Agriculture and Food Security

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Abstract

The discourse about agriculture and its link to food security evolved greatly over the past century. Early thinking focused solely on the ability to increase production of staple foods to meet a real or assumed growth in population. Modern discourse looks at agriculture as a way to meet food security in all its facets, including availability of and access to food and nutrition diets among individuals and households, as well as the health of producers, consumers, and the environment. Furthermore, agriculture has a role in economic growth, at the national level as well in the livelihoods of rural populations. Yet this more holistic view of agriculture and food security is often challenging to put into practice, as evidenced by case studies of countries in
Asia and Africa. Recent food price crises put agriculture and food security back on the global agenda, giving the sector a chance to reinvent itself.

**Keywords:** agriculture, agricultural development, food security, nutrition security
Introduction

In the wake of the 2007–08 and 2010–11 world food price crises, agriculture and food security are high on the global agenda. They were last at the forefront in the 1960s and 1970s, when poor weather reduced harvests in many countries, cereal stocks were perilously low, food prices were high and volatile, and food shortages and famines were killing millions of people in Asia (notably Bangladesh and China) and Africa (notably Ethiopia and the Sahel). The World Food Conference was convened in 1974 to assess the magnitude of the food problem and to discuss solutions. National and international policy-makers ramped up investments in agricultural science and technology; in hard and soft infrastructure such as irrigation, electricity, roads, and education; and in improved policies to encourage farmers to grow and sell more food and to conserve natural resources.

These efforts led to enormous gains in agricultural productivity, increased the global availability of food, and lowered food prices. The Green Revolution—the breeding of improved rice and wheat varieties, combined with increased use of fertilizers, irrigation, and supportive public policies—spread rapidly across Asia and improved the livelihoods of an estimated 1.8 billion
people (Hazell 2009). Agriculture was a key driver of growth and development for many of the world’s poorest countries and helped countless people improve their incomes and thus their access to food. The proportion of the world’s population going hungry declined dramatically, from about one-third in the late 1950s to about one-eighth in the late 2000s.

As world food supplies burgeoned and food prices fell, policy-makers became complacent and began to neglect agriculture. Investments in agriculture did not keep pace with other investments and agriculture’s profile on the global agenda slowly diminished. Yet the number of people going hungry remains stubbornly at just below one billion. In 2006–08, 850 million people in the world were undernourished, a number virtually unchanged from 1990–92. Of course, while the total number may have remained unchanged, large numbers of people have moved in and out of hunger over this period: in approximate terms, for every person who moved out of hunger in China after 1990, another one moved into it in Africa or South Asia. In 2011, the hot spots of hunger were South Asia (home to 40 percent of the world’s hungry people) and sub-Saharan Africa (25 percent) (FAO 2011). Going beyond calorie deficiency, about 2 billion people suffer from micronutrient malnutrition, also known as “hidden hunger,” caused by a lack of critical dietary micronutrients such as Vitamin A, zinc, and iron (WHO and FAO 2006).
The world food price crisis of 2007–08—wherein weather-related shocks such as droughts and floods were compounded by escalating demand for agricultural products from emerging economies, high oil prices, the expansion of biofuels, and panic-induced protectionist policies—sharply raised food prices, ignited food riots around the world, and threw many millions of people into hunger and poverty. The factors that pushed up prices then were again at play a few years later, making it evident that a fundamental transformation of the world food system was underway. Agriculture is no longer about food production only; the purpose of agriculture has broadened to development outcomes such as nutrition and health, sustainability of natural resources, and remunerative employment. An Evergreen Revolution—increases in agricultural productivity without associated ecological harm—is needed.

This chapter reviews the evolution of food security and agricultural development; assesses how agriculture has contributed to improving food security; highlights the experiences of India, China, and Ethiopia; and looks forward to opportunities for leveraging agriculture to improve food and nutrition security.
The evolution of food security

The term “food security” originated in the mid-1970s when the World Food Conference defined food security in terms of assuring the availability and price stability of food: “availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices.” In the early 1980s, the UN Food and Agriculture Organization (FAO) included a focus on physical and economic access to food at the individual and household levels. The 1986 World Bank Report on Poverty and Hunger brought in temporal aspects, distinguishing between “chronic” and “transitory” food insecurity—chronic food insecurity being associated with structural poverty and low incomes, and transitory food insecurity being associated with natural disasters, economic collapse, or conflicts (World Bank 1986). This was complemented by Amartya Sen’s entitlement approach toward analyzing famines, which concluded that food insecurity depends as much on people’s inability to access food (because of poverty or inequitable distribution systems) as on the actual supply of food (Sen 1981). The “right to food” movement has also been influential in framing food security as a human right, a right that is derived from the International Covenant on Economic, Social and Cultural Rights. Currently, twenty-two countries explicitly refer to this right in their constitutions.
Today the internationally accepted definition of food security is that emerging from the World Food Summit of 1996: “Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” This definition reinforces the multidimensionality of food security—availability, access, and absorption/utilization of food:

- **Availability** refers to the physical availability of food in desired quantities as determined by production net of feed, seed, and wastage plus net imports and drawdown of stocks. As noted in the World Food Summit definition, food security also depends upon the ability to obtain food at all times, including through economic or climatic shocks or non-harvest seasons, as well as the availability of locally acceptable foods, as compared to taboo foods which may be proscribed on the basis of culture, religion, health, or economic value.

- **Access** is determined by the bundle of entitlements related to people’s initial endowments and what they can acquire, especially in terms of physical and economic access to food.
• **Absorption** is the ability to biologically utilize the food consumed, which is turn is related to the availability of safe drinking water, sanitation, hygienic environment, primary health care, and nutritional knowledge. This broadening of food security toward nutrition security is a recent evolution.

### Food security and agricultural development

Agriculture and food security have been intertwined throughout human history. Agricultural growth is critical for improving food security, most immediately by increasing food production and availability. Agriculture grows crops and livestock for food and raw materials and is the main source of calories for the world’s population. The availability of food is a necessary but not a sufficient condition to assure food security. The rural poor are often net consumers of food, and poor households can spend over half of their income on food (Headey 2011). Agriculture, as the employer of 60 to 80 percent of people in low-income countries, raises the incomes of the poorest and most food-insecure people. Non-farm employment that is linked to agriculture, such as food processing, manufacturing, and transportation, also employs many rural people. By
acting as a source of income, agriculture and agriculturally-related sectors enable people to
purchase the food they need to augment what they can grow themselves.

Higher incomes also allow households to purchase higher-quality food, safer food, and a more
diverse diet, gains that contribute to the more nutrition-focused dimensions of food security.
Income growth in households and across countries has been projected to significantly reduce
malnutrition, though direct health and nutrition interventions are also needed to ensure the
impact (Haddad et al. 2003). Whether a higher income can successfully translate into better
nutrition is also influenced by the level of power women have within the household. Women are
more likely to spend the income that is under their control on food, health care, and the education
of their children (Meinzen-Dick et al. 2012).

Closely related are the linkages between agriculture and ecology. Poor management of natural
resources such as land and water can lead to soil erosion, water siltation, water-borne diseases,
and even water scarcity. Similarly, poor farming practices can lead to contamination of food and
water by microbes, chemicals, and toxic metals. These factors all have a negative impact on
sustainable agricultural yields, and producers’ and consumers’ health and nutrition. Protecting
the quality of natural resources, preserving biodiversity, and putting into place better pest
management practices that protect farmers from excessive pesticides and consumers from toxins can ensure that the relationship between agriculture and ecology is a positive one. At the same time, though, improving the safety of food cannot raise food prices to the point where poor households can no longer afford to purchase food, threatening their food security (Pinstrup-Andersen 2012).

Agricultural growth is a catalyst for broad-based economic growth and development in most low-income countries. Very few countries have experienced rapid economic growth without agricultural growth either preceding or accompanying it (Pinstrup-Andersen and Pandya-Lorch 1995). Agriculture’s linkages to the non-farm economy generate considerable employment, income, and growth in the rest of the economy. Economic growth raises incomes, increases the asset base, and creates wealth; it enables governments and communities to better provide the enabling environment, infrastructure, and services essential for improving food and nutrition security.

Barrett, Carter, and Timmer (2010) review how the discourse on agricultural development has evolved. They note that the critical role of agriculture in the broader development process was first documented by W. Arthur Lewis, who pointed out that “economies in which agriculture is
stagnant do not show industrial development” (Lewis 1954). Johnston and others (1961, 1975, and 1982) and Mellor (1966, 1976, and 1986) all saw higher productivity on small farms as the key to rapid poverty reduction and structural transformation. Schultz (1964) made the case for technical change in agriculture as a key driver for higher productivity. As Barrett, Carter, and Timmer (2010) note, “If W. Arthur Lewis built the intellectual framework supporting the ‘why’ of agriculture’s role in economic development, T. W. Schultz built the framework for understanding the ‘how’ of stimulating agriculture to play that role.” Eicher and Staatz (1998) observed that in the 1950s and 1960s many development economists focused on analyzing how the agricultural and nonagricultural sectors interacted during the process of economic growth. During the 1970s and 1980s attention shifted to understanding the rural economy, and in the 1990s to how the rural economy was linked to a broader world market and the role of institutions.

Barrett, Carter, and Timmer (2010) highlight a few salient points. First, they find general consensus that structural transformation is the only sustainable pathway out of poverty. This realization hones in on the role of institutions in both defining a country’s pattern of economic growth and distributing the benefits of that growth equally to its citizenry. Second, the rural non-farm sector often facilitates linkages between agriculture and the larger economy, linkages
that make agricultural transformation essential to overall economic development. Finally, the food security of individuals and nations depends not only on supply side factors associated with agricultural productivity, but equally on demand factors related to incomes, risks, health status, social protection policies, and caregiving within the household. Higher productivity in agriculture releases capital and labor that can then be used for gains in the larger economy. Agriculture also spurs industrialization. It provides raw materials for use by the industrial sector, provides markets for industrial outputs, and provides the exports for the foreign exchange that is needed to import capital goods.

The evolution of agriculture

Modern worries about the ability to ensure food security for a booming world population are not new. In the United States, the industrial revolution led to a massive population increase, from 5 million in 1800 to 76 million in 1900. Previously, the thinking about the role of agriculture had been dominated by classical theory, which viewed agriculture as a sector with low productivity and decreasing returns which only passively provided food and employment. In this context, agriculture had to release labor and capital for the industrial sector to thrive, and technological
innovation in industry occurred independently of agriculture (Diao et al. 2007). In response to this boom in population, the discourse placed agriculture in a more active role characterized by innovation. Farmers, scientists, and engineers developed technological advances such as tractors and harvesters, and pushed improvements in animal breeding and animal health. Agricultural research and extension was carried out by land grant universities, which first appeared in the 1860s and focused on teaching practical agriculture, science, and engineering. Commercial agriculture also began to emerge during this time period with the advent of the commercial fertilizer industry. When the 1930s brought on the Dust Bowl, a decade of drought and dust storms in the Great Plains of the United States, the federal government undertook conservation projects to prevent soil erosion and subsidized farmers so that they could afford to reduce agricultural intensification.

The ideas of Thomas Malthus, who espoused the nineteenth-century theory that population growth will inevitably outstrip the availability of food and other natural resources, were for a long time influential in framing the discourse on agriculture and food security. The experience of the Irish Potato Famine in the 1840s and 1850s, for example, was explained away as the problem of overreliance on a single crop, the supply of which was wiped out so as not to be able to feed a booming peasant population. In reality, applying Sen’s approach to the famine would have
revealed the failings of a larger agricultural political system that reduced Irish farmers’ landholdings to subsistence levels and pushed them into famine.

Malthusian sentiments continued into the 1950s and 1960s, when agriculture focused solely on intensifying staple food production, primarily the staple cereals of maize, wheat, and rice. As developing countries emerged from war and conflict, and were buffeted by pests and droughts, agriculture was challenged to address widespread hunger. The Rockefeller Foundation responded to the challenge by leading the formation of a global agricultural research system based in Mexico with the aim of increasing the output (greater production) and yields (greater production from a given area of land) of mainly wheat, but also beans, maize, potatoes, and other staple crops. Research, science, and technology were put to work for agriculture—to fight wheat rusts, to develop improved crop and livestock varieties, to improve resistance to pests and diseases, to better use fertilizers and other chemical inputs, and so forth. The eventual success of the Mexico program in developing semi-dwarf, high-yield varieties of wheat mirrored agricultural research successes in other parts of the world, such as rice in the Philippines and tropical agriculture in Colombia and Nigeria. In the 1960s, the Rockefeller Foundation and the Ford Foundation helped formally establish research centers in these four countries. A series of policy consultations with other key actors such as the World Bank, Food and Agriculture Organization (FAO) of the

The transfer of knowledge and seeds from the early CGIAR centers—mostly new wheat varieties from Mexico, and subsequently new rice varieties from the Philippines—helped catalyze the Green Revolution in India. At its most basic level, the Green Revolution was the introduction of a package consisting of modern inputs—improved seeds, fertilizers, and pesticides—together with a supportive economic and policy environment that included food price stabilization policies as well as substantial investments in irrigation systems, rural roads networks, fertilizer production, and provision of credit to farmers. The Indian government invested heavily in the infrastructure and policies that made this possible. Assured and remunerative marketing, under which a minimum support price for farmers is coupled with a guaranteed procurement at that price, was a major factor in the widespread acceptance of dwarf wheat by farmers (Swaminathan 1993).

While India was at the epicenter of the Green Revolution, the initiative spread rapidly across much of Asia. The global population boom that followed the Green Revolution prompted fear of a Malthusian crisis, but farmers adopted the new farming practices and technologies to such a
massive extent that cereal yields and outputs doubled between 1965 and 1990, not only pulling India and other Asian countries back from the brink of famine but also generating food surpluses. An estimated 1.8 billion people benefited from the Green Revolution in terms of improved access to food and increased earnings from agriculture (Hazell 2009). The Green Revolution also worked to confirm the view of agriculture as a growth sector on its own.

In the 1970s, agriculture evolved to include environmental and equity considerations. Sustainable development issues came to the forefront, partly in response to concerns associated with the Green Revolution such as the overuse of agricultural chemicals, the depletion of scarce water resources, and the neglect of farmers and communities in policy making processes. These concerns encouraged a shift away from a narrow focus on increasing staple food productivity to a more complex perspective on agriculture and rural development. This latter approach coupled intensive agricultural practices with integrated pest management practices, improved water management practices, precision farming, and other tools and techniques that facilitated stewardship of natural resources. Efforts were accelerated to make the Green Revolution not only more sustainable but more pro-poor. New policies, programs, and investments were specifically designed to integrate rural communities into decision making processes about their own agricultural and rural development as a way of addressing sustainability along with equity issues.
There was growing attention to land reform, especially equitable distribution of land with secure property rights, access to credit and financial services, and programs more geared toward small-scale farmers.

During the 1970s and 1980s, agriculture diversified out of major cereals. As a means of improving food security and increasing farm incomes, investments were scaled up in raising the productivity, cultivating, and marketing of non-staple and high-value crops such as legumes, fruits, and vegetables as well as dairy, livestock, and fish. This period was marked by a few widespread successes. Many countries in Asia, for example, benefited from the diffusion of improved mung beans, with traits such as higher yields and shorter maturity times, that reached an estimated 1.5 million farmers. The global initiative to eradicate rinderpest, a livestock disease capable of killing more than 95 percent of infected animals, was yet another success that helped avoid enormous losses of milk, meat, and vital income to pastoralists. The initiative represents the first time an infectious disease has been eliminated since the eradication of smallpox in humans in 1977. In India, Operation Flood created a national dairy grid and accompanying infrastructure that transformed the country from being a net importer of dairy products to being a major player in world dairy markets (Spielman and Pandya-Lorch 2010).
During this same time period, agriculture also moved its attention from the farm to markets. Market-driven development became a popular approach in many economies. A major incentive for countries to pursue this approach was the introduction of structural adjustment programs in order to reduce public deficits and improve balance of payments. The terms of these structural adjustment programs often necessitated the liberalization of national markets and a boost in private investment in the economy. In terms of the link to agriculture, market forces were expected to contribute to agricultural development by freeing up seed and fertilizer markets from state-owned monopolies and by removing price-setting policies in agricultural commodity markets to encourage more vibrant trading.

Other countries homed in on food value chains, defined as the sum of the activities and actors that interact with a food product as it moves through research, production, storage and processing, distribution, retailing, and marketing. A value chain is different from a supply chain in that each activity and actor presumably adds value to the product. Value has traditionally been defined in financial terms, but can also be defined according to added nutritional or food safety value (Hawkes and Ruel 2011). During this time period, countries undertook efforts to make value chains more efficient by closing the gaps that link farmers to markets through traders, processors, distributors, wholesalers, and retailers. Value-chain-oriented policies aimed to
improve the incentives of farmers to increase production and consequently improve the food security of both producers and consumers.

As the thinking about the role of agriculture in the wider economy evolved, it became clear that agricultural development could be stimulated by policies and developments outside the agricultural sector. Economic reforms could change the traditional urban biases that historically discriminate against farmers, by reducing distortionary effects of exchange rate and lending policies on the agricultural sector, and opening new market opportunities and leverage trade and aid.

China provides the most compelling example. Between 1978 and 1984, China undertook a series of reforms that transformed the country’s food and agricultural sector and reduced hunger on a scale unrivaled in history (Bruce and Li 2009). The reforms effectively reintroduced household farming after more than thirty years of collective agriculture. More than 95 percent of China’s farmland was returned to some 160 million farm households. The reforms contributed to enormous increases in rural incomes and grain production, and dramatic reduction in rural poverty. In Vietnam, similar reforms between 1987 and 1993 led to the decollectivization of agricultural production and improvement of land tenure security, liberalizing of markets, and
promotion of new economic incentives; the reforms transformed the agricultural sector and dramatically increased food security (Kirk and Do Anh Tuan 2009).

In recent years, the development community has begun to pay more attention to the linkages between agriculture, nutrition, and health. There is increasing recognition that agriculture plays a central role in the production, access, and use of nutritious and safe food. It also influences other determinants of nutrition, such as access to clean water and sanitation. Health is now considered a major goal of food systems, in part because of the triple burden of malnutrition: hunger, nutrient deficiencies, and excess calorie intake that leads to overweight and obesity in many countries. In the 2010s, many donors and governments redesigned their programs to increasingly focus on nutrition alongside hunger. The United Nations launched the Scaling Up Nutrition (SUN) movement, the Comprehensive Africa Agriculture Development Program (CAADP) began looking at nutrition security, and the CGIAR launched a major new program on nutrition and health. These developments reflect a change in thinking about agriculture as a tool that can bring disparate sectors together to create a healthy and safe food system that can meet the food security needs of many.

A few major factors have enabled agricultural development to substantially improve food security and feed billions of people. First, sustained investment in agricultural research and
development helped make the link between agriculture and food security in many countries during the past fifty years. Advances in crop breeding formed the basis for the successes achieved during the Green Revolution. Technologies stayed ahead of pests and diseases, and boosted yields in many parts of the world. Research on marketing systems triggered reforms that achieved national level food security in some countries. Although it is difficult for policy-makers and donors to make long-term commitments to science and technology, given the long lead times involved, such investments nonetheless proved vital in addressing global hunger.

Second, private incentives have been an important factor in increasing the likelihood of success in agricultural development. Incentives can encourage investments in agriculture, helping markets provide timely information that can boost production of and access to safe and healthy foods. Different actors can be motivated to cooperate and collaborate with one another along the entire food chain, from inputs and production to processing and marketing.

Finally, many successful initiatives emerged from localized experiments. These allowed participants to adapt incrementally, rather than through a “big bang,” to the political and cultural landscape. Great successes in agriculture came not only from scientific progress but from the practical experiences of local communities. Examples include community forestry in Nepal in
the 1970s, efforts to regreen the Sahel in the 1980s, and homestead food production in
Bangladesh in the 1990s (Spielman and Pandya-Lorch 2010). In all of these cases, creating a
space for agricultural experimentation and innovation helped achieve widespread food security.

Country experiences

The varying agricultural paths taken by different countries during the past fifty years provide an
opportunity to place the evolution of agriculture and food security, and the discourse on this
evolution, in a national context. Emerging economies offer particularly rich narratives of how the
linkages between agriculture and food security play out in the real world. India, which grew at a
rate of 4.2 percent per year from 1990–2005, has seen very little commensurate decline in child
undernutrition, a paradox that remains unexplained (Gillespie and Kadiyala 2012). In this case
study, agricultural growth has not automatically translated into food security, underlining the
need to shed light on the factors that complicate this relationship. The second case study follows
the evolution of China, highlighting the importance of local experimentation in designing
effective agricultural policies and incentives. The Chinese narrative is a success story, showing
that agricultural growth can indeed translate into reductions in hunger and an increase in food
production and food security. Finally, the third case study focuses on Ethiopia, and the efforts made there to cater to a hugely agrarian society characterized by mostly smallholders working in vastly different agroecological areas. In this last narrative, the relationship between agricultural growth and food security has not yet been clarified.

**India**

Looking back on India’s progress in agriculture since 1947, India has gone through four distinct phases in its agricultural evolution (Swaminathan 2011):

- **Phase I (1947–64):** The emphasis was on the development of infrastructure for scientific agriculture—establishment of fertilizer and pesticide factories, construction of large multi-purpose irrigation-cum-power projects, organization of community development and national extension programs, and initiation of agricultural universities. Still, the growth in food production was inadequate to meet the consumption needs of the growing population, and food imports became essential.
• Phase II (1965–85): The emphasis was on maximizing the benefits of the infrastructure created during Phase I, particularly in irrigation and technology transfer. The reorganization and strengthening of agricultural research, education, and extension along with the creation of institutions for providing farmers assured marketing opportunities and remunerative prices for their produce led to a quantum jump in the productivity and production of crops such as wheat and rice, a phenomenon christened in 1968 as the Green Revolution.

• Phase III (1985-2000): Organization innovations such as Technology Missions were introduced—the Mission approach involved concurrent attention to conservation, cultivation, consumption, and commerce. This period saw a gradual decline in public investment in irrigation and the infrastructure essential for agricultural progress as well as a gradual collapse of the cooperative credit system. Large grain reserves led to a mood of complacency toward agriculture.

• Phase IV (2001 to present day): Fatigue among policy-makers resulted in stagnant technology, extension, and production. A weak coalition government and powerful lobby interests meant little progress in reforming policies relating to inputs, irrigation,
food prices, subsidies, and food distribution. Recent steps, however, seek to reverse this decline, including the Mahatma Gandhi National Rural Employment Guarantee Act. Also being discussed are policies to address the mismatch between production and post-harvest technologies by way of improving crop storage.

The Indian enigma is the persistence of widespread undernutrition in spite of substantial progress in agricultural production. Agricultural growth led to great strides in food production in India, but chronic undernutrition persists. One part of the solution to this enigma likely involves focusing on crops and livestock that have large nutritional impacts on both farmers and consumers. Another part may involve addressing socioeconomic factors that affect the link between agriculture and nutrition, including the distribution of assets, particularly land; the role of women; rural infrastructure; and rural health and sanitation (Gillespie and Kadiyala 2012). The Women Farmers’ Entitlements Bill of 2011, for example, was introduced in the Indian Parliament with the aim of establishing women farmers’ rights to agricultural inputs, land, water, and credit, among other resources.

India will remain a predominantly agricultural country for much of the twenty-first century, particularly with reference to livelihood opportunities. Enhancing small farm productivity and
profitability will likely make a major contribution to reducing hunger and poverty. An integrated crop–livestock–fisheries farming system is the way forward for the country. This calls for an Evergreen Revolution (i.e., increase in productivity in perpetuity without associated ecological harm), focused on rain-fed farming areas and crops suited to these areas (Swaminathan 2010).

The technology required has three components: (i) Defending the gains—through soil health enhancement, water harvesting and management, credit and insurance, technology and inputs, and remunerative marketing; (ii) Extending the gains—through an appropriate mix of technology, services, and public policies; and (iii) Making new gains—through improvement in post-harvest technology, agro-processing, genomics and gene pyramiding, and integrated asset reform aimed at equitable land distribution and utilization of water.

Looking forward, the National Food Security Bill 2011 mandates the government to procure wheat, rice, and nutri-millets (often called coarse cereals). Such procurement at a remunerative price is the pathway for stimulating interest among farmers to produce more. India is also just beginning to uncover the potential agribusiness, diversification, marketing and exports, as well as increasing the value addition to food production. The country is exploring whether, with proper protections for the poor and vulnerable, commercial agriculture can be a catalyst for economic development.
To sum up, Indian agriculture has undergone considerable technological and management transformation since 1947, when the country gained independence. The human population, which was about 350 million then, has now reached 1.2 billion. There is hence no time to relax. Jawarhalal Nehru said in 1947, “Everything else can wait, but not agriculture,” and that message is even more relevant today.

China

During the past thirty years China has implemented significant reforms, catalyzing an agricultural transformation that in turn set off an economic transformation. China has gone through several phases in its agricultural development (Bruce and Li 2009; Fan, Zhang, and Zhang 2002).

- Phase I (1949–52): The Communist Party launched a “land-to-the-tiller” program wherein it confiscated land and redistributed it to peasants. Farming families were
still made to sell their crops to the government at fixed low prices and also faced substantial taxes on their farming income.

- Phase II (1952–58): Production cooperatives were created and later scaled up to communes. This collectivization was expected to provide a base for the developing rural industry, an assumption that did not materialize.

- Phase III (1959–78): With full collectivization in the Great Leap Forward, a strict system of controls was placed on price and quantity of inputs and outputs as well as production decisions. Grain production declined, serious famine ensued, and food shortages were widespread. The entire agricultural system was tightly controlled and farmers had few incentives for improvement and efficiency in agricultural production.

- Phase IV (1978–84): A few brigades in the Anuhi Province began to secretly distribute their land among their member households, leading to a two- to five-fold increase in production. The experiment eventually received support from Party leaders, introducing the opportunity to divide communal lands into household holdings. Thus, a shift toward the household responsibility system wherein
production teams could choose to produce more food than the quota assigned to them, thus keeping the excess food. While in January 1980 only one percent of the production teams had converted to household farming, by December 1983 98 percent had done so. This shift was accompanied by reforms in the state procurement system for agricultural products, with significantly higher prices for major crops. Farmers were allowed to grow cash crops, like vegetables, and to trade grain.

The household responsibility system created two types of surpluses in labor (due to new efficiencies) and funding (for investing in local enterprises). These surpluses, along with an assortment of old, unused collective factories, created a “perfect storm” that was seized upon by local townships and village governments. Millions of Township and Village Enterprises were formed using inexpensive local labor and infrastructure. This boom in rural industrialization eventually employed more than 135 million people, approximately one-third of the rural labor force. The two-pronged strategy developed in China for enhancing on-farm productivity and increasing non-farm employment opportunities through the Township and Village Enterprises is one of the key reasons why China’s rural poverty rate is so low.
In just a few short years, the reforms increased calorie consumption among rural people, doubled their incomes, and slashed the poverty rate from 76 percent in 1980 to 23 percent in 1985. This progress has remained relatively constant during the past few decades. China managed to reduce its number of undernourished citizens by nearly 40 percent from the early 1990s to the mid-2000s (FAO 2011). Agricultural growth has also remained on an upward trend. In 2010, for example, China’s total grain production exceeded 550 million metric tons for the first time in half a century. Today, China supports more than 20 percent of the world’s population with a 98 percent overall food self-sufficiency, an impressive feat.

**Ethiopia**

Ethiopia is one of the most agrarian countries in the world: only 16 percent of Ethiopians live in urban areas, and in 2006, agriculture’s share of GDP was 48 percent, one of the highest rates globally. Nevertheless, the country regularly experiences serious food shortages due to low productivity, droughts, and variable rainfall.

Since 2000, Ethiopia has seen vast economic growth, mostly driven by agricultural production. The country has invested heavily in its agricultural sector through an Agricultural Development
Led Industrialization strategy. Much of this strategy is based in previous policies, which evolved through the decades to eventually focus on access to modern inputs and agricultural extension by smallholders, who comprise the majority of the agriculture sector (Spielman et al. 2011).

- **Phase I (1968–73):** Ethiopia’s Imperial regime promoted Comprehensive Integrated Package Projects, which provided modern inputs, credit, and agricultural extension, and helped cooperatives to form. The scale of these projects, however, was too small to impact agricultural productivity or to effectively reach the majority of smallholder farmers. Instead, policies in this period mainly served the country’s feudal class.

- **Phase II (1974-91):** Under the military Derg regime, Ethiopia’s feudal system was dismantled and the gap filled by peasant cooperatives, state-owned farms, and collectives. Research and extension services, which previously had focused on specific areas, were now extended to the entire country. However, by the end of the regime, extension was viewed as a political instrument rather than a service provided to smallholders. In the 1980s, political instability and armed conflict, exacerbated by a sequence of rain failures, led to hundreds of thousands of deaths and a catastrophic loss of livestock. The government responded by forcibly resettling villagers, while the
international community invested heavily in food aid and humanitarian relief, much of which is now believed to have been used for military purposes.

- Phase III (1992–2000): The government pursued agriculture-led industrialization, which introduced policies to boost the production of cereals, accelerate agricultural growth, and attain food security. A large extension program reached approximately 40 percent of farm households. The government also liberalized markets for agricultural products and promoted the use of seed and fertilizer packages to intensify the production of staple crops.

- Phase IV (2001–08): Maize prices collapsed, partly because of intensified production. Drought hindered the production of most cereals and highlighted the country’s vulnerability to price and weather shocks. Afterwards, though Ethiopia achieved 12 percent annual growth in agricultural GDP, food price inflation soared from 2 percent in 2003–04 to 78 percent in 2007–08 (Spielman et al. 2011). The government allocated three million hectares of land for commercial agriculture and offered an array of incentives to encourage investors, the majority of whom came from India.
Despite investments in policies that prioritize agricultural production, Ethiopia has not yet seen stable cereal yields, lower food prices, or less reliance on food aid. These obstacles appear to underpin the 2010–11 drought and famine in Somalia and the Horn of Africa. This shows that agricultural development strategies need to be tailored to local contexts in order to achieve food security. Since the agricultural sector is characterized by smallholders working in heterogeneous agroecological zones, policies need to focus on improving farmers’ access to inputs and information and incentives to adopt and use technologies in each area. A vibrant private sector may be well placed to provide flexibility in input and services to a wide variety of smallholders.

**Looking forward**

Significant advances have been made in improving the availability of and access to food, but far less progress has been achieved in improving the quality of food. There is currently a shift from the concept of food security at the aggregate level to one of nutrition security at the level of every child, woman, and man. This is evidenced by a number of recent initiatives that link agriculture, nutrition, and health. Opportunities to improve nutrition and reduce health risks exist
all along the agricultural value chain, from production to post-harvest processing to marketing and trade. Interventions include biofortification (the breeding of new varieties of food crops with improved nutritional content), and school feeding programs and home food production (to increase consumption of micronutrient-rich vegetables, fruits, and animal-source foods). Some important tools that could help to leverage agriculture for better nutrition and health include economic levers, which include, at the broadest level, agricultural growth or overall economic growth (with the caveat that growth alone is not enough to solve the nutrition problem); and social levers, which involve bringing people together across sectors and within communities to work jointly toward improving nutrition and health. Work on mainstreaming nutritional considerations in the design of cropping and farming systems research must accelerate.

Looking ahead, agriculture will remain for many developing countries the most effective and frequently the only viable lead sector to generate economic growth. Diversification out of agriculture will occur in the long term, but in the short term many countries lack alternatives.

One major challenge is to produce more and more from diminishing per capita arable land and irrigation water resources and expanding abiotic and biotic stresses. Climate change will put more pressure on agriculture by way of either excess or deficit of precipitation, more extreme
weather events, and shifting seasons. On the other hand, agriculture can offer opportunities for mitigating emissions through carbon sequestration, soil and land use management, and biomass production (Nelson 2009). More generally, investments in science and technology will be key, especially in the areas of agricultural research and development, in order to keep the pipeline for innovation, discovery, and dissemination full. Resources must also be targeted to nutrition-relevant projects, like work on nutrient-rich vegetables and other crops and livestock, as almost all agricultural research through the years has been directed toward increasing production of a few staple crops (Fan and Pandya-Lorch 2012).

With long lead times for developing new technologies for small-scale farmers, sustaining public investment in agricultural science and technology in the face of competing demands for public resources will not be easy. The quick uptake of new technologies, such as biofortification, is also complicated by the need to conduct careful research on consumers’ willingness to purchase and utilize new crop varieties. While the public sector is critical in directing attention to the development of crops that can benefit the poor, the private sector can play a significant role in scaling up successful interventions, coordinating disparate actors along the value chain, and reaching a wide array of consumers through marketing campaigns. Considering the different
motivations of these two sectors, private-public partnerships will be crucial in order to create win-win propositions for both producers and consumers.

Another key challenge is the ability to reach smallholders, who comprise the majority of farmers around the world. Smallholders often cannot keep up with the rising demand for food and face limited resources, high marketing and transportation costs, and poor access to markets, affordable inputs and technologies, credit, and infrastructure. Creative options—such as insurance schemes to help reduce small farmers’ risk from weather and price shocks, group lending and contract farming to link farmers to food supply chains, and investments in smallholder climate change adaptation—are just a few possible solutions (Fan 2011). These and other initiatives can help smallholders increase their agricultural production sustainably as well as achieve food security for themselves and their families.

On the macro level, the food price crisis has given way to a number of proposals meant to smooth global price volatility and ensure the food security of the poor, who are most vulnerable to price shocks. These proposals, some of which are already being actualized, include the reform of biofuel policies, the expansion of social safety nets, the elimination of export bans, the
creation of an early warning food crisis system, and the establishment of a globally managed
emergency physical grain reserve.

Agriculture has evolved over the past half century from a narrow focus on staple cereals to a
wider array of crops and livestock and fisheries, from subsistence farming to commercial
agriculture, from the farm to off the farm and toward the larger economy, and from food security
to nutrition security. Agriculture has increasingly integrated gender, equity, and sustainability
considerations into its portfolio. We should look upon agriculture not just as a food-producing
machine but as the major source of skilled and remunerative employment, the backbone of the
rural livelihood system, and a powerful engine toward larger economic growth. Still, agriculture
and food security are part of a larger system that depends on effective and inclusive institutions,
growing non-rural sectors, and attention to demand factors such as incomes, health, social
protection, and care practices to pull people out of poverty and help them live long, healthy lives.
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