PART I

A Global Overview of Agriculture

Chapter 1

AGRICULTURAL DEVELOPMENT IN A CHANGING WORLD

Shenggen Fan and Keijiro Otsuka

The world has been changing rapidly, and major issues surrounding agriculture have evolved as well. In fact, over the last several decades major shifts have occurred in the thinking on and practice of agricultural development. Accordingly, agricultural development goals have moved far beyond traditional ones such as food production and availability, agricultural productivity, farmers' incomes (particularly those of smallholders), and employment. The set of new goals includes poverty reduction, adequate nutrition, functioning food value chains (FVCs), environmental sustainability, climate adaptation and mitigation, and gender equality and equity. Looking forward, agriculture will face new challenges and will have to be positioned to deliver broader development outcomes such as those mandated under the Sustainable Development Goals (SDGs).

It is therefore timely to publish a new volume that reflects the latest developments and new perspectives on agricultural development. Such a book will be useful to policymakers, students, and development economists alike. It will also fill an important gap, as few if any such comprehensive volumes exist in the field of agricultural development.

First, this is an edited volume that benefits from the expertise of numerous top scholars in different fields. This allows for coverage of a broad array of emerging and complex issues such as rapid urbanization and agricultural transformation, nutrition and health, and natural resource management and climate change.

Second, this book covers most developing countries and regions, providing a global perspective. Such a perspective is extremely useful because many relevant issues are global in nature, often crossing national borders, in part due to increasingly interconnected agricultural systems in a globalizing world. The global perspective is also useful because it can reflect the many commonalities and differences in major issues across regions.

Third, we follow developments since the framework of induced technological and institutional innovations was developed by Yujiro Hayami and

Vernon W. Ruttan (1985), particularly in Part II, where we review technological change, productivity growth, and beyond in major regions. Innovations are seen in new institutions, including those related to international trade, land and water rights, producer cooperatives for rural industrialization and contract farming, and social norms on women's status, as well as a variety of institutions to prevent or mitigate climate change. Technological and institutional innovations in agriculture have also been increasingly influenced by innovations outside of agriculture, for example, rapid development of information technologies and biotechnologies.

Fourth, this book departs from the Hayami-Ruttan and other conventional theses in several significant ways. Increasing production of high-value products, development of modern FVCs, nutrition and health, gender and intrahousehold resource allocation, insurance and credit, property rights and natural resource management, and climate change are newly emerging and interrelated issues. This book is a first attempt to analyze them in an integrated manner. It also reviews the literature that uses applied microeconomics to study development, including studies based on randomized controlled trials (RCTs) and natural and quasi experiments. Such studies are a critical step toward evidence-based agricultural policymaking.

Finally, the book will point out clear policy implications for key institutional innovations and explore policy reforms conducive to agricultural development. In particular, we will attempt to identify effective strategies for developing sustainable agriculture and reducing food insecurity and malnutrition, which are missing in the existing literature.

This volume is divided into four parts. Part I (A Global Overview of Agriculture) introduces the aims of the book, identifies major global trends and emerging global issues in agricultural development, and explains the structure of the book, including how the various chapters are interrelated.

Part II (Regional Issues in Agricultural Development) provides overviews of technological innovations, agricultural research, agricultural development, and economic transformation by major region—East Asia, South Asia, Africa south of the Sahara, Latin America and the Caribbean, and Eastern Europe and Central Asia. Specifically, chapters in Part II examine long-term changes in cultivation area, land-labor ratios, composition of agricultural products (for example, staple foods vs. high-value products, including livestock products), adoption of land-saving or yield-enhancing technologies (adoption of improved seeds and the use of chemical fertilizer) and labor-saving or

mechanical technologies, total factor productivity, farm size, and land tenancy institutions. These chapters also identify newly emerging important issues in various regions, such as increased overweight and obesity, which are examined in depth by a series of thematic chapters in Part III.

Part III (Context for Agricultural Development) focuses on context for agricultural development, with particular attention to the role of (1) urbanization, rural-to-urban migration, poverty reduction, food security, and nutritional transitions; (2) emerging FVCs, development of nonfarm sectors, microfinance, weather-based crop insurance, and land markets in transforming agricultural and rural economies; (3) community organizations (for forest and irrigation management, development of rural industries, and production of high-value products) and land rights in facilitating land transactions, investment in land improvement, and management of common property resources; (4) social norms and women's ownership and control of land and other assets in the transformation of women's status; and (5) international agreements on international trade and agricultural policies in agricultural development. These issues are highly interrelated. For example, new FVCs emerge in response to increases in market demand for safe and high-quality products associated with the development of nonfarm sectors and urbanization, to globalized trade of high-value agricultural products, and to the increasing consciousness of health and nutrition among urban consumers.

Part IV (Emerging Challenges and Opportunities in Agricultural Development) delves into the emerging challenges and opportunities in agricultural development, particularly those associated with changes in food systems and climate change, by examining the growing scarcity of water, possible effects of climate change, and the future of agricultural research. This is followed by the concluding analysis of how to reshape and transform agrifood systems for environmentally sustainable and inclusive development toward achieving the SDGs.

In the remainder of this chapter, we provide an overview of agricultural growth by reviewing the evolution of agricultural development thinking through macro- and micro-lenses. We briefly review the literature influencing major shifts in agricultural development below; a comprehensive review of the literature on the contemporary and emerging issues can be found in Chapter 2. We conclude with a summary of the regional overview and key themes discussed in the rest of the book.

Evolution of Macroeconomics Literature on Agricultural Development

The theory of agricultural development has evolved over the years, as have its contexts, practices, and goals. Early development theories, most prominently, Lewis's dual economy theory in the 1950s, viewed the agriculture sector as a supplier of surplus labor whose share in the labor force and economy declined through the course of development (Lewis 1954). Surplus labor from the traditional, rural agriculture sector has a negligible or zero marginal product. The modern, urban, nonagricultural industrial sector has a higher marginal product and absorbs this surplus labor by creating jobs, thereby increasing aggregate output and incomes and stimulating economic growth. Ranis and Fei (1961) built upon this model to assert that without agricultural growth and sufficient food output, development of the industrial sector will be constrained. In these models, agriculture plays a critical but passive role in economic development and transformation.

In the 1960s, a new paradigm extended the duality model to view agricultural development as an engine for industrialization and economic growth. Conceptually, agriculture contributes to development of industry by raising farmers' incomes and earning foreign exchange and by generating surplus capital and labor (Johnston and Mellor 1961). Higher farmer incomes from higher output increase demand for farm inputs and value-added services, and higher incomes for farmers and laborers increase the demand for food and nonagricultural goods and services. Agricultural growth then has a multiplier effect on other sectors, jump-starting transformation and accelerating growth.

Schultz (1964) argued that poor smallholder farmers are rational, as they respond to price incentives and will adopt new profitable technologies, but are constrained by the absence of such technologies. Schultz's "efficient but poor" hypothesis inspired subsequent research by Hayami and Ruttan (1971, 1985), who formalized the theory of agricultural growth by highlighting the importance of technological innovations. They state that technological and institutional changes are induced through responses of actors to changing resource endowments. In other words, as scarcity of a factor of production increases, technology that saves the use of the factor is induced to develop, along with supportive institutions, such as property rights systems, public-sector research and extension systems, and marketing institutions. Binswanger (1974) later demonstrated that changes in product prices also play an important role in stimulating innovations.

With the rapid economic growth in developing countries in the 1990s, especially in Asia, Timmer (1988) marked a shift in the theory of agricultural

development toward structural transformation. The theory noted that agriculture enhances labor productivity in the rural economy, increasing wages and driving urbanization and industrialization. As a result, the share of agriculture in economic output and employment falls, and urban economic activity in industry and services grows. At the same time, rural workers migrate to urban areas and the overall population undergoes a demographic transition (Timmer 1988, 2017).

Initially, empirical studies focused on the importance of agriculture for nonfarm economic growth as well as spillovers of growth across sectors, as seen in Gemmell, Lloyd, and Mathew (2000) and Tiffin and Irz (2006), among others. Agriculture was considered in the context of a broader development agenda, highlighting the role of agriculture in the formulation of development strategies. Studies also looked at agriculture's impact on poverty reduction—in particular, its role in driving overall economic growth and, indirectly, reductions in food prices, which especially benefit the poor. For instance, Ravallion and Chen (2007) found the impact of agricultural growth on poverty in China to be four times greater than that of nonagriculture. Christiaensen, Demery, and Kuhl (2011) found that the poverty reduction impact of agricultural growth in Africa south of the Sahara was two to three times greater than that of growth in nonagriculture, but also noted substantial heterogeneity depending on country characteristics like natural resources and initial economic conditions (Dercon and Gollin 2014).

Computable general equilibrium (CGE) modeling was later added as one of the tools for analyzing the role of agriculture in overall economic growth and poverty reduction (for example, in Dorosh and Haggblade 2003; Diao and Dorosh 2007; Dorosh and Thurlow 2012). Much of the CGE modeling focused on African economies found that agricultural productivity growth generates positive impacts on overall growth and positive poverty impacts as well. However, it should be noted that much of this literature was based on assumptions that the model economies are closed and must meet their food needs through domestic production (Dercon and Gollin 2014).

Together with agricultural development, the food value chain evolved over time as well. With rising incomes and growing urbanization, the FVC became spatially longer, stretching across rural and urban areas. This transition also led to the emergence of food industries such as milling and food processing to add value and transport food. Reardon et al. (2003) and others added to the notion of the modern FVC, focusing on the rapid rise of supermarkets, which further transformed and integrated food markets, driven by urbanization, economic growth, and improved infrastructure. Fan, Yosef, and Pandya-Lorch

(2019) further analyzed how agriculture can contribute to nutrition through FVCs, nutrition-sensitive programs, government policies, and private-sector investments.

Triggered by the 2008 food price crisis, Díaz-Bonilla (2015) systematically analyzed how macroeconomic policies like fiscal policies, monetary and financial policies, exchange rate policies, and trade policies can fundamentally affect the agricultural sector. He argues that a macroeconomic policy framework is needed to maintain fiscal balances and avoid the overvaluation of the exchange rate, thereby reducing significantly the possibility of financial/fiscal crises and ensuring that tradable products (particularly agricultural and food products) are not disadvantaged. A monetary policy that maintains low inflation levels is also needed. On credit, Díaz-Bonilla suggests that agriculture needs specific credit programs, institutions, and instruments that emphasize a variety of instruments and approaches for financial inclusion for the poor.

Evolution of Microeconomics Literature on Agricultural Development

Microeconomics in agricultural development mainly considers the behavior of rural households, namely, the constraints they face and the determinants of their decision-making. It has evolved over time from the analysis of resource allocation, particularly labor, land, and capital market failures, to technology adoption and extension services, property rights and externalities, intrahousehold bargaining, and risk management. While the macroeconomics literature essentially focuses on the role of agriculture in economic development and enabling macroeconomic policy environments, the microeconomics literature covers a diverse range of issues related to the behavior of rural households, justifying a much longer review.

Schultz's (1964) "efficient but poor" hypothesis fundamentally affected the microeconomics literature on agricultural development because if farmers are rational maximizers, a profit or utility maximization model can be applied to the analysis of farmers' behaviors in developing countries. Thus, Schultz stimulated the subsequent analysis of farm household behavior. Deeper understanding of farm household behaviors improves macroeconomic models and modeling of general equilibrium effects.

Singh, Squire, and Strauss (1986) pioneered the analysis of agricultural household behavior, which led to the debate in the late 1980s about nonseparability between production and consumption decisions of rural households and the relationship between productivity and farm size. These authors clarify

the "non-separable behavior" of households in using resources, fundamentally as a result of missing or imperfect markets, particularly labor markets, implying that households are an integrated production and consumption unit.

Labor markets are widely assumed to fail, because agency costs make the productivity of hired labor less than that of family labor. While households with land endowments too small to hire labor behave according to predictions in the separable model, households with more land will begin to hire labor but face a growing monitoring cost of labor, creating the inverse farm productivity–farm size relationship. Carter and Yao (2002) call this "local non-separability." De Janvry, Fafchamps, and Sadoulet (1991) showed that transaction costs drive a wedge between producer and consumer prices, where some households do not purchase or sell the goods they produce and, hence, have limited response to price incentives. Similarly, Key, Sadoulet, and de Janvry (2000) and Bellemare and Barrett (2006) explore the endogeneity of market participation decisions and related econometric implications. In a recent paper, Foster and Rosenzweig (2017) observed a **U**-shaped relationship between farm productivity and farm scale—the initial fall in productivity as farm size increases from its lowest levels and the continuous upward trajectory as scale increases after a threshold—in low-income countries across the world. They show that the existence of labor-market transaction costs can explain why the smallest farms, which rely on family labor, are most efficient; slightly larger farms are least efficient because they employ a host of hired workers; and larger farms are as efficient as the smallest farms because they adopt large-scale machines.

The microeconomics literature on agricultural development pays special attention to transaction costs in land markets, which lead to market failures. Eswaran and Kotwal (1984) studied how productivity is influenced by distribution of land among rural households under land, labor, and capital market imperfections. The authors noted that an economy with high inequality of land distribution will produce less than an economy with more equal land distribution, because farmers endowed with less land have less favorable access to credit. Consequently, credit market reforms that equalize access to capital across farm households can also have effects similar to those of land redistribution reforms. Otsuka, Chuma, and Hayami (1992) applied the principal-agent theory to share tenancy issues and argued that share tenancy is chosen partly because it has risk-sharing advantages and partly because labor contracting is less efficient due to higher monitoring costs.

Market failures also occur due to difficulty in establishing land rights, the lack of which reduces incentives to invest in land improvement (Besley

1995). Feder et al. (1988) found that enhanced formal land-tenure security in Thailand offered substantial payoffs in increased investment in land improvement and enhanced productivity. In Latin America, Carter and Olinto (2003) found that the investment demand effects of property rights reform applied to everyone, but that credit supply expanded only for medium- and larger-scale farmers. In other words, property rights reform is shown to have substantial impacts for only relatively advantaged farmers.

The lack of secure property rights for community-owned resources leads to market failures because individual users do not pay attention to the negative impact of their resource extraction on the productivity of other community members. For instance, Robalino and Pfaff (2012) find in Costa Rica that individuals are more likely to deforest when their neighbors deforest. Internalization of resource-related externalities requires collective action among users (Ostrom 1990), but the likelihood of collective action to resolve natural-resource-related externalities depends on the costs of cooperation, which vary depending on numerous environmental factors, existing norms, and users (Pender and Scherr 2002; Godquin and Quisumbing 2008). Lawry et al. (2014) suggest that secure land property rights contribute to welfare through greater perceived security of ownership and consequent long-term investments. Land ownership can help incentivize farmers in terms of land security, which has a positive effect on farmers' decisions to adapt to climate change (Yegbemey et al. 2013).

The Green Revolution revealed the importance of purchased inputs and small farmers' access to credit. Feder (1985) showed that if capital access improved with land endowments, the relationship between farm productivity and size could become positive even with labor market failures. Monitoring costs due to poor contract enforcement lead to different lending and deposit rates in financial markets, meaning that the wealthy will tend to invest more than the poor. Poor farmers who lack assets may not be able to offer the collateral necessary to access credit (Banerjee 2006), and if poor farmers lack access to insurance markets, loan terms may become too risky to borrow (Boucher, Carter, and Guirkinger 2008). Certain technologies, for instance, are more difficult for smallholders to finance, especially when the need for access to credit is greatest in order to meet high up-front costs. Despite enthusiasm over the last 10 to 15 years about the potential of microfinance as a major driver of poverty reduction in developing countries, recent studies have pointed to the lack of evidence and mixed long-term results. For example, Banerjee et al. (2015) find that while a microcredit program in India helped small business investment and profits of preexisting businesses to increase, consumption

did not see a significant increase. Durable goods expenditure increased, and "temptation goods" expenditure declined, but there were no significant changes in health, education, or women's empowerment. Very few significant differences were found between treatment and control groups two years later.

Technology adoption has been studied by many researchers since the 1970s, with focus on the spillover effect of technological information. Early adopters of technologies provide information for others on benefits and correct use while disproportionately bearing the cost of the learning process. Thus, there is incentive to strategically delay adoption and to free ride when information is more readily available (Foster and Rosenzweig 1995; Bandiera and Rasul 2006; Maertens 2017). Any type of positive spillover in an area or network creates incentive to postpone adoption, as seen also in adoption of health products that generate immunity benefits for others (Kremer and Miguel 2007). Unreliable supply and high prices of fertilizer and other inputs are often noted as major barriers to adoption of new technologies. Mitra et al. (2013) study the importance of information asymmetries in the price gap between farmgate and market. Farmers' organizations have the potential to address many of these constraints by improving farmers' bargaining power, aggregating demand, and reducing individual risk, while also enhancing smallholder competitiveness in markets (World Bank 2007). However, inequality of asset ownership affects the degree of profit extracted by members, and smallholders may benefit less than larger landholders (Banerjee et al. 2001; Bernard, de Janvry, and Sadoulet 2010).

More recently, the role of farmer-to-farmer extension, which is likely to be complementary to public-sector extension, has received increased attention, and many RCT-based studies are conducted to identify the desirable characteristics of farmer-trainers (see Takahashi, Muraoka, and Otsuka 2020 for a recent review of the literature). Further, recent advancements in information and communications technologies (ICTs) have been evaluated by many studies. A study in India finds that mobile-phone-based agricultural extension alters management practices, increasing adoption of more effective pesticides and levels of farmer education (Cole and Fernando 2012). At the same time, other studies have pointed to more mixed results. Information on markets and weather provided through mobile phones was found to have no significant impact on prices received by farmers, crop value-added, crop losses, or likelihood of changing crop varieties or cultivation practices (Fafchamps and Minten 2012). Similarly, Nakasone, Torero, and Minten (2014) find that while access to mobile phones has generally improved agricultural market performance at the macro level, impacts at the micro level are mixed.

The study of the impact of risk on household decision-making was pioneered by Binswanger and Sillers (1983), who saw that risk mattered most due to differences in access to credit and other financial markets that could be used to mediate risk. Binswanger and Rosenzweig (1986) argue that covariate risk in agriculture further suppresses development of agricultural loan markets in risk-prone, low-income, rainfed agricultural regions, where all farmers in the neighborhood suffer from the same risk. Deaton (1991) shows that a modest amount of risk can be managed by maintaining some savings that could be used to smooth consumption in the face of income fluctuations or credit constraints. Further, Carter and Barrett (2006) describe several types of dynamic models where risk and capital constraints create a poverty trap. Unequal asset distribution that leaves large numbers of households below a critical asset threshold results in stagnation of productivity with persistent poverty. Also, uninsured risk in the face of a poverty trap has far higher costs for households. Findings often show better-off households are better at smoothing consumption than are poorer ones (Morduch 1995; Barrett, Carter, and Timmer 2010). Risk considerations also factor into household portfolio choices about assets and activities, whereby if risk preferences are related to ex ante wealth, portfolio choices may reinforce pre-existing unequal wealth distribution. Rosenzweig and Binswanger (1993) find wealthier households in rural India hold higher risk and higher expected return portfolios, which lead to different growth rates and increasing inequality over time, also contributing to a poverty trap among less well-endowed agricultural households. In considering the role of assets to address household risk, studies have evaluated the role of livestock and its wide spectrum of benefits, such as cash income, food, savings and insurance, and social capital. A study of microeconomic data from 12 developing countries (Pica-Ciamarra et al. 2015) finds that the majority of rural households keep livestock, and less well-off households are more likely than better-off households to keep livestock. However, poorer households often lack the resources to invest in small animals. The study also suggests there are many factors at play, meaning that policies need to account for farming systems, species, uses of livestock, and different wealth groups. Livestock ownership has also been shown to be associated with additional benefits like animal food consumption and relative nutritional benefits (Kim et al. 2019).

Informal mechanisms of coping with risk include risk pooling among households in a community, including through community insurance schemes to protect against idiosyncratic shocks. Social networks have been found to encourage insurance adoption. For example, one study finds that knowledge diffusion through peer effects (i.e., social networks) among

farmers in rural China resulted in a premium reduction of up to 13 percentage points (Cai, de Janvry, and Sadoulet 2015). In addition to knowledge diffusion, informal risk-sharing arrangements can also help to manage basis risk of formal insurance, especially when the main source of basis risk is an idiosyncratic risk, and help to avoid free-riding and coordination problems (de Janvry et al. 2014; Dercon and Gollin 2014; Geng et al. 2018).

Studies show that other informal mechanisms, such as self-help groups (SHGs), have broader benefits beyond addressing household risk. SHGs tied to microcredit in India have been shown to improve women's empowerment and nutritional intake, though the impact on asset formation or income was not significant (Deininger and Liu 2013). SHG skills-training components have been found to facilitate empowerment through development of financial skills and access to household decision-making (Brody et al. 2015). SHGs have also been found to increase women's access to information and their participation in some agricultural decisions, and participating women are more likely to take advantage of a greater number of public entitlement schemes (Kumar et al. 2019; Raghunathan, Kannan, and Quisumbing 2019).

Conventionally, each household is assumed to possess a single utility function; this is known as the *unitary model of household behavior*. In the 1990s, however, it was recognized that household members have different preferences. This is important because intrahousehold inequality is a nontrivial factor impacting distribution of goods among household members. Several studies analyze household bargaining functions based on individual utility functions and threat points based on assets that individuals can carry away from the household, as well as the external legal and social environments that shape individuals' ability to use those assets. Interventions influencing the exit option of one household member can affect the intrahousehold distribution of goods. For instance, interventions that enhance men's legal and economic control over land resources may weaken women's bargaining power and decrease their and their children's well-being (Haddad, Hoddinott, and Alderman 1997; Quisumbing 2003). Bargaining matters for household expenditure priorities, and this continues to shape agricultural resource allocations. Ownership and control of assets by women is shown to be important for poverty reduction and has positive development outcomes at both household and individual levels (Johnson et al. 2016).

The microdevelopment literature from the early 2000s has been linked to the rise of decision science and behavioral economics. For agriculture, this has been centered around questions regarding the ability of farmers to achieve efficient or optimal outcomes in the face of problems in decision-making

(Duflo 2006). Behavioral economics has shown that individuals may be motivated by factors other than profit maximization. Research indicates that default options can play an important role in coordinating behavior where needed (Choi et al. 2003). For example, agricultural technologies like pest-resistant seeds require coordination to generate sufficient demand to improve input markets. Farmers' organizations may be influential in this regard, by providing pest-resistant seeds as a default input to their members, to help facilitate adoption and demand. Savings commitment devices have also been the subject of several recent studies that show there is an unmet demand for commitment products among the very poor. In the Philippines, the introduction of a commitment savings product increased savings significantly after one year (Ashraf, Karlan, and Yin 2006). Similarly in Kenya, when testing free delivery and price subsidies to purchase fertilizer, a savings commitment brought in new adopters instead of subsidizing those who would have adopted anyway (Duflo, Kremer, and Robinson 2009).

Other behavioral issues, like mental accounting or separate household accounts, are linked to inefficient allocations of expenditures and savings behavior if individuals associate certain funds with different expenditures. Duflo and Udry (2004) found that rainfall shocks that increase the output of crops cultivated individually by either husbands or wives are associated with strong expenditure shifts toward adult private goods like jewelry. In contrast, shocks that increase the output of crops predominantly cultivated by wives shift expenditures toward food consumption, but shocks affecting cash crops cultivated by men have no effect on the purchases of food. The literature also suggests that individual decisions made under risk and uncertainty are subject to irrational biases (Kahneman 2003). For instance, individuals tend to weigh the value of losses more than the value of gains and may give undue weight to small probabilities, which negatively affects adoption of new agricultural technologies (Liu 2013). Bryan (2010) also suggests that more ambiguity-averse households demand less insurance, and Ross, Santos, and Capon (2012) show that more ambiguity-averse individuals are more likely to adopt improved varieties. Studies have also evaluated interventions that directly incorporate behavior change communication components. For instance, Olney et al. (2015) found that integration of two programs, an agriculture homestead food production program and a nutrition and health behavior change communication program targeted to women and children, helped improve several child health outcomes, including wasting, diarrhea prevalence, hemoglobin levels, and anemia.

Three prominent economists, Michael Kremer, Abhijit Banerjee, and Esther Duflo, received the 2019 Nobel Prize in Economic Sciences for their seminal work on evaluating the impact of poverty reduction programs. They reshaped economics research by designing a new approach to alleviating global poverty. Utilizing RCTs, they sought to answer key questions on global poverty at individual or group levels through specially designed field experiments. In just the past 20 years, this new research has contributed key evidence to inform global development efforts. In 2010, Barret and Carter (2010) reflected on the power and pitfalls of RCTs and after a decade of work on the subject identified three more key issues to consider: First, ethical risks continue to exist and have not been dealt with. Second, interventions often have extremely heterogeneous impacts, which could mean that in some cases other research methods would be more suitable. Finally, nonclassical measurement errors resulting from the use of an RCT could weaken a study's statistical power (Barrett and Carter 2020). Quisumbing et al. (2020) proposed to address such concerns by identifying and assessing programmatic pathways to impact with quantitative and qualitative methods; by studying similar programs implemented by different organizations across various settings; and by working closely with implementing partners on the design, research, and dissemination processes to inform adaptation and scaling-up of programs and policies.

Field experiments or lab-like field experiments (LFEs) can be used in analyzing policy issues in agricultural and rural development to address the above concerns and complement other methods. Viceisza (2015) highlighted four main purposes of LFEs. The first is to test theories or heuristic principles; the second is to identify and estimate parameters associated with various characteristics; the third is to explore the structural nature of parameters derived from empirical methods, including other types of experiments; and the fourth is to assess methodological difficulties associated with LFEs and how these can impact parameter estimates. He also emphasized the importance of generalizability for LFEs that are intended to inform policymaking, and in the process, he proposed basic principles for conducting LFEs and suggested directions for future research.

Key Themes Addressed in This Book

In this section, we briefly sketch the purposes and key themes addressed in subsequent chapters and lay out the structure of this book.

Agricultural Growth across Time and Regions

We look to recent years and across regions to examine recent technological innovations in and outside of agriculture (such as ICTs), changing contexts for agriculture (such as rapid urbanization), and emerging challenges (including climate change) that impact agricultural productivity and efficiency.

Chapters 2 to 7 build upon the Hayami and Ruttan hypothesis, based on technological change in agriculture as an engine of agricultural growth, and compare patterns of agricultural growth across seven major regions.[1] Table 1.1 compares growth rates of land productivity (Y/A), labor productivity (Y/L), and the land-labor ratio (A/L) across major regions over time.[2] As can be seen from Figure 1.1, enormous differences exist and enormous changes in labor productivity have occurred among the seven major regions over the last several decades. Such large differences in labor productivity can be partly attributed to the difference in factor endowment represented by the land-labor ratio. The close relationship between the land-labor ratio and mechanization is clearly reported in Chapters 3 to 7. It is equally important to observe the changes in land and labor productivity over time. Table 1.1 clearly shows that in the 1960s, 1970s, and 1980s, many regions experienced a decline in the land-labor ratio; this was due to rapid population growth. Figure 1.2 shows the changing relationship between labor and land productivity, with the logarithm of labor productivity on the horizontal axis and that of land productivity on the vertical axis. To examine the importance of technological change in affecting different growth paths, Table 1.2 shows the annual growth rate of total factor productivity (TFP) from the 1970s to the early 2010s. Five regional chapters show that while some regions fit the Hayami and Ruttan hypothesis, other regions' growth paths have differed over time. It is clear that East Asia took the high-land-productivity development path, which looks like a concave production function. An interesting finding from Figure 1.1 is that not only South Asia but also Africa south of the Sahara (SSA) seem to have been following the East Asian path. Indeed, it seems that South Asia is

1 The five chapters in Part II deal with (1) East Asia, (2) South Asia, (3) Africa south of the Sahara, (4) Latin America and the Caribbean, and (5) Eastern Europe and Central Asia. Latin America is divided into two areas—Mexico and Central America, and South America; Eastern Europe and Central Asia are divided into two areas—the former Soviet Union (FSU) excluding the Baltics, and Eastern Europe (that is, the Baltics, Central Europe, and Balkans)—because of the large differences in factor endowments between subregions, among other things.

2 Output (Y) is the gross production value in constant international US$ 2004–2006, labor (L) is the number of economically active adults in agriculture, and land (A) is the sum of arable land and land for permanent crops and pasture. Data are from FAOSTAT, supplemented by data from USDA Economic Research Service on China and from Eurostat on Eastern Europe and Central Asia.

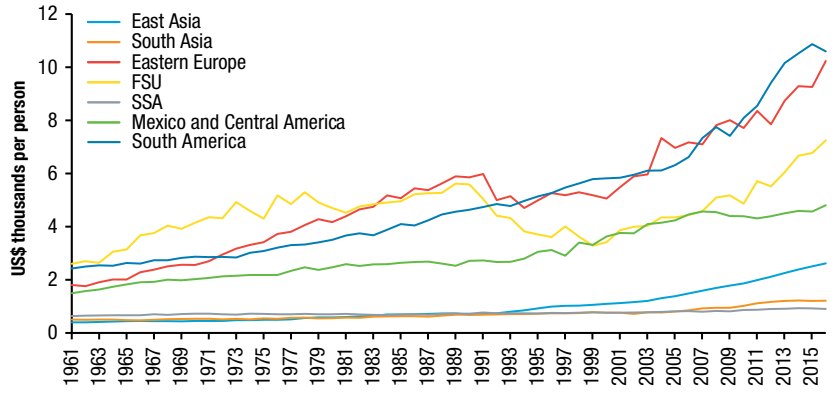
TABLE 1.1 Growth rates in land productivity, labor productivity, and land per labor, over decades, by region

Region	Growth rates	1960s	1970s	1980s	1990s	2000s	2010s
East Asia	Land productivity	0.300	0.194	0.361	0.363	0.278	0.063
	Labor productivity	0.084	0.290	0.255	0.521	0.571	0.246
	Land per labor	−0.166	0.081	−0.077	0.116	0.230	0.172
South Asia	Land productivity	0.098	0.104	0.336	0.220	0.215	0.121
	Labor productivity	0.046	0.028	0.225	0.174	0.145	0.101
	Land per labor	−0.047	−0.069	−0.083	−0.038	−0.058	−0.018
Eastern Europe	Land productivity	0.224	0.230	0.116	−0.148	0.174	0.113
	Labor productivity	0.403	0.674	0.401	−0.003	0.496	0.192
	Land per labor	0.146	0.361	0.255	0.170	0.275	0.071
Former Soviet Union	Land productivity	0.259	0.096	0.135	−0.411	0.339	0.216
	Labor productivity	0.273	0.186	0.185	−0.437	0.531	0.377
	Land per labor	0.011	0.082	0.044	−0.044	0.144	0.133
Africa south of the Sahara	Land productivity	0.091	0.154	0.056	0.164	0.124	−0.016
	Labor productivity	0.114	−0.061	0.046	0.069	0.070	0.009
	Land per labor	0.021	−0.186	−0.009	−0.082	−0.048	0.025
Mexico and Central America	Land productivity	0.460	0.298	−0.026	0.184	0.183	0.131
	Labor productivity	0.324	0.175	0.021	0.248	0.257	0.138
	Land per labor	−0.093	−0.095	0.048	0.053	0.063	0.006
South America	Land productivity	0.020	0.131	0.220	0.254	0.157	0.018
	Labor productivity	0.165	0.188	0.307	0.329	0.422	0.140
	Land per labor	0.143	0.050	0.072	0.059	0.230	0.120
Caribbean	Land productivity	−0.149	−0.076	0.069	−0.187	0.093	0.157
	Labor productivity	0.011	0.060	0.109	−0.141	0.044	0.111
	Land per labor	0.189	0.148	0.037	0.056	−0.045	−0.039
West Asia and North Africa	Land productivity	0.214	0.255	0.218	0.216	0.287	0.041
	Labor productivity	0.222	0.256	0.156	0.226	0.251	0.073
	Land per labor	0.007	0.001	−0.051	0.008	−0.028	0.030
High Income	Land productivity	0.128	0.212	0.072	0.173	0.108	0.032
	Labor productivity	0.559	0.434	0.334	0.478	0.311	0.176
	Land per labor	0.382	0.183	0.245	0.260	0.183	0.139
Other	Land productivity	0.278	0.159	−0.092	0.284	0.267	0.064
	Labor productivity	0.182	0.076	−0.001	−0.045	0.010	−0.021
	Land per labor	−0.075	−0.072	0.100	−0.256	−0.203	−0.081

Source: Calculated from USDA (2019) except for land and output, which were obtained from FAO (2019).

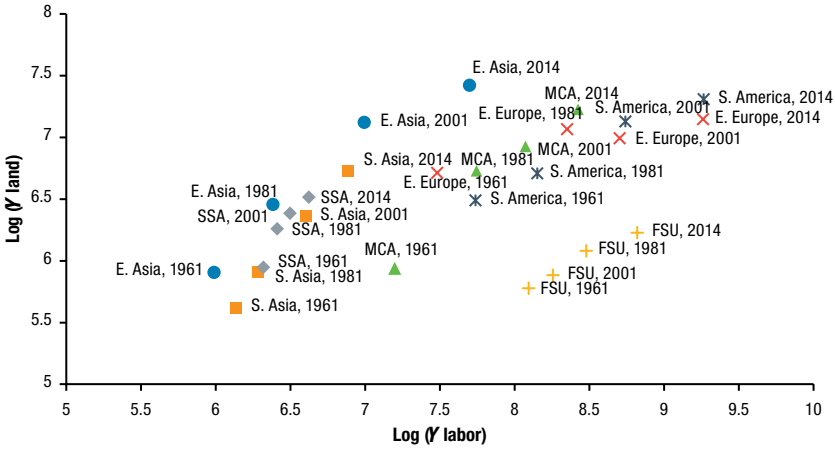
Note: 1960s is limited to 1961–1969; 2010s is limited to 2010–2014.

FIGURE 1.1 Changes in labor productivity by major region, in US$1,000 (2004–2006) per person



Source: Estimated from USDA (2019) and FAO (2019).
Note: FSU = former Soviet Union; SSA = Africa south of the Sahara.

FIGURE 1.2 Changes and differences in relationship between labor and land productivity by major region, double-log scale



Source: Calculated from USDA (2019) except for land and output, which were obtained from FAO (2019).
Note: Y = productivity; FSU = former Soviet Union; SSA = Africa south of the Sahara; MCA = Mexico and Central America.

TABLE 1.2 Average total factor productivity growth rates, over decades, by region

Region	1970s	1980s	1990s	2000s	2010s
East Asia	–0.740	0.983	1.783	2.372	1.869
South Asia	–1.277	0.101	0.528	0.556	1.780
Eastern Europe	–0.115	0.578	1.098	1.067	1.646
Former Soviet Union	–0.263	–0.650	0.281	2.220	2.594
Africa south of the Sahara	–1.403	–0.297	1.345	1.199	0.759
Mexico and Central America	0.363	0.263	0.693	2.039	1.986
South America	–0.775	0.968	1.326	2.011	1.963
Caribbean	–0.736	0.190	–1.056	1.320	1.321
West Asia and North Africa	–0.153	0.661	1.929	1.740	1.742
High Income	0.993	1.188	1.493	1.354	1.593
Other	–2.051	0.552	1.719	–0.278	–0.006

Source: Estimated from USDA (2019) except for land and output, which were obtained from FAO (2019).
Note: 2010s is limited to 2010–2014.

attempting to catch up with East Asia (see Chapter 4) and that SSA also follows the Asian path so long as smallholder-based agriculture is maintained (Chapter 5). While the growth paths of Mexico and Central America, Eastern Europe, and South America may look similar, a closer examination reveals that Eastern Europe primarily improved its labor productivity, whereas South America and Mexico and Central America improved both labor and land productivity simultaneously.

On the whole, East Asia has performed well since the early 1980s, which is consistent with its frontier position in Figure 1.2. Growth rates of TFP in South Asia and SSA are lower than in East Asia, suggesting that their catch-up process has been taking place only slowly. However, it is remarkable that SSA achieved a TFP growth rate of more than 1 percent per year from the early 1990s to the mid-2000s, indicating that major technological changes have been taking place on this continent. As argued in Chapter 11, this may be a result of the Green Revolution in SSA. Indeed, land productivity began increasing in SSA in the 1990s (Chapter 5). A noteworthy trend is the relatively high and steady growth rate of TFP in South America, consistent with the rapid growth of both labor and land productivity as well as the region's active agricultural research activities (Chapter 6). Another conspicuous trend is the recent rise of TFP growth in the former Soviet Union (FSU), which may give rise to the potentially high production and export growth of this region (Chapter 7).

The five regional chapters examine the extent to which variations in the land-labor ratio can be explained by mechanization and variations in land productivity can be explained by fertilizer use per unit of land. They also explore new contexts and development imperatives for agriculture, including urbanization, nutrition transition, nonfarm employment, poverty and food security, and FVCs, among other things. Chapter 8 provides a summary view of regional experiences.

Nonfarm Activities and Urbanization

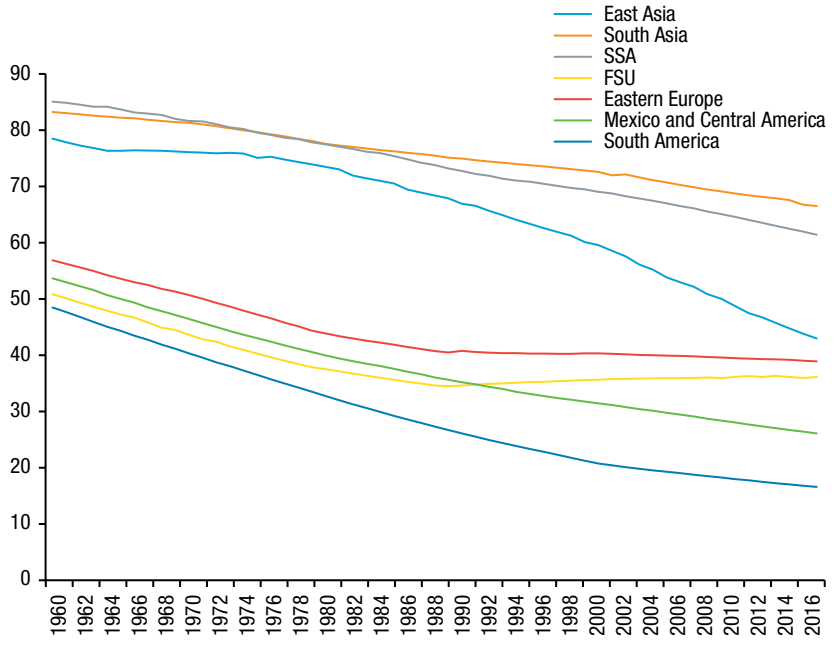
The nonfarm economy grows faster than agriculture, partly because of the low and decreasing income elasticity of demand for agricultural products and partly because of the ease of transfer of technologies in nonfarm sectors from developed to developing countries compared with agricultural technology, whose transfer is often constrained by climate factors. Thus, agriculture sectors tend to shrink at least relatively. The faster growth of nonfarm sectors creates an income gap between rural and urban areas. Consequently, economic transformation begins, which accompanies urbanization and rural-to-urban migration. In this process, people shift from low-income jobs in rural areas to high-income jobs in urban areas, thereby reducing the income gap and poverty.

As shown in Figure 1.3, the share of rural labor force has been declining in all seven regions under study.[3] The shares were high and declined slowly in SSA and South Asia because of the slow growth of nonfarm sectors in these regions. In contrast, labor share declined most rapidly in East Asia because of the successful development of nonfarm sectors in this region. The rural labor share in East Asia, however, was still higher than in Eastern Europe, FSU, Mexico and Central America, and South America in the 2010s.

An example of the close linkage between agriculture and urban centers is contract farming, which is designed to promote the production of new high-value products, such as fresh vegetables and fruits and livestock products, in response to increasing urban and foreign demand for such products (see Chapter 11). Obviously, farmers in developing countries must take advantage of the emergence of new production opportunities to increase their incomes and reduce poverty (World Bank 2007) (Table 1.3). Another major way to increase employment opportunities in rural areas is rural industrialization (Chapter 11). In general, rural industries are clustered because of the benefit of agglomeration and often linked with the processing of high-value products.

3 As is cogently pointed out in Chapter 8, the distinction between urban and rural areas is often arbitrary.

FIGURE 1.3 Declining share of rural labor force (%) by major region



Source: Calculated from USDA (2019) and FAO (2019).

Note: FSU = former Soviet Union; SSA = Africa south of the Sahara

TABLE 1.3 Poverty headcount ratio at $1.90 a day (2011 PPP), percent of population, by region

Region	1981	1984	1987	1990	1993	1996	1999	2002	2005	2008	2011	2013	2015
South Asia	55.7	53.0	50.1	47.3	44.9	40.3	—	38.6	33.7	29.5	19.8	16.1	—
East Asia and Pacific	80.5	70.1	59.2	61.3	53.7	40.9	38.5	29.7	18.9	15.3	8.6	3.6	2.3
Europe and Central Asia	—	—	—	—	5.2	7.3	7.9	6.0	4.9	2.8	2.1	1.6	1.5
Latin America and Caribbean	13.5	16.5	13.5	14.8	14.0	13.7	13.5	11.8	9.9	6.9	5.7	4.6	3.9
Middle East and North Africa	—	8.9	8.1	6.2	7.0	6.2	3.8	3.4	3.1	2.7	2.7	2.6	4.2
Africa south of the Sahara	—	—	—	54.7	59.6	58.9	58.3	55.3	50.8	48.0	45.0	42.4	41.0

Source: Data from World Bank (2019).

Note: PPP = purchasing power parity; — = data not available.

Together with rural-to-urban migration, stimulating contract farming and developing rural industries are major means to facilitate rural transformation. As a result, poverty has declined significantly, particularly in East Asia (Table 1.3).

Urbanization and economic transformation are closely linked with diversification of diets caused by shifting consumer demand. Particularly after the classic "food problem" is solved, adequate nutrition and health become major "agricultural problems." Thus, Chapter 10 explores the linkages between agricultural development and nutrition, including increasing incidence of obesity. This is a critically important issue in developing countries because not only malnutrition but also stunting and anemia are highly prevalent among children, as can be clearly seen from Tables 1.4 and 1.5.

Changes in Markets and Food Value Chains

While Chapters 9 to 11 analyze the roles of agriculture in supply of staple foods, employment generation, poverty reduction, and nutritional transition, essentially from a sectoral point of view, Chapter 12 (Food Value Chain Transformation in Developing Regions), Chapter 13 (Agricultural Development and International Trade), and Chapter 14 (The Political Economy of Agricultural and Food Policies) deal with diverse issues of markets and international trade of agricultural products.

The continuous evolution of agricultural development can be seen through the remarkable transformation of the FVC in developing countries, particularly in the past 25 years. The share of grains and other staples in the food economy declined and was replaced by animal and horticultural products. Rapid globalization fundamentally changed FVCs in developing countries at a much faster pace than that of the transformation that occurred much earlier in developed countries. Chapter 12 describes this dramatic evolution and transformation of FVCs.

As discussed in Chapter 13, international food trade increased appreciably, driven by liberalization of trade and foreign direct investment (FDI) and increased demand for diverse processed foods and safe and high-quality fresh fruits and vegetables. On the supply side, FDI by European, US, and Japanese chains played a crucial role in the FVC transformation (Reardon et al. 2003). This rapid transformation of FVCs is reflected in increasing international trade of agricultural commodities. The amount of total agricultural trade as well as that of cereals, oilseeds, and high-value products (fruits, vegetables, meats, and dairy products) increased in recent years, as shown in Figure 1.4 (see also Chapter 13).

TABLE 1.4 Prevalence of undernourishment, by region, percent of population (3-year average)

Region	2000–2002	2002–2004	2004–2006	2006–2008	2008–2010	2010–2012	2012–2014	2014–2016	2016–2018
Caribbean	23.7	24.3	23.4	22.1	20.8	19.5	19.0	18.3	18.1
Central America	7.9	8.3	8.3	7.5	7.3	7.2	6.9	6.3	6.1
South America	11.5	9.7	7.9	6.4	5.6	5.0	4.7	5.0	5.4
Central Asia	13.8	13.6	11.0	8.8	7.8	6.7	5.8	5.5	5.6
Northeast Asia	14.5	14.3	14.0	13.2	11.9	10.6	9.4	8.5	8.4
Southeast Asia	21.5	19.9	18.4	16.7	14.3	11.7	10.5	9.8	9.4
South Asia	19.6	21.6	21.1	18.6	17.3	17.2	16.8	15.7	14.9
West Asia	10.1	9.8	9.5	9.2	8.9	9.2	9.9	11.0	12.1
Eastern Africa	38.3	36.7	34.4	33.1	32.1	30.6	30.3	30.3	30.9
Middle Africa	38.1	35.5	32.5	30.5	28.8	27.0	25.3	25.1	26.3
Northern Africa	6.5	6.2	6.1	5.6	5.2	4.9	7.6	7.0	7.1
Southern Africa	7.0	6.6	6.5	7.0	7.2	7.0	7.2	7.9	8.3
Western Africa	15.2	14.1	12.3	11.1	10.5	10.4	10.9	11.7	13.9
Oceania	5.4	5.5	5.5	5.2	5.1	5.3	5.7	5.9	6.1

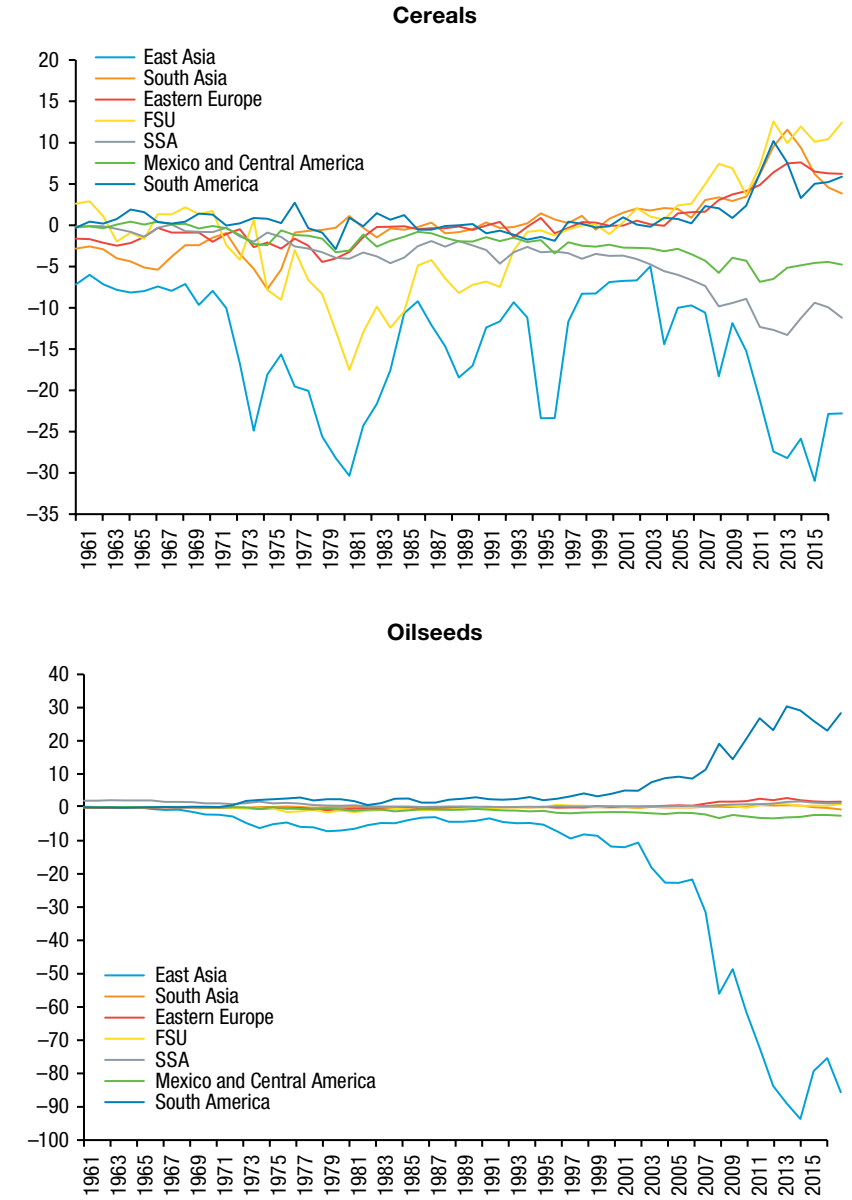
Source: Data from FAO (2019).

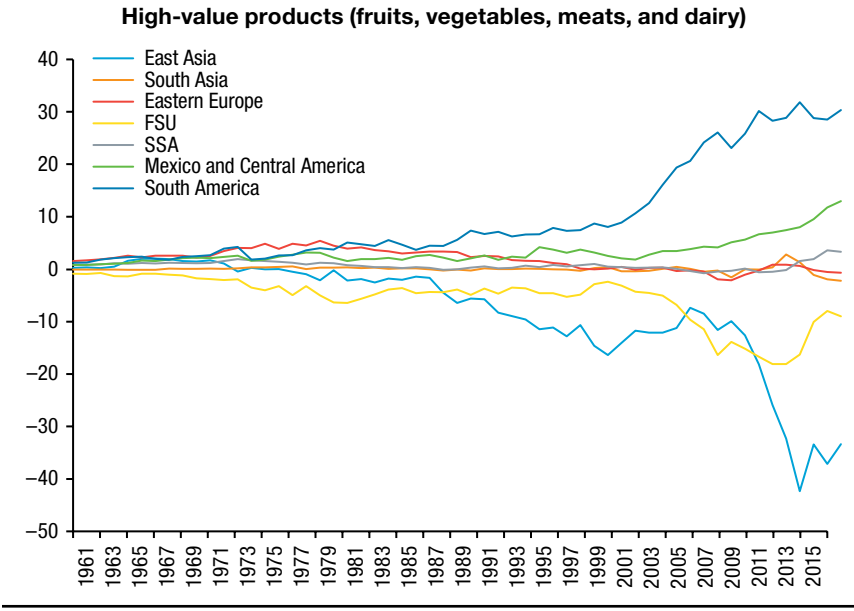
TABLE 1.5 Prevalence of stunting in children under age 5, by region, percent of population

Region	1990	1995	2000	2005	2010	2015	2018
Caribbean	20.8	17.8	15.2	12.9	11.0	9.2	8.3
Central America	31.8	27.6	23.7	20.2	17.1	14.4	12.9
South America	19.1	16.2	13.6	11.4	9.5	7.9	7.1
Central Asia	—	34.9	28.0	22.0	17.0	12.9	10.9
Northeast Asia	35.6	26.6	19.2	13.4	9.2	6.2	4.9
South Asia	59.4	54.6	49.7	44.8	40.0	35.4	32.7
Southeast Asia	46.9	42.6	38.4	34.4	30.6	27.0	25.0
West Asia	28.7	25.8	23.1	20.6	18.3	16.2	15.1
Eastern Africa	51.9	48.8	45.8	42.8	39.8	36.9	35.2
Middle Africa	44.3	42.0	39.8	37.6	35.4	33.3	32.1
Northern Africa	28.0	25.8	23.7	21.7	19.9	18.2	17.2
Southern Africa	35.0	34.0	32.9	31.9	30.9	29.9	29.3
Western Africa	40.7	38.5	36.4	34.3	32.3	30.3	29.2
Oceania	36.0	36.4	36.8	37.2	37.6	37.9	38.2

Source: Data from UNICEF-WHO-World Bank Group (2019).
Note: — = data not available.

FIGURE 1.4 Changes in real value of net export of selected agricultural commodities by major region, billion 2011 US dollars





Source: Calculated from USDA (2019) and FAO (2019).
Note: FSU = former Soviet Union; SSA = Africa south of the Sahara.

Undistorted open markets maximize the net benefit that international trade can offer to boost global food security (Chapter 13). Yet agriculture in developing countries was traditionally discriminated against by export taxes and restricted import of agricultural inputs, whereas agriculture in developed countries was heavily protected by subsidies, tariffs, and restricted imports of agricultural products. In other words, farmers are taxed when they are the majority of the population but subsidized when they are the minority. This is referred to as the "development paradox." The question is why agricultural markets are so often distorted throughout much of history and across the globe. This is precisely the issue of political economy addressed in Chapter 14.

The Role of Gender, Credit, and Insurance in Household Decision-Making

Women are often handicapped in ownership and control of agricultural land and other assets in developing countries, as shown in Chapter 15. Since women tend to spend more resources on children's education and health and nutrition, their handicapped access to productive resources may lead to underinvestment in these and other areas. Understanding the roles of men and women, their decision-making powers, and the level of their cooperation

within a household is essential for the analysis of household behaviors. Chapter 15 seeks deeper understanding of household behaviors in order to facilitate gender equity and investments in child schooling, nutrition, and health.

Access to institutional credit is critically important for smoothing consumption over time under risky agricultural production environments, financing purchase of modern inputs such as improved seeds and inorganic fertilizer, introducing new high-value products, and investing in land improvement to increase long-term productivity. Yet only a small fraction of farmers borrow from formal institutions. Furthermore, borrowing is used primarily for smoothing consumption, but not for raising agricultural productivity. While borrowing from microfinance institutions, which does not require collateral, is encouraged by many governments in developing countries and international organizations, these institutions are designed to provide small-scale and short-term lending primarily for nonfarm businesses. Thus, Chapter 16 seeks new effective institutions to provide credit for smallholders to accelerate agricultural development.

Also difficult is the design of efficient, effective, and widely acceptable insurance programs (Chapter 17). Traditional crop insurance programs, designed to insure farm-specific losses, are bound to fail, partly because of moral hazard (whereby an insured farmer does not exert optimum effort to reduce risk or mitigate its impact) and partly because of adverse selection (whereby only the most risk-prone farmers purchase insurance). Recently, index insurance programs have been promoted as a low-cost alternative to traditional insurance programs. In the case of index insurance products, payments are based on an independent measure, for example, rainfall, which is highly correlated with farm-level yield or revenue outcomes. Since rainfall is exogenous to the individual insurance policyholder, there is no incentive for a farmer to commit moral hazard. Despite high expectations for the wide adoption of index insurance, however, most index insurance programs have experienced low take-up rates. Thus, various solutions are sought to make insurance programs work in developing countries, as discussed in Chapter 17.

Climate Change and Sustainable Development of Agrifood Systems

Achieving sustainable agricultural development without sacrificing environmental quality is one of the most important challenges the world will need to meet, especially if we are to achieve poverty reduction, food security, and better nutrition and health. The global environment, however, has been

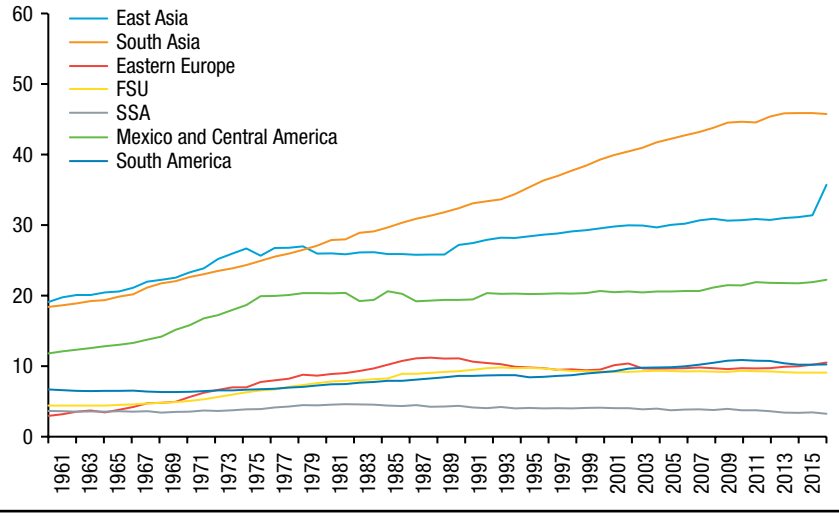
deteriorating, and it is predicted that climate change will result in substantial reduction in agricultural production unless adequate investment in productivity-enhancing technological development is made (see Chapter 19). Efforts to expand agricultural areas in developing countries have resulted in deforestation, a major source of greenhouse gas emissions. Communal natural resources, such as forests, grazing land, and irrigation systems, also suffer from deterioration (see Chapter 18). In total, agriculture, forestry, and other land uses account for 24 percent of greenhouse gas emissions (Chapter 19). Also worrisome is increasing water scarcity due to rising demand for water in industrialized and urban areas, dietary changes toward more water-intensive foods, and frequent droughts associated with climate change (see Chapter 20).

It is important to strengthen both our ability to mitigate or reduce deterioration of global environments and the inefficient use of natural resources and our ability to adapt to a deteriorated global climate and environments. For adaptation to climate change, agricultural research plays a critical role (see Chapter 21). Adaptation can benefit from the use of biotechnologies, for example, gene editing, to develop crop varieties that are tolerant to heat, drought, salinity, and submergence and from the capacity to develop agronomic practices to use new varieties effectively. Efficient use of water is also an integral part of adaptation strategies, because the availability of irrigation water enhances resilience to frequent droughts. At present, the irrigation ratio is particularly low in low-income regions (Figure 1.5). For more effective adaptation to climate change, further irrigation investments will be required.

For sustainable resource management, it is essential to reduce the cost of measuring, monitoring, and verifying the use of natural resources or the emissions of greenhouse gases. In terms of global environmental issues, an international system is needed to determine the penalty amounts for resource use and greenhouse gas emissions and to enforce payments. Increasing the cost of natural resource use should contribute not only to the efficient allocation of such resources in the short term, but also to the development of natural-resource-saving technologies in the long term. If agriculture fails to contribute to solving climate change by not constructing the proper incentive systems in natural resource use and inducing the development of natural-resource-saving technologies, sustainable agricultural development may remain an unachievable dream and agriculture may become a culprit of global climate deterioration.

The challenge is how to mitigate climate change and preserve or improve ecosystems while delivering healthy foods to consumers. For these purposes, it will be critical to build a food system that is simultaneously nutrition- and health-driven, productive and efficient, environmentally sustainable and

FIGURE 1.5 Changes in irrigation ratio (%) by region



Source: Calculated from USDA (2019) and FAO (2019).
Note: FSU = former Soviet Union; SSA = Africa south of the Sahara.

climate smart, inclusive, and business friendly (Fan 2016). Chapter 22, the final chapter of the book, focuses on these critical and burning issues.

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