit; training to improve quality and technical assistance	Contract farming brings about a 17 percent increase in total household income
INDIA *Narayanan (2014)* Sample includes 474 farmers located in the state of Tamil Nadu	Poultry, papaya, marigold and gherkins	Various contractual arrangements with agreement to purchase product at harvest and with different degrees of involvement by purchasing firms: for poultry firm provides day-old chicks to contracted farm, vaccination, feed and health monitoring; papaya production involves crop monitoring and training; marigold contracts involve seed provision at subsidized prices, technical advice and training	Contract farming is estimated to result in changes in the profitability per hectare: for poultry an increase of 123 percent; for papaya an increase of 47 percent; for gherkins an increase of 27 percent; and for marigold a decrease of 50 percent; the study concludes that impacts are very heterogeneous

Farm size was estimated to be positively related to contract farming participation. On the one hand, the larger the farm, the more opportunities for diversifying production and thus participating in contract farming. On the other hand, as participation in contract farming is often found to be biased towards larger and relatively wealthier farms – that can better meet quality and quantity requirements – this indicates that contract farming may lead to greater inequality in rural areas. Indeed, it is likely that poorer farmers are not included in contract farming. In general, a systematic review of the literature on the effects of contract farming arrangements on income found that 61 percent of contract farmers had larger farms or more assets than their non-contract counterparts.[42]

Senegal case study: cash crops

However, farm size and household wealth may not be the only significant driver of contract farming participation; the relationship may also depend on whether the production of contracted crops requires specific investments. For example, in Senegal, the participation of farmers in contract farming schemes for peanuts was shown not to depend on farm size. The cultivation of peanuts is a traditional cropping system that does not require any specific investments in either capital or knowledge as would be the case for an unfamiliar high-value crop.[43] Contract arrangements, based on local community information and reputation instead of farm assets, were found to increase farm income significantly, thus reducing poverty and

inequality (see Table 3.1 for details on the contract components of the Senegal study).

Viet Nam, People's Republic of China and Nicaragua case studies: fruit and vegetables

In Viet Nam, households with limited assets had the capacity to sell vegetables under contract to supermarkets, directly to consumers or to spot markets. Despite the small farm size, these households were found to be able to meet food quality and safety requirements and produce high-value products.[44]

Food safety and quality requirements for fruit and vegetables by supermarkets and exporters give rise to increased vertical coordination and contract farming. In the People's Republic of China, contract farming of apples and green onions was found to result in a 22 percent increase in the average income of apple growers and a 45 percent increase in that of green onion growers.[45] For labour-intensive products such as fruit and vegetables, participation was found to depend on the availability of family labour, rather than on farm size. For apple growers, income increases were due to higher yields as a result of technical advice and inputs provided through the contract. For green onion farmers, higher prices more than offset the input costs per unit, also resulting in increased incomes (see Table 3.1 for more details on the contract components). Higher income allowed these households to spend more on schooling, healthcare, food consumption and house improvements.

Contracts could have lasting effects on farmers' livelihoods. In Nicaragua, participation in high-value fresh vegetable supermarket chains could result in a 16 percent increase in a household's productive assets, such as tractors, plows and irrigation pumps over a period of 2.5 years.[46] Households located near a road and with access to irrigation water – factors that allow a steady supply of produce throughout the year – were found to be more likely to participate in these contract schemes. This increase in assets was the result of better access to credit and of the predetermined minimum prices that, as part of the contract, reduced farmers' exposure to risk and promoted investments (see Table 3.1 for the contract details of the Nicaragua study). As assets determine productivity, contract arrangements that guarantee minimum prices could have long-term effects on household income and, thus, on poverty reduction.

Indeed, contract farming is often seen as addressing insurance market failures. In Madagascar, contracts where a guaranteed fixed price was offered to farmers were also associated with a decrease in average household income variability, as price risk was transferred to the purchasing firms.[47]

Viet Nam and Senegal case studies: dairy

Milk is becoming an increasingly popular high-value food item, leading to high growth rates in the dairy sector in Viet Nam, and more generally, in Asia. In such value chains, product quality is an important factor in determining participation and farm-gate prices. When quality attributes are not observable, such as in milk, and individual testing is excessively costly, information asymmetries can lead to inferior market outcomes.[48] For example, purchasing firms may underreport quality levels to farmers to reduce the price that they have to pay. As a result, farmers may limit investment, thus negatively affecting farm productivity (see also Box 3.5 for an innovative solution to this information asymmetry problem).

A study assessed the impact of milk testing and quality verification by an independent third party agency on the behaviour of randomly selected smallholder dairy farmers in Viet Nam who were contracted by a dairy company. The addition of such a contract-enforcing institution to a rapidly grown market was shown to have a positive impact on input use (such as feed), quality and output levels (quantity of milk fat and total solids). This led to higher revenue and, on average, higher household welfare.

In Senegal, in another contract farming arrangement for milk, innovative contract design focused on building trust and social capital between the buyer and farmer. In order to secure adequate milk supplies from a large number of semi-nomadic farmers, a dairy firm provided a nutrition-based incentive that could improve children's nutritional status as a component of the contract and in order to increase milk deliveries. This incentive – the daily provision of

a micro-nutrient fortified yogurt for each young child in the household – compensated farmers for consistent milk deliveries. This innovative approach showed significant impacts on the frequency and amount of milk delivered, especially during the dry season, when it is difficult to meet delivery requirements compared to the rainy season. These effects were shown to be more significant when women managed contracts. The impact on total milk delivered in both the dry and rainy season is large for female-headed households, representing an increase of 64 percent in the dry season and 33 percent in the rainy season, thus underlining that the empowerment of women significantly improves nutrition and well-being for the entire household.[49]

Benin case study: staple food value chains

Unlike fruit and vegetables, staples have limited possibilities for increasing value added and upgrading quality through contracts. Staple foods are not perishable like vegetables and can be stored and transported easily. However, increasing the efficiency of staples' value chains through contract farming is important for developing countries. First, it could benefit a significant number of smallholder farmers and, second, it could contribute to strengthening access to food by a growing urban population thus promoting food security.

Although most contract farming analyses focus on high-value products, in Benin rice contract farming is found to have significant effects on household income, yields and farm-gate prices. Benin's rice sector competes with imports but is characterized by low value added and low quality. Studies show that membership in an organized farmers' group is important for participation in the rice contract scheme, together with the household size and the education level of the household head. Farm size and assets are found not to influence participation.[50]

Improvements in quality due to better sorting that increased purity levels resulted in increases in farm-gate prices by 11 percent compared with average prices. Contract farming also brought improvements in yields through better access to inputs and an expansion of the area under rice, resulting in an average 60 percent increase in production. The effect of participation in contract farming on household income was estimated at an increase of 17 percent (see Table 3.1).

Nevertheless, contract farming for staple foods may be limited. The rice market in Benin is still small compared to staple markets across developing countries that are characterized by many farmers and traders. Rice production requires specific investments in levelling, flooding and draining the fields which, in conjunction with more possibilities for quality differentiation, can render contract farming possible.

Benefits of contract farming

In general, the evidence on the positive effects of contract farming on welfare is overwhelming, at least within the local contexts of the studies. However, impacts can be highly heterogeneous both across different contract schemes and between farmers participating in a particular scheme. Analysis of various high-value contract schemes in India revealed that, in some cases, participation resulted in significant increases in net profits per hectare while, in other cases, it had a negative effect on profitability per hectare (see Table 3.1 for more details in the various contract arrangements included in the India study).[51]

Indeed, in developing countries, the evidence suggests that participation in markets and contract farming is subject to reversals. Contract schemes collapse frequently, and there is a high rate of exit, as farmers move in and out of contracts. If markets are to contribute to development, sustained participation is necessary; the positive effects of contract farming on farmers will be larger if participation is continuous, as investments in productive assets, technologies and knowledge take time to generate benefits. This highlights the need to carefully analyse the contractual terms and arrangements against the effects on farmers' welfare to understand better the dynamics of sustained participation in such markets.[52]

A comprehensive review of the evidence on the income effects of contract farming suggests that participation increases farm income by an

average of 63 percent. Out of the 26 contract farming schemes analysed, only two were found to have negative effects. This finding underlines the positive impact of contract farming on welfare but, at the same time, masks the heterogeneous effects contract farming might have.[42] Similar conclusions are drawn from the analysis of empirical studies in this report.

Although all studies reviewed used statistical techniques that properly identified the causal impact of contract farming on welfare, these income effects may be overestimated. First, it is likely that non-significant income effects are not reported, as scientific articles are more likely to be published if they found a significant effect (this is called publication bias). Second, most of the studies may neglect contract farming schemes that failed as well as farmers' exits from contracts (this is called the survivor bias). Both sources of bias may result in an overestimation of the income effects.

Participation in contract farming schemes is also subject to spillover and trade-off effects. For example, the higher labour requirements of contract farming can affect employment off-farm. A study, using data from Madagascar, suggests that contract farming is associated with a 79 percent decline in household income per capita derived from labour markets and a 47 percent decrease in the income generated by non-farm businesses. This is a consequence of increased specialization in the production that is necessary to meet contract requirements. It may also indicate that contract farming is more profitable relative to non-farm employment. This relationship between earnings from contract farming and earnings from the labour market could potentially explain why farmers move in and out of contracts frequently. At the same time, there are positive spillover effects, as knowledge and technology obtained by participation in a contract can affect non-contracted crops. Such technological spillovers could result in a 51 percent increase in agricultural income derived from non-contracted crops.[53]

Despite its weaknesses, the analysis of contract farming participation can provide valuable insights into the effects that different forms of contracts and service provision may have in obviating market failures. Secure access to markets, the provision of inputs and credit, price premia that reward quality, predetermined farm-gate prices, extension services and technical advice form a complex service structure that addresses specific constraints and risks faced by farmers in developing countries.

Although more research is necessary, the evidence suggests that price premia, when combined with input provision and credit, have an important positive income effect in the context of annual crops. While predetermined prices address price risk for all contracted crops, the effect of price premia can be especially significant in the context of remunerative markets and global value chains for differentiated and certified products. Extension services and transport provision, when included in the contract, also have a strong impact on income, highlighting the importance of improved technologies and better transport infrastructure on market participation.[42] ■

INNOVATIONS IN INCLUSIVE CONTRACT FARMING MODELS

Various types of coordination mechanisms can simultaneously address different market failures faced by farmers in developing countries. Many innovative business models are designed to address multiple market failures simultaneously through "bundling" inputs and services together.

In development and poverty reduction programmes, where the objective is to promote self-employment, empirical evidence suggests that combined interventions may be needed to achieve a significant and persistent impact on a large part of the beneficiaries. Different actions simultaneously targeting the poor over a limited period, such as the transfer of a productive asset with consumption support, technical skills training, coaching, access to savings and health education, can complement each other in supporting households to improve their livelihoods.[54]

Such a comprehensive approach could be effective in the context of multiple market failures that vary widely in terms of severity and across space. In agriculture, bundling inputs and services may perform better than standalone provision.

For example, linking the provision of modern inputs with insurance can lead to relatively higher productivity and income increases compared with facilitating the provision of technology and insurance separately. Investing in improved seeds is perceived as risky, as in the event of a drought, farmers may lose their investment. Using traditional low-quality inputs is preferable under uncertainty, especially for subsistence farmers for whom the additional cost of modern technology would make up for a significant share of their income. However, contract farming that links improved seeds to insurance could increase farmers' demand for technology by reducing their exposure to risk. In Kenya, bundling crop insurance with improved seeds is found to increase investments on-farm, including on land and inputs such as fertilizers and machinery.[55]

Innovative business models can also decrease the costs for buyers of contracting with smallholder farmers. Another set of innovations increases benefits to both parties through introducing product differentiation in terms of quality and other characteristics; these innovations can change the amount and nature of risks involved and can also provide access to niche and more remunerative markets.

Many attributes of these business models are not new, especially when they are considered on their own. Innovations are tailored in a way so that models address multiple market failures simultaneously to include smallholder farmers in value chains.

Bundling inputs and services with insurance to address production risk

There is a range of options for contract farming to include production insurance directly. Especially in developing countries, where farmers are characterized by low collateral, standalone insurance contracts can have minimal impact on the adoption of new technologies. In contrast, insurance interlinked with credit can be much more effective at promoting technological change.[56] Firms purchasing from farmers through contracts can better bundle credit and production insurance to farmers. This is because the contracting relationship itself and the related services provide additional means of enforcing the lending contract (see Box 3.3 for an example of bundling insurance).

Within a contract, insurance can play an important role in two ways. First, it can reduce the risk to the contracting firm, and thus encourage the provision of quality inputs to farmers that are key for increasing production and income.[f] As the insurance is provided as part of a package along with assured access to markets, banks may also be willing to provide additional credit outside the contract. Second, adding insurance to the input bundle offered to farmers can increase participation in contracts, especially if they involve the introduction of new technologies. Production insurance leads to strong increases in farmer investment, with farmers taking on riskier and potentially more profitable production choices.[58,59]

The effects of bundling inputs and services through contracts on farm sales and income

Contract farming agreements that guarantee a minimum price can provide farmers with a measure of price insurance, thus creating powerful incentives for investment. Often, either traditional domestic markets for a contracted commodity are thin (as can be the case with rainfed horticulture), or the international price exhibits high volatility and extended periods in which prices are depressed (as in the coffee and cocoa markets). Therefore, contracts that include predetermined fixed prices can reduce farm income variability and promote investments.

For the purchasing firm, one important challenge associated with these contracts is the risk that farmers may opt to sell contracted

f Currently, there is little academic research on linking credit with insurance.

BOX 3.3
BUNDLING INSURANCE IN CONTRACT FARMING SCHEMES

PepsiCo in India offers voluntary weather index-based insurance to farmers participating in its potato programme. Insurance is especially important because of the risk of potato blight, a disease that can destroy the crop for processing purposes (for more information on weather index-based insurance, see Part 4).

The blight is induced by warm, humid weather, so the insurance index is set on humidity levels and temperature. It is provided through the ICICI Lombard General Insurance Company, a large private insurance company, and managed by Weather Risk Management Services, a private broker and weather station operator. PepsiCo added voluntary weather index-based insurance to its contract farming package to hedge farmers' weather risk, establish long-term relationships with farmers and also reduce the risk in its supply chain. Insurance plays an important role in the package of services for smallholders that includes: high-quality potato seed; access to fertilizers, pesticides and other chemicals; technical advice on production practices; fixed purchase price and incentives from the beginning of the season; and weather information and advice through mobile phone Short Message Service (SMS). The contract sets a base buy-back price for farmers at the beginning of the season and offers incremental price incentives according to the quality of the potato crop, the use of fertilizers and pesticides and the purchase of weather index-based insurance.

Several factors influence a farmer to purchase weather index-based insurance. They include an assured buy-back price from PepsiCo, the ability to finance the insurance premium and other production costs through a loan, trust in the various actors involved in the supply chain, the demonstration of timely payouts in previous seasons, and a perceived need to mitigate the risk of losing the significant upfront costs of production, in part to cover the production costs for the following season. Among the 24 000 PepsiCo contract farmers across nine state locations, around 50–60 percent elected to purchase index insurance – a high proportion driven in part by price incentives and conditions on state bank loans that require insurance. The programme has provided claim payouts in almost all state locations over a period of five years, with farmer retention rates over 90 percent.

SOURCE: Adapted from Meyer *et al.* 2017.[57]

production to buyers outside of the contract – a practice known as side-selling. For example, farmers may deviate and side-sell when market prices sufficiently exceed the contracted price, assessing that gains from such one-time defections exceed the longer-term benefits of adhering to the contract.[58]

Contracts featuring protection from price volatility are likely to be most sustainable and prosperous, especially when farmers are risk-averse and value less exposure to price risk. For example, farmers in Nicaragua contracting with Walmart proved to be willing to accept a contract that featured an average contract price lower than the average price in the traditional market.[60]

Moreover, price guarantees through contracts have been shown to induce investments in production. Bundling inputs and services together with a predetermined price can provide additional benefits, especially in terms of increased market participation. For example, researchers working with a rice processor in Benin (see Box 3.4) found that a contract guaranteeing a producer pre-determined price showed production impacts similar to contracts that also included the provision of extension services and input loans. Nevertheless, contracts that included only predetermined prices had a lower impact on the share of household production that was marketed compared with contracts that bundled predetermined prices with inputs and services.

BOX 3.4

PRICE GUARANTEE AND RICE CONTRACT FARMING IN BENIN: A RANDOMIZED CONTROL TRIAL OF DIFFERENT CONTRACT PROVISIONS

A recent study implemented in collaboration with a rice processor in Benin was designed to identify which components of contracts are most important to ensure desired outcomes. The study involved the randomization of the various components included in rice contracts with smallholder rice farmers. The contracting firm in the study was Enterprises de Services et Organisations de Producteurs de Bante (ESOP), a private rice processing and marketing company with previous experience in using smallholder farmer contracts to purchase rice.

The study involved 953 farmers organized into 107 farmer groups; it randomly assigned these farmers to one of three treatment groups and a control group. The first group signed written contracts with ESOP for a specified quantity of rice to be delivered on a specified date and location, meeting a quality standard defined by an impurity percentage (presence of foreign matter and debris). Farmers in this first group were contracted to grow a specific rice variety, and all contracts guaranteed a fixed harvest sale price.

For the other two groups, the contracts bundled additional components into the agreement offered to the first group. Farmers in the second group were given contracts that included all of the features in the contracts of the first group, as well as extension services provided by the purchasing firm. Farmers in the third group received not only the conditions of the second group but also seeds and fertilizers provided on loan from the contracting firm at a price specified in the contract. The control group farmers in this study were rice growers who had no contracting relationship with the buyer.

The findings suggest that the contracts setting price, quality and transaction details (first group) led to increases in rice productivity, in the quantity of rice sold by the participating household and in per capita rice income for the household. Adding extension services and input provision to the price guarantee (second and third groups), also improved these outcomes. However, for the area planted with rice and the productivity per hectare, the magnitude of these increases was found to be statistically indistinguishable from the contract that only specified price, quality and transaction details.

Price guarantees proved sufficient to impact rice area and productivity among treatment farmers. This suggests that once the problem of price risk is resolved, farmers can improve technical efficiency and address asset constraints on their own without the additional costs of extension services and input provision for the purchasing firm.

Nevertheless, the contracts that included extension services and extension services plus inputs (second and third groups) increased market participation and household per capita rice income. Farmers without contracts sold about 26 percent of their rice harvest into the market. Those with contracts setting a price, quality and transaction details increased their market participation by selling 50 percent of their harvest. Adding extension services to the contract increased sales to 56 percent. Farmers who produced rice under the contract that also included input provision sold 67 percent of their harvest.

SOURCES: Adapted from Michelson. 2020; Arouna *et al.* 2019.[58,62]

Innovations in product quality differentiation

The large number of growers, intermediaries and traders involved in agricultural markets in developing countries makes it difficult for information on product quality to pass through the value chain. Potential product quality premiums are rare and, given the number of transactions and the scope of sourcing across many farmers and locations, it is difficult for quality signals and product differentiation based on brand or reputation to be transmitted through markets.

BOX 3.5
PRODUCT QUALITY DIFFERENTIATION IN COFFEE CONTRACT FARMING

Intelligentsia is a Chicago-based coffee roaster and retailer at the innovative forefront of the direct trade model of coffee purchasing. The firm shortens supply chains to increase coordination, quality, and value to the farmer and the consumer. The significant and salient feature is the direct engagement between the farmer and the coffee seller, including direct negotiation on price, quality, volume and delivery. Though the conventional coffee market (known as the C-market) is characterized by low and volatile prices, most specialty coffee is purchased on differential terms under which buyers pay some fixed premium over the C-market. Quality is a path that growers can use to de-commodify, but moving into high-quality production can spur challenges.

Intelligentsia structures its direct-trade contracts with farmers to decouple them from the C-market. The firm purchases micro-lots of coffee, i.e. high-quality coffee with special characteristics, but also other quality grades on fixed-price terms independent of the price level and the fluctuations in the C-market. Producing coffee of extraordinary quality is difficult, and farmers often grow various quality grades in a single harvest season, with the lowest (A grade) quality beans the most common and with AAA or micro-lot coffee comparatively scarce. Intelligentsia buys all production through multi-tiered contracts, specifying five different quality levels at five different price points. The contracts are designed to create persistent incentives for quality and to remove the price volatility from the market for farmers. They thereby enable growers to project earnings at least one year ahead, an advantage which in turn helps Intelligentsia to sustain and retain its array of growers.

While direct trade models of purchasing and marketing coffee are now well established in the industry, the substrate innovation here is the purchase of multiple quality grades from contract growers. This is a departure from the standard micro-lot model, in which buyers directly purchase only the highest quality coffee from suppliers.

Direct trade, as practiced by Intelligentsia, requires farmers to separate their beans into lots according to quality. All the firm's contracts are multi-grade including blender-grade coffees (A and AA) and single-origin (AAA) and micro-lot coffees as part of the commitment to creating more value. These contracts reward growers for their efforts to produce the highest quality possible by purchasing at premium prices coffees that do not "sell themselves" in the same way that the extremely high-quality grade coffees do (AAA and micro-lots).

Shortening the value chain in this way allows farmers to benefit from investing in quality. It provides stable financial incentives for growers to improve quality, given that efforts map into returns. The firm also fosters durable relationships in which communications address not just price but also trends in consumption and taste, impacting farmer decisions around production and harvesting.

SOURCE: Adapted from Michelson. 2020.[58]

Quality heterogeneity can impede smallholder farmer market participation and also make household autarky more likely.[61] Where contract farming does incorporate quality-based price premia (differential prices based on quality grades), this grading can provoke complaints from farmers about opportunistic product devaluation on the part of the purchasing firm to manipulate and reduce the contracted prices. This information asymmetry between buyers and sellers on quality grading can lead to chronic underinvestment in production by farmers, which in turn can adversely impact product quality and market participation.[58]

Innovations in quality differentiation in contract farming can help "de-commodify" smallholder agriculture, i.e. move away from single-grade bulk production to graded-scale production.

Coffee provides an example of an internationally traded commodity that is grown by millions of farmers in Africa, Latin America and Asia and is also characterized by low and volatile prices. At the retail level, coffee has become an increasingly differentiated product catering to a rising population of sophisticated consumers.

This quality differentiation creates opportunities for participants in the value chain to benefit from emerging price differences. Nevertheless, a quality-based model must provide additional returns and risk-mitigation to farmers through contracts that are long-term and that set fixed prices, quantity guarantees for multiple quality grades and transparent payment mechanisms (see Box 3.5). ■

FARMERS' INTEGRATION IN SUSTAINABLE VALUE CHAINS

Increases in farm productivity and commercialization can raise incomes and improve livelihoods but may also lead to undesirable outcomes in the context of the social and environmental dimensions of sustainable development. For example, modern value chains could exclude women farmers or those with small landholdings, resulting in a range of inequalities and lack of opportunities to integrate into the development process. Increasing pressure by markets to leverage economies of scale could further marginalize smallholder farmers, potentially creating social challenges.

There are also concerns that increased crop production for exports resulting from trade openness and globalization is the leading driver of deforestation (see Part 2). It is estimated that, in Latin America, commercial agriculture accounted for almost 70 percent of the deforestation in the period 2000–2010.[63] The loss of forests increases carbon emissions that contribute to climate change, as trees can store large amounts of carbon, but also reduces biodiversity, eradicating the natural habitat of fauna and flora.

Economists, in general, commend the market economy for creating incentives for people to deliver products and services, generating wealth and spurring economic growth. However, they recognize that in some instances markets may fail to reconcile the interests of individuals with those of society as a whole. Markets may result in negative environmental outcomes or may fail to address social objectives, such as reducing inequality.

Such environmental and social impacts are "external" to the market and not accounted for in the prices of agricultural products. To align markets with collective interest and social well-being, it is necessary to support the market economy with institutions. Governments commonly use direct regulation, as well as taxes and subsidies, so that markets account for costs that would otherwise not be included.

For example, some governments levy taxes on pesticides to "internalize" their environmental cost to society and to reduce their use or subsidize climate-smart agriculture practices. Across the world, social protection systems are established to address inequality. At the same time, institutional arrangements such as sustainability certification schemes can harness the market mechanism to produce public goods and sustainable outcomes.

Sustainability certification schemes and standards

While governments can regulate and intervene in markets through taxes and subsidies, other actors can also address market failures and provide environmental and social benefits. For example, the private sector, non-governmental organizations and multi-stakeholder initiatives can invest in voluntary sustainability certification schemes and standards in global value chains.[g]

Sustainability standards are gaining importance in global markets, especially for high-value products with established links to »

g Private standards that are imposed by processing firms and supermarkets may also contribute to sustainable development objectives but, in general, they focus on product specifications.

KENYA
An African woman collecting coffee berries from a coffee plant.
©iStock.com/Bartosz Hadyniak

» global value chains. They are often seen as strengthening the link between smallholder farmers in developing countries and affluent consumers in industrialized countries (see Part 2 for a discussion on the growing demand for sustainability certified products).[64] For farmers, higher and more stable prices for certified products and better market access provide the incentive to adopt sustainability standards, comply with standard-specific rules in production, and undergo regular inspections by independent certification agencies, such as FLOCERT for Fairtrade certification or the International Federation of Organic Agriculture Movements for organic certification. Often, higher prices compensate for the increased costs of production and farm management that are necessary to comply with the standards.

Sustainability certification schemes have various objectives. For example, organic standards provide incentives to produce crops without synthetic fertilizers and pesticides; fair trade standards aim at improving market access and prices for smallholder farmers in developing countries. Other schemes include a range of requirements for environmentally friendly farm practices to promote agroecological management, such as agroforestry, the use of organic fertilizers and pesticides, and safer treatment and disposal of waste.

Some certification schemes include social rules aiming at improving the working and living conditions of farmers and workers in developing countries.[65] These rules relate to the safety and health of workers, social rights such as remuneration equal to or above the minimum wage, rights to education for children, and child labour policies. Other certification programmes include requirements for establishing effective producer or worker organizations in an attempt to strengthen the bargaining power of farmers (see Figure 3.9 for more information on the requirements of selected sustainability certification schemes).

Compliance with sustainability certification schemes often implies significant trade-offs. For example, organic or other environmental provisions tend to increase production costs, which farmers may not always be able to pass down to consumers. Sustainability certification can also exclude the most disadvantaged farmers when they cannot meet the requirements set by the standards.

Environmental outcomes of sustainability certification schemes

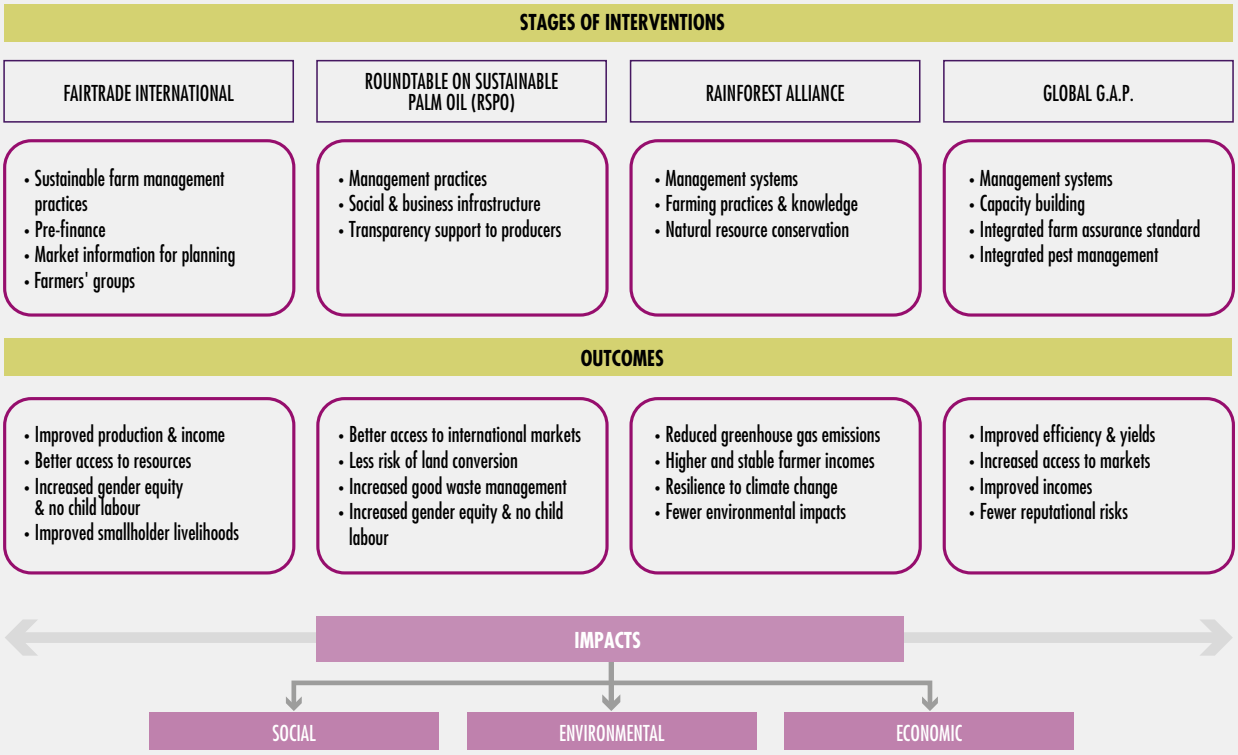
In general, sustainability certification schemes are found to improve environmental practices. For example, in Brazil, Colombia, Costa Rica, Guatemala and Mexico, standards set by a multinational corporation were seen to improve the environmental conduct of certified smallholder coffee producers compared with their non-certified counterparts.[66] This positive relationship between certification and environmental benefits was shown to be stronger if farmers were organized in cooperatives rather than if they were selling directly to private intermediaries such as traders and coffee roasters.

The institutional structure of the value chain plays an important role in how sustainability certification shapes economic, environmental and social outcomes, as different intermediaries may transmit different signals to farmers on the applied standards.[67] Often, farmers' groups or cooperatives are seen as better placed to provide technical support and managerial advice to certified farmers.

In Costa Rica, organic standards contributed to reducing the use of fertilizers, pesticides and herbicides and to increasing the use of organic fertilizers among certified coffee farmers. Nevertheless, the analysis suggested that although standards can have significant environmental benefits, they are likely to entail high costs for farmers that should be compensated by increased price premia.[68]

In the Tapi River basin in Thailand, which makes up 60 percent of palm oil production in the country, crude oil palm producers certified by the Roundtable on Sustainable Palm Oil (RSPO) were found to cause the lowest environmental impacts, especially for global warming and photochemical ozone

FIGURE 3.9
SELECTED SUSTAINABILITY CERTIFICATION SCHEMES: STANDARDS AND POTENTIAL OUTCOMES



SOURCE: Elaborated by FAO.

formation.[h] This resulted from efficient use of fertilizers, good quality of oil palm fruit for palm oil processing and good waste management.[69] Nevertheless, RSPO standards in Indonesia did not seem to be effective in attaining biodiversity goals and protecting the orangutan habitat. This outcome was due to the lack of information on the distribution of orangutans in the forest, as well as to the inadequate compensation to palm growers for the costs of compliance with standards.[70]

In Nicaragua, coffee farms complying with a range of sustainability standards (including Coffee and Farmer Equity [C.A.F.E.] Practices, Fairtrade, Organic, Rainforest Alliance and UTZ) demonstrated improved environmental performance.[i] This included greater carbon stocks in trees used for shade-grown coffee production, better practices for soil conservation and recycling of coffee pulp, and application of organic fertilizers.[71]

Shade-grown coffee can support multiple ecosystem services, such as climate-change adaptation, pest control by birds, and the production of food and other products of economic value by shade trees. In Ethiopia,

h For more information on RSPO certification scheme see https://rspo.org.

i For more information on C.A.F.E. Practices see https://www.starbucks.com/responsibility/community/farmer-support/farmer-loan-programs, on Fairtrade see https://www.fairtrade.net; on Rainforest Alliance see https://www.rainforest-alliance.org; and on UTZ see https://utz.org.

shade-grown coffee Rainforest Alliance certification programmes effectively alleviated forest degradation.[72] Adequate incentives – certified farmers received 15 to 20 percent higher prices for their coffee compared to the market – combined with a high standard of criteria for certification and monitoring increased the density of the certified forest coffee areas compared with those without the certification.

Economic outcomes of sustainability certification schemes

Improved welfare and incomes for smallholder farmers is one of the main objectives of many sustainability certification schemes. But the exclusion of the most disadvantaged smallholder farmers is a risk associated with many of these schemes.

For example, in Thailand, the income of vegetable producers complying with international sustainability standards set by the GlobalGAP certification scheme was shown to be, on average, 90 percent higher than that of non-certified farmers in the first year of certification.[i] However, this estimate does not take into account the costs of compliance. GlobalGAP certification depends on stringent requirements on food safety and traceability, environmental protection, animal welfare, and workers' health and safety. It also requires a quality management system that details on-farm processes, procedures and responsibilities for meeting the certification scheme's requirements. Developing such a management system requires specific skills, and farmers either form groups or cooperatives supported by donors or rely on exporting firms. Donors and exporters also partly covered the high initial fixed costs of adopting the GlobalGAP standards.[73]

Support to farmers to adopt and continue complying with stringent standards is important. In the case of vegetable producers in Thailand, the analysis suggests that for cooperative-led farmers, the costs of compliance with GlobalGAP standards make continued certification possible only for larger farmers, especially after the withdrawal of donors' support. Receiving support from an exporter was shown to help overcome the initial costs of standards adoption and to increase the likelihood of being re-certified by 85 percent. Establishing farmers' groups and long-term partnerships among actors along the value chains as well as with development agencies and non-governmental organizations is a crucial factor in including smallholder farmers in high-value certified product markets.

In Uganda, research indicates that the economic benefits of sustainability certification for coffee can only partly offset the compliance costs.[74] By establishing rural producer organizations, farmers can leverage technical support from non-governmental organizations to obtain group certification, as well as increase the volumes of certified coffee that is delivered.

In Côte d'Ivoire, cocoa farmers' cooperatives are central to helping their members to comply with Fairtrade standards. Fairtrade aims at improving smallholder livelihoods and promotes collective action among farmers. Certification is awarded to cooperatives and offers minimum guaranteed prices for certified products, as well as a Fairtrade premium to provide cooperatives with technical advice and inputs.[75] The evidence suggests that Fairtrade certification increases the yield of certified farmers by an average of 13 percent compared with their non-certified counterparts, and a gain of 4 percent in the price received. On average, per capita consumption expenditure for certified farmers is 20 percent higher than that of uncertified producers.[76]

The characteristics of cooperatives are also found to affect the likelihood of certification and to shape farmers' productivity and income. In the case of cocoa in Côte d'Ivoire, while cooperatives with higher assets and better service provision were more likely to be certified, Fairtrade certification largely increased the income of cocoa farmers who were members of cooperatives that were less well-endowed. This suggests that the Fairtrade premium that targets support to cooperatives adds to their capacity to provide technical advice and inputs.

[i] For more information on GlobalGAP certification scheme see https://www.globalgap.org/uk_en/.

As economic growth, urbanization and rising living standards transform consumers' preferences in developing countries, domestic certification schemes become increasingly popular, as they provide information on both the quality and safety of food to consumers. In Viet Nam, rapid supermarket penetration in domestic markets has promoted the use of domestic certification, such as VietGAP, that creates opportunities for smallholder farmers to enter high-value and differentiated products markets. Often, domestic standards may be less stringent than international ones – for example, VietGAP recommends using integrated pest management practices (IPM), while for GlobalGAP certification IPM is essential.

In Thai Nguyen province in the northeast of Viet Nam, VietGAP-complying green tea farmers, both individually and organized in cooperatives, were shown to increase their access to lucrative domestic value chains and to receive prices 11–20 percent higher than those paid for non-certified tea. At the same time, as certified farms used more labour to comply with the standards, their labour costs were found to be twice those of non-certified farms. Despite the increased costs of production, the net income of certified farms was estimated to be 30 percent higher compared to non-certified farms.[77]

Generally, smallholder farmers' integration in sustainability certified products value chains is found to generate economic benefits. However, recent reviews synthesizing the evidence suggest mixed results on the impact of sustainability certification on sales revenue, farm income and agricultural wages.[65,78] Such differences across studies can be attributed to context-specific factors that are often ignored or not fully captured by the analyses, but also on the range of requirements and service provision across various certification schemes.

In Uganda, for example, farm household participation in different combinations of sustainably produced coffee certification schemes (a double Fairtrade–Organic scheme and a triple UTZ–Rainforest Alliance–4C scheme[k]) was found to affect poverty, production, labour productivity and income in different ways.[79] On the one hand, although the Fairtrade and Organic certification schemes included a price premium of 11 percent, lower yields resulted in lower productivity, thus failing to increase income. On the other hand, the triple certification programme had a significant positive effect with a yield increase of about 45 percent, resulting in higher coffee revenues, higher total and per capita household income, and reduced poverty.

Other studies suggest that smallholder farmers' participation in sustainability certification schemes may improve welfare in the short term, but in the longer term, the evidence is mixed, and for some households integrating into the labour market provides a way out of poverty.[80] Although sustainability certification schemes are not the only pathway to sustainable growth, they are generally seen as providing a structured system to achieve and document improvements through clearly defined rules, indicators and mechanisms.

Social outcomes of sustainability certification schemes: education and gender

Many sustainability certification schemes include specific requirements that adhere to social principles. For example, Fairtrade requires that certified farmer organizations promote non-discrimination, ensure workers' health and occupational safety, and ban child labour. Such schemes can encourage investments in the education of children. For example, data from smallholder coffee farmers in Uganda suggests that Fairtrade certified households spend 146 percent more on child education and keep children at school longer than non-certified households. For many certification schemes, income from cash crops is often earmarked for larger investments, such as education, thus directly contributing to child education.[81]

Investment in children's education generally tends to increase with income, but the decisions of households on education can be complex and shaped by a range of factors. Many studies find mixed evidence, but, overall, a positive relationship between participation in certified product value chains and schooling can be

k For more information on 4C certification see https://www.4c-services.org.

ascertained.[65] For example, in Oaxaca and Chiapas in rural southern Mexico, households' participation in Fairtrade–Organic certified cooperatives was found to increase schooling more for girls than boys. While for girls between 16 and 25 years of age, schooling was estimated to increase by 0.7 years; for boys, the impact was weaker, probably due to better rural labour market opportunities for males.[82]

Certification schemes can also affect household members in different ways, depending on their roles in crop production, control over income and decision-making power. Often, the certified crops are traditional cash crops, over which men have more control. When certification increases the profitability of traditional cash crops, existing gender roles and inequalities might be reinforced or exacerbated.[65] In general, in farm households, commercialization may change gender roles, resulting in a lower share of the income being controlled by women.

Some certification schemes, such as Fairtrade and UTZ, involve specific gender and non-discrimination policies that might help promote women's status and reduce prevalent gender disparities in access to information, inputs and services. For example, some standards require farmer organizations to encourage and document female participation in regular agricultural training, to organize workshops that raise awareness on gender issues, or to offer services that specifically target disadvantaged groups such as women.

An analysis of certified coffee-producing households in Uganda suggests that standards aiming to promote gender equity were successful in integrating women in the certified coffee value chain. The results indicate that in a certified household the probability that a man controls the revenues from coffee sales is reduced significantly, compared with a non-certified farm. This may be due to the certification scheme's gender mainstreaming activities but also due to increases in labour by female household members. As quality standards increase the demand for labour and women work more, they increase women's bargaining power and their influence on decision-making.[83]

Once more, these gender effects are context-specific. For example, increases in labour following participation in certification schemes may increase the burden on women's workload and jeopardize other employment opportunities.[I]

Sustainability certification can bring additional non-tangible social benefits. Fairtrade standards for wage labour include provisions for distributing the premium, facilitating freedom of expression, ensuring safe labour practices, and providing arrangements for collective bargaining on safe, decent and equitable working conditions. A study was conducted to survey the Fairtrade certification and well-being of wageworkers on banana plantations in the Dominican Republic, where banana production directly provides jobs to an estimated 32 000 workers. The banana is one of the most traded tropical commodities in the world, and only an estimated 5–8 percent is Fairtrade-certified or covered under another sustainability standard. Overall, the study found positive effects on the labour force, particularly by delivering in-kind benefits, offering a sense of job security, improving workers' voice and enabling private savings.[84] ■

I For example, another study in Peru finds no significant effects on gender. See Ruben, R. & Fort R. 2012. The impact of Fairtrade certification for coffee farmers in Peru. World Development, 40: 570–582.

UNITED STATES OF AMERICA
Agronomist using technology in agricultural corn field.
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PART 4 DIGITAL TECHNOLOGIES AND AGRICULTURAL AND FOOD MARKETS

PART 4 looks at how digital technology can make agricultural and food markets more efficient and more inclusive. The analysis investigates the digital divide in agriculture across and within countries and focuses on how digital technology can address market failures. A range of different applications are examined, from text messages relaying information on prices to complex e-commerce platforms that integrate farmers into markets and the use of blockchain on value chains. The discussion brings together the benefits of digital technology in contributing towards all dimensions of sustainable development, while addressing its risks and the need for policies and regulatory frameworks.

PART 4

DIGITAL TECHNOLOGIES AND AGRICULTURAL AND FOOD MARKETS

KEY MESSAGES

1 Digital technologies are having a profound impact on economies and societies and are transforming agricultural and food markets. Connectivity has improved dramatically, but a digital gap remains across countries and populations. Women in rural areas of developing countries are at a particularly large disadvantage.

2 Digital technologies can be leveraged to address multiple market failures and facilitate smallholder farmers' integration in markets and value chains. They can also promote international trade and effectively improve market-based institutional arrangements for contributing towards sustainable outcomes.

3 Digital applications can bring about significant gains in terms of increased efficiency, traceability and transparency in markets and value chains. However, their long-run transformative impact, as well as the related risks, are not yet fully understood.

KEY ACTIONS

➔ Effective public-private partnerships, good regulations to crowd-in the private sector and policy coherence are needed to improve digital infrastructure and skills in rural areas and to facilitate the uptake of digital technologies, especially in agricultural and food markets of developing countries.

➔ Continuous research and analysis on the potential impacts of digital technologies on agricultural and food markets, their structure and their functioning are crucial to anticipate disruptive effects better and to promote sustainable outcomes.

➔ Understanding the challenges that arise from digital technologies and addressing the risks associated with their use require enhanced collaboration and consensus among all stakeholders, including governments, the private sector and the farmers themselves, to improve governance mechanisms.

Digital technologies are rapidly transforming our economies and societies. Their adoption is driving down information and transaction costs, improving efficiency, creating new jobs, generating new income streams and saving resources. At the same time, they can be disruptive, modifying or displacing activities and products. Digital technologies can help agriculture meet the global challenges it faces. These include increasing the production of sufficient, safe and nutritious food for a growing population to ensure food security; generating jobs, improving incomes, reducing poverty and promoting rural economic growth; and sustainably managing natural resources.

Some digital technologies accelerate the evolution of agricultural and food value chains.

BOX 4.1
DIGITAL TECHNOLOGY GLOSSARY

Agriculture is a knowledge-intensive activity. Farmers assess the weather, soil nutrient and moisture levels, plant and animal appearance, the presence of parasites, market prices, and many more variables before they make decisions on farm practices and production. Technological improvements have greatly facilitated these decision-making processes. Though the access to technology and the rate of adoption differ greatly across the world and also within countries (see next section on the digital divide), technology can be present at every stage of farming, marketing and processing.

Information and communications technology (ICT) refers to the integration of telecommunications, computers and the necessary systems that enable users to access, store, share and use information.

Digital technology is an all-encompassing term to refer to computerized tools that generate, store and use data for a variety of purposes.

Digital platforms are virtual hubs for trading goods and services (e-commerce).

Internet of Things (IoT) is a term coined to refer to the collection of internet-enabled devices that capture information from the real world. The information collected is processed with the help of a software application (app).

Distributed ledger technology (DLT), is in essence, a decentralized, consensus-based record-keeping system (see more details in Box 4.6).

Precision agriculture (PA) is a whole-farm management approach using information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering.

Artificial intelligence (AI) refers to software systems that can make decisions which normally require a human level of expertise, often using real-time data.

Big Data is an umbrella term referring to the large amounts of digital data continually generated by the global population as a by-product of everyday interactions with digital products or services.

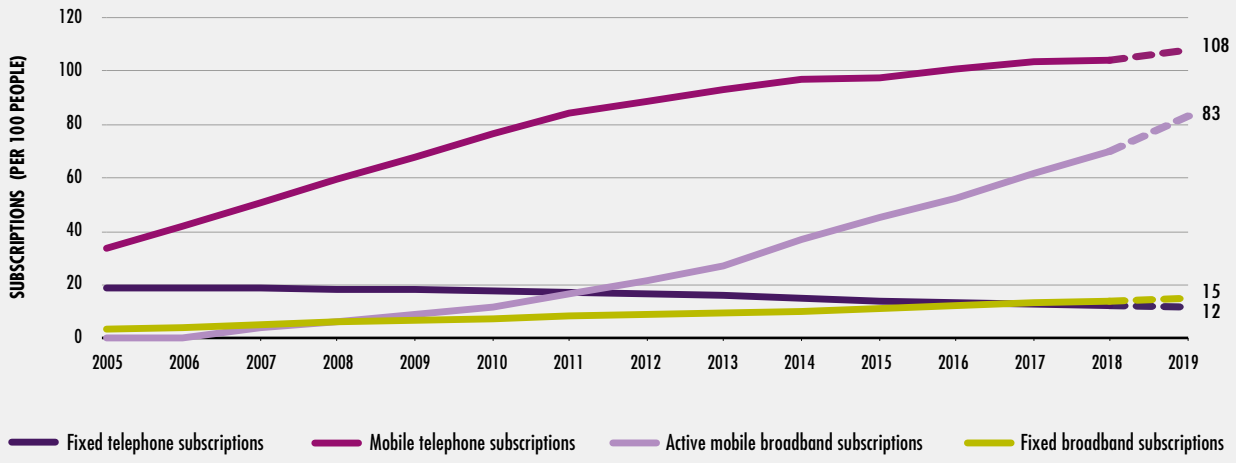
SOURCES: West. 2018; United Nations Global Pulse. 2013; Đurić. 2020.[1,2,7]

Other technologies significantly affect the contribution of labour, capital and other inputs to the production, processing and marketing of food. Thus, the adoption of digital technologies can result in changes in relative prices, disrupting markets.

Sensors, satellites, robots and drones are examples of digital technologies that can revolutionize farming and value chains. Sensors and satellites provide information on soil conditions, weather and temperature, or crop growth. They enable farmers to achieve better yields by optimizing farm management, reducing the use of fertilizers, pesticides and water, and also contributing to better and more sustainable outcomes. The Internet of Things that connects robots, drones and vehicles to the internet can make labour-intensive tasks, such as monitoring plant health or sowing crops, more cost-effective.

These technologies also generate large amounts of data that can be combined with other information, stored and analysed to support decision-making. Such Big Data can contain high-variety information assets which can be processed by new methods of analysis, such as artificial intelligence, to assess possible outcomes based on a range of actions and conditions to help guide future interventions (see Box 4.1 for definitions of digital technologies and innovations).

FIGURE 4.1
GLOBAL SUBSCRIPTIONS TO FIXED AND MOBILE TELEPHONES, AND FIXED AND MOBILE BROADBAND, 2005–2019 (PER 100 PEOPLE)



NOTE: 2019 values correspond to ITU's estimate for 2019 as of 28 October 2019.
SOURCE: ITU. 2020. ITU Statistics: ICT Key Indicators. Available at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed May 2020).[4]

Distributed ledger technology (DLT), such as blockchain, can offer many benefits downstream by providing a secure and decentralized way to perform transactions between untrusted parties along value chains. Combined with sensors that give information on the timing of delivery at each stage of the value chain as well as on the quality of the product, DLTs can disrupt vertical coordination activities, where numerous actors are involved from farm to fork.

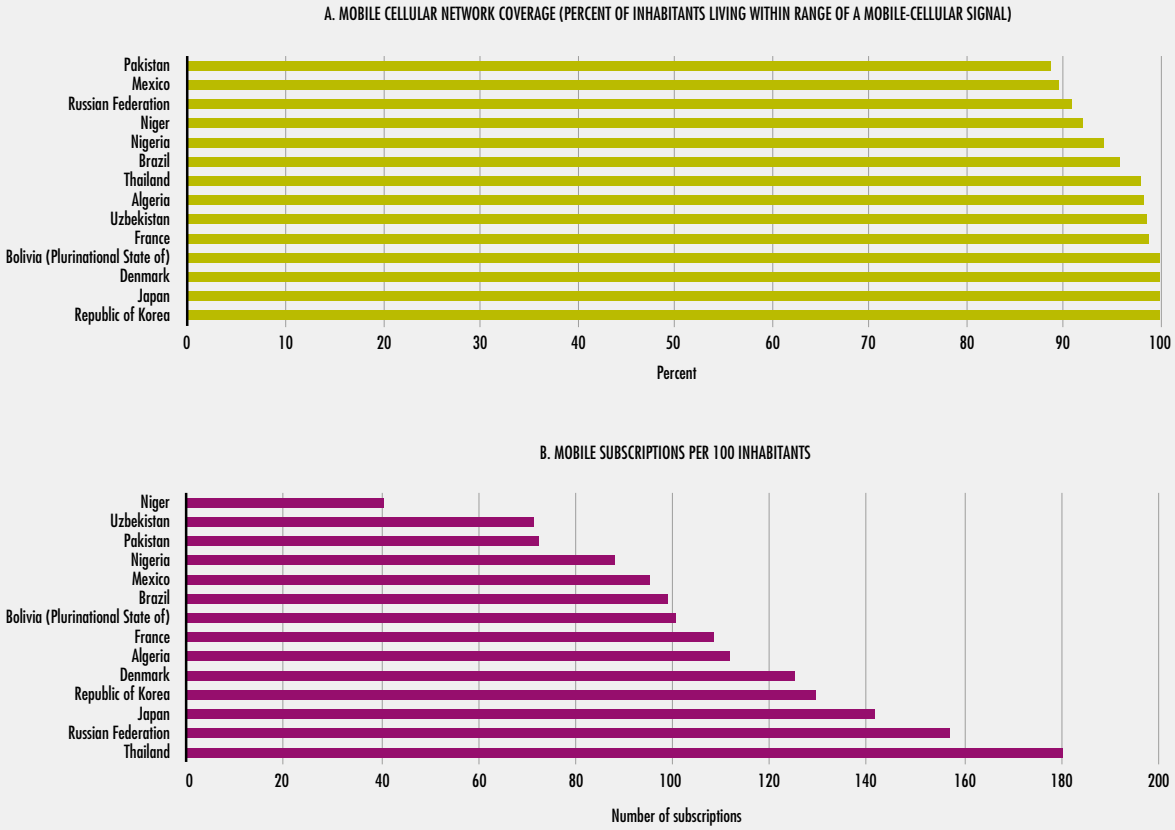
These developments are taking place in the context of a broader evolution of global food systems; digital technology contributes to the pace of this evolution. Consumer preferences are changing – driven by economic growth, urbanization and modern lifestyles – which in turn affect markets. Consumers are demanding progressively higher-value foods, nutritional attributes and quality assurance.

Yet, a marked digital divide exists across countries, reflecting differences in access to information and technology. A digital divide is also present within countries, between rural and urban areas, between genders, and across sectors. And nowhere is the digital divide more evident than in agriculture. Commercial farms and businesses in developed countries and emerging economies already use technology intensively, while smallholder farmers in many developing countries continue to struggle to access information, markets and inputs. ■

THE DIGITAL DIVIDE

Technological innovation is crucial for economic growth. Once an innovation takes place, it is common for improvements to follow and for the innovation to be also used differently than initially intended. Innovation can take time to reach the markets at scale. This is often due to the costs of technological adoption, but acceptance and familiarity also play a role, especially in the diffusion of more complex innovations.

FIGURE 4.2
MOBILE CELLULAR ACCESS IN SELECTED COUNTRIES, 2018

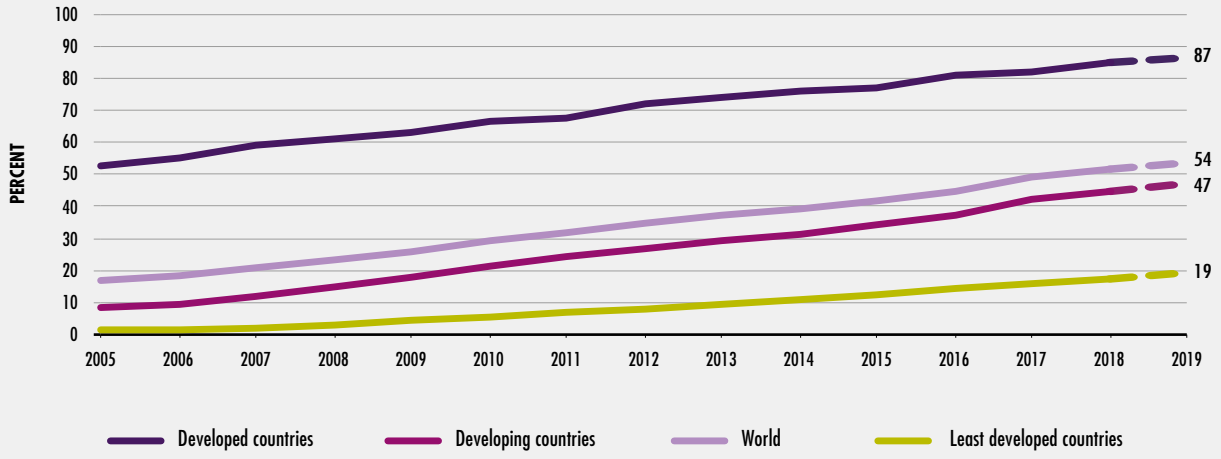


NOTE: Data refer to 2018 or latest year available.
SOURCE: ITU. 2019. *Yearbook of Statistics: Telecommunication/ICT Indicators 2009–2018*. Statistical Reports. Geneva, ITU.[6]

Fixed-line telephones have been displaced by mobile phones as a mode of communication, and mobile broadband subscriptions have also significantly surpassed fixed broadband subscriptions (Figure 4.1). The speed of mobile phone technology uptake was made possible in part by the lower infrastructure costs it entailed. Communication improved significantly, and, on average, most of the world's population now lives within range of a mobile-cellular signal, irrespective of whether or not they are subscribers or users.

Nevertheless, there are large discrepancies in network coverage and mobile phone ownership across countries, and these mostly reflect differences in average income per capita (Figure 4.2). Gaps between countries are lower in terms of network coverage when compared to the number of subscriptions that provide a better indication of mobile phone access. For instance, Thailand has nearly 180 subscriptions per 100 inhabitants – many people may own more than one SIM (Subscriber Identity Module) card or device, while some may not own a device at all. The latest data for Niger indicates only 40 mobile-cellular subscriptions per 100 inhabitants.[6]

FIGURE 4.3
INDIVIDUALS USING THE INTERNET, PERCENT OF POPULATION



NOTE: 2019 values correspond to ITU's estimate for 2019 as of 28 October 2019.
SOURCE: ITU. 2020. ITU Statistics: ICT Key Indicators. Available at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed May 2020).[4]

Around 54 percent of the global population was estimated to use the internet in 2019.[4] Internet access has spread rapidly, but gaps persist across countries and grow progressively as average income per capita decreases. Not only is access lower in least developed countries, the rate of adoption is also lower (Figure 4.3).

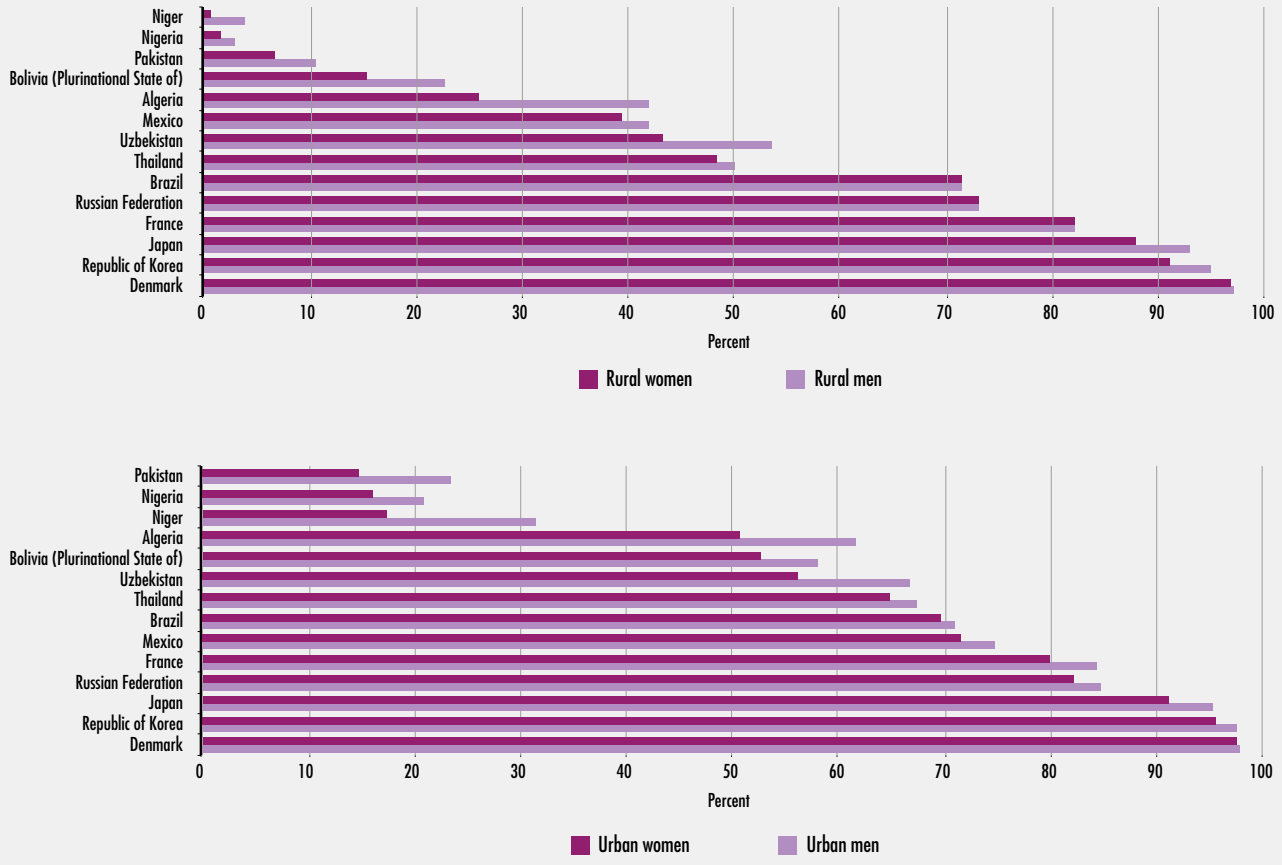
Access to the internet in least developed countries is low, and about 19 percent of the population used the internet in 2019. In the same year in Africa only 18 percent of households had access to the internet at home. Active mobile-broadband subscriptions in Africa amounted to only 34 out of every 100 inhabitants in 2019.[3]

Important connectivity gaps remain between urban and rural areas, posing a challenge to farmers' ability to adopt new technologies, innovate and participate in markets. On average, in rural Africa, only 10 percent of households have access to the internet, but these rates can be much lower for individual countries in the region.[5] Gender imbalances also extend into the digital realm, with rural women having the least access to the internet. Worldwide, 48 percent of women have access to the internet, compared to 58 percent of men.[3]

Rural areas in developed countries are better connected to the internet. Denmark has the highest connectivity rate, with 97 percent of both rural men and women using the internet, and nearly no gap with respect to urban areas. In developing countries, there is a significant gap between urban and rural areas. In the Plurinational State of Bolivia, 15 percent of rural women reportedly use the internet, compared to nearly 53 percent of urban women. In Niger, only 0.6 percent of rural women use the internet (Figure 4.4).[6]

Smartphones – mobile phones with touchscreen interface that perform a number of complex tasks like computers – were an important technological breakthrough. They make it possible for households to have access to the internet without a computer. Indeed, since 2014, more households have had access to the internet than have had a computer.[3] Lowering the costs of smartphones can contribute to significantly reducing the digital divide.

FIGURE 4.4
INDIVIDUALS USING THE INTERNET IN SELECTED COUNTRIES BY GENDER AND LOCATION, 2018 (PERCENT)



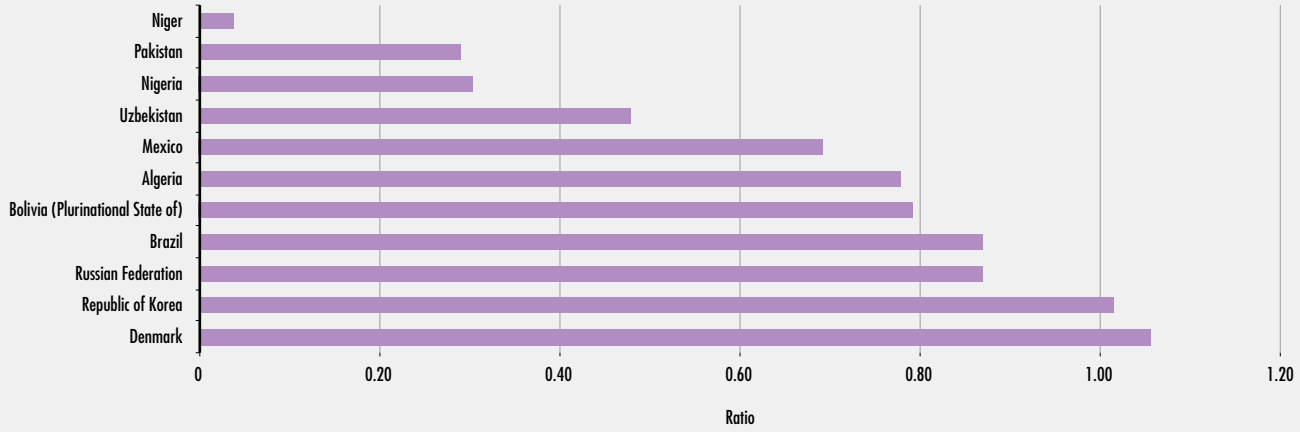
NOTE: This figure concerns individuals using the internet from any location. Data refer to 2018 or latest year available.
SOURCE: ITU. 2019. *Yearbook of Statistics: Telecommunication/ICT Indicators 2009–2018*. Statistical Reports. Geneva, ITU.[6]

Denmark and the Republic of Korea have subscription rates that surpass one smartphone per inhabitant. However, data and voice mobile-broadband subscriptions – that provide an indication of smartphone-based subscriptions and ownership – remain low in many countries (Figure 4.5).

Access to the internet is indispensable to ensure equal access to information and services. Reducing the digital divide across countries, between urban and rural areas, and between men and women is a pressing need. Including the elderly and vulnerable groups is also needed, since they face additional constraints.

The role of governments will be significant in enabling adequate environments for innovations and further technological development.[7] Long-established development pillars remain key to ensure that rural households will be able to take advantage of the digital revolution. Access to

FIGURE 4.5
RATIO OF DATA AND VOICE MOBILE BROADBAND SUBSCRIPTIONS OVER POPULATION FOR SELECTED COUNTRIES, 2018



NOTE: Data refer to 2018 or latest year available.
SOURCE: FAO estimate using ITU data. ITU. 2019. *Yearbook of Statistics: Telecommunication/ICT Indicators 2009–2018*. Statistical Reports. Geneva, ITU.[6]

education and improved physical infrastructure will be indispensable to enable smallholder farmers to engage in the modern economy. A conducive environment for the digitalization of agriculture requires (i) expanding and improving infrastructure – both for ICT and otherwise; (ii) improving people's ability to use the internet effectively so that they benefit from digitalization; and (iii) designing a regulatory framework that is both conducive to innovation and takes into account the specificities and risks digitalization entails.

The Taobao villages in China (see Box 4.3) make possible a new, innovative economic development model through e-commerce. Higher education levels, logistics and communication infrastructure were the preconditions for establishing digital business platforms that are inclusive of farmers. The villages' novel business model sheds light on how to address challenges to regulation.

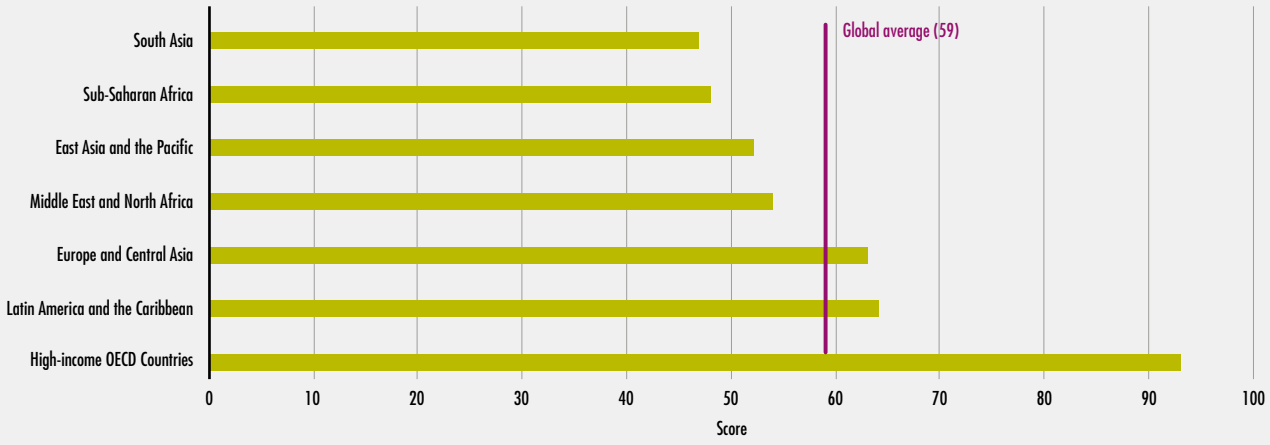
Innovative partnerships will be needed to increase digital inclusion. The successful digitalization of agri-food value chains – one which generates benefits across social, economic and environmental areas – will require public-private partnerships and multi-stakeholder cooperation. ■

THE DIGITALIZATION OF AGRICULTURE

The digitalization of food and agriculture has taken different paths in developed and developing countries. The internet made possible the creation of a plethora of technologies, some of whose potential and impacts are being witnessed at present, such as in the case of e-commerce platforms. Others, such as distributed ledger technology, have not yet been adopted at scale. A better understanding of their potential and limitations will be indispensable to ensure they make a positive contribution to the sustainable development of the sector and across economic, social and environmental objectives.

The digital divide is nowhere more evident than in agriculture. In developed countries and emerging economies, the use of technology in agriculture is advanced. The fast pace

FIGURE 4.6
ENABLING THE BUSINESS OF AGRICULTURE ICT SCORE



NOTE: Individual questions on ICT regulations are assigned numerical scores ranging from 0 to 1. The scoring reflects the quality of the regulations and is based on internationally recognized good regulatory practices that enable access to ICT in rural areas. Individual components are then normalized to a "distance to frontier" score, which captures the gap between a country's performance and a measure of best practice across the entire sample of 62 countries. An aggregate EBA ICT score for each country is expressed on a scale from 0 to 100, where 0 represents the worst performance.
SOURCE: Kayumova. 2017. [10]

of innovation, which allows for digital technologies to collect, store and analyse data, is revolutionizing production systems and value chains. For example, precision agriculture is emerging as an innovation-driven solution in many regions and countries, such as central and northern Europe, North America, Argentina and Australia, where large farms provide economies of scale and higher returns to investments in technology.[8]

Precision agriculture methods rely on satellite positioning systems, remote sensing and the Internet of Things to manage crops and optimize the use of labour, fertilizers, pesticides and water. These methods improve efficiency but can also increase food safety, as well as reduce the negative environmental impacts of farming practices. Precision agriculture operations also generate data that can feed into Big Data and analytics, thus supporting decision-making. Such technological advances can have significant impacts on markets for agricultural labour, capital, and food and agricultural inputs.

However, in some developing countries, digital technology adoption rates are low. Often, applications are limited to text messages through mobile phones or simple offline farmer advisory digital videos that provide information to farmers in rural areas. However, a number of initiatives address specific challenges smallholders face and have produced multiple benefits (see Box 4.2).

On average, agricultural productivity is higher where countries adhere to good regulatory practices.[9] Effective regulation can improve access to digital technologies, strengthen the coordination of actors along the food value chain, and promote productivity and income growth. Indeed, agriculture's digital divide between developed and developing countries becomes more apparent when one focuses on the enabling environment.

A new dataset produced by the World Bank Enabling the Business of Agriculture (EBA) project allows benchmarking of regulations that

promote an enabling environment for providing and using digital technology services, with a particular focus on rural areas. The EBA data covers information related to the licensing framework for mobile operators, spectrum management and infrastructure sharing.[10]

This EBA ICT score reveals the extent of the digital divide in agriculture across developed and developing countries (Figure 4.6). Sub-Saharan Africa and South and East Asia face significant constraints in promoting digital technologies in agriculture. None of the countries in these regions have introduced regulation that encourages competition among mobile telephony operators to enter telecommunication markets. In contrast, high-income OECD countries exhibit strong regulatory frameworks that provide incentives to the private sector to increase connectivity beyond urban centres.

To increase digital technology adoption rates in the rural areas of developing countries requires investments in supply-side and demand-side factors. On the supply side, rural network coverage and availability of digital applications are needed. Demand-side factors include digital skills and literacy, especially for smallholder farmers. Addressing these factors necessitates a range of public policy interventions and, most importantly, a regulatory environment that attracts private sector investments.[11] Effective regulation that also promotes market competition will be essential to expand broadband access and lower users' costs across and within countries. The participation of governments in investments, through public-private partnerships, can ensure that gaps in infrastructure and access are bridged also in rural areas. Public-private partnerships will be important to provide incentives for private investment in poor developing countries.[5] ■

DIGITAL TECHNOLOGIES AND MARKET FAILURES

High information and transaction costs explain why agricultural markets in many developing countries are thin or missing. Improving infrastructure helps markets develop. Institutional arrangements, such as contract farming, aim to reduce costs related to searching for a trader to negotiate a deal, bargain, and reach and monitor an agreement (see Part 3 for a discussion on contract farming). Modern food value chains introduce additional costs that are often related to information about consumer preferences, especially on quality and food safety. Digital technologies can help reduce these costs and promote access to markets, addressing many of the constraints smallholders face to become part of the formal economy and value chains.[7] For example, search costs are significantly lower in digital environments compared with the physical, analogue world, and this expands both the quality and scope of searches.

Lower search costs can significantly improve the match between buyers and sellers, such as in the context of a digital e-commerce platform, and can reduce bargaining costs while potentially adding to the bargaining power of the farmer.[12] Expanding the scope of matching through digital technologies means that buyers and sellers can agree on a contract that closely corresponds to their preferences. Facilitating exchange can affect prices, as well as price dispersion. For example, decreasing farmers' costs of searching for traders offering the highest price could reduce price dispersion across farmers and markets. All these benefits help increase welfare.

Digital technologies also make it easier to ascertain the reputation and trustworthiness of both buyers and sellers. For example, DLTs can promote access to multiple dimensions of information on business history, including price levels, production methods, product quality and other attributes. This can facilitate both contracts and markets for differentiated and certified products that can attract price premia and generate environmental and social outcomes (see Part 3 for a discussion on sustainability certification schemes).

In addition, such low-cost exchanges can have an impact on the organization of firms and facilitate vertical integration and global value chains (see Part 2 for a discussion on global value chains). Evidence from the manufacturing industry suggests that low-cost information

enables managers to understand better what is taking place at a distance, while also facilitating problem-solving by employees on the front line.[13]

Although the cost of transportation in the digital world is approximately zero – information can be replicated and disseminated easily – the role of physical distance in shaping trade costs remains significant. Digital technology allows producers and consumers everywhere in the world to access enhanced information on products; however, it is difficult to assess its impact on trade. There is little evidence of this, but some studies suggest that while trade flows decrease with distance, based on information available both online and offline, distance may matter less online.[14]

For example, ePhyto is a software solution that standardizes phytosanitary information and stores it remotely (through a cloud system). The International Plant Protection Convention (IPPC) developed this electronic phytosanitary certificate platform. ePhyto bridges the phytosanitary certificates issued by exporting countries and required by importing countries. Certificates can be issued and exchanged electronically; ePhyto thus facilitates trade by reducing costs associated with sorting, distributing, retrieving and archiving. Housing phytosanitary certificates on an electronic platform also lowers the risk of fraudulent certificates, improves communication, and reduces possibilities for misunderstandings and disputes. The platform thereby increases efficiency and reduces delays. Moreover, it is a particularly inclusive trade innovation for low-income developing countries that can join the electronic system without having to bear the full costs of creating and maintaining the software.[a]

In sum, digital technologies hold the potential to address a range of information asymmetries in markets, improve farmers' access and reshape value chain management.[5] They also represent an important tool for achieving the 2030 Agenda for Sustainable Development and the Sustainable Development Goals as they can be used to promote a more productive, resilient, sustainable and transparent food system.[7]

a See https://www.ippc.int/en/ephyto/

Improving access to information

Information on prices is particularly important to farmers. Prices signal opportunities to producers, consumers and traders – such as when excess demand creates more profitable opportunities to sell. Prices reflect changing consumption preferences and contain information that enables farmers to decide what and how much to produce.

Today, mobile phones are the most widespread form of digital technology in use, and mobile phone applications that provide information on prices is the most frequent digital technology in agriculture. However, the evidence on the impact of price information is mixed.

A number of studies provide a range of estimates on the effects of disseminating price information on smallholders' sale prices and profits. For example, in the central highlands of Peru, SMS-disseminated price information increased farmers' sale prices by 13–14 percent, especially for crops that are perishable and for which market information is valuable.[15] In Cambodia, where local rice markets can be characterized as oligopsonistic and in which farmers sell below the average wholesale price level, improved flows of information through mobile phones led to an increase of about 4–5 percent in the farm-gate price of rice.[16] On the other hand, in West Bengal, in a market environment where transaction costs are high and where middlemen earn large margins, the bargaining power of potato farmers was found not to benefit from price information provided through various means including mobile phones.[17]

In general, most studies agree that mobile phone use reduces price volatility and improves market integration.[18] In rural Niger, mobile phones helped decrease the dispersion of prices for cowpea, a perishable good, but not for millet and sorghum – both storable commodities. Although no increases in prices received by farmers were found, information reduced price volatility more in remote markets and during periods when markets were thin.[19]

Other studies suggest impacts of a different nature. In Colombia, information on prices shaped decisions depending on the size of the

BOX 4.2
DIGITAL INNOVATION FOR CROSSCUTTING BENEFITS: THE CASES OF E-CHOUPAL IN INDIA AND ESOKO IN GHANA

E-Choupal is an initiative to help smallholder farmers overcome multiple market failures in India (https://www.echoupal.com). It functions through a network of internet kiosks run by a farmer who acts as a focal point. The farmer provides access to the e-Choupal online platform which offers information on farming practices, market prices, weather forecasts and advice by agricultural experts. E-Choupal reportedly reaches 4 million farmers across India. It also partners with banks to increase farmers' access to financial services and has built a network of warehouses to provide inputs to farmers and assess output quality. Evidence suggests that e-Choupal services have helped improve farming practices and increase farm incomes. For example, the introduction of e-Choupal kiosks had a positive effect on soybean prices, which increased between 1 and 3 percent. This innovation also resulted in a 19 percent increase in soy production, leading to an overall 33 percent rise in farmers' net profits. A part of the increase in profits was due to a redistribution of surpluses from traders to farmers. There was also evidence that 1 to 5 percent of traders' profit margins were transferred to farmers.

Esoko started operating in 2005 to provide information on market prices by SMS to smallholder farmers in Ghana (https://esoko.com). Over the years, the initiative evolved into an internet and mobile phone application that provides services to farmers through SMS, voice messages and call centres. These include extension information messages, farmer surveys and SMS polls, marketplace matching, and data collection. The platform provides two-way communication and information flow between farmers and other value chain actors. This has led to increased farmer knowledge and access to quality inputs, credit and formal markets. The business model of voice, video and call centres is easily accessible to illiterate farmers. At present, Esoko operates in ten countries in Africa and reportedly connects over 1 million farmers to essential services. Evidence indicates that farmers using its services have enjoyed a 10–11 percent rise in revenues, most likely through better information that resulted in increased bargaining power with traders. Some evidence suggests that this effect varies by crop type; income effects for yam, for instance, were present only in the first year of participation.

SOURCES: Nakasone, Torero & Minten. 2014; Trendov, Varas & Zeng. 2019; Aker, Ghosh & Burrell. 2016; Halewood & Surya. 2012; Tinsley & Agapitova. 2018; Goyal. 2010.[18, 21, 22, 23, 24, 25]

farm. Smaller farms responded by planting crops on which they received information through SMS, while larger farms used the information to search for new markets. For both small and large farms, price information did not result in higher farm-gate prices.[20]

Similarly, in Niger, the use of mobile phones did not have any impact on quantities produced, market participation or the prices received for crops. Nevertheless, households with mobile phones were found to plant a more diverse basket of crops, particularly marginal cash crops grown by women.[26]

Price information disseminated by mobile phones can successfully improve welfare when other market failures are not binding. This is the case, for example, when transport infrastructure is adequate to support arbitrage, output markets are competitive and related markets, such as for inputs and credit, are also functioning well.

Successful initiatives not only give price information via mobile phones, but they also combine a variety of digital technologies and tools to provide information on other market attributes, credit, farming practices and weather (Box 4.2).

Improving access to markets through e-commerce platforms

In agriculture, the use of e-commerce platforms is still in its infancy if compared to the online trade of consumer goods. The widespread use of such platforms could disrupt traditional agricultural value chains, reducing the need for the many intermediaries typically engaged across each stage of a chain or changing how these intermediaries work. Various digital e-commerce platforms have emerged to connect farmers with households or restaurants or to allow new wholesale intermediary modes for aggregating produce from many smallholder farmers and for reselling more efficiently.[27]

In developed countries and emerging economies, modern lifestyles shape food preferences, with time-constrained urban dwellers demanding more convenient meals. Increasing consumer awareness on health and sustainability challenges generates demand for more information on the origin of food and the methods used to produce it (see Part 1). These drivers have spurred the proliferation of food e-commerce platforms that cater to various demand niches, from fresh produce to ready-to-eat meals.[b,7]

In developing countries, e-commerce platforms can reduce search costs and promote efficient matching between farmers and consumers, leading to increased market access and better outcomes in terms of income and welfare. Shortening the value chain can also reduce overall transaction costs and improve price transparency, thus resolving a number of market failures. The exponential growth of the Taobao villages in the People's Republic of China illustrates the potential of e-commerce to generate employment, income, and market participation growth. Increased participation of smallholder farmers in the digital economy through e-commerce is key for sustainable development, as it creates opportunities for marginalized groups to benefit from economic growth. About 3 000 Taobao villages have annual online sales of more than USD 1 million and also support a growing services sector (see Box 4.3).[32]

Some digital e-commerce platforms provide physical logistics hubs and warehousing services that are located near consumers, thus reducing transport costs and delivery times, two critical challenges faced by smallholder farmers.[c] These platforms usually have a business model that is capital-intensive and entails a higher level of financial risk, as they need to ensure that farmers fulfil their obligations and that storage capacity is used efficiently. For these reasons, in many developing countries e-commerce platforms are not taking on the responsibility of storage and quality control.[7]

At the retail level, recognizing an emerging demand for food online shopping, mainstream supermarket chains now also offer online shopping and delivery services (see Part 1 for a discussion on food retail e-commerce). During the COVID-19 pandemic, restrictions on movements to contain the spread of the virus generated a dramatic increase in the demand for online food shopping and home delivery services in some countries. Early market analysis forecasts the online grocery market to grow by 33 percent in 2020 in the United Kingdom of Great Britain and Northern Ireland, for instance.[28] In the People's Republic of China estimates suggest that the share of the online market increased from 11 to 38 percent of total food retail purchases in February 2020.[29] As the importance of e-commerce increases worldwide, it is possible that negative effects arise such as environmental concerns related to overpackacing.

Improving access to financial services

Savings and credit facilitate on-farm investments and help farm households to accumulate assets that promote productivity, adding to food security and resilience. Low population density, poor infrastructure and lack of information on collateral increase »

b Some examples of food e-commerce platforms connecting farmers to final consumers include RegoPantes in Indonesia (https://8villages.com/regopantes), Zolle in Italy (https://zolle.it/), Raizs in Brazil (https://www.raizs.com.br/) and Wild Organics in South Africa (https://www.wildorganics.co.za/).

c Examples include RegoPanters (which belongs to the PT 8villages Indonesia Business Group, https://8villages.com/), MUCHO (Colombia and the United Kingdom of Great Britain and Northern Ireland, http://www.getmucho.com), Twiga Foods (Kenya, https://twiga.ke/), and TaniHub (Indonesia, https://tanihub.com/).

BOX 4.3
E-COMMERCE AND THE CASE OF THE TAOBAO VILLAGES IN THE PEOPLE'S REPUBLIC OF CHINA

Taobao is the predominant online platform for e-commerce in the People's Republic of China. It caters for the domestic market, while its holder, Alibaba, serves a broader, English-speaking market. Taobao villages use Alibaba's support services (logistics, capacity building) to sell a wide variety of goods online. The exponential growth of Taobao villages in China has drawn significant attention to the potential of e-commerce for rural development, employment and income growth.

The first Taobao villages grew near established commercial areas, predominantly in the eastern coastal areas of the country. The development of the first villages was fostered by the introduction of a project, but the Taobao villages spread rapidly in coastal areas where conditions favoured e-commerce. These included good infrastructure network, reliable internet access and higher education levels. These factors enabled farmers to engage in online trade. Alibaba and the government provided support through logistic and specialized services during the incubation period to encourage the penetration of Taobao villages farther inland. In some cases, Alibaba and the local governments subsidized transportation costs at the initial stage of the project.

The spread of internet access facilitated e-commerce in rural areas and created a multiplier effect. As more and more rural households engaged in e-commerce, a multitude of services developed around the business model, generating jobs in the transport and shipping sectors as well as digital services to support e-commerce engagement. The first Taobao village entered the e-commerce business in 2012. The number of Taobao villages grew exponentially, from 212 villages in 2014 to over 3 200 in 2018.

Taobao offers advantages for farmers as well as customers. Farmers can join the platform at no cost (Taobao derives its income from advertising), which eliminates a significant barrier to entry. The detailed online customer rating system encourages transparency and fosters competition among sellers. Customers can also select from a wider variety of goods than would be possible in a physical shop.

A typical Taobao village has access to broadband internet, a mobile communications network and good infrastructure. An important finding is that the farther a household is from a train station, the more likely it is to engage in e-commerce. Proximity to a train station indicates households' accessibility to traditional markets. E-commerce is thus emerging as a substitute for traditional markets for many farmers.

Household heads that engage in e-commerce are typically younger and better educated. In addition, participation results in higher household incomes, with the income gains being relatively significant for less wealthy households.

The creation and clustering of Taobao villages also yield positive social outcomes, providing incentives to educated youth and women to remain in or return to rural areas. This has a myriad of effects, from supporting social and family cohesion, to alleviating pressures on cities and transforming rural areas into attractive places to live and work.

As technology innovation disrupts traditional business activities, gaps in regulation emerge. In the People's Republic of China, divergences between products sold and delivered, quality issues, and the engagement of unlicensed businesses arose with the increase of food e-commerce. As a result, lawsuits related to e-commerce increased by over 40 percent in 2017, and over half of these concerned food e-commerce. The government revised its legal framework to expand coverage to food e-commerce in 2015 and enhanced it further in 2016 and 2017. This regulatory framework introduced legislation tailored to the specificities that emerged with food e-commerce. It created obligations for e-commerce platforms, de facto establishing a shared responsibility between the public and the private sectors. In addition to changes in national legislation, provinces introduced policies to regulate small online food businesses.

SOURCES: Xiao. 2017; Asian Development Bank. 2019; Luo & Niu. 2019; Qi, Zheng & Guo. 2019; Xiao. 2019.[30, 31, 32, 33, 34]

BOX 4.4
TULAA: A DIGITAL PLATFORM FACILITATING ACCESS TO CREDIT IN KENYA AND GHANA

Tulaa is a start-up digital lending platform that links farmers, input suppliers, traders, financial institutions and insurance providers. Its business model addresses a number of market failures by providing access to credit for inputs, such as improved seeds, and extension services to increase yields and access to markets. In addition to mobile phone applications, Tulaa uses satellite data and artificial intelligence to provide specific agronomic advice to farmers during the crop cycle, based on their location, crop and inputs purchased.

Tulaa directly links different value chain actors, eliminating the need for cash-based loans or credit disbursements. The lenders directly disburse loans to the input suppliers over Tulaa's digital platform. The commodity traders repay the loans on behalf of the farmers, who receive the remaining balances as payments to mobile money accounts. This reduces transaction costs.

Tulaa has developed a mobile application that enables its staff or affiliated input retailers to register farmers so they can purchase input supply packages on credit. During registration, farmers provide information on their crops, farm location, production quantities and the inputs they desire. Each farmer is required to have a registered SIM card and a mobile money account (in Kenya the provider is M-Pesa) to receive crop-sale payments once the loan has been paid in full by the commodity trader.

The platform is offered to agricultural enterprises and corporate clients through an annual licensing fee. These clients and other partners, including microfinance lenders, access the Tulaa platform through mobile phones or computers, where account dashboards provide data profiles and a range of transaction information.

In most cases (over 90 percent), farmers apply for a loan to cover input costs. When a loan is requested, the farmer provides cash collateral to the lender, which can either be Tulaa itself or a lending partner, such as the microfinance provider Musoni in Kenya. For loans from microfinance lenders, farmers may be required to save a percentage of the total value of the inputs.

Tulaa has raised capital from several donors and investors including the Consultative Group to Assist the Poor (CGAP) and USAID. Launched in 2017, Tulaa had approximately 9 000 farmers using its platform in Ghana and Kenya in 2018 and facilitated over USD 1 million in orders. Tulaa services are also bundled with weather index-based insurance in partnership with ACRE Africa, an insurance company (see Box 4.5).

SOURCE: IFC & Mastercard Foundation. 2018.[40]

» the costs of financial services and result in missing credit and insurance markets. For a bank, the fixed costs to establish a branch in a remote and sparsely populated area are very high compared with the quantity of business it will conduct. Digital technologies lower costs and allow financial institutions to enter rural markets without establishing a costly physical presence, thereby leading to the inclusion of population groups that previously had no access to a bank.

Transfers and payments, credit and savings are examples of financial services that are offered through digital technologies. Mobile phone services, such as M-Pesa launched initially in Kenya, facilitate money transfers across the developing world. Since its establishment in 2007, M-Pesa has expanded into other services, such as savings. M-Pesa allows registered users to send, receive and store money for a small fee. Over the years, M-Pesa has widened to include small businesses that can receive payments from customers, as well as pay employees directly into their M-Pesa accounts.[d]

d For more information see https://www.safaricom.co.ke/personal/m-pesa

Nevertheless, there is no clear consensus about the effects of the use of mobile banking by households. Some studies find that M-Pesa is mostly used for money transfers, especially remittances from cities to rural areas, rather than savings.[35] Other evidence shows that it is more common for the poor, the non-educated and women to not have an M-Pesa account, or to not save money in their accounts if they have them.[36]

A study using data collected from 379 households in three Kenyan provinces found that M-Pesa money transfers increased market participation by 37 percent, resulting in higher household incomes.[37] There is also evidence that mobile phone-based transfers can increase resilience in times of distress through reduced transaction costs. For example, it was estimated that M-Pesa contributed to lifting 2 percent of Kenyans out of poverty, with households that used it being better able to mitigate negative shocks. Such impacts were found to be more pronounced in female-headed households.[38]

Digital platforms that facilitate linkages between value chain actors can increase financial access (see Box 4.4). In Ghana, the AgroTech Smartex mobile application – designed and implemented by the Grameen Foundation – aims to strengthen linkages between farmers, extension workers, input suppliers and traders. It also facilitates access to credit through better record-keeping and monitoring. The application collects data including farmers' profiles and farm-related information, such as crops grown, yields, inputs and past credit history. This data can serve to attract formal lenders (such as banks and microfinance institutions) and traders or to encourage suppliers to provide inputs on credit.[39]

Improving access to insurance

Climate change is likely to increase the frequency and severity of extreme weather events, and the uncertainty that surrounds climate variability hinders investment in productive technologies, which can result in poverty traps.[41] Agricultural insurance can promote on-farm investments in technologies and inputs; but it can also build resilience by facilitating the adoption of sustainable production approaches.

Innovative insurance schemes, such as weather index-based insurance, differ from traditional indemnity insurance. The latter involves high costs of administering contracts and determining crop or livestock losses with large numbers of dispersed farmers. Index-based insurance, on the other hand, provides coverage based on an index of weather conditions that are correlated with those losses; the conditions include wind speed, the temperature or rainfall during a certain period. For example, with weather index-based programmes, farmers are paid whenever rainfall or temperature is higher or lower than specific thresholds likely to cause a significant fall in crop yields.

Digital innovations in earth observation, satellite rainfall estimations and remote sensing, combined with *in situ* data, can support index-based insurance programmes at lower costs. Insurers do not need to make field assessments, as in the case of multi-peril crop insurance schemes, thereby reducing insurance premiums. Index-based insurance programmes can provide coverage to millions of smallholder farmers, many of whom were previously considered uninsurable.

The Agriculture and Climate Risk Enterprise (ACRE) in sub-Saharan Africa, is the largest weather index-based insurance programme in the developing world for which the farmers pay a market premium. It is also the first agricultural insurance programme worldwide to reach smallholders using mobile phone technologies (see Box 4.5).[42] ■

APPLYING DISTRIBUTED LEDGER TECHNOLOGY TO AGRI-FOOD VALUE CHAINS

Distributed ledger technology is a disruptive technology with potential impacts across many sectors. It currently lies at the centre of discussions on digital applications, including those related to food and agriculture. In essence, DLT is a decentralized, consensus-based

BOX 4.5
WEATHER INDEX-BASED AGRICULTURAL INSURANCE: AGRICULTURE AND CLIMATE RISK ENTERPRISE (ACRE)

ACRE is a commercial company with a partner network which includes insurers, reinsurers, agribusinesses, microfinance institutions, non-governmental organizations and input suppliers.

The company offers three weather index-based products:

Loan-linked insurance: ACRE's main product is linked to the provision of credit for agricultural inputs from microfinance institutions. ACRE insures the loan and thus the investment, which must have a minimum value of USD 100. Depending on the crop, premium costs vary between 5 and 25 percent of the input value and are paid either by farmers or the microfinance institution. In case of a payout, the loan is covered by the insurance. The insurance programme also provides agronomic training for farmers by microfinance institution agents.

Replanting guarantee: The replanting guarantee is offered in collaboration with seed companies. Each seed bag that farmers receive contains a scratch card with a code inside. To register and pay for the guarantee, farmers send the code to ACRE by SMS. The replanting guarantee starts at registration and ends after two weeks. If there is a drought within that period, smallholders receive a voucher for a new bag of seeds, enabling them to replant within the same season.

Hybrid index and multi-peril crop insurance: This product combines the traditional yield-based approach and weather index-based approach. Unlike traditional insurance, it covers the entire crop cycle, starting in the germination phase, thus providing comprehensive coverage.

ACRE has established innovative distribution channels by building strong ties with the private sector. Both input suppliers and microfinance institutions, which have access to large numbers of people who would otherwise be costly to reach, function as aggregators. All ACRE products use mobile banking, including the M-Pesa scheme in East Africa.

A 2012 impact study found that insured farmers invested 19 percent more than those without insurance and had incomes that were 16 percent higher. Virtually all insured farmers (about 97 percent) received loans linked to the insurance. Many of them would not have been eligible for credit without such assistance. Cumulatively, by 2018, over 1 700 000 farmers in Kenya, Rwanda and Tanzania insured over USD 181 million against a variety of weather risks (see http://www.acreafrica.com/).

SOURCE: Adapted from Tinsley & Agapitova. 2018.[24]

record-keeping system, and its use in agri-food value chains can have a significant impact. These value chains comprise a large number of production stages within and across countries and involve many actors, including farmers, traders, processors, banks, retailers and consumers.

Currently blockchain – the best-known DLT – is used only marginally in agri-food value chains, although many pilot initiatives are underway to assess its potential (for examples, see Boxes 4.7 to 4.12). Blockchain's impact on food and agriculture will be more evident in the years to come when its use reaches a critical scale. Box 4.6 elaborates on the origins of blockchain, its purposes, and how it functions.

In agri-food value chains, blockchain technology can be of particular importance for applying "smart contracts" that are designed to self-execute once a number of predetermined conditions are met. In a smart contract, the clauses that rule the exchange of goods or services are embedded in coding, and actions (such as payment) are triggered automatically

BOX 4.6
UNDERSTANDING DISTRIBUTED LEDGER TECHNOLOGY

Distributed ledger technology emerged in 2008 as a supporting system for the Bitcoin cryptocurrency. It was intended as a peer-to-peer consensus-based mechanism to carry out financial transactions without the use of a bank.

DLT makes possible the creation and use of decentralized **consensus-based** record-keeping of any type of information. For example, blockchain functions as a ledger in which all transactions are recorded chronologically. This record exists **simultaneously across all computers** of transaction parties, as well as those of the record keepers (that are called nodes in the blockchain jargon) in the network.

In a blockchain, every new transaction (called a block) is linked to its predecessor (and subsequently to its successor) through a highly complex code generated automatically by an algorithm. In practice, once a transaction takes place, information is entered in the blockchain, verified by the record keepers and replicated throughout the entire network. Verification is triggered through a complex consensus mechanism, with the record keepers (nodes) assessing the new information and agreeing to this new entry (Figure 4.7).

Once the transaction is verified, is it difficult to change, unless the same consensus mechanism is triggered again. The **immutability** of blockchain is a key characteristic, without which users could easily choose alternative solutions. In addition, the verification process is decentralized with dispersed record keepers reaching consensus and is not dependent on an arbitrator or a third-party. Another important characteristic is that, often, users also take the role of record keepers.

DLTs may be **permissioned**, which means that one or more participants retain some control over who can join and what actions a participant can take. This can influence the function of the blockchain-enabled platform. For example, with fewer participants, there is less information to verify transactions, and, with fewer record keepers, the DLT platform moves towards a more centrally controlled mechanism that resembles other digital solutions, such as normal databases.

Permissionless platforms, however, operate so that anyone can join. By joining, users agree to the rules of the platform. This enables peer-to-peer interaction, more information on transactions and a more effective consensus. DLTs can also allow transfers of assets without the use of an intermediary.

The blockchain is **pseudonymous**. In the traditional banking system, the identities of transaction parties are recorded. In the blockchain, each user and record keeper has a pseudonym in the form of a unique alphanumeric address (or a public key), and the technology makes it very difficult to reveal the real identities of any given user.

To use blockchain, an individual or firm needs access to an internet connection, an internet-enabled device and blockchain software. Users can either develop their own blockchain software or join a platform that provides blockchain-based software for multiple purposes. Etherium is an example of such a platform.

The perceived advantages of blockchain are (i) peer-to-peer interactions that forego an intermediary; (ii) increased transparency, as records are available to all, at all times; (iii) enhanced traceability, since the history of transactions is recorded and immutable, and all can see it; and finally, (iv) a significant reduction in the risk of data-tampering. These attributes contribute to market efficiency by both lowering transaction costs and enhancing information. As lack of information on past transactions influences perceptions on the expected capacity of a supplier to meet expectations, DLTs can significantly facilitate entry into markets and thus increase competition.

SOURCES: Đurić. 2019; Cong & He. 2018; Catalini & Gans. 2019.[7,43,44]

once conditions are met (such as the delivery of products). Smart contracts can significantly reduce transaction costs and increase the efficiency and transparency of transactions.

For example, exporting agricultural commodities, say grains, involves a complex web of intermediaries. These include farmers, wholesalers and buyers, but also a large number of providers of logistic services such as transport,

BOX 4.7
BLOCKCHAIN AND INTERNATIONAL COMMODITY TRADING

In December 2018, a consortium formed by commodity traders, including Louis Dreyfus Co (LDC), Shandong Bohi Industry, ING, Société Générale and ABN Amro, ran a pilot sale of 60 000 tonnes of soybeans from the United States of America to People's Republic of China using blockchain technology. Blockchain trade reportedly reduced document processing time to one-fifth of the time needed to process physical paperwork.

Going a step further, ADM, Bunge, Cargill, COFCO, LDC and Glencore Agriculture partnered to develop a blockchain-based prototype for international bulk agricultural commodity trading. The partnership, Covantis, was formally launched in March 2020 (https://www.covantis.io). The initiative partnered with ConsenSys, a technology firm, to develop its prototype, with testing expected to be initiated in 2020. Access to the prototype is to be granted on subscription.

International commodity trade relies heavily on processes that are often manual, paper-based and time-consuming. International trade and shipping of commodities in bulk involve many intermediaries. As commodities move along the value chain, it is often necessary to issue new documents that confirm information previously provided (such as dates, origin, destination, quantity, quality, etc.), which creates redundancies and increases the margin for error. There are also significant internal coordination needs within a given commodity trader company, with different people responsible for contracting with farmers, transportation over land, shipping companies and other services. Through digitalization, Covantis aims to substantially improve transaction efficiency, increase real time visibility, reduce the risk of manual errors and shorten waiting times.

Since the initiative brings together six of the largest agricultural commodity traders, its influence could be large enough to trigger an industry-wide wave of technological change.

SOURCES: Kamilaris *et al.* 2019; Covantis. 2020.[45, 46]

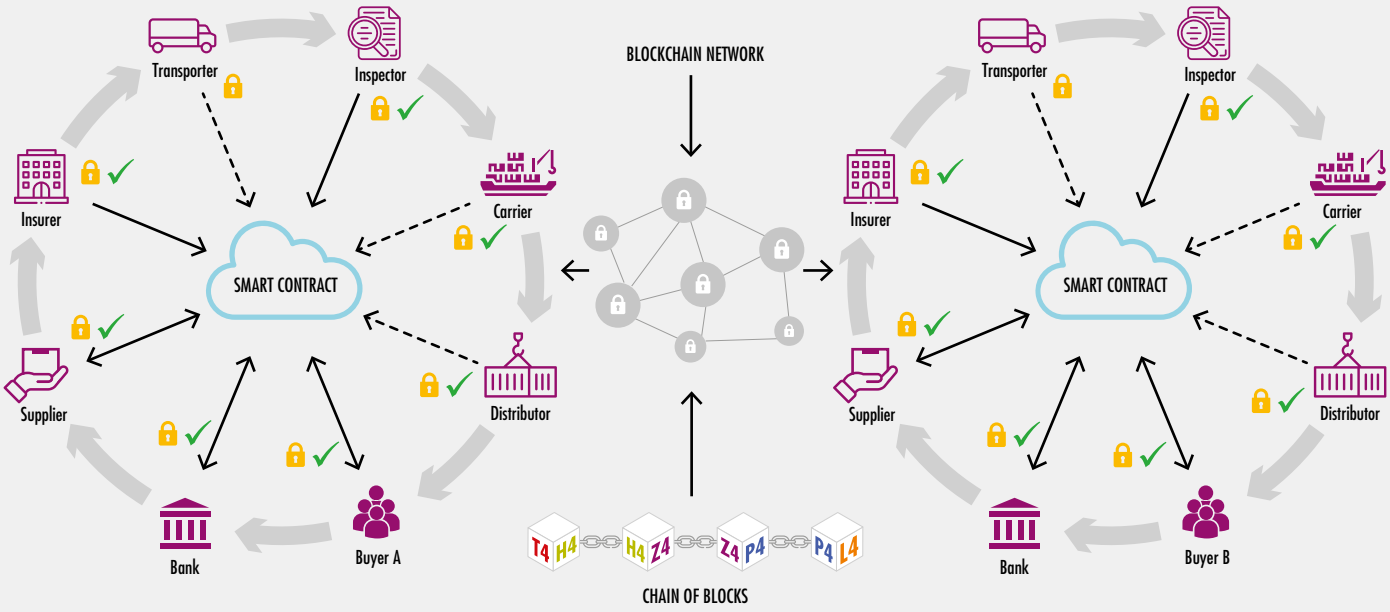
storage, quality control, shipping, ports and customs, and trade financing, as well as contract and authentication services. At each stage of this value chain, the commodity should be stored, handled and transported in line with specific standards that set humidity, temperature and impurity thresholds.

This global value chain involves considerable transaction costs and paperwork, which can be drastically reduced by blockchain and smart contracts (see Figure 4.7). As transactions are completed at each stage of the value chain, information is sent to record keepers. This is done by the supplier, the buyer, other service providers or IoT devices, such as sensors, that can follow the merchandise and signal its position, temperature and other quality parameters. For each stage of the value chain, the record keepers verify this information. Once the transaction at each stage is completed and a consensus is achieved, a block is added to the blockchain and payments are made to suppliers and service providers through smart contracts.

Blockchain technology could fundamentally change trade practices and reduce, modify or entirely eliminate the need for a number of intermediary services along a value chain. It holds potential for both developing and developed countries. In developing countries, it is being used to tackle market failures and empower smallholder farmers (see for example Boxes 4.8, 4.9 and 4.10). In developed economies, users are pursuing increased value chain efficiency and transparency (see Boxes 4.7, 4.11 and 4.12).

The public and decentralized nature of the technology enables participants to see each other's data entries in real time, improving information flows, efficiency and coordination. Box 4.7 presents an example of a blockchain initiative that aims at improving coordination, efficiency and transparency of the agricultural commodity trading industry.

FIGURE 4.7
ILLUSTRATION OF BLOCKCHAIN BASED AGRI-FOOD VALUE CHAINS



SOURCE: Elaborated by FAO.

Market access, financial inclusion and social outcomes through blockchain

Blockchain technology can be applied to address multiple market failures. Smallholder farmers often do not operate in the formal economy, meaning transactions take place in cash and are not recorded over time. Blockchain technology can help build a record of financial information, creating a history and digital identity. This record can help farmers establish a business reputation, improving their market access and also enhancing their eligibility to obtain credit by formal financial institutions (see Box 4.8).[7]

There are very few examples of blockchain applications for financial inclusion in developing countries. WFP ran a blockchain pilot to assess its potential in humanitarian aid cash transfers. The Building Blocks pilot project was launched in 2017 to reach 10 000 Syrian refugees in Jordan and extended to 100 000 refugees in 2018 in two Syrian refugee camps.[e] Money was transferred from WFP to a financial service provider, but, for each beneficiary, the value of the cash transfer was transferred into blockchain accounts and used to purchase groceries at partner stores. The beneficiary's identity was verified by iris scanning. The project reduced third-party financial service provider fees by up to 98 percent. In addition to the savings in financial transaction fees, blockchain contributed to greater security and privacy for the refugees. There were also gains in efficiency since it was unnecessary to verify data between financial service providers, vendors and in-house records.[47]

e See https://innovation.wfp.org/project/building-blocks

BOX 4.8

SUPPORTING SMALLHOLDER FARMERS' ACCESS TO MARKETS AND FINANCIAL SERVICES THROUGH BLOCKCHAIN

BanQu (https://banqu.co) is a company applying blockchain technology to value chains. The BanQu blockchain solution builds a transaction record, which can be used by smallholder farmers as proof of transactions and income. The premise is that if a farmer can prove his/her history of participation in a given value chain, independent of the buyer, then this documented identity can unlock marketing opportunities, as well as access to financial services. To establish this identity and history, participating farmers make their transaction history available in the BanQu platform (quantities delivered, dates of delivery, prices and total payments received by the farmer).

In the BanQu arrangement, the buyer takes the initiative of seeking the farmer in the platform, making the contractual arrangement and, when the transaction is completed, paying for agreed produce with virtual tokens. These tokens can be saved, redeemed for cash, used for paying bills and transferred as remittances. The buyer also shares with others the participating farmer's business history and identity in the BanQu platform. In exchange for these efforts, the buyer is certain of who grew the crops and where. In the long term, the buyer's cost (time and effort) to search and purchase from a farmer is expected to decrease, because records accumulate on the BanQu blockchain over time.

BanQu uses blockchain's immutability (data that is secure from tampering and deletion) as well as consensus from an array of participants. In the blockchain arrangement, the buyer, the farmer and BanQu acquire and maintain an identical record of each transaction. BanQu's innovation is that it does not hold onto the data. There is no single and proprietary database. If a relationship with a buyer ends, farmers' records will still be accessible by the farmer. With SMS records as proof, farmers can also log onto the platform. The shared benefits for the purchasing firm and the farmer include accurate price records, secure payments, no need for stored hard-copy receipts, direct relationships between the buyer and the producer, and records for intermediary aggregators (with the potential to unlock financing and marketing opportunities). According to BanQu, as of March 2019, the platform had registered 70 000 households across 15 countries.

SOURCE: Adapted from Michelson. 2020.[48]

Blockchain-based solutions could reduce the number of intermediaries in the value chain, providing farmers with a more direct connection to markets and shortening the value chain. Within the blockchain, smart contracts can also help build trust and promote transparency. For example, many crops are characterized by seasonal labour needs, and informal seasonal labour markets are common in agriculture. Smart employment contracts, both immutable and public, could reduce costs and increase transparency, especially when foreign seasonal workers are concerned. In these blockchain applications, information could be made available to the employer, employee and legal authorities, such as immigration departments and welfare and social insurance programmes.[7] Some firms are reportedly exploring the use of smart employment contracts to eradicate unfair practices in hiring workers in their value chains.[45]

Smart contracts could also considerably reduce agricultural insurance costs (see Box 4.9). In the case of climate risks, for instance, weather index-based insurers could combine information from multiple sources (weather stations, satellites and sensors) with blockchain technology to both determine whether farmers should be paid and trigger the payment.

Blockchain, traceability, transparency and sustainable outcomes

Blockchain can facilitate the traceability of food throughout the value chain, allowing for the record-keeping of a product's origin and

BOX 4.9
BLOCKCHAIN APPLICATION FOR SMALLHOLDER WEATHER INDEX-BASED INSURANCE

Agricultural insurance products remain costly and unaffordable to the vast majority of smallholder farmers. At the same time, insurance is a valuable coping mechanism for adversity.

Blockchain Climate Risk Crop Insurance is an initiative created in partnership by The Lab, Sprout Insure, ACRE Africa and Etherisc, targeting smallholder farmers in Africa. It has developed blockchain-based crop insurance indexed to local weather (see also Box 4.5). The insurance policy, a smart contract, is triggered automatically if an extreme weather event occurs. The project is due to start a four-year pilot in Kenya in 2020. During this pilot phase, its objective is to add blockchain-based technology to already existing weather index-based insurance infrastructure to test and prove the innovation.

Tying insurance payments to a weather index can yield benefits for both farmers and insurers. Merging blockchain technology with weather index-based insurance can reduce premiums for farmers, as well as claim times. Initial estimates made by the project indicate that, in the long term, this model could lower the costs of issuing an insurance policy by up to 41 percent – which translates into a premium reduction of up to 30 percent – and reduce claim cycles from 3 months to 1 week. This model also facilitates payment and increases transparency, which benefits both parties.

SOURCES: Tinsley & Agapitova. 2018; Global Innovation Lab for Climate Finance. 2019. [24, 49]

trajectory through all stages of production, processing and distribution. Increased ability to trace products can be valuable for many purposes. First, blockchain technology can enable actors to know the stage of a product in real time, helping identify delays, irregularities and bottlenecks and improving coordination. Second, it can significantly facilitate corrective action should unsafe food items reach the market. Finally, it can respond to a growing demand by consumers for more information on the location where food is produced and on the production methods. The ability to share and guarantee this information is becoming an important factor for gaining consumers' trust.

Food products can be accidentally contaminated throughout the value chain. For example, in 2006 in the United States of America, health officials took nearly two weeks to identify the source of an E. coli outbreak related to spinach. In another case, about three weeks were needed to identify the source of a salmonellosis outbreak connected to papayas in 2017.[50]

Such periods are necessary due to the complexity of the value chain and the need for many stakeholders to verify multiple records and trace backwards each step of the chain. In both cases, the outbreaks were connected to a specific supplier; but the time involved in establishing the identity and location of the producer resulted in both loss of confidence in these products and consumers completely foregoing consumption for fear of purchasing unsafe food. Many farmers lost income despite the safety of their products. Food safety and improved traceability were the key motivations for some supermarket firms to run blockchain pilots on product value chains (see Box 4.10).

Blockchain technology also holds the potential to curb intentional adulteration of food products. High-value food items are more prone to malicious actors' adding or substituting with a cheaper alternative. The increased transparency that accompanies blockchain technology would render it more difficult, for instance, to inflate weight or replace ingredients while remaining anonymous (see Box 4.11 for an

BOX 4.10
SUPERMARKETS EXPLORING BLOCKCHAINS

Walmart and IBM ran a pilot on Walmart's mango and pork value chains to verify blockchain technology's potential to facilitate food traceability, support food safety controls and guarantee food authenticity. Walmart chose to pilot the project on fresh mangos from Mexico due to the complexity of the value chain. The use of blockchain technology reduced the time needed to trace the origin of a pre-packaged portion of mangoes from nearly seven days to 2.2 seconds. The technology enabled value chain actors to identify the exact path the produce took from the farm to the store. The blockchain solution also allowed Walmart to follow the speed at which the mangos moved through the supply chain and identify where delays occurred.

In People's Republic of China, Walmart used blockchain technology to guarantee the origin and authenticity of pork. The country has experienced strong and sustained demand for pork meat over the years, and the pilot blockchain technology successfully increased transparency and addressed consumer trust issues. The pilot resulted in additional benefits, such as a reduction in the time necessary to access veterinary certificates, as well as increased confidence in veterinary control.

Many more initiatives are ongoing across the agri-food value chains to test the use of blockchain to solve challenges related to traceability. For example, Carrefour developed a blockchain for its branded chicken, providing consumers with increased information on poultry breeding and the supply chain. Another firm, Bext360, is working to apply blockchain solutions to the coffee sector to track coffee beans from the producer to consumers (https://www.bext360.com).

SOURCES: IFC & Mastercard Foundation. 2019; Kamilaris *et al.* 2019; Kamath. 2018; IFC. 2019; Jouanjean. 2019; Yiannas. 2018.[40,45,50,51,52,53]

example of blockchain applications on spices). The immutability of blockchain could also deter other intentional malpractices.

Increased traceability through blockchain would facilitate verifying the authenticity of products that are certified by sustainability certification schemes (see also Part 2 for a discussion on sustainability certification in GVCs and Part 3 for a discussion on farmers' participation in such schemes). Sustainable standards and labelling provide information to consumers on environmental and social dimensions of production and can result in better management of natural resources and the inclusion of smallholder farmers in global markets. Better traceability can promote trust and enable consumers to modify their consumption patterns, which in turn changes incentives and allocations through markets and can foster sustainable outcomes for all. Promising blockchain solutions are also emerging to tackle biodiversity challenges (see Box 4.12).

Barriers to blockchain adoption

Despite its potential for agri-food value chains, blockchain technology has not yet been adopted at scale. Its slow diffusion and adoption should not be interpreted as a failure. Adopting blockchain technology can take many years in spite of potential productivity gains across many industries.[44] The complexity of the technology could be a deterrent to adoption; as well as the important requirements in terms of computer processing capacity, and costs related to high electricity needs. These are issues that are expected to prevent wider adoption of DLTs in the short term.

Blockchain technology is cumulative, meaning that transactions build on each other. The trustworthiness of the system depends on having many record keepers to build the consensus mechanism and verify transactions that take place. This requires significant storage and computer memory capacities. It also results in a relatively slow speed of recording

BOX 4.11
TRACING SPICES AND HERBS USING BLOCKCHAIN TECHNOLOGY

Spices and herbs are used in a wide range of foods and food products and form a unique segment within the food sector. They are distributed mostly in their dried, low water formats and are associated with long and complex value chains. They are grown across the world and pass through multiple touchpoints which could increase the potential for food fraud, such as dilution, substitution and unapproved enhancements. Spices and herbs are prone to food fraud because they have a high value by weight and it is difficult for final consumers to detect adulteration in the final product. Common authenticity issues linked to spices' adulteration are the addition of (i) lower-value products (of foreign or own material, such as peel), which may dilute flavour but increase volume, and (ii) unapproved color "enhancements", such as dyes to cover up the extension. Ground spices are particularly susceptible to adulteration because the milling or grinding changes both the spice and adulterant into a powder. Examples of foreign items used to inflate the volume of ground spices include ground coffee husks, starches and chalk powder.

Saffron is one of the most expensive spices in the market, produced from the dried stigma of the flower of saffron crocus. The global saffron market was valued at USD 390 million in 2017 and is forecast to increase to about USD 555 million by 2026. It is also the fourth most adulterated food in the world, mostly due to the lack of value chain regulation and of monitoring and technical methodologies. A survey of saffron in India found that 44 percent of samples were adulterated with non-stigma parts of the saffron plant or parts of other plants. In the same survey, none of the samples met ISO (International Organization for Standardization) quality grades I or II.

In response to spice fraud, QuillHash (https://www.quillhash.com), a blockchain development company, created QuillTrace, a blockchain-based procurement solution to counteract malpractices performed in the industry. Since each step of the chain from harvesting to packaging can be recorded on the blockchain, it is more difficult for actors to inflate quantities throughout the chain. As information is tracked from production to delivery point, QuillTrace aids in analysing, planning activities, and cross-checking for quality and volumes based on data from the entire value chain. In addition, the integration of IoT devices for live tracking provides complete visibility for all parties involved, as well as data accessibility by any party of the system at any time. The route of saffron from the producer to the retailer can also be shared with the final consumer, who can verify the authenticity of the product.

SOURCES: Hoffman. 2020; Mzabri, Addi & Berrichi. 2019; Silvis *et al.* 2017; Shahbandeh. 2019; The Telegraph. 2018.[54,55,56,57,58]

transactions, since the blockchain needs to synchronize transactions across all nodes.[61] The constraints on the size and amount of blocks that can be created in a given time limit the number of transactions that can take place per second on the blockchain.[44]

Developing and implementing a novel blockchain solution can be costly. While the entry costs reflect investments that will produce benefits over time, in its current form the technology's energy costs will likely continue to rise, generating negative environmental outcomes. Running costs are high due to electricity needed to validate an increasing number of transactions constantly.[61]

Using blockchain technology does not entail greater digital literacy than mobile phone applications, but developing a blockchain solution does require substantial technological know-how. Many blockchain pilots in the agri-food value chain are underway in developed countries. Developing countries lag behind despite the potential the technology holds for them. This is because blockchain applications require stable electricity supply, hardware power and memory, high-speed internet access, and a skilled labour force, all elements that may not be present across the developing world. Not all countries have a labour force with the skills needed to apply

BOX 4.12
BLOCKCHAIN TECHNOLOGY AND SUSTAINABLE FISH VALUE CHAINS

Awareness of the dangers posed by unsustainable fishing practices, such as for tuna, has grown over the years. Tuna fish is of great importance because of its high economic value and extensive international trade. Its sustainable management is subject to great challenges owing to tunas' highly migratory and often straddling distributions. In 2015, among the seven principal tuna species, 43 percent of the global stocks were estimated to be fished at biologically unsustainable levels.

In 2018, the World Wildlife Foundation (WWF) launched a blockchain pilot in Fiji's tuna sector. The objective was to create a transparent and traceable tuna supply chain, thereby identifying the origin of tuna fish and promoting the reduction of illegal fishing practices and human rights abuses. The pilot used a combination of radio-frequency identification (RFID) and Quick Response (QR) codes to capture information throughout the supply chain.

Each fish that landed on a fishing vessel received an identifying tag, and tagged fish data were transmitted and recorded on a blockchain using a mobile device with internet access. The tag followed the fish and registered automatically at various devices positioned throughout the value chain (vessel, dock and processing facility). At the packaging stage, the tag was replaced by a QR code to identify the product.

While the pilot had promising traceability results, it also faced challenges. For example, it underlined the need for substantial and crosscutting digitalization in a sector that used mostly paper-based documentation, including government agencies. It also highlighted the importance of a specialized workforce to solve technical issues. Finally, the project's bottom-up approach left the final consumer without knowledge of the provenance of the fish, as not all international buyers were involved in this pilot.

The increased demand for information by final consumers is expected to provide an incentive for actors along the value chain to adopt more sustainable fishing practices and full value-chain transparency. Many other initiatives using blockchain for traceability in the seafood value chain exist, for instance Hyperedger Sawtooth and Balfegó.*

* See more for Hyperedger Sawtooth at https://sawtooth.hyperledger.org/examples/seafood.html and for Balfegó at https://balfego.com/ca/trasabilitat/

SOURCES: Kamilaris *et.al.* 2019; FAO. 2018; Cook. 2018.[45,59,60]

blockchain across the agri-food markets or other sectors of the economy. This could have implications for the digital divide across countries and between sectors.

It is expected that as the technology evolves, these barriers will be reduced. Both public and private sectors will play key roles in its evolution and application to food and agriculture.[52] Traditional development areas, such as infrastructure and education, including digital literacy, will continue to be essential to allow for actors to benefit from the digitalization of the economy and to facilitate the uptake of blockchain technology.

At the moment, many blockchain pilots are being pursued in parallel, using various blockchain systems, mostly by the private sector. Blockchain solutions by the public sector lag far behind. This could reveal a missed opportunity to increase the efficiency of agricultural policies, such as payments for environmental services, or compliance with food safety requirements and SPS measures. To fully integrate DLTs into the agri-food value chains would require interoperability between the systems used by different agents (governments, producers and trade partners) and across countries. ■

OPEN QUESTIONS AND POTENTIAL RISKS FOR AGRICULTURAL AND FOOD MARKETS

While digital technology can bring significant gains, many questions remain unanswered. It is still difficult to foresee the full impact that digital applications can have on agricultural and food markets.

Digital technologies still face many constraints to adoption at scale, and they would be best used where they can provide benefits that other technologies cannot. This is, first and foremost, where market failures can be directly and effectively addressed; second, where there are significant efficiency gains to be realized for all. Third, and especially in the case of blockchain, where trust between parties is missing.[62]

There are many questions and potential risks to address in the context of agricultural and food markets. These relate to the impacts that digital technologies could have on market participation, data issues and market power.

Risks for market participation

Digital technologies can empower all value chain actors – including smallholder farmers in developing countries – by reducing transaction costs and barriers to entry. At the same time, digital technologies can exclude from markets those smallholder farmers who cannot afford the initial costs to become part of the digital economy or who lack the skills to do so. Exclusion from the digital economy could add to the challenges smallholders already face and further undermine the smallholder farm sector and the livelihoods of millions of people in the rural areas of developing countries. The risk of exclusion from an increasingly digital economy is particularly high for illiterate smallholder farmers. While some technologies may help foster inclusion of illiterate farmers (see Box 4.2, for instance), it is indispensible to redouble efforts to reach full literacy and ensure that all have the skills to use the internet fully and effectively.

Exclusion from markets can be an unintended outcome of digital technologies. In agriculture, failure to respect contract requirements may occur for many reasons. For example, a farmer may fail to meet obligations to deliver specified quantities complying with certain quality standards due to extreme weather events, pests, diseases, or lack of credit. In this case, the immutable, public and perennial nature of blockchain may work against smallholder farmers who are more susceptible to such difficulties. This could generate a new information asymmetry, which could lead to farmers' exclusion from markets, thus limiting livelihood opportunities. At present, it is unclear if and how agents using the blockchain could adjust to such potential problems and other specificities of smallholder farming.

The digitalization of the sector is expected to affect agricultural labour markets considerably. Automation may reduce or eliminate the need for some types of manual jobs on the farm and some intermediary services, adding to the impact of structural transformation on labour in rural areas. Emerging employment opportunities will be skewed towards the higher end of the skills base. Progressively higher skills will be needed to farm and engage effectively in agri-food value chains as technology advancements spread further. This will increase employment opportunities for high-skilled labour but risks further marginalizing low-skilled workers.

To engage in agri-food value chains effectively, both farmers and labourers will need to be capable of accessing digital technologies and to have the skills to use them. Promoting capacity building and digital literacy will be key to the workforce across all levels of agri-food value chains.

Data collection, privacy concerns and regulatory gaps

Data management is at the forefront of current concerns related to digital technology, and lack of trust surrounding data issues is a major obstacle to the digitalization of agriculture.

Information in agriculture has been created, disseminated and used by farmers for centuries. Since the middle of the nineteenth century, agriculture has been driven by data – information that was collected, analysed and communicated. For example, the establishment of the United States Department of Agriculture in 1862 resulted in annual reports which, based on national surveys, disseminated information on yields, prices and new farming practices. In 1905, with the creation of the International Institute of Agriculture – FAO's predecessor – information on worldwide production, trade and prices was made available.[63]

Digital technology revolutionized data collection, a traditionally costly and lengthy process, but also resulted in real time-data being captured and collected by computers, smartphones, the internet and IoT devices. Everyone is generating large amounts of personal data that, under the proper legal frameworks, can be of value to the public and private sectors. All economic sectors, including food and agriculture, are becoming progressively more data-intensive.

Big Data is different from the "analogue" data that was previously collected and analysed, both in terms of volume and the potential for analysis. Analysing such data can shed light on hidden patterns, or unexpected relationships, that can support decision-making. For example, in agriculture, analysis of ten years of weather and crop data in Colombia revealed specific patterns of climatic variation impacts on rice yields. This analysis could support accurate site-specific forecasts and provide advice to farmers to change the sowing date and take advantage of optimum solar energy during the ripening stage.[64]

Such climate-smart, site-specific information can deliver significant and sustainable benefits to farmers and society in general. In developed countries, the private sector, such as large suppliers of seeds and agrochemicals and agricultural machinery manufacturers, already engages in such innovative Big Data "smart farming" applications. These firms have made significant investments in digital technologies and services, leveraging economies of scale and their market shares. Through a multitude of digital technologies and devices, they collect information on farming practices and operations of their clients, as well as data on weather and soil conditions. They process and analyse these and relay the knowledge they produce back to their clients. The firms thus enhance production efficiency and, in many cases, provide wider benefits, such as preserving natural resources and minimizing the use of fertilizers or pesticides. The sale of innovative inputs and the provision of specific know-how to farmers through digital technologies also generate returns for these firms which often are protected by patents and copyright – otherwise businesses would have no incentive to engage in research and development of such technologies.

Nevertheless, the nature and ownership of such data have raised concerns; indeed, the spectrum covering personal and public data is very wide. On one end of the spectrum are open data, free and accessible by all, that can serve to accelerate data-driven development.[f] On the other end are private data, generally related to an individual's personal information, which should be only willingly provided by the individual. There are questions on the ownership of data across this spectrum that are collected through digital technologies. This is the case, for example, of data generated by an IoT device on a farm, and subsequently processed and analysed by input suppliers or other firms.

Concerns about data ownership, portability, privacy, trust and liability in the commercial relationships governing smart farming are contributing to farmers' reluctance to adopt digital technologies. More work is needed to craft systems that address privacy concerns without undermining innovation and technological progress. For example, in 2014, farmers' organizations and agriculture technology providers in the United States of America agreed on a set of Big Data privacy and security principles that shape how such information is collected, protected and shared.[g] In many countries, policy-makers are aware »

f For example, the Global Open Data for Agriculture and Nutrition (GODAN) initiative seeks to support global efforts to make agricultural and nutritionally relevant data available, accessible and usable for unrestricted use worldwide.

g See https://www.fb.org/newsroom/farmers-agriculture-technology-providers-reach-agreement-on-big-data-privac

BOX 4.13
THE GLOBAL FORUM FOR FOOD AND AGRICULTURE AND THE INTERNATIONAL PLATFORM FOR DIGITAL FOOD AND AGRICULTURE

The Global Forum for Food and Agriculture (GFFA) is an annual international conference that brings together agriculture ministers and high-level representatives from international organizations, civil society and the private sector. The three-day forum, hosted by the German Federal Ministry of Food and Agriculture in Berlin, provides a global platform to discuss critical issues for the future of global food and agriculture from different perspectives and to develop global solutions. Against this backdrop, the GFFA Agriculture Ministers' Communiqué of 2019 recognized the potential of digitalization of agriculture to contribute fully to achieving the Sustainable Development Goals. It requested that FAO and other international organizations consider establishing an inclusive forum to focus on digital applications on agriculture and discuss both benefits and risks.

Digital technologies have the potential to promote sustainable agriculture but can also entail risks. For example, the protection of personal and private data and how data are shared remain elements of concern. Digitalization often implies a large use of data and requires strong regulatory policy frameworks to build trust in digital technology applications. As agriculture becomes data-driven, the use of digital technology, such as for Big Data and applications of Artificial Intelligence, may have a significant impact on farm management but could also affect markets. In the long term, digital technologies could also affect farm structures and agricultural labour, bringing about both economic and social change in the sector.

Responding to the request by the GFFA 2019, FAO and other international organizations proposed creating an inclusive platform to facilitate discussion on digital technologies and agriculture – the International Platform for Digital Food and Agriculture. The proposed forum will include governments, farmers' organizations, the private sector, international organizations, and the civil and knowledge societies to examine how to maximize the benefits of digital technology for agriculture and minimize its risks.

In January 2020, the GFFA agriculture ministers meeting considered the proposal to establish the International Platform for Digital Food and Agriculture. They recognized that its addition in the landscape of international initiatives would bridge gaps in understanding the effects of digital technology on agriculture and address the most pressing needs of the food system. Key objectives of this Platform will be to provide a shared space for all stakeholders and to facilitate debates and the convergence of views. Such discussions can lead to consensus on actions and research-based voluntary guidelines, recommendations, and best practices for governments regarding policy frameworks.

Another important objective of the Platform will be to bridge the gap between international fora on the digital economy and those on food and agriculture. Digital technologies are transforming the economy and society with specific impacts on agriculture, and there is a need to increase digital economy policy-makers' awareness. For example, the International Telecommunication Union's AI for Good Global Summit should also include discussions on AI's effects on agriculture (and related voluntary principles that can ensure sustainable agricultural development through AI); the Platform would ensure that agriculture is reflected in the discussions and the consensus on AI general guidelines, standards and norms.

The scope and function of the proposed International Platform for Digital Food and Agriculture would have significant impacts on increasing the positive benefits of digitalization in food and agriculture, contributing to improving rural livelihoods and local economies.

SOURCES: Adapted from FAO. 2020; GFFA. 2020.[65,66]

» of the potential sensitivities involved in using and storing farmers' data, but it is difficult for legislation to keep the pace of technological innovation. Work is on-going in this area, but much remains to be done (see Box 4.13).

Risks associated with non-competitive behaviour

Competition is necessary to capture the benefits of markets and promote economic growth. Markets should be competitive to contribute towards resource allocations that, together with effective policies and regulation, can advance sustainable development. Digital technologies can affect competition in agricultural and food markets. More specifically, the way a blockchain is set up influences the information available to participants and can have a broad range of impacts on competitiveness.

For example, blockchain can allow access to transaction records that provide information on suppliers' reputation and thus can facilitate competition. In addition, the use of blockchain's decentralized consensus for verifying transactions avoids third-party control mechanisms that are labour-intensive and often have excessive market power. But blockchain, by its nature, can also be designed to ensure the secrecy of certain information.[67] This is witnessed clearly with cryptocurrencies, such as bitcoin, which can be used by people who do not want their identity to be revealed.

The decentralized nature of blockchain can improve competition through increased information but also raises new concerns for potential departures from competitive behaviour.[44] In principle, increased information, the ability to commit to price agreements through smart contracts, and a reduction in the cost of transactions and access to markets can significantly promote competition in markets. In general, this implies a lower risk of non-competitive collusive behaviour – for example, when firms agree among themselves to offer a certain price level to farmers to increase profits.

In the analogue world, information is difficult to obtain – there is information asymmetry. Firms cannot fully observe either the quantities purchased by their rivals or the prices paid. To collude, they need to communicate and agree to coordinate their behaviour in the market.[68] In the blockchain world, there is no information asymmetry, and this may facilitate collusive and other forms of non-competitive behaviour in many ways.

When applying the information available in the blockchain world to economic models of non-competitive behaviour, the analysis suggests that, in theory, blockchains can lead to tacit collusion. Tacit collusion, in this case, refers to unspoken actions by firms that hinder competitive behaviour and can affect prices or quantities, and therefore welfare. This type of collusion may resemble that of a cartel.[43]

The information available through the blockchain makes it easier for firms to infer the behaviour of their rivals. Because firms can observe each other's actions in real time, it is possible to follow transactions and identify when a firm deviates from competitive behaviour. This could open the possibility for a response to restore competitiveness or the opportunity to join in the non-competitive action to maximize profits – a tacit collusion.[43]

For example, tacit collusion in the blockchain would hypothetically take place if one firm sees another offer contracts to farmers for specified quantities at a lower price and, instead of setting price levels in line with demand and supply, also proposes lower prices to farmers. The number of firms involved in the blockchain could influence such theoretical outcomes. For example, in permissionless blockchains, the number of participating firms may be large compared with permissioned ones. However, it is possible that, as the technology evolves, firms acquire the capability to process and analyse large quantities of data in the blockchain in near real time, facilitating tacit collusion.[67]

Blockchain could also be deliberately programmed to facilitate collusive behaviour. The technology makes possible the creation of smart contracts (through self-executing code)

that coordinate and regulate collusive behaviour of many actors, which increases colluders' capability to accompany each other's behaviour.[67] This could be made possible by introducing "sidechains" that store confidential information parallel to the main blockchain.

In addition, some analysts suggest that smart contracts can make such non-tacit collusive agreements more stable. Smart contracts between firms can contain clauses to automatically punish deviations from collusive behaviour, reinforcing the incentives for participants to adhere to such behaviour and furthering the stability of the collusive agreement.[67]

Blockchain technology can also influence the nature and options for regulatory oversight. In the blockchain, users are pseudonymous, which makes it difficult to identify and investigate the participants. Transactions can be encoded and only visible to the parties involved.[67] On the other hand, anti-trust and competition regulators could have access to information in blockchains and thus could observe market behaviour in more detail – just like firms can infer deviation from competitive behaviour, regulators can observe behaviour that reflects tacit collusion. Legal action to combat tacit collusion in blockchains is, however, far from straightforward. It will take time to crystallize the extent to which regulators can successfully prevent or correct tacit collusion through blockchain.

Governments should focus on providing an enabling environment that encourages new entrants and facilitates the innovation and diffusion of digital technologies. In blockchain, separating the consensus-generating record keepers from the participating firms is among the options suggested to prevent collusion.[43] Currently, blockchain users can also assume the role of a record keeper, having access to all information available.

Auditing record keepers in the blockchain or adding regulatory record keepers can also maintain competitiveness. Some people also argue that it would be possible to programme blockchain applications to restrict information sharing, but this would come at the cost of reducing the quality of the consensus and preventing the use of smart contracts since (encrypted) data cannot be validated.[43] Resorting to encrypted data would also invalidate one of the key advantages for using blockchain technology, namely increased transparency.

More work is needed to understand the risks posed by digital technologies on market power, the possibility for collusive behaviour and, more broadly, the formation of digital monopolies. Governments will need to equip themselves to effectively regulate the digital economy. Building a deep understanding of the evolving technologies that will shape our future within antitrust and competition agencies is of pressing importance. This will entail investing to increase the technical competencies needed by regulatory and enforcement agents to understand blockchain technology and detect and deter collusion.

Legal frameworks will need to evolve before they become obsolete to address the risks listed above. At the same time, it is important to ensure that legislation does not undermine investment and technological innovation. Responding to these contrasting needs will be a challenge of the future. ■

ANNEX

TABLE A.1
DEFINITION OF FOOD AGGREGATES AS USED IN PART 1, TRADE BY FOOD AGGREGATES

Short name	Description	HS chapters	HS chapter descriptions
Meat and fish	Meat, fish and preparations	01, 02, 03, 16	Animals, live; meat and edible meat offal; fish and crustaceans, molluscs and other aquatic invertebrates; meat, fish or crustaceans, molluscs or other aquatic invertebrates, preparations thereof
Dairy and eggs	Dairy products and eggs	04	Dairy produce; birds' eggs; natural honey; edible products of animal origin not elsewhere specified or included
Fruit and vegetables	Fruit and vegetables	07, 08	Vegetables and certain roots and tubers, edible; fruit and nuts, edible; peel of citrus fruit or melons
Grains	Cereals and oilseeds	10, 11, 12	Cereals; products of the milling industry; malt, starches, inulin, wheat gluten; oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit, industrial or medicinal plants; straw and fodder
Sugar and cocoa	Sugars, cocoa and confectionary	17, 18	Sugars and sugar confectionery; cocoa and cocoa preparations
Processed food	Food preparations and beverages	19, 20, 21, 22	Preparations of cereals, flour, starch or milk; pastrycooks' products; preparations of vegetables, fruit, nuts or other parts of plants; miscellaneous edible preparations; beverages, spirits and vinegar
Coffee and tea	Coffee, tea and spices	09	Coffee, tea, mate and spices
Fats and oils	Animal or vegetable fats and oils	15	Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes
Others	Other agri-food products	05, 06, 13, 14, 23, 24	Animal originated products not elsewhere specified or included; trees and other plants, live; bulbs, roots and the like; cut flowers and ornamental foliage; lac; gums, resins, and other vegetable saps and extracts; vegetable plaiting materials; vegetable products not elsewhere specified or included; food industries, residues and wastes thereof; prepared animal fodder; tobacco and manufactured tobacco substitutes

NOTE: HS refers to the Harmonized Commodity Description and Coding System of the World Customs Organization.

ANNEX

TABLE A.2
DEFINITION OF FOOD AGGREGATES BASED ON FAO FOOD BALANCE SHEETS

Short name	Description (based on Food Balance Sheets)	Details (based on Food Balance Sheets)
Sugars	Sugar and sweeteners; sugar crops	Sugar, cane, raw, centrifugal; sugar, beet, raw, centrifugal; sugar raw centrifugal; sugar refined; sugar confectionery; sugar flavoured; sugar crops
Meat	Meat	Bovine meat; pigmeat; poultry meat; mutton and goat meat; meat, other
Fruit and vegetables	Vegetables; fruits (excluding wine)	Tomatoes and products; onions; vegetables, other; apples and products; bananas; citrus, other; dates; fruits, other; grapefruit and products; grapes and products (excluding wine); lemons, limes and products; oranges, mandarines; pineapples and products; plantains
Dairy products	Milk (excluding butter; including milk, whey and yoghurt)	Milk, whole fresh cow; milk, skimmed cow; milk, whole condensed; whey, condensed; yoghurt; yoghurt, concentrated or not; buttermilk, curdled, acidified milk; milk, whole evaporated; milk, skimmed evaporated; milk, skimmed condensed; milk, whole dried; milk, skimmed dried; milk, dry buttermilk; whey, dry; cheese, whole cow milk; whey, fresh; cheese, skimmed cow milk; whey, cheese; cheese, processed; milk, reconstituted; milk, products of natural constituents not elsewhere specified; ice cream and edible ice; casein; milk, whole fresh buffalo; milk, skimmed buffalo; cheese, buffalo milk; milk, whole fresh sheep; cheese, sheep milk; milk, skimmed sheep; milk, whole fresh goat; cheese of goat milk; milk, skimmed goat; milk, whole fresh camel
Cereals	Cereals (excluding beer)	Barley and products; cereals, other; maize and products; millet and products; oats; rice and products; rye and products; sorghum and products; wheat and products
Fats and oils	Animal fats; vegetable oils	Butter, ghee; cream; fats, animals, raw; fish, body oil; fish, liver oil; coconut oil; cottonseed oil; groundnut oil; maize germ oil; oilcrops oil, other; olive oil; palm oil; palmkernel oil; rape and mustard oil; ricebran oil; sesameseed oil; soybean oil; sunflowerseed oil

NOTES

NOTES TO PART 1

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THE STATE OF THE WORLD

2020
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The State of Agricultural Commodity Markets 2020 (SOCO 2020) aims to discuss policies and mechanisms that promote sustainable outcomes – economic, social and environmental – in agricultural and food markets, both global and domestic. The analysis is organized along the trends and challenges that lie at the heart of global discussions on trade and development. These include the evolution of trade and markets; the emergence of global value chains in food and agriculture; the extent to which smallholder farmers in developing countries participate in value chains and markets; and the transformative impacts of digital technology on markets.

Along these themes, SOCO 2020 discusses policies and institutions that can promote inclusive economic growth and also harness markets to contribute towards the realization of the 2030 Agenda and its Sustainable Development Goals.

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