

Agricultural Transformation and Rural Development

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It is in the agricultural sector that the battle for long-term economic development will be won or lost.

—Gunnar Myrdal, *Nobel laureate in economics*

Recent developments in the land, water, and energy sectors have been wake-up calls for global food security.

—*International Food Policy Research Institute, 2012*

Many development policies continue to wrongly assume that farmers are men.

—*World Bank, World Development Report, 2008*

Africa is the only region where overall food security and livelihoods are deteriorating. We will reverse this trend by working to create an environmentally sustainable, uniquely African Green Revolution. When our poorest farmers finally prosper, all of Africa will benefit.

—*Kofi Annan, former secretary general of the United Nations, Nobel laureate for peace, and first chairman of the Alliance for a Green Revolution in Africa*

9.1 The Imperative of Agricultural Progress and Rural Development

If the migration of people with and without school certificates to the cities of Africa, Asia, and Latin America is proceeding at historically unprecedented rates, a large part of the explanation can be found in the economic stagnation of outlying rural areas. Despite real progress, nearly 2 billion people in the developing world grind out a meager and often inadequate existence in agricultural pursuits. Over 3.1 billion people lived in rural areas in developing countries in 2013, about a quarter of them in extreme poverty. And despite the extraordinary urbanization taking place throughout the world (examined in Chapter 7), people living in the countryside make up more than 60% of the population in both low- and lower middle-income countries on average. Latin America is highly urbanized, having reached the same level of urbanization as the high-income Organization for Economic Cooperation and Development (OECD) countries by 2011. But in sub-Saharan Africa, rural dwellers constitute 64% of the total population; in South Asia, some 69% of the population live in rural areas as of 2011, with the result that more than half the workforce is concentrated in agriculture. Countries whose population is more than 80% rural include Ethiopia, Nepal, Niger, Papua New Guinea, Rwanda, South Sudan, Sri Lanka, and Uganda. India remains more than two-thirds rural.¹

Of greater importance than sheer numbers is the fact that well over two-thirds of the world's poorest people are also located in rural areas and engaged primarily in subsistence agriculture. Their basic concern is survival. Many hundreds of millions of people have been bypassed by whatever economic progress their nations have attained. The United Nations Food and Agriculture Organization estimated that in 2012, about 870 million people did not have enough food to meet their basic nutritional needs.² In the daily struggle to subsist, behavior of poor farmers in developing countries often seemed irrational to many observers who until recently had little comprehension of the precarious nature of subsistence living and the importance of avoiding risks. If development is to take place and become self-sustaining, it will have to include the rural areas, in general, and the agricultural sector, in particular. The core problems of widespread poverty, growing inequality, and rapid population growth all originate in the stagnation and often retrogression of economic life in rural areas, particularly in Africa.

Traditionally in economic development, agriculture has been assumed to play a passive and supportive role. Its primary purpose is to provide sufficient low-priced food and manpower to the expanding industrial economy, which is thought to be the dynamic "leading sector" in any overall strategy of economic development. Lewis's famous two-sector model, discussed in Chapter 3, is an example of a theory of development that places heavy emphasis on rapid industrial growth, with an agricultural sector fueling this industrial expansion by means of its cheap food and surplus labor. Nobel laureate Simon Kuznets introduced an early schema, noting that agriculture made four "contributions to economic development": the product contribution of inputs for industry such as textiles and food processing, the foreign-exchange contribution of using agricultural export revenues to import capital equipment, the market contribution of rising rural incomes that create more demand for consumer products, and the factor market contribution, divided between the labor contribution (Lewis's manpower)—workers not needed on farms after agricultural productivity was raised could then work in industry—and the capital contribution (some farm profits could be reinvested in industry as agriculture became a steadily smaller fraction of national income). The capital contribution was misapplied as a "squeezing of the peasantry," but it meant investing first in agriculture and later reaping profits that would be partially reinvested in industry. As can be seen from this description, however, the framework implicitly—and ironically—still treats industrialization rather than rural modernization as the core development goal.³

Today, most development economists share the consensus that far from playing a passive, supporting role in the process of economic development, the agricultural sector, in particular, and the rural economy, in general, must play an indispensable part in any overall strategy of economic progress, especially for the low-income developing countries.

An agriculture- and employment-based strategy of economic development requires three basic complementary elements: (1) accelerated output growth through technological, institutional, and price incentive changes designed to raise the productivity of small farmers; (2) rising domestic demand for agricultural output derived from an employment-oriented, urban development strategy; and (3) diversified, nonagricultural, labor-intensive rural development activities that directly and indirectly support and are supported

by the farming community.⁴ To a large extent, therefore, agricultural and rural development has come to be regarded by many economists as the sine qua non of national development. Without such **integrated rural development**, in most cases, industrial growth either would be stultified or, if it succeeded, would create severe internal imbalances in the economy.

Seven main questions, therefore, need to be asked about agricultural and rural development as it relates to overall national development:

1. How can total agricultural output and productivity per capita be substantially increased in a manner that will directly benefit the average small farmer and the landless rural dweller while providing a sufficient food surplus to promote food security and support a growing urban, industrial sector?
2. What is the process by which traditional low-productivity (peasant) farms are transformed into high-productivity commercial enterprises?
3. When traditional family farmers and traditional (peasant) cultivators resist change, is their behavior stubborn and irrational, or are they acting rationally within the context of their particular economic environment?
4. What are the effects of the high risks faced by farmers in low-income countries, how do farm families cope with these risks, and what policies are appropriate to lessen risk?
5. Are economic and price incentives sufficient to elicit output increases among traditional (peasant) agriculturalists, or are institutional and structural changes in rural farming systems also required?
6. Is raising agricultural productivity sufficient to improve rural life, or must there be concomitant off-farm employment creation along with improvements in educational, medical, and other social services? In other words, what do we mean by *rural development*, and how can it be achieved?
7. How can countries most effectively address problems of national food security?

In this chapter, after a look at broad trends, we will examine the basic characteristics of agrarian systems in Latin America, Asia, and Africa. Although there is considerable diversity among developing nations, as well as within developing countries, each region tends to have a number of characteristics in common. First, these regions typically reflect the agricultural patterns of agriculture-based economies (in Africa), agriculturally transforming economies (in Asia), and urbanized economies (in Latin America). Relatedly, agriculture in these regions often typifies the stages of subsistence, mixed, and commercial farming, with important regional exceptions and varying success at inclusion of the poor. With successful development, countries tend to move toward commercialized agriculture, though with different trajectories and differing economic, social, and technical problems to solve along the way. Regions that have high concentrations of poverty also often reflect patterns of traditional agriculture (in Africa), high population density and subdivided smallholdings (in Asia), and the sharp inequalities of very large and very small farms (in Latin America). We will identify the various challenges facing

Integrated rural development

The broad spectrum of rural development activities, including small-farmer agricultural progress, the provision of physical and social infrastructure, the development of rural nonfarm industries, and the capacity of the rural sector to sustain and accelerate the pace of these improvements over time.

each group of countries and look at countries that are typical of their region and some countries and districts that deviate from the pattern.

Over two-thirds of the world's extreme poor are involved in agricultural activities. We will therefore examine the economics of traditional (or peasant) subsistence agriculture and discuss the stages of transition from subsistence to commercial farming in developing nations. Our focus is not only the economic factors but also on the social, institutional, and structural requirements of small-farm modernization. We will then explore the meaning of *integrated rural development* and review alternative policies designed to raise levels of living in rural areas. The chapter concludes with a case study of problems of agricultural extension for women farmers in Africa.

9.2 Agricultural Growth: Past Progress and Current Challenges

Trends in Agricultural Productivity

The ability of agricultural production to keep pace with world population growth has been impressive, defying some neo-Malthusian predictions that global food shortages would have emerged by now. And it has actually been output gains in the developing world that have led the way. According to World Bank estimates, the developing world experienced faster growth in the value of agricultural output (2.6% per year) than the developed world (0.9% per year) during the period 1980–2004. Correspondingly, developing countries' share of global agricultural GDP rose from 56% to 65% in this period, far higher than their 21% share of world nonagricultural GDP. Since 2005, the growth gap has widened further. And research by the International Food Policy Research Institute points up that a wide range of successful programs have reduced hunger while raising agricultural productivity over the last several decades, including **Green Revolution** successes in Asia; containment of wheat rusts; improved maize and pest-resistant cassavas in sub-Saharan Africa; shallow tubewells for rice and homestead food production in Bangladesh; hybrid rice and mung bean improvement in East Asia; pearl millet and sorghum and smallholder dairy marketing in India; improved tilapia in the Philippines; successful land tenure reform in China and Vietnam; cotton reforms in Burkina Faso; and improvements of markets in Kenya.⁵

The degree to which general agricultural output grew significantly faster in developing countries in the 40-year period from 1970 to 2010 is reflected in Table 9.1. Output also grew in OECD regions; the sole exception was the poor performance in the transition countries. But growth in the value of output has not kept pace with population growth in Africa.

As Figure 9.1 shows, low-income countries tend to have the highest share of the labor force in agriculture, sometimes as much as 80 to 90%. The share of agriculture in GDP is lower but can represent as much as half of the value of output. These shares both tend to fall as GDP per capita rises: This is one of the broad patterns of economic development (see Chapter 3). But attention to the time paths of the share of agriculture in specific countries reveals a great deal of variation, which is also informative. In particular, sometimes the share of labor in agriculture declines greatly even when GDP per capita does not

Green Revolution The boost in grain production associated with the scientific discovery of new hybrid seed varieties of wheat, rice, and corn that have resulted in high farm yields in many developing countries.

TABLE 9.1 Average Annual Growth Rates of Agriculture, by Region (%)

	1971–1980	1981–1990	1991–2000	2001–2010	1971–2010
High-income countries	1.83	0.97	1.25	0.47	1.14
Developing countries					
Latin America and Caribbean	2.93	2.35	3.09	3.21	2.89
Northeast Asia	3.23	5.04	5.04	3.39	4.19
South Asia	2.19	3.70	2.76	2.80	2.86
Southeast Asia	3.66	3.32	3.41	4.23	3.64
Sub-Saharan Africa	1.05	2.68	3.11	2.97	2.44
West Asia and North Africa	3.31	3.84	2.61	2.75	3.13
Transition countries	0.81	1.42	–4.03	2.28	0.04
World	2.08	2.42	2.09	2.42	2.25

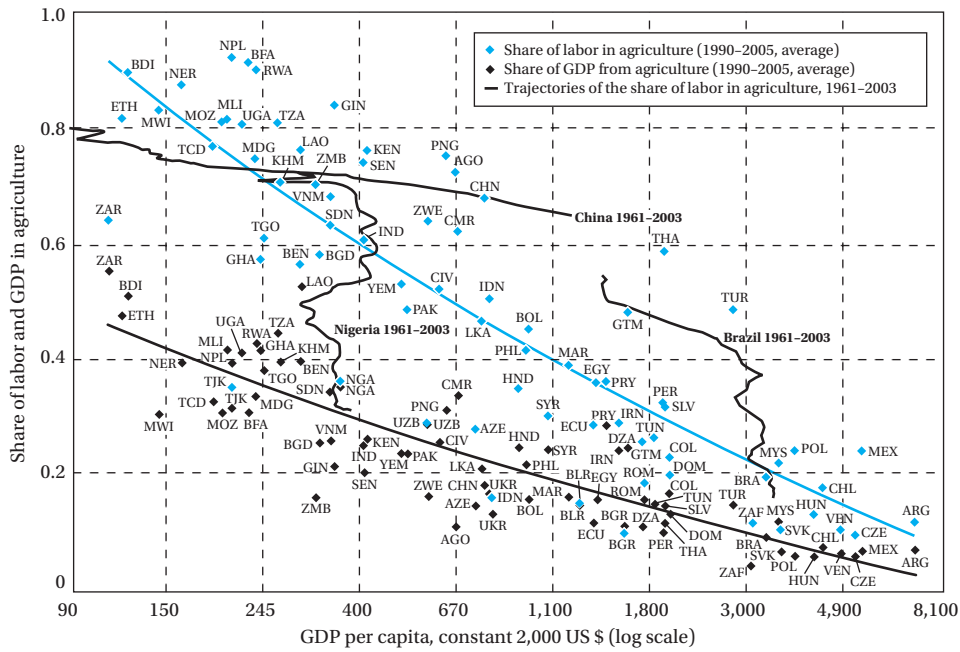
Source: IFPRI (International Food Policy Research Institute). 2013. Global Food Policy Report, Table 1. Washington, DC.

increase much, if at all; examples are seen in the time paths of Nigeria and Brazil, as traced out in Figure 9.1. This finding parallels the observation in the Chapter 7, that urbanization is proceeding in many countries even when per capita income is falling or not rising much. Problems in the agricultural sector can suppress incomes, encouraging more migration to the urban informal sector. We will review the most important problems of developing-country agriculture in this chapter. Figure 9.1 also illustrates the time path of China, in which growth has been extremely rapid but the fall of the share of labor in agriculture has been unusually slow due in significant part to restrictions on rural-urban migration (though migration out of agriculture has greatly accelerated in the ensuing decade through 2013).

In marked contrast to the historical experience of advanced countries' agricultural output in their early stages of growth, which always contributed at least as much to total output as the share of the labor force engaged in these activities, the fact that contemporary agricultural employment in developing countries is much higher than agricultural output reflects the relatively low levels of labor productivity compared with those in manufacturing and commerce.

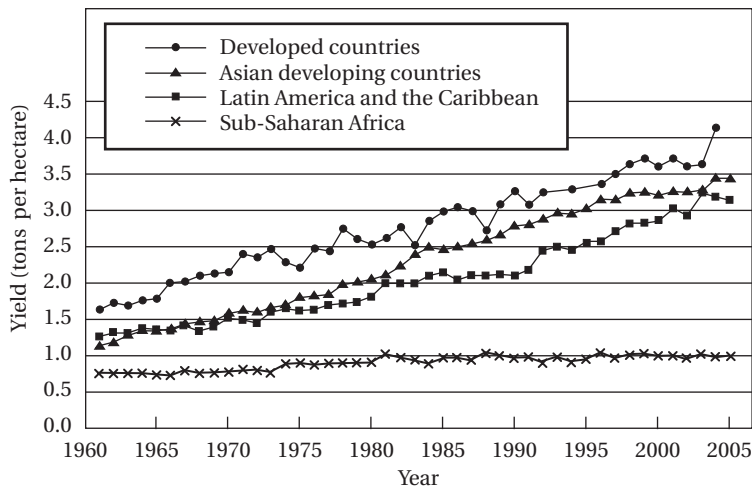
Agricultural production continues to rise around the world, broadly keeping pace with the rising population. But progress has been very uneven, as seen in Figure 9.2. In Asian developing countries, cereal yields per hectare in 2005 were nearly triple their 1960 levels. Production in Latin America also posted strong gains. Hunger in China fell. Agriculture in South Asia performed well, although hunger is thought to have increased in India in recent years. And in sub-Saharan Africa, yields increased by only about one-third. One of the causes is that in many areas of Africa, the population has reached a size where traditional slash-and-burn agricultural practices are no longer feasible without reusing land after too little rest, resulting in significant deterioration of soil nutrients. But subsistence farmers cannot purchase improved seeds, fertilizers, and other essentials of modern agriculture; the result can be a poverty trap in which farmers must work harder and harder just to stay in place.

FIGURE 9.1 As Countries Develop, the Shares of GDP and Labor in Agriculture Tend to Decline, but with Many Idiosyncrasies



Source: International Bank for Reconstruction and Development/World Bank, *World Development Report, 2008*. Reprinted with permission.
 Note: The list of 3-letter codes and the countries they represent can be found in Table 2.1 on pp. 43–44 of this text.

FIGURE 9.2 Cereal Yields by World Region, 1960–2005



Source: International Bank for Reconstruction and Development/The World Bank, *World Development Report, 2008*. Reprinted with permission.

Recurrent famine, regional famine, and catastrophic food shortages have repeatedly plagued many of the least developed countries, particularly in Africa. The 2011 drought and famine in the Horn of Africa, which affected over 13 million people, brought renewed attention to the problem (see Box 9.1). Of Africa's 750 million people, more than 270 million suffer from some form of malnutrition associated with inadequate food supplies. The severe famine of 1973–1974 took the lives of hundreds of thousands and left many more with permanent damage from malnutrition across the continent in the Sahelian belt that stretches below the Sahara from Cape Verde, off the coast of Senegal in the west, all the way to Ethiopia in the east. Four times in the 1980s and 1990s, at least 22 African nations faced severe famine. In the 2000s, famine again seriously affected African countries as widely separated as Mauritania in the northwest, Ethiopia and Eritrea in the east, and Angola, Zambia, Zimbabwe, Malawi, and Mozambique across the south.⁶ The recent famine in the Horn of Africa is examined in Box 9.1.

Calls to mount a new Green Revolution in Africa like the successful one in Asia are now starting to get the hearing they deserve, with public, private, and nonprofit sector actors getting involved—including major support from the Alliance for a Green Revolution in Africa (AGRA), chaired by former UN secretary general Kofi Annan. Technical advances are clearly needed, and institutional and social transformation on the ground will also be needed to achieve the goals of rural development. The African Union's peer-review NEPAD initiative developed the Comprehensive Africa Agricultural Development Program to emphasize investments and regional cooperation in agriculture-led growth as a main strategy to achieve the first Millennium Development Goal of halving hunger and poverty. It targets the allocation of 10% of national budgets to agriculture and a 6% rate of growth in the agriculture sector at the national level.⁷

One early success is in work at the Africa Rice Center in Benin to develop varieties of New Rice for Africa (NERICA). These have so far proven beneficial in Benin, Uganda, and the Gambia, with apparently greater impact on women farmers than men farmers. It is not easy to replicate successes across Africa, however; for example, NERICA varieties have not helped in Guinea and Côte d'Ivoire. And food production will not automatically solve the problems of hunger among people living in poverty.

The food price spike of 2007–2008 and an additional spike in 2011 highlighted the continuing vulnerabilities. During the food price crisis, progress in reducing hunger ground to a halt and showed little improvement in the ensuing years. Some of the causes were temporary factors. But expert predictions are for high food prices in the longer term. Throughout the twentieth century, food prices fell at an average rate of 1% per year; but so far in the twenty-first century, food prices have risen on average. Figure 9.3 shows price trends for several key agricultural commodities; prices have generally returned to levels not seen since the late 1970s.⁸

As Nora Lustig has summarized, some of the causes of the 2007–2008 food price spike also reflect longer-term forces that will lead to high future food prices, including diversion of food to biofuels production, increase in the demand for food (particularly meat, which uses much more land than grain

**BOX 9.1** Development Policy Issues: Famine in the Horn of Africa

On July 20, 2011, the United Nations declared formally that a famine was under way in two regions of Somalia, after horrific images of suffering were publicized.

Facts about the Famine

Somalia and neighboring countries faced a terrible drought, probably the worst in a half-century. More importantly, it took place in one of world's worst governance situations, which created a catastrophe for many women, children, and other noncombatants caught in the crossfire—metaphorically and sometimes literally. The situation was further compounded by rapidly increasing food prices. Tens of thousands of people died as a result of this famine according to UN estimates. The appalling images of the famine compare with similar catastrophes, and already 100,000 residents reportedly fled to refugee camps to seek shelter and food. Health and nutrition conditions in the camps were reportedly very dangerous. Malnutrition rates in southern Somalia are among the highest in the world, over 50% in some regions, with 6 deaths per 10,000 people per day. After famine was declared, some commentators said starvation in Somalia seemed like a never-ending story, but this was the first time in close to 20 years that conditions reached the point of a declared famine.

Drought afflicts not just Somalia but also parts of Ethiopia, Kenya, and South Sudan, and agencies report that about 11.5 million people are severely affected. A key to the drought seems to be an unusually strong Pacific La Niña, which has interrupted seasonal rains for the last two seasons. About half of all livestock has died in some areas. Staple food prices are soaring in affected areas, making the situation dire for the poor. Globally, food prices have risen greatly over the past few years with a new spike in 2011, which saw average global prices nearly double. Some causes are temporary including bad weather, but longer-term forces at work include diversion of food to biofuels production, increase in demand, including grain, for meat production for China, general population growth, higher energy prices

affecting agricultural costs, lack of new farmland, and impacts of climate change. Food prices have shot up more than the global average in this region, most dramatically in Somalia, where prices reportedly have tripled—just when the earnings capacity of most households has been falling. There are severe hardships in the other drought-stricken areas, such as northern Kenya, and people living there are at serious risk and need help. At the same time, more aid is getting to those who need it, and the suffering is not on the same scale, reflecting Somalia's "man-made" famine conditions.

Perspective on the Region

The East African "Horn" region is sometimes given a broad definition to include large parts of Ethiopia, Eritrea, Kenya, Djibouti, southern Sudan, and Uganda as well as Somalia. Taken as a region, the Horn is the poorest area in sub-Saharan Africa, though at least nine individual countries elsewhere in Africa are even poorer. Conditions in the region have historically been difficult; the record shows drought has intermittently afflicted the area. No doubt the region was seriously harmed by colonialism, with regions agglomerated arbitrarily, notably Eritrea to Ethiopia, and South Sudan to northern Sudan. This is a major reason the region has been plagued by conflict in the postcolonial era. The assumption in much of the press is that there must be something fundamentally different and special about the geography and climate of this region and the culture of its peoples to explain its recurrent plight. But, in fact, similar root problems are found in this area as in other regions that have failed to develop: poor institutions, ethnolinguistic fractionalization, and "fault lines" of regional inequality corresponding with ethnic or religious areas. Undoubtedly the area has some quite unfavorable geography; but other regions with unfavorable endowments have substantially overcome their disadvantages over time. However, adapting to future impacts of climate change projected for this region will be a challenge the international community will have to respond to.

Other conditions have compounded the problems; for example, Somalia's population was well under 3 million in 1960 but is well over 9 million today, and this is a factor putting strain on the food supply. However, as explained in Chapter 6, the poor have children as a survival necessity; rapid population is far more a symptom of poverty than its cause.

International Response

This famine has already reached a huge scale, and it would be difficult to reach all the affected people without a large, consolidated effort even under low-conflict conditions. But as with the last famine in Somalia in 1992, it will be one thing to rush food into the country and another to see that it reaches many of the people most in need. Al-Shabaab, a militant Islamist group linked to Al-Qaeda controls large parts of the declared famine areas. Some relief groups are getting through, but the militants have thwarted efforts by the UN'S World Food Program (WFP)—one of the most efficient food deliverers—from coming into these regions, claiming the WFP is biased and has a hidden agenda. The militants claim drought conditions have been exaggerated into famine proportions for political purposes, but the facts on the ground are too obvious to ignore; and there are indications they are reconsidering: There is little political gain in claiming dominance of an area depopulated by the escape of refugees and famine deaths. But governments, international organizations, and NGOs are now gearing up for a full-scale response to worsening famine. The problem is complex, because low incomes resulting from drought mean people cannot afford food, but dumping food on markets may keep prices so low that local growers find it unfavorable to produce for the market. In response, an important strategy is to purchase food for those suffering from local producers whenever possible.

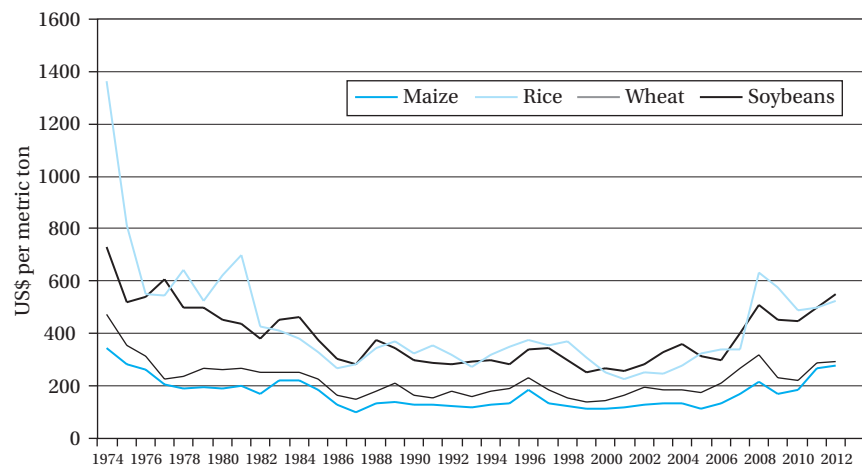
The Entitlement Problem

Historically, a large majority of famines have been “man-made.” Amartya Sen frames “the acquirement problem” as one of establishing “command over commodities.” *Famine* is defined for international

humanitarian and UN purposes as a combination of child malnutrition, deaths from hunger, and low food access, specifically: (1) more than 30% of children suffering from acute malnutrition; (2) more than two adults or four children dying of hunger each day per 10,000 people; and (3) the population overall having access to less than 2,100 kilocalories of food and 4 liters of water per day on average. This definition is not quite the same as Webster's “extreme scarcity of food; a great shortage.” For example, in the Bangladesh famine in 1974, food output was actually there; it just wasn't getting to hungry people. According to Amartya Sen's research, also in Bengal in 1943, incomes were actually up as an average, which increased those more fortunate peoples' purchasing power, thus pushing food prices up, and then others such as laborers could not afford it in sufficient amounts.

In Somalia, and elsewhere in the region, output is drastically lower due to the severe drought. Commonly in famines, when many people are unable to buy as much locally grown food as they usually do, it becomes more attractive for sellers to export food out of the area. But if people had earning power, they could afford to buy food and traders would bring it to villages where they lived. The problem is that markets may not provide command over commodities, or entitlements, which people living in poverty need to survive in such conditions. While specific evidence of food exporting is not yet readily verifiable in Somalia, this problem is one of the reasons why public action is generally needed in a famine when entitlement is not established. There may be droughts and drastic declines in food output, but there never needs to be a famine.

Sources: Dreze, Jean, and Amartya Sen. *Hunger and Public Action*. New York: Oxford University Press, 1989; Amartya Sen. *Poverty and Famines: An Essay on Entitlement and Deprivation*. New York: Oxford University Press, 1981. For more details on the economics of conflict and development, see section 14.6, pages 708–717. For analysis of the importance of institutions and the historical legacy, see section 2.7, pages 83–91. On impact of and adaptation to climate change in developing countries, see section 10.3, pages 476–480

FIGURE 9.3 World Prices for Agricultural Commodities, 1974–2012

Source: Based on International Food Policy Research Institute, 2012 Global Food Policy Report, p. 90 (Washington, D.C.: IFPRI, 2013); downloaded at: <http://www.ifpri.org/sites/default/files/publications/gfpr2012.pdf> (accessed February 7, 2014). Prices for 2012 are through August 2012.

Note: Prices are in real 2005 US dollars.

production) due to higher incomes in China and elsewhere, the slowdown in productivity growth of agricultural commodities, higher energy prices affecting agricultural input costs, running out of new land to be brought into farming, and the negative impact of climate change on developing-country food production. These are exacerbated by a number of unfavorable policies, including various forms of interference with food prices.⁹

Furthermore, there is not a large global market for food in relation to total demand. Most countries strive for food self-sufficiency, largely for national security reasons. Embargoes of food exports by such countries as Egypt, Vietnam, and Russia reflect this reluctance. In the late 2040s, the world will find itself having to manage to feed over 9 billion people. While highlighting impressive successes, we must also keep in mind looming challenges.

Market Failures and the Need for Government Policy

A major reason for the relatively poor performance of agriculture in low-income regions has been the neglect of this sector in the development priorities of their governments, which the initiatives just described are intended to overcome. This neglect of agriculture and the accompanying bias toward investment in the urban industrial economy can in turn be traced historically to the misplaced emphasis on rapid industrialization via import substitution and exchange rate overvaluation (see Chapter 12) that permeated development thinking and strategy during the postwar decades.¹⁰

If agricultural development is to receive a renewed emphasis, what is the proper role for government? In fact, one of the most important challenges for agriculture in development is to get the role of government right. A major theme of development agencies in the 1980s was to reduce government intervention in agriculture. Indeed, many of the early interventions did more harm than good; an extreme example is government requirements for farmers to sell at a low price to state marketing boards, an attempt to keep urban food prices low. Production subsidies, now spreading like a contagion from high-income to middle-income countries, are costly and inefficient.

Agriculture is generally thought of as a perfectly competitive activity, but this does not mean that there are no market failures and no role for government. In fact, market failures in the sector are quite common and include environmental externalities, the public good character of agricultural research and development and extension services, economies of scale in marketing, information asymmetries in product quality, missing markets, and monopoly power in input supply, in addition to the more general government roles of providing institutions and infrastructure. Despite many failures, sometimes government has been relatively effective in these roles, as in Asia during its Green Revolution.¹¹

But government also has a role in agriculture simply because of its necessary role in poverty alleviation—and a large majority of the world's poor are still farmers. Poverty itself prevents farmers from taking advantage of opportunities that could help pull them out of poverty. Lacking collateral, they cannot get credit. Lacking credit, they may have to take their children out of school to work, transmitting poverty across generations. Lacking health and nutrition, they may be unable to work well enough to afford better health and nutrition. With a lack of information and missing markets, they cannot get insurance. Lacking insurance, they cannot take what might seem favorable risks for fear of falling below subsistence. Without middlemen, they cannot specialize (and without specialization, middlemen lack incentives to enter). Being socially excluded because of ethnicity, caste, language, or gender, they are denied opportunities, which keep them excluded. These poverty traps are often all but impossible to escape without assistance. In all of these areas, NGOs can and do step in to help (Chapter 11), but government is needed to at least play a facilitating role and to create the needed supporting environment.¹²

Policies to improve efficiency and alleviate poverty are closely related. Many market failures, such as missing markets and capital market failures, sharply limit the ability of poor farmers to take advantage of opportunities of globalization when governments liberalize trade, for example. If these problems are not addressed prior to deregulation or making other structural changes, the poor can remain excluded and even end up worse off. A key role for government, then, is to ensure that growth in agriculture is shared by the poor. In some countries, impressive agricultural growth has occurred without the poor receiving proportional benefits. Examples include Brazil, with its extremely unequal land distribution, and Pakistan, with its social injustices and inequality of access to key resources such as irrigation. But by including the poor, the human and natural resources of a developing nation are more fully employed, and that can result in an increased rate of growth as well as poverty reduction.¹³

9.3 The Structure of Agrarian Systems in the Developing World

Three Systems of Agriculture

A first step toward understanding what is needed for further agricultural and rural development progress is a clear perspective of the nature of agricultural systems in diverse developing regions and, in particular, of the economic aspects of the transition from subsistence to commercial agriculture.

One helpful way to categorize world agriculture, proposed by the agricultural development economist Alain de Janvry and his colleagues in the World Bank's 2008 *World Development Report*, is to see that alongside advanced agricultural systems in developed countries, three quite different situations are found among developing countries.

First, in what the report terms *agriculture-based countries*, agriculture is still a major source of economic growth—although mainly because agriculture makes up such a large share of GDP. The World Bank estimates that agriculture accounts for some 32% of GDP growth on average in these countries, in which 417 million people live. More than two-thirds of the poor of these countries live in rural areas. Some 82% of the rural population of sub-Saharan Africa lives in these countries. It also includes a few countries outside the region, such as Laos. And a few African countries, such as Senegal, are undergoing transformation.

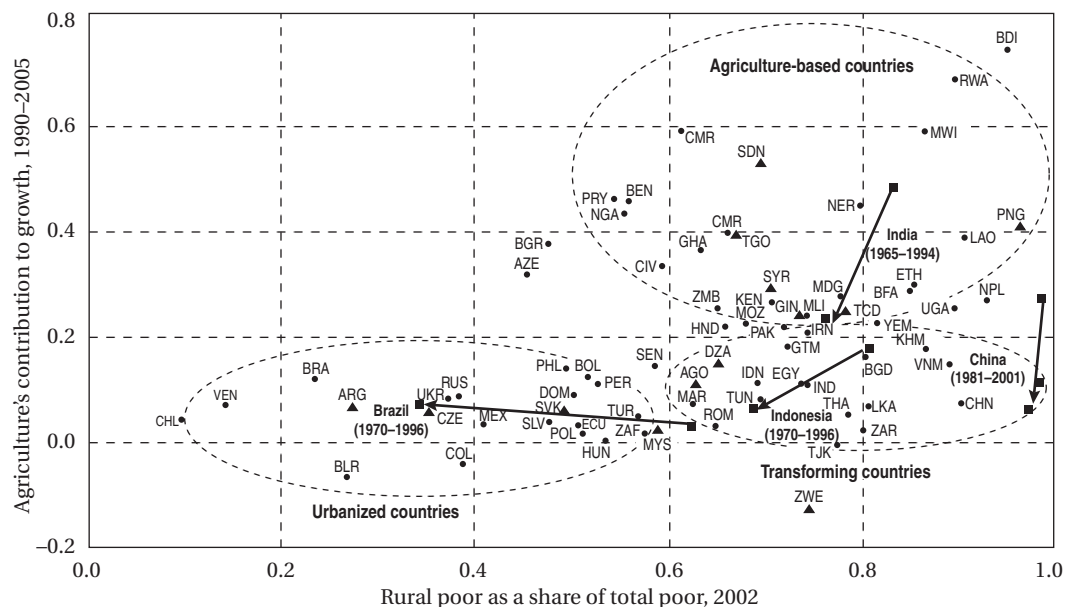
Second, most of the world's rural people—some 2.2 billion—live in what the report categorizes as transforming countries, in which the share of the poor who are rural is very high (almost 80% on average) but agriculture now contributes only a small share to GDP growth (7% on average). Most of the population of South and East Asia, North Africa, and the Middle East lives in these countries, along with some outliers such as Guatemala.

Third, in what the report calls *urbanized countries*, rural-urban migration has reached the point at which nearly half, or more, of the poor are found in the cities, and agriculture tends to contribute even less to output growth. The urbanized countries are largely found in Latin America and the Caribbean, along with developing eastern Europe and Central Asia, and contain about 255 million rural dwellers.

In many cases, the position of countries within these groups is not stagnant. Many countries that were in the agriculture-based category moved to the transforming category in recent decades, most prominently India and China.

Figure 9.4 shows some of the country positions in each group, along with the movement over time for four major countries over an approximately three-decade period: China, India, Indonesia, and Brazil. For example, Brazil has moved from being a borderline transforming country to a solidly urbanized one according to the World Bank classification.

Agricultural productivity varies dramatically across countries. Table 9.2 shows variations in land productivity (measured as kilograms of grain harvested per hectare of agricultural land) between 3 developed countries (Canada, Japan, and the United States) and 12 developing countries, along with the averages for low-, middle-, and high-income countries. Despite the far smaller number of farmworkers per hectare in the United States, its grain yield per hectare was about 2.4 times that of India and almost 9 times that of the DRC

FIGURE 9.4 Agriculture's Contribution to Growth and the Rural Share in Poverty in Three Types of Countries

Source: International Bank for Reconstruction and Development/The World Bank, *World Development Report*, 2008. Reprinted with permission.

Note: Arrows show paths for Brazil, China, India, and Indonesia in previous periods. A triangle denotes predicted poverty data used. Country letter codes are found in Table 2.1 on pp. 43-44 of this text.

(Congo). The value added per worker in U.S. agriculture was over 75 times that of India and over 177 times that of Congo.

It is also important to note that regional disparities can be quite large *within* countries. India has regions that fall within each of the three classifications, from modernized Punjab to semifeudal Bihar. Even upper-middle-income, urbanized Mexico has regions in the south with substantial poverty and high dependence on agriculture. Moreover, within regions, large and small, rich and poor often exist side by side—though large does not necessarily mean efficient. Let us look at agricultural issues facing countries in Latin America, Asia, and sub-Saharan Africa in more detail.

Traditional and Peasant Agriculture in Latin America, Asia, and Africa

In many developing countries, various historical circumstances have led to a concentration of large areas of land in the hands of a small class of powerful landowners. This is especially true in Latin America and parts of the Asian subcontinent. In Africa, both historical circumstances and the availability of relatively more unused land have resulted in a different pattern and structure of agricultural activity.

Although the day-to-day struggle for survival permeates the lives and attitudes of impoverished peasants in both Latin America and Asia (and also

TABLE 9.2 Labor and Land Productivity in Developed and Developing Countries

Country Group	Agricultural Productivity (value added per worker, US\$, in 2011)	Average Grain Yield (kilograms per hectare, 2011)
Low-income	337	2,035
Middle-income	953	3,678
High-income	21,957	4,645
Country		
Burundi	123	1,326
Congo, DR	281	766
Senegal	346	966
Kenya	363	1,514
Bangladesh	475	4,191
Bolivia	629	2,365
India	657	2,883
China	713	5,706
Ghana	810	1,594
Indonesia	937	4,886
Mexico	4,028	3,241
Brazil	5,019	4,038
Japan	42,953	4,911
United States	49,817	6,818
Canada	59,818	3,527

Source: Based on data from World Bank, *World Development Indicators*, 2013 (Washington, D.C.: World Bank, 2013), tab. 3.3.

Agrarian system The pattern of land distribution, ownership, and management, and also the social and institutional structure of the agrarian economy.

Africa, although the rural structure and institutions are considerably different), the nature of their **agrarian systems** differs markedly. In Latin America, in a number of poorer and more backward areas, the peasants' plight is rooted in the *latifundio–minifundio* system (to be explained shortly). In Asia, it lies primarily in fragmented and heavily congested dwarf parcels of land. The average farm size in Latin America is far larger than in Asia; the countries included in Table 9.3 are typical. The average farm size for Latin American countries such as Ecuador, Chile, Panama, and Brazil are several *times* larger than farm size in Asian countries such as Bangladesh, Pakistan, Thailand, and India. But the variance of farm size is much higher in Latin America, with huge farmlands controlled by the largest farms in Latin America. As the table reveals, patterns are anything but uniform, with farms in some countries splitting into smaller sizes and in other countries consolidating to larger sizes, and some experiencing increasing and others showing decreasing inequality over time.

Just as we can draw income Lorenz curves from data on the distribution of income (see Figure 5.1), we can draw land Lorenz curves from data on the distribution of farmholds among farmers. In this case, the *x*-axis reports the proportion of total holdings, and the *y*-axis reports the proportion of total

TABLE 9.3 Changes in Farm Size and Land Distribution

Country	Period	Land Distribution Gini (percent)		Average Farm Size (hectares)		Change (%)		Farm Size Definition Used
		Start	End	Start	End	Total Number of Farms	Total Area	
Smaller Farm Size, More Inequality								
Bangladesh	1977–1996	43.1	48.3	1.4	0.6	103	–13	Total land area
Pakistan	1990–2000	53.5	54.0	3.8	3.1	31	6	Total land area
Thailand	1978–1993	43.5	46.7	3.8	3.4	42	27	Total land area
Ecuador	1974–2000	69.3	71.2	15.4	14.7	63	56	Total land area
Smaller Farm Size, Less Inequality								
India	1990–1995	46.6	44.8	1.6	1.4	8	–5	Total land area
Egypt	1990–2000	46.5	37.8	1.0	0.8	31	5	Total land area
Malawi	1981–1993	34.4	33.2 ^a	1.2	0.8	37	–8	Cultivated crop area
Tanzania	1971–1996	40.5	37.6	1.3	1.0	64	26	Cultivated crop area
Chile	1975–1997	60.7	58.2	10.7	7.0	6	–31	Arable land area
Panama	1990–2001	77.1	74.5	13.8	11.7	11	–6	Total land area
Larger Farm Size, More Inequality								
Botswana	1982–1993	39.3	40.5	3.3	4.8	–1	43	Cultivated crop area
Brazil	1985–1996	76.5	76.6	64.6	72.8	–16	–6	Total land area
Larger Farm Size, Less Inequality								
Togo	1983–1996	47.8	42.1	1.6	2.0	64	105	Cultivated crop area
Algeria	1973–2001	64.9	60.2	5.8	8.3	14	63	Arable land area

^aFigure for 2004–2005

Source: *World Development Report, 2008: Agriculture and Development* by World Bank. Copyright © 2008 by World Bank. Reproduced with permission.

area. A land Gini may be calculated in a manner analogous to that of the income Gini: It is the ratio of the area between the land Lorenz curve and the 45-degree line, and the whole triangle. Table 9.3 presents land Gini coefficients and their change over time for representative developing countries.

One of the broadest trends is for farm sizes to become smaller over time in Asia as land is subdivided, and this trend is seen increasingly also in Africa.

Agrarian Patterns in Latin America: Progress and Remaining Poverty Challenges

In Latin America, as in Asia and Africa, agrarian structures are not only part of the production system but also a basic feature of the entire economic, social, and political organization of rural life. The agrarian structure that has existed in Latin America since colonial times and is still widespread in a substantial

Latifundio A very large landholding found particularly in the Latin American agrarian system, capable of providing employment for more than 12 people, owned by a small number of landlords, and comprising a disproportionate share of total agricultural land.

Minifundio A landholding found particularly in the Latin American agrarian system considered too small to provide adequate employment for a single family.

Family farm A farm plot owned and operated by a single household.

Medium-size farm A farm employing up to 12 workers.

Transaction costs Costs of doing business related to gathering information, monitoring, establishing reliable suppliers, formulating contracts, obtaining credit, and so on.

part of the region is a pattern of agricultural dualism known as *latifundio-minifundio*.¹⁴ Basically, *latifundios* are very large landholdings. They are usually defined as farms large enough to provide employment for more than 12 people, though some employ thousands. In contrast, *minifundios* are the smallest farms. They are defined as farms too small to provide employment for a single family (two workers) with the typical incomes, markets, and levels of technology and capital prevailing in each country or region.

Using Gini coefficients to measure the degree of land concentration, as seen in Table 9.3, researchers report that the coefficient for Brazil is 0.77, for Panama is 0.75, and for Ecuador is 0.71. Although estimates vary, changes in land inequality are limited in the case of Latin America (for example, see the data for Brazil and Ecuador in Table 9.3). Other countries are even more unequal; the Gini for Paraguay has been estimated to be an astoundingly unequal 0.94, and very high inequality has been estimated for Colombia and Uruguay, among others.¹⁵ These are the highest regional Gini coefficients in the world, and they dramatically reflect the degree of land ownership inequality (and thus, in part, income inequality) throughout Latin America.

But *latifundios* and *minifundios* do not constitute the entirety of Latin American agricultural holdings. A considerable amount of production occurs on **family farms** and **medium-size farms**. The former provide work for two to four people (recall that the *minifundio* can provide work for fewer than two people), and the latter employ 4 to 12 workers (just below the *latifundio*). In Venezuela, Brazil, and Uruguay, these intermediate farm organizations account for almost 50% of total agricultural output and employ similar proportions of agricultural labor. These farms use a more efficient balance between labor and land, and studies show that they have a much higher total factor productivity than either *latifundios* or *minifundios*, as the law of diminishing returns would suggest. Indeed, evidence from a wide range of developing countries demonstrates that smaller farms are more efficient (lower-cost) producers of most agricultural commodities.¹⁶

A major explanation for the relative economic inefficiency of farming the fertile land on the *latifundios* is simply that the wealthy landowners often value these holdings not for their potential contributions to national agricultural output but rather for the considerable power and prestige that they bring. Much of the land is left idle or farmed less intensively than on smaller farms. Also, *latifundio* **transaction costs**, especially the cost of supervising hired labor, are much higher than the low effective cost of using family labor on family farms or *minifundios*. It follows that raising agricultural production and improving the efficiency of Latin American agrarian systems in traditional areas will require much more than direct economic policies that lead to the provision of better seeds, more fertilizer, less distorted factor prices, higher output prices, and improved marketing facilities.¹⁷ It will also require a reorganization of rural social and institutional structures to provide Latin American peasants, particularly indigenous people who find it more challenging to migrate, a real opportunity to lift themselves out of their present state of economic subsistence and social subservience.¹⁸

Despite the fact that many *minifundio* owners remain in poverty, especially among indigenous and mixed-race populations, and many *latifundios* continue to operate well below their productivity potential, a more dynamic sector,

including some larger farms, has emerged. Efficient family and medium-size farms are found throughout the region.

At an aggregate level, the agricultural sector in Latin America appears to be doing fairly well. Chile has led the way in “nontraditional exports,” notably fresh fruits for the northern hemisphere winter markets and also aquaculture, vegetables, and wines; performance in Chile has benefited from an active and relatively efficient agricultural extension system that has included efforts to promote new exports. Diversification has reduced variance in export earnings. Productivity growth in cereals has been quite solid. Sugarcane-based biofuels and soybeans have played important roles in agricultural growth in Brazil. And in traditional exports, particularly coffee, Latin America has led the way in taking advantage of niche opportunities for higher-value-added activities such as organic and Fair Trade markets.¹⁹

Some Latin American countries, such as Guatemala and Honduras, are still in the mixed transition phase, and in such countries, the *latifundio-minifundio* pattern tends to remain particularly dominant. But much of this pattern still prevails in many other areas. As noted in Chapter 2, the extreme rural inequalities in Latin America typically stem from the Spanish and Portuguese colonial period, in which indigenous peoples were exploited in what often amounted to slavery (see Box 2.3 on continuing effects of the *mita* system in Peru) and African slaves were forcibly brought to the region. Overcoming this legacy has been a long and painful process, with much remaining to be achieved. Social discrimination continues, and improved access for the poor to agricultural land in countries such as Colombia is still in all too many cases suppressed.²⁰

Areas with less favorable agricultural conditions, often with a concentration of minority populations, such as northeast Brazil, the Andean region, and parts of Mexico and Central America, tend to have persistently high poverty levels. Extreme rural inequality inhibits progress in these areas, both because of reduced access by the poor to credit and other inputs and because elites effectively continue to block political participation by the poor, who often receive low levels of government services. Moreover, rural-to-urban migration has been disproportionately among more educated people, and the result is that rural populations are becoming older, more female, and more indigenous. These are factors in poverty rates that remain high for middle-income countries and will require sustained action by government and civil society.²¹

Transforming Economies: Problems of Fragmentation and Subdivision of Peasant Land in Asia

If the major agrarian problem of Latin America, at least in traditional areas, can be identified as too much land under the control of too few people, the basic problem in Asia is one of too many people crowded onto too little land. For example, the average farm size is just 3.4 hectares in Thailand, 3.1 hectares in Pakistan, 1.4 hectares in India, and 0.6 hectares in Bangladesh; in each of these cases, farm sizes have been getting even smaller over time (see Table 9.3). The land is distributed more equally in Asia than in Latin America but still with substantial levels of inequality. As seen in Table 9.3, the estimated Gini coefficients for land distribution in Asia range from 0.448 in India, to 0.483 in Bangladesh and 0.467 in Thailand, to 0.540 in Pakistan.

Throughout much of the twentieth century, rural conditions in Asia typically deteriorated. Nobel laureate Gunnar Myrdal identified three major inter-related forces that molded the traditional pattern of land ownership into its present fragmented condition: (1) the intervention of European rule, (2) the progressive introduction of monetized transactions and the rise in power of the moneylender, and (3) the rapid growth of Asian populations.²²

The traditional Asian agrarian structure before European colonization was organized around the village. Local chiefs and peasant families each provided goods and services—produce and labor from the peasants to the chief in return for protection, rights to use community land, and the provision of public services. Decisions on the allocation, disposition, and use of the village's most valuable resource, land, belonged to the tribe or community, either as a body or through its chief. Land could be redistributed among village members as a result of either population increase or natural calamities such as drought, flood, famine, war, or disease. Within the community, families had a basic right to cultivate land for their own use, and they could be evicted from their land only after a decision was made by the whole village.

The arrival of the Europeans (mainly the British, French, and Dutch) led to major changes in the traditional agrarian structure, some of which had already begun. As Myrdal points out, "Colonial rule acted as an important catalyst to change, both directly through its effects on property rights and indirectly through its effects on the pace of monetization of the indigenous economy and on the growth of population."²³ In the area of property rights, European land tenure systems of private property ownership were both encouraged and reinforced by law. One of the major social consequences of the imposition of these systems was, as Myrdal explains, the

breakdown of much of the earlier cohesion of village life with its often elaborate, though informal, structure of rights and obligations. The landlord was given unrestricted rights to dispose of the land and to raise the tribute from its customary level to whatever amount he was able to extract. He was usually relieved of the obligation to supply security and public amenities because these functions were taken over by the government. Thus his status was transformed from that of a tribute receiver with responsibilities to the community to that of an absolute owner unencumbered by obligations toward the peasants and the public, other than the payment of land taxes.²⁴

Landlord The proprietor of a freehold interest in land with rights to lease out to tenants in return for some form of compensation for the use of the land.

Sharecropper A tenant farmer whose crop has to be shared with the landlord, as the basis for the rental contract.

Tenant farmer One who farms on land held by a landlord and therefore lacks ownership rights and has to pay for the use of that land, for example, by giving a share of output to the owner.

Contemporary **landlords** in India and Pakistan are able to avoid much of the taxation on income derived from their ownership of land. There are variations, but landlords in South Asia are often absentee owners who live in the town and turn over the working of the land to **sharecroppers** and other **tenant farmers**. Sharecropping is widespread in both Asia and Latin America but more pervasive in Asia. It has been estimated that of all tenanted land, some 84.5% is sharecropped in Asia but only 16.1% in Latin America. The institution is almost unknown in Africa, where the typical arrangement continues to be farms operated under tribal or communal tenures. For example, it has been estimated that about 48% of all tenanted land is sharecropped in India, 60% in Indonesia, and 79% in the Philippines. Though common in Colombia, sharecropping is unusual elsewhere in Latin America; for example, it has all but disappeared in Peru.²⁵

The creation of individual titles to land made possible the rise to power of another dubious agent of change in Asian rural socioeconomic structures, the **moneylender**. Once private property came into effect, land became a negotiable asset that could be offered by peasants as security for loans and, in the case of default, could be forfeited and transferred to the often unscrupulous moneylender. At the same time, Asian agriculture was being transformed from a subsistence to a commercial orientation, both as a result of rising local demand in new towns and, more important, in response to external food demands of colonial European powers. With this transition from subsistence to commercial production, the role of the moneylender changed drastically. In the subsistence economy, his activities had been restricted to supplying the peasant with money to tide him over a crop failure or to cover extraordinary ceremonial expenditures such as family weddings or funerals. Most of these loans were paid in kind (in the form of food) at very high rates of interest. With the development of commercial farming, however, the peasant's cash needs grew significantly. Money was needed for seeds, fertilizer, and other inputs. It was also needed to cover his food requirements if he shifted to the production of cash crops such as tea, rubber, or jute. Often moneylenders were more interested in acquiring peasant lands as a result of loan defaults than they were in extracting high rates of interest. By charging exorbitant interest rates or inducing peasants to secure larger credits than they could manage, moneylenders were often able to drive the peasants off their land. They could then reap the profits of land speculation by selling this farmland to rich and acquisitive landlords. Largely as a consequence of the moneylenders' influence, Asian traditional peasant cultivators saw their economic status deteriorate.²⁶ And rapid population growth often led to fragmentation and impoverishment.²⁷

To understand the deterioration of rural conditions in some Asian countries during the twentieth century, consider the cases of India, Indonesia, and the Philippines. In 1901, there were 286 million Indians; by 2013, there were more than quadruple that number. The Indonesian population grew from 28.4 million in 1900 to 210 million in 2000. The population of central Luzon in the Philippines increased more than tenfold from its level of 1 million from 1903 to 2003. In each case, severe fragmentation of landholdings inevitably followed so that today average peasant holdings in many areas of these countries are less than 1 hectare. As seen in Table 9.3, average farm size has fallen throughout South Asia and in Thailand.

For many impoverished families, as these holdings shrink even further, production falls below the subsistence level, and chronic poverty becomes a way of life for many. Peasants are forced to borrow even more from the moneylender at interest rates ranging from 50 to 200%. Most cannot repay these loans. They are then compelled to sell their land and become tenants with large debts. Because land is scarce, they are forced to pay high rents or sharecrop on unfavorable terms. And because labor is abundant, wages are extremely low. Peasants can thus get trapped in a vise of chronic poverty from which, in the absence of major rural reconstruction and reform, there is no escape. Thus, many rural Asians are gradually being transformed from small proprietors to tenant farmers and sharecroppers, then landless rural laborers, then jobless vagrants, and finally migrant slum dwellers on the fringes of modern urban areas.²⁸ At the same time, many other farmers have benefited from the

Moneylender A person who lends money at high rates of interest, for example to peasant farmers to meet their needs for seeds, fertilizers, and other inputs.

enormous productivity gains resulting from the Green Revolution; yet for an increasing number of them, environmental problems such as rapidly falling water tables represent new and looming challenges.

Again, as noted in Chapter 2, colonial practices often had long-lasting influences. In the case of India, regions in which property rights to land were given to landlords had significantly lower productivity and agricultural investments—and significantly lower investments in health and education—in the postindependence period than regions in which property rights were given to cultivators.²⁹

Subsistence Agriculture and Extensive Cultivation in Africa

Subsistence farming Farming in which crop production, stock rearing, and other activities are conducted mainly for personal consumption.

Subsistence farming on small plots of land is the way of life for the majority of African people living in agriculture-based economies. The great majority of farm families in tropical Africa still plan their output primarily for their own subsistence. There are important exceptions, including the sugar, cocoa, coffee, tea, and other plantations in East and West Africa; and farms devoted to such export crops as green beans in Niger, cut flowers in Kenya and Ethiopia, legumes in Tanzania, and other contract farming arrangements.

Since the basic variable input in traditional African agriculture is farm family and village labor, African agriculture systems are dominated by three major characteristics: (1) the importance of subsistence farming in the village community; (2) the existence of some (though rapidly diminishing) land in excess of immediate requirements, which permits a general practice of shifting cultivation and reduces the value of land ownership as an instrument of economic and political power; and (3) the rights of each family (both nuclear and extended) in a village to have access to land and water in the immediate territorial vicinity, excluding from such access use by families that do not belong to the community even though they may be of the same tribe. Where traditional systems are breaking down, inequality is often increasing.

The low-productivity subsistence farming characteristic of most traditional African agriculture results from a combination of three historical forces restricting the growth of output:

1. In spite of the existence of some unused and potentially cultivable land, only small areas can be planted and weeded by the farm family when it uses only traditional tools such as the short-handled hoe, the ax, and the long-handled knife, or *panga*. In some countries, use of animals is impossible because of the tsetse fly or a lack of fodder in the long, dry seasons, and traditional farming practices must rely primarily on the application of human labor to small parcels of land.
2. Given the limited amount of land that a farm family can cultivate in the context of a traditional technology, these small areas tend to be intensively cultivated. As a result, they are subject to rapidly diminishing returns to increased labor inputs. In such conditions, **shifting cultivation** is the most economic method of using limited supplies of labor on extensive tracts of land. Under shifting cultivation, once the minerals are drawn out of the soil as a result of numerous croppings, new land is cleared, and the process of planting and weeding is repeated. In the meantime, formerly

Shifting cultivation Tilling land until it has been exhausted of fertility and then moving to a new parcel of land, leaving the former one to regain fertility until it can be cultivated again.

cropped land is allowed to recover fertility until it can be used again. Under such a process, manure and chemical fertilizers have been unnecessary, although in most African villages, some form of manure (mostly animal waste) is applied to nearby plots that are intensively cultivated in order to extend their period of fertility.

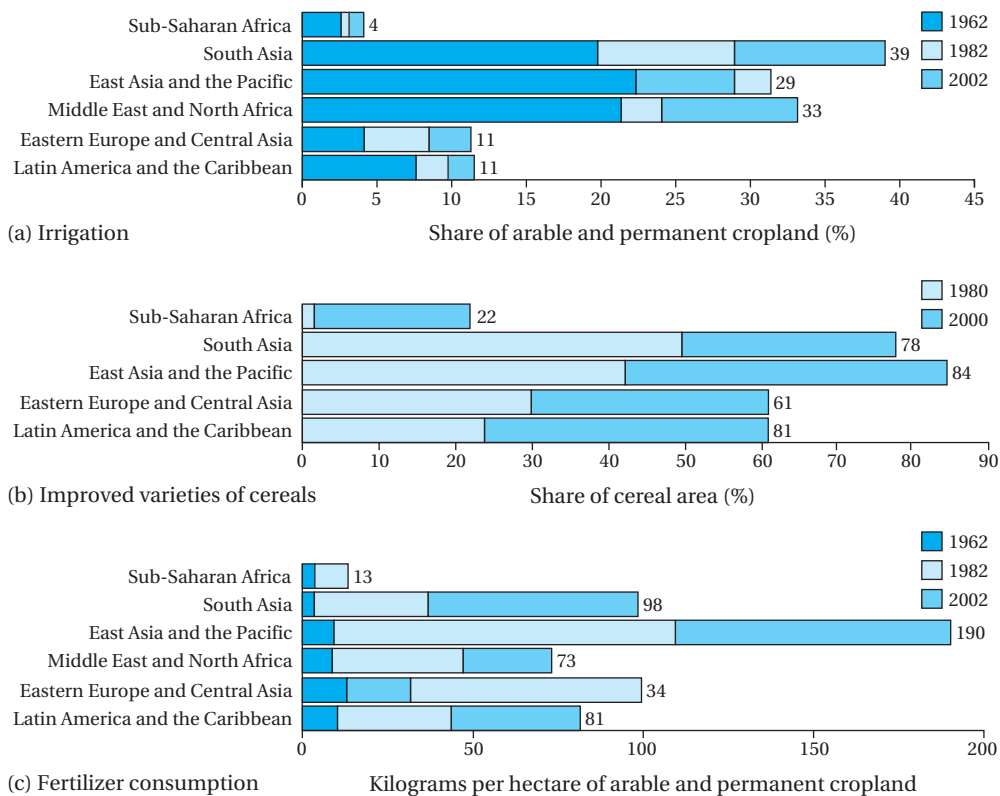
3. Labor is scarce during the busiest part of the growing season, planting and weeding times. At other times, much of the labor is underemployed. Because the time of planting is determined by the onset of the rains and because much of Africa experiences only one extended rainy season, the demand for workers during the early weeks of this rainy season usually exceeds all available rural labor supplies.

The net result of these three forces had been slow growth in agricultural labor productivity throughout much of Africa. As long as population size remained relatively stable, this historical pattern of low productivity and shifting cultivation enabled most African tribes to meet their subsistence food requirements. But the feasibility of shifting cultivation has now broken down as population densities increase. It has largely been replaced by sedentary cultivation on small owner-occupied plots. As a result, the need for other nonhuman productive inputs and new technologies grows, especially in the more densely populated agricultural regions of Kenya, Nigeria, Ghana, and Uganda. Farm size has also fallen in countries such as Malawi and Tanzania, as seen in Table 9.3. Moreover, with the growth of towns, the penetration of the monetary economy, soil erosion and deforestation of marginal lands, and the introduction of land taxes, pure subsistence-agricultural practices are no longer viable. And as land becomes increasingly scarce, land degradation is increasing in scope. The 2008 *World Development Report* concluded:

Higher productivity is not possible without urgent attention to better soil and water management. Sub-Saharan Africa must replace the soil nutrients it has mined for decades. African farmers apply less than 10 kilograms of fertilizer per hectare, compared with more than 100 kilograms in South Asia. Programs to develop efficient fertilizer markets, and agroforestry systems to replenish soil fertility through legumes, need to be scaled up.³⁰

Moreover, by 2007, only 4% of the cropland in sub-Saharan Africa was irrigated, in sharp contrast to 39% in South Asia and 29% in the East Asia and Pacific region. Despite some recent progress, just 22% of the cereal-growing farmland in sub-Saharan Africa is sown with improved varieties, which are used on a large majority of the land in all other developing regions. Dependence on unimproved seeds sown on unfertilized, rain-fed fields is a worsening problem for the region, given both the depletion of soils and the unreliability of rainfall (see Figure 9.5).

Of all the major regions of the world, Africa has suffered the most from its inability to expand food production at a sufficient pace to keep up with its rapid population growth.³¹ As a result of declining production, African per capita food consumption fell dramatically during the 1980s and 1990s, while dependence on imports—particularly wheat and rice—increased.³²

FIGURE 9.5 Expansion of Modern Inputs in the World's Developing Regions

Source: *World Development Report, 2008: Agriculture and Development* by World Bank. Copyright © 2008 by World Bank. Reproduced with permission.

Note: Figures for improved cereal varieties are based on estimates for rice, wheat, maize, and sorghum.

9.4 The Important Role of Women

A major and until recently often overlooked feature of agrarian systems in the developing world, particularly in Africa and Asia, is the crucial role played by women in agricultural production.³³ In Africa, where subsistence farming is predominant and shifting cultivation remains important, nearly all tasks associated with subsistence food production are performed by women. Although men who remain home generally perform the initial task of cutting trees and bushes on a potentially cultivable plot of land, women are typically responsible for all subsequent operations, including removing and burning felled trees, sowing or planting the plot, weeding, harvesting, and preparing the crop for storage or immediate consumption. In her pioneering work on women and development, Ester Boserup examined many studies on African women's participation in agriculture and found that in nearly all cases recorded, women did most of the agricultural work. In some cases, they were found to do around 70% and in one case, nearly 80% of the total. Typically, these tasks are performed only with primitive tools and require many days of

long, hard labor simply to produce enough output to meet the family's subsistence requirements, while the men often attempt to generate cash income through work on nearby plantations or in the cities.³⁴ Recent research confirms women's "time poverty" predicament.

Women do much of the labor for cash crop production, cultivate food for household consumption, raise and market livestock, generate additional income through cottage industries, collect firewood and water, and perform household chores, including the processing and cooking of food. Due to the time-consuming nature of their diverse responsibilities—and no doubt to their limited household bargaining power—women tend to work longer hours than their male counterparts. Studies concerning the allocation of women's time among different activities have greatly increased recognition of the importance of rural women's economic contribution. It has become clear that since women produce a large share of agricultural output and supply a large share of the labor—a share that has actually been increasing over time—successful agricultural reform will require raising women's productivity and ensuring that gender-specific policies are at the core of rural development strategy. The necessity of starting with women's activity when agricultural policy is designed is captured by the maxim of feminist economists that "you cannot just add women and stir."

The diversity of women's duties makes it difficult to determine their share of agricultural production, much less place an economic value on their work. However, current estimates underscore the importance of women's agricultural labor. It is estimated that in addition to work in the household, women provide 60 to 80% of agricultural labor in Africa and Asia and about 40% in Latin America. Much of this work, however, is statistically "invisible" in that women often receive no payment for the work they perform.

Women make an important contribution to the agricultural economy through the labor they supply in the cultivation of **cash crops**. Though the production and profits from commercial crops are generally controlled by men, women are usually responsible for the strenuous jobs of weeding and transplanting. As population density increases and land becomes more fragmented, the length of time that women must spend walking to and from the fields increases, often in very hot climates that make strenuous work exceedingly difficult. In addition to commercial crops, women frequently cultivate small vegetable gardens that provide food for family consumption. Though the cash value of produce from these gardens may be small, it often represents an important component of the total resources available to women.

Women's work in the low-income household involves a range of demanding tasks, including processing and pounding raw grains, tending livestock, cooking, and caring for children. Collecting increasingly scarce firewood and water from distant sources may add several hours to the workday. To raise additional income, it is common for women to engage in household production of goods for sale in village markets. These items are specific to each region, but a few examples are homemade beer, processed foods, handicrafts, and textiles.

Perhaps the most important role of women is providing food security for the household. This is accomplished through the supplementation of household earnings, diversification of household income sources, and raising of livestock to augment household assets. The production of vegetables for

Cash crops Crops produced entirely for the market.

household consumption helps insulate households from swings in food prices and reduces cash outlays for the purchase of household necessities. Women's investments in revenue-generating projects and livestock are crucial to stabilizing household income, especially but not only in female-headed households, where resource constraints are the most severe.

However, financial investments are inherently risky, and the poorer the household, the more averse its members are to taking any kind of risk. When credit and resources are unavailable, reducing the variability of household earnings generally entails choosing less efficient methods of production and thus, lower average income. This trade-off occurs most frequently in female-headed households, where resource constraints are greatest. Thus, as a consequence of their restricted range of choices, women tend to retain traditional modes of economic activity. The upshot is that their productivity has stagnated while that of men has continued to improve.

Where the structure of agriculture is becoming more commercialized, women's roles and hence their economic status are changing. In many developing regions, women are still unremunerated for the long hours they contribute to the tending of commercial crops. As revenue-generating cash cropping rises in importance, the proportion of resources controlled by women tends to diminish. This is largely due to the fact that household resources, such as land and inputs, are transferred away from women's crops in order to promote the production of cash crops. Nonfarm activities are growing in importance and represent an important path for rural women's economic and social advancement.

Government extension programs that provide resources exclusively to men tend to exacerbate existing disparities between men's and women's access to resources (see the case study at the end of this chapter). If credit is provided solely or preferentially to men for the purpose of cash cropping, commercial production will increase at the expense of women's vegetable gardens. Since homegrown vegetables must be replaced by purchased substitutes, significant increases in a male spouse's cash contribution are necessary to offset a woman's losses. If the market price of vegetables increases markedly (there are now fewer producers) and the increase in the husband's contribution is not sufficient to compensate for the increased need for cash, the welfare of the woman and her children will decline.

This drop in the well-being of family members is due to the fact that a considerably higher proportion of women's income than men's is used for nutrition and basic necessities. Thus, if men's incomes rise at the expense of women's resources, as many studies have indicated, an increase in household income will not necessarily lead to improvements in health and nutrition. Changes in land use that increase household income but reduce women's economic status can be detrimental to the welfare of both women and children. Consequently, it is important that the design of government extension programs reflect the interests of all household members.

Recent economic studies have improved our understanding of these problems. A traditional economics assumption following Nobel laureate Gary Becker has been that households cooperate to maximize effectively shared objectives: the "unitary household" model. But development economics research has found that households engage in extensive bargaining, sometimes to the point where higher incomes would be possible if husbands and wives

could cooperate more extensively. First, households spend differently, depending on whether the wealth or income is contributed to the family or otherwise controlled by the wife or the husband. Apparently, providing resources to the household increases bargaining power over how they will be used, contrary to what would be expected in a unitary household. When men control income from cash crops after development leads to new marketing opportunities, the perverse result can be to increase men's already high bargaining power.

The differing use of funds affects not only adults but also the children. Again, the evidence is clear that in most contexts, a larger fraction of income provided and controlled by the wife tends to be used for children's health and education than that by husbands. Moreover, evidence is growing that agricultural households could earn more by reallocating inputs such as manure from husbands' to wives' plots, for example. Thus, gender inequality also leads to significant losses in efficiency. Further gains could be had by shifting from subsistence crops to cash crops on wives' plots, though given different preferences for how cash income would be used, this could turn out to be at the expense of food for the wife and children. For example, in a detailed study of Burkina Faso, Christopher Udry found that "plots controlled by women have significantly lower yields than similar plots within the household planted with the same crop in the same year, but controlled by men." His detailed data enabled him to clearly identify the difference as due to "significantly higher labor and fertilizer inputs per acre on plots controlled by men." Udry's estimates showed that "about six percent of output is lost due to the misallocation of variable factors across plots within the household." In addition to the obvious social justice concerns, this efficiency argument forms part of the economic case for supporting programs that empower rural women.³⁵

Yet many government-sponsored programs effectively continue to exclude women, often because women lack collateral for loans or are barred from owning property or conducting financial transactions without their husbands' permission. Agricultural inputs and training are rarely provided to female applicants. Even efforts to reduce poverty through land reforms have been found to reduce female income and economic status because they distribute land titles only to male heads of household. Cultural and social barriers to women's integration into agricultural programs remain strong because, in many countries, women's income is perceived as a threat to men's authority. While men are taught new agricultural techniques to increase their productivity, women, if involved at all, are trained to perform low-productivity tasks that are considered compatible with their traditional roles, such as sewing, cooking, and basic hygiene. Women's components of development projects are frequently little more than welfare programs that fail to improve economic well-being. Furthermore, these projects tend to depend on the unpaid work of women, while men are remunerated for their efforts.

Although efforts to increase the income of women by providing direct access to credit and inputs have experienced considerable success, programs that work indirectly with women have frequently fallen short of their stated goals. Studies have found that projects are most likely to elicit the engagement of women when resources are placed directly under their control. Clearly, projects that depend on the unremunerated labor of women are likely to obtain only minimal support. Adoption of new crops and technologies will

be more effective where patterns of production are consistent with the interests of female household members. Because the active participation of women is critical to agricultural prosperity, policy design should ensure that women benefit equally from development efforts (this is examined further in the case study at the end of this chapter).

9.5 The Microeconomics of Farmer Behavior and Agricultural Development

The Transition from Traditional Subsistence to Specialized Commercial Farming

For expository convenience, we can identify three broad stages in the evolution of agricultural production.³⁶ The first stage is the pure, low-productivity, mostly subsistence-level traditional (peasant) farm, still prevalent in Africa. The second stage is what might be called *diversified* or *mixed family agriculture*, where a small part, of the produce is grown for consumption and a significant part for sale to the commercial sector, as in much of Asia. The third stage represents the modern farm, exclusively engaged in high-productivity, specialized agriculture geared to the commercial market, as in developed countries, and often found in the highly urbanized developing countries.

Agricultural modernization in mixed-market developing economies may be described in terms of the gradual but sustained transition from subsistence to diversified and specialized production. But such a transition involves much more than reorganizing the structure of the farm economy or applying new agricultural technologies. Transforming traditional agriculture often requires, in addition to adapting the farm structure to meet the demand for increased production, profound changes affecting the entire social, political, and institutional structure of rural societies. Without such changes, agricultural development will either continue to lag greatly behind or, more likely, simply widen the already sizable gap between the few wealthy large landholders and the masses of impoverished tenant farmers, smallholders, and landless laborers.

We first consider the evolution of the agricultural system of a developing nation over time from a predominantly traditional, subsistence-level and small-scale peasant orientation to more diversified operations and eventually to the rise of fully commercial enterprises, though still often family based.

Subsistence Farming: Risk Aversion, Uncertainty, and Survival

On the classic traditional (peasant) subsistence farm, most output is produced for family consumption (although some may be sold or traded in local markets), and a few **staple foods** (usually including cassava, wheat, barley, sorghum, rice, potatoes, or corn) are the chief sources of nutrition. Output and productivity are low, and only the simplest traditional methods and tools are used. Capital investment is minimal; land and labor are the principal factors of production. The law of diminishing returns is in operation as more labor is applied to shrinking (or shifting) parcels of land. The failure of the rains, the appropriation of the land, and the appearance of the moneylender to collect

Staple food A main food consumed by a large portion of a country's population.

outstanding debts are the banes of the peasant's existence. Labor is underemployed for most of the year, although workers may be fully occupied at seasonal peak periods such as planting and harvest. The traditional farmer (peasant) usually cultivates only as much land as his family can manage without the need for hired labor, although many traditional farmers intermittently employ one or two landless laborers. Much of the cash income that is generated comes from nonfarm wage labor.³⁷

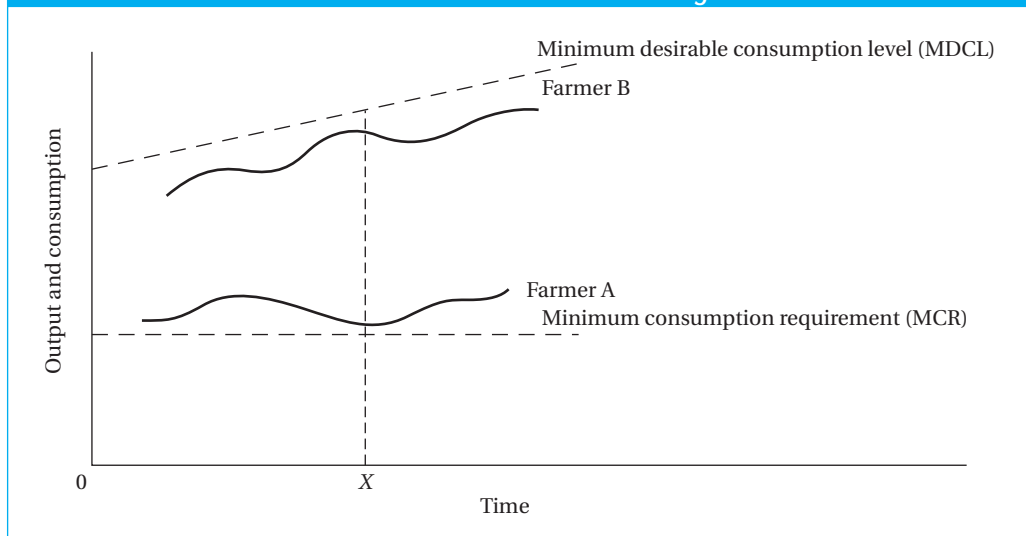
In much of sub-Saharan Africa, agriculture is still largely in this subsistence stage, as it is in pockets in Asia and even Latin America. The Green Revolution has bypassed much of Africa. But in spite of the relative backwardness of production technologies and the misguided convictions of some foreigners who attribute the peasants' resistance to change as a sign of incompetence or irrationality, the fact remains that given the nature of the peasants' environment, the uncertainties that surround them, the need to meet minimum survival levels of output, and the rigid social institutions into which many peasants, but particularly women, are locked, most farmers do behave in an economically rational manner when confronted with alternative opportunities.

Some insight into the economics of subsistence agriculture is provided by the traditional two-factor neoclassical theory of production in which land (and perhaps capital) is fixed, labor is the only variable input, and profit is maximized. Specifically, the theory provides an economic rationale for the observed low productivity of traditional agriculture in the form of the law of diminishing marginal productivity.

Unfortunately, this theory does not satisfactorily explain why small-scale farmers are often resistant to technological innovation in farming techniques or to the introduction of new seeds or different cash crops. According to the standard theory, a rational income or profit-maximizing farm or firm will always choose a method of production that will increase output for a given cost (in this case, the available labor time) or lower costs for a given output level. But the theory is based on the crucial assumption that farmers possess "perfect knowledge" of all technological input-output relationships as well as current information about prevailing factor and product prices. This is the point at which the simple theory loses a good deal of its validity when applied to the environment of subsistence agriculture. Furthermore, when access to information is highly imperfect, the transaction costs of obtaining this information are usually very high. Given price uncertainty, traditional (peasant) farmers often face a wide range of possible prices rather than a single input price. Along with limited access to credit and insurance, such an environment is not conducive to the type of behavior posited by neoclassical theory and goes a long way toward explaining the actual risk-averse behavior of peasant farmers, including their caution in the use of purchased inputs such as fertilizer.³⁸

Subsistence agriculture is thus a highly risky and uncertain venture. It is made even more so by the fact that human lives are at stake. In regions where farms are extremely small and cultivation is dependent on the uncertainties of variable rainfall, average output will be low, and in poor years, the peasant family will be exposed to the very real danger of starvation. In such circumstances, the main motivating force in the peasant's life may be the maximization, not of income, but of the family's chances of survival. Accordingly, when risk and uncertainty are high, small farmers may be very reluctant to shift from a traditional technology and crop pattern that over the years they have come to

FIGURE 9.6 Small-Farmer Attitudes toward Risk: Why It Is Sometimes Rational to Resist Innovation and Change

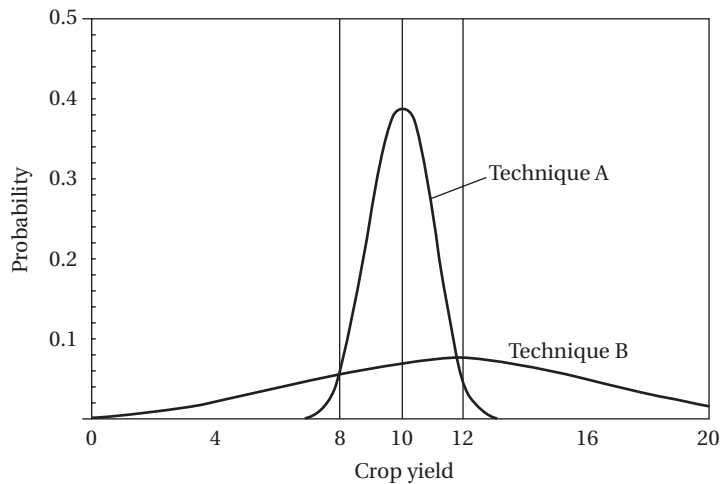


know and understand to a new one that promises higher yields but may entail greater risks of crop failure. When sheer survival is at stake, it is more important to avoid a bad year (total crop failure) than to maximize the output in better years. Risk-avoiding traditional farmers are likely to prefer a technology of food production that combines a low *mean* per-hectare yield with low *variance* (fluctuations around the average) to alternative technologies and crops that may promise a higher mean yield but also present the risk of a greater variance.

Figure 9.6 provides a simple illustration of how attitudes toward risk among small farmers may militate against apparently economically justified innovations.³⁹ In the figure, levels of output and consumption are measured on the vertical axis and different points in time, on the horizontal axis, and two straight lines are drawn. The lower horizontal line measures the minimum consumption requirements (MCR) necessary for the farm family's physical survival. This may be taken as the starvation minimum fixed by nature. Any output below this level would be catastrophic for the peasant or subsistence farming family. The upper, positively sloped straight line represents the minimum level of food consumption that would be desirable, given the prevailing cultural or potential productivity factors affecting village consumption standards. It is assumed that this line rises over time.

Looking at Figure 9.6, we see that at time X, farmer A's output levels have been very close to the MCR. She is barely getting by and cannot take a chance of any crop failure. She will have a greater incentive to minimize risk than farmer B, whose output performance has been well above the minimum subsistence level and is close to the minimum desired consumption level (MDCL). Farmer B will therefore be more likely than farmer A to innovate and change. The result may be that farmer A remains in a self-perpetuating poverty trap.⁴⁰ Moreover, inequality is growing.

There is an alternative way to look at risk-aversion decisions of peasant farmers. In Figure 9.7, two curves portray hypothetical probabilities for crop yields. The higher curves (technique A) shows a production technology with a

FIGURE 9.7 Crop Yield Probability Densities of Two Different Farming Techniques

lower mean crop yield (10) than that of technique B (12), shown by the lower curve. But it also has a lower variance around that mean yield than technique B. Clearly, the chances of starving are much greater with technique B, so risk-averse peasant farmers would naturally choose technique A, the one with the lower mean yield.⁴¹ Evidence is clear that farmers pay for “self-insurance” of this type with much lower average returns.⁴²

Many programs to raise agricultural productivity among small farmers in Africa and elsewhere have suffered because of failure to provide adequate insurance (both financial credit and physical “buffer” stocks) against the risks of crop shortfalls, whether these risks are real or imagined. An understanding of the major role that risk and uncertainty play in the economics of subsistence agriculture would have prevented early and unfortunate characterizations of subsistence or traditional farmers as technologically backward, irrational producers with limited aspirations or just plain “lazy natives,” as in the colonial stereotype. Moreover, in parts of Asia and Latin America where agriculture has performed poorly, a closer examination of why traditional (peasant) farmers have apparently not responded to an “obvious” economic opportunity will often reveal that (1) the landlord secured much if not all of the gain, (2) the moneylender captured the profits, (3) the government’s “guaranteed” price was never paid, or (4) complementary inputs (fertilizers, pesticides, assured supplies of water, adequate nonusurious credit, etc.) were never made available or their use was otherwise more problematic than outsiders understood. In particular, when peasants have reason to be concerned about the risk of eviction or expropriation—whether by landlords or by the state—incentives for those who work the land to invest in it will be proportionately reduced.

Farmers will consider the expected value of the marginal product of any inputs they apply, such as fertilizer, which will be lowered in relation to the probability they place on expropriation. For example, if fertilizer lasts for two growing seasons but the peasant is sure her land will be expropriated as soon as someone with the power to do so sees that the land has already been

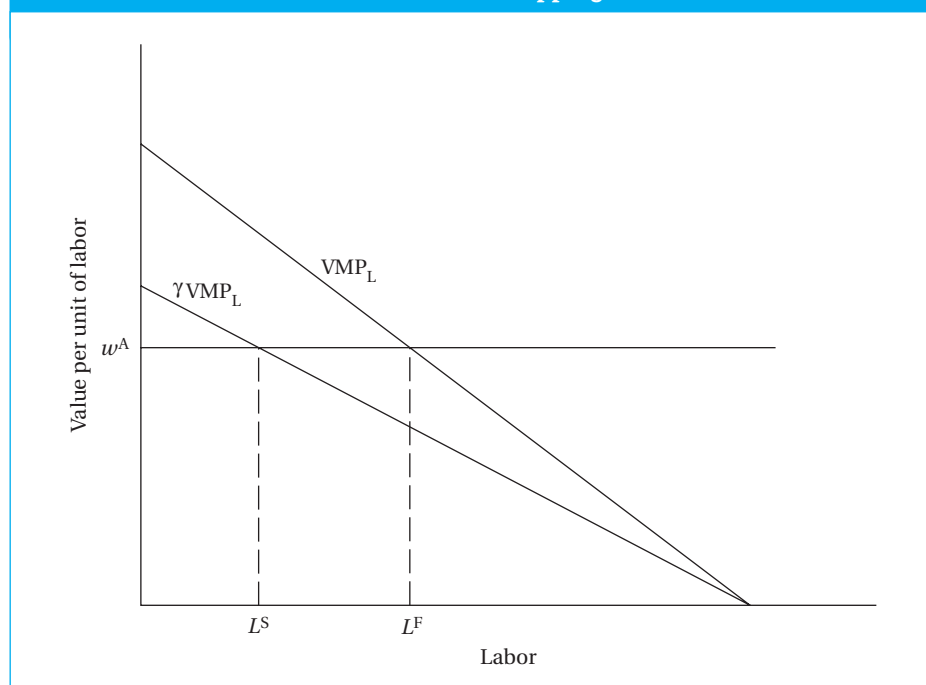
fertilized, then too little fertilizer will be used from the social point of view, because the peasant will consider the benefits of the fertilizer as if it disappeared after just one season (while its price is not lowered). This type of effect has been confirmed by careful econometric evidence from China.⁴³

The Economics of Sharecropping and Interlocking Factor Markets

The phenomenon of risk aversion among peasant farmers in the presence of high land inequality also helps explain the prevalence of sharecropping throughout much of Asia and parts of Latin America.⁴⁴ Although different types of relationships may arise between the owners of land and the people who work on them (e.g., the farmers could rent or act as wage laborers), sharecropping is widespread. Sharecropping occurs when a peasant farmer uses the landowner's farmland in exchange for a share of food output, such as half of the rice or wheat grown. The landlord's share may vary from less than a third to more than two-thirds of output, depending on local labor availability and the other inputs (such as credit, seeds, and tools) that the landlord provides.

The poor incentive structure of sharecropping lends itself to inefficiency. Alfred Marshall observed that the farmer was, in effect, paid only part, rather than all, of his marginal product and would rationally reduce work effort accordingly.⁴⁵ This effect can be seen graphically in Figure 9.8. Labor input is found along the x -axis, which may be interpreted as number of hours of work or of total effort; value of output per unit of labor is found along the y -axis. A farmer who owned his own farm would work until his value marginal product of labor (VMP_L) was equal to his alternative wage, or opportunity cost of labor, w^A , and so would put in an

FIGURE 9.8 Incentives under Sharecropping



efficient amount of labor effort, L^F . However, a sharecropper receives only a fraction, γ , of his effort; for example, under 50–50 sharecropping, the sharecropper's share would be $\gamma = 0.5$. Thus, the sharecropper would receive only γ of his value marginal product, or γVMP_L . As a result, the sharecropper would have an incentive to put in an inefficiently low level of effort, L^S , as seen in Figure 9.8.

This view was challenged in the 1960s by Steven Cheung, who argued that profit-maximizing landlords would establish contracts requiring adequate work effort from the tenant as well as stipulating each party's share of the output. If, as Cheung argued, effort was not too difficult to monitor, then if one tenant failed to live up to his part of the bargain, he would be replaced by another tenant who was willing to work harder; as a result, sharecropping would be as efficient as any other contractual form. Cheung's theory is known as the *monitoring approach*, in contrast to the *Marshallian approach* to the analysis of sharecropping illustrated in Figure 9.8; Cheung argued that labor effort, L^F , would also obtain under sharecropping.⁴⁶

The monitoring approach was popular for two decades, and it was difficult to test because of endogeneity. For example, only low-productivity people may choose to enter into sharecropping contracts. In fact, some scholars believe that landlords may offer tenants an option of either sharecropping or pure rental contracts precisely because higher-ability people more often choose pure rental arrangements: High-ability farmers are able to get the full value of their high marginal product, while this is not as attractive to lower-ability farmers. If landlords are not sure which farmers have high ability, they may find out by observing which ones choose the pure rental contract. The motivation may be to enable landlords to squeeze more profits out of the renters, charging higher effective rents for pure rental contracts than for sharecropping contracts—but not *too* high or even high-ability farmers would choose sharecropping. This approach is known as the *screening hypothesis* of sharecropping.⁴⁷

However, Radwan Ali Shaban identified farmers who farmed plots that they owned and who also leased out additional farmland under a sharecropping contract. By comparing the *same* farmers' behavior under different contractual arrangements, Ali Shaban controlled for factors specific to individual farmers that cannot be easily observed. He found that farmers used fewer inputs and produced less output on the sharecropped land than on their own land, all else being equal. These results provide evidence that sharecropping is less efficient than farming one's own land, just as Marshall predicted.⁴⁸

A final approach suggests that sharecropping is relatively efficient after all, in that it makes the best out of an inherently uncertain and risky situation for both parties.⁴⁹ If the landlord paid the tenant a straight wage, which would be efficient if the tenant always gave his full effort and it didn't cost the landlord anything to make sure of this, the tenant would have every incentive to accept the money and not work hard. If the tenant paid a straight rent for the land, he would face the appalling risk that there would be a particularly lean year, such as a drought, and there would not be enough food left after the rent was paid to prevent starvation. Thus, sharecropping represents a compromise between the risk to the landlord that the tenant will not do much work and the risk to the tenant that a fixed rent will in some years leave him no income. So even though sharecropping, with its poor work incentives, would be inefficient in a world of perfect certainty, in the real world, with inequality in land ownership

as well as uncertainty, it is “as efficient as we can get.” However, this arrangement is necessary only because of extreme inequality of land ownership. Farmers who own their own farms do not generally choose sharecropping contracts for themselves. As a result, the enormous efficiency loss, as seen in Figure 9.8, is not negated by this important explanation of why sharecropping arises.⁵⁰

Where tenancy reform is well designed and enforced, giving sharecroppers a larger share of the produce and security of tenure on the land, the result can be not only higher income for the tenants but also greater overall efficiency. A clear example is the tenancy reform policy implemented in the Indian state of West Bengal in the late 1970s.⁵¹ The explanation is clear from what we have just established: that a higher product share gives greater work effort incentives, and greater security of tenure gives greater investment incentives. Land reform that distributes ownership of “land to the tiller” can provide similar and superior improvements in incentives, if needed complementary inputs are provided.

More broadly, the economic and social framework in which sharecropping takes place is one of extraordinary social inequality and far-reaching market failure. When the peasant faces his landlord, he often faces not only the individual whom he must persuade to rent him productive land but at the same time his prospective employer, his loan officer, and even his ultimate customer for any crops he wishes to sell. Such conditions, an example of **interlocking factor markets**, provide the rural landlord with abundant sources of monopoly and monopsony power. Under some conditions—in particular, the availability of a perfectly elastic supply of tenants and the ability of the landlord to subdivide his land into as many plots as he chooses—the peasant is forced to his *reservation utility level*, or next-best income opportunity. (In practice, on one hand, peasants are sometimes prevented from learning about some of the alternatives available to them; on the other hand, subdivision may be restricted.) Interlocked-factor-market sharecropping does have the resource allocation advantage that it is in the landlord’s interest to see to it that his sharecropper receives credit from the lowest-cost source. At the same time, the personal nature of interlinkage gives the dominant party far-ranging leverage and acts as a barrier to entry that restricts competition that might ultimately benefit the peasant. In this regard, as an observation applying to interlinkage and to other rural institutions, Pranab Bardhan and Christopher Udry make the important point that “the thin line between *understanding* an institution and *justifying* it is often blurred, particularly by careless interpreters of the theory.”⁵²

For many analysts, a study of interlinkage involving a dominant landlord often concludes that nothing short of land reform will reliably affect the tenant’s welfare. We discuss land reform more fully later in the chapter.⁵³

The Transition to Mixed or Diversified Farming

It is neither realistic nor necessarily desirable to think of instantly transforming a traditional agrarian system that has prevailed for many generations into a highly specialized commercial farming system. Attempts to introduce cash crops indiscriminately in subsistence farms have often resulted in the peasants’ loss of land to moneylenders or landlords. Subsistence living is merely substituted for subsistence production. For small farmers, exclusive reliance on cash crops can be even more precarious than pure subsistence

Interlocking factor markets

Factor markets whose supply functions are interdependent, frequently because different inputs are provided by the same suppliers who exercise monopolistic or oligopolistic control over resources.

agriculture because the risks of price fluctuations are added to the uncertainty of nature.

Diversified or mixed farming therefore represents a logical intermediate step in the transition from subsistence to specialized production. In this stage, the staple crop no longer dominates farm output, and new cash crops such as fruits, vegetables, coffee, tea, and pyrethrum are established, together with simple animal husbandry. These new activities can take up slack in farm workloads during times of the year when disguised unemployment is prevalent.

For example, if the staple crop occupies the land only during parts of the year, new crops can be introduced in the slack season to take advantage of both idle land and family labor. And where labor is in short supply during peak planting seasons, simple labor-saving devices (such as small tractors, mechanical seeders, or animal-operated steel plows) can be introduced to free labor for other farm activities. Finally, the use of better seeds, fertilizers, and simple irrigation to increase yields of staple crops such as wheat, maize, and rice can free part of the land for cash crop cultivation while ensuring an adequate supply of the staple food. The farm operator can thus have a marketable surplus, which she can sell to raise her family's consumption standards or invest in farm improvements. Diversified farming can also minimize the impact of staple crop failure and provide a security of income previously unavailable.

The success or failure of such efforts to transform traditional agriculture will depend not only on the farmer's ability and skill in raising his productivity but also, even more important, on the social, commercial, and institutional conditions under which he must function. Specifically, if he can have reasonable and reliable access to credit, fertilizer, water, crop information, and marketing facilities; if he receives a fair market price for his output; and if he can feel secure that he and his family will be the primary beneficiaries of any improvements, there is no reason to assume that the traditional farmer will not respond to economic incentives and new opportunities to improve his standard of living. Evidence from such diverse countries as Colombia, Mexico, Nigeria, Ghana, Kenya, India, Pakistan, Thailand, and the Philippines shows that under the proper conditions, small farmers are responsive to price incentives and economic opportunities and will make radical changes in what they produce and how they produce it.⁵⁴ Lack of innovation in agriculture, as noted earlier, is usually due not to poor motivation or fear of change but to inadequate or unprofitable opportunities. In Africa, lack of information is often a constraint, but farmers learn from each other when valuable new crops and techniques are introduced locally. This facilitates dissemination of new technologies, as a study in Ghana revealed (see Box 9.2).

From Divergence to Specialization: Modern Commercial Farming

The specialized farm represents the final and most advanced stage of individual holding in a mixed market economy. It is the most prevalent type of farming in advanced industrial nations. It has evolved in response to and parallel with development in other areas of the national economy. General rises in living standards, biological and technical progress, and the expansion of national and international markets have provided the main impetus for its emergence and growth.

Diversified (mixed) farming

The production of both staple crops and cash crops and simple animal husbandry typical of the first stage in the transition from subsistence to specialized farming.



BOX 9.2 FINDINGS Learning about Farming: The Diffusion of Pineapple Growing in Ghana

Agricultural experts cannot train millions of farmers—who sometimes also know constraints and opportunities that trainers do not. So farmers must partly learn new products and techniques from each other, and social learning is very difficult to identify. But Timothy Conley and Christopher Udry collected detailed information from farmers in the Akwapim South district of Ghana, asking them whom they know and talk to about farming, to better understand and test for “social learning in the diffusion of a new agricultural technology.”

In Akwapim South, farmers traditionally grew maize and cassava, which they sold to urban consumers. But a transformation was under way toward farmers cultivating pineapples for export to Europe. Doing so required intensive fertilizer use—adoption of a new technology. Pineapple technologies were spreading geographically through the region. But a farmer might adopt a new technology soon after his neighbor, not from learning, but just because neighbors tend to be similar in other ways. Conley and Udry collected information on geography, soil and agronomics, credit, and family relationships to control for similarities that previous studies had been unable to observe. Then the researchers tested “whether farmers adjust their inputs to align with those of their information neighbors who were surprisingly successful in previous periods,” and they found robust evidence to support this idea: “We find strong effects of news about input productivity in the information neighborhood of a farmer on his innovations in input use.”

Data on inputs used and output harvested by each farmer let Conley and Udry infer the information conveyed by each “experiment” with pineapples and fertilizer by any of their respondents. They utilize data on “information flow between farmers to trace the impact of the information revealed by each experiment on the future input decisions of other farmers who are in the information neighborhood of the cultivator who conducted the experiment.”

Important findings include the following:

- A farmer is “more likely to change his fertilizer use after his information neighbors who use similar amounts of fertilizer achieve lower than expected profits.”
- A farmer “increases (decreases) his use of fertilizer after his information neighbors achieve unexpectedly high profits when using more (less) fertilizer than he did.”
- A farmer’s “responsiveness to news about the productivity of fertilizer in his information neighborhood is much greater if he has only recently begun cultivating pineapple.”
- A farmer “responds more to news about the productivity of fertilizer on plots cultivated by veteran farmers and farmers with wealth similar to his.”

Since novice farmers “are most responsive to news in their information neighborhoods,” the results probably reflect learning. This conclusion is reinforced because there is no evidence of learning when the authors’ research methods are “applied to a known maize-cassava technology.” Sometimes a neighbor’s surprising lower profit leads a farmer to make the wrong decision by lowering his own fertilizer use. But this is also part of the ongoing learning process.

The evidence implies that information “has value in these villages, as do the network connections through which that information flows.” But forming and maintaining a connection has real costs; and such costs—as well as benefits—generally depend on factors such as religion, gender, wealth, or family ties. This implies that “measurement of the extent of social learning is not sufficient for adequate evaluation of policy regarding the diffusion of technology.” Moreover, the paper highlights that network connections are endogenous; this is a very important consideration for policy analysis.

Source: Based on Timothy G. Conley and Christopher R. Udry, “Learning about a new technology: Pineapple in Ghana,” *American Economic Review* 100 (2010): 35–69. Copyright © 2010 by the American Economic Association. Used with permission.

In **specialized farming**, the provision of food for the family with some marketable surplus is no longer the basic goal. Instead, pure commercial profit becomes the criterion of success, and maximum per-hectare yields derived from synthetic (irrigation, fertilizer, pesticides, hybrid seeds, etc.) and natural resources become the object of farm activity. Production, in short, is entirely for the market. Economic concepts such as fixed and variable costs, saving, investment and rates of return, optimal factor combinations, maximum production possibilities, market prices, and price supports take on quantitative and qualitative significance. The emphasis in resource utilization is on capital formation, technological progress, and scientific research and development in stimulating higher levels of output and productivity.

Specialized farms vary in both size and function. They range from intensively cultivated fruit and vegetable farms to the vast wheat and corn fields of North America. In most cases, sophisticated laborsaving mechanical equipment, ranging from huge tractors and combine harvesters to airborne spraying techniques, permits a single family to cultivate many thousands of hectares of land.

The common features of all specialized farms, therefore, are their emphasis on the cultivation of one particular crop, their use of capital-intensive and in many cases laborsaving techniques of production, and their reliance on economies of scale to reduce unit costs and maximize profits. In some ways, specialized farming is no different in concept or operation from large industrial enterprises. In fact, some of the largest specialized farming operations in both the developed and the less developed nations are owned and managed by large, multinational, corporate agribusiness enterprises. Large, modern farms are now found in many middle-income countries such as Brazil. But for small-holder farmers where subsistence farming predominates, strategies for dealing with risk, and in some cases overcoming coordination failures in specialization as described in Chapter 4, remain prerequisites for successful specialization.

Although we can find all three types of farms—subsistence, mixed, and specialized commercial—coexisting in almost all developing countries at any given time, for the majority of low-income countries, particularly in Africa, contemporary agricultural systems are still dominated by small-scale mixed and even subsistence-based family farms. The further transition to a preponderance of commercial enterprises may be difficult to achieve, depending as it does on the solution to many other short- and intermediate-term problems. But there is wide agreement that the improvement of small- and medium-scale mixed farming practices that will not only raise farm incomes and average yields but, if labor-intensive, also effectively absorb underutilized rural labor offers the major immediate avenue toward the achievement of real people-oriented rural development.

Specialized farming The final and most advanced stage of the evolution of agricultural production in which farm output is produced wholly for the market.

9.6 Core Requirements of a Strategy of Agricultural and Rural Development

If the major objective of agricultural and rural development in developing nations is the progressive improvement in rural levels of living achieved primarily through increases in small-farm incomes, output, and productivity,

along with genuine food security, it is important to identify the principal sources of agricultural progress and the basic conditions essential to its achievement.

Improving Small-Scale Agriculture

Technology and Innovation In most developing countries, new agricultural technologies and innovations in farm practices are preconditions for sustained improvements in levels of output and productivity. In many parts of Africa, however, increased output in earlier years was achieved without the need for new technology simply by extending cultivation into unused but potentially productive lands. Almost all of these opportunities have by now been exploited, and there is little scope for further significant or sustainable expansion.

Two major sources of technological innovation can increase farm yields. Unfortunately, both have somewhat problematic implications for agricultural development. The first is the introduction of mechanized agriculture to replace human labor. The introduction of laborsaving machinery can have a dramatic effect on the volume of output per worker, especially where land is extensively cultivated and labor is scarce. For example, one man operating a huge combine harvester can accomplish in a single hour what would require hundreds of workers using traditional methods.

But in the rural areas of many developing nations, where land parcels are small, capital is scarce, and labor is abundant, the introduction of heavily mechanized techniques is often ill suited to the physical environment and has the effect of creating more rural unemployment without necessarily lowering per-unit costs of food production.⁵⁵ Importation of such machinery can require large tracts of land (and thus the consolidation of small holdings) and tends to exacerbate the already serious problems of rural poverty and underemployment. And if mechanized techniques exclude women, the male-female productivity gap could widen further, with serious repercussions.⁵⁶

Biological (hybrid seeds and biotechnology), water control (irrigation), and chemical (fertilizer, pesticides, insecticides, etc.) innovations—the second major source—are not without their own problems. They are land-augmenting; that is, they improve the quality of existing land by raising yields per hectare. Only indirectly do they increase output per worker. Improved seeds; advanced techniques of irrigation and crop rotation; the increasing use of fertilizers, pesticides, and herbicides; and new developments in veterinary medicine and animal nutrition represent major scientific advances in modern agriculture. These measures are often technologically **scale-neutral**; theoretically, they can be applied equally effectively on large and small farms. They do not necessarily require large capital inputs or mechanized equipment. They are therefore particularly well suited for tropical and subtropical regions, and offer enormous potential for raising agricultural output in developing nations and have been highly effective in doing so, particularly in Asia. Again, the major challenge is to extend this success to sub-Saharan Africa, which will in some cases need new innovations. There are also important environmental challenges in many parts of the developing world, including risks posed by a falling water table, salination, and other resource degradation for which well-designed government policy and in some cases restored collective action mechanisms are usually necessary.

Scale-neutral Unaffected by size; applied to technological progress that can lead to the achievement of higher output levels irrespective of the size (scale) of a firm or farm.

Institutional and Pricing Policies: Providing the Necessary Economic Incentives

Unfortunately, although the green revolution varieties of wheat, corn, and rice, together with needed irrigation and chemicals, are scale-neutral and thus offer the potential for continued small-farm progress, the social institutions and government economic policies that accompany their introduction into the rural economy are often *not* scale-neutral.⁵⁷ On the contrary, they often merely serve the needs and vested interests of the wealthy landowners. Because the new hybrid seeds require access to complementary inputs such as irrigation, fertilizer, insecticides, credit, and agricultural extension services, if these are provided only to a small minority of large landowners, one impact of the green revolution can be (as in parts of South Asia and Mexico) the further impoverishment of many peasants. Large landowners, with their disproportionate access to these complementary inputs and support services, are able to gain a competitive advantage over smallholders and eventually drive them out of the market. Large-scale farmers obtain access to low-interest government credit, while smallholders are forced to turn to moneylenders. The result has all too often been the further widening of the gap between rich and poor and the increased consolidation of agricultural land in the hands of a very few so-called progressive farmers. A developmental innovation with great potential for alleviating rural poverty and raising agricultural output can thus turn out to be antidevelopmental if public policies and social institutions militate against the active participation of the small farmer in the evolving agrarian structure.⁵⁸

Another critical area of many past and some continued failures in government policies relates to the pricing of agricultural commodities, especially food grains and other staples produced for local markets. Many governments in developing nations, in their headlong pursuit of rapid industrial and urban development, maintained low agricultural prices in an attempt to provide cheap food for the urban modern sector. Farmers were paid prices below either world competitive or free-market internal prices. The relative internal price ratio between food and manufactured goods (the domestic terms of trade) thus turned against farmers and in favor of urban manufacturers. With farm prices so low—in some cases below the costs of production—there was no incentive for farmers to expand output or invest in new productivity-raising technology. As a result, local food supplies continually fell short of demand, and many developing nations, especially in sub-Saharan Africa, that were once self-sufficient in food production had to import food.

Many development economists therefore argue that if governments are to promote further increases in agricultural production that make a larger impact on poverty reduction through Green Revolution technologies, they must make not only the appropriate institutional and credit market adjustments but also continued progress to provide incentives for small and medium-size farmers by implementing pricing policies that truly reflect internal market conditions.⁵⁹

Adapting to New Opportunities and New Constraints As a route out of poverty and toward genuine rural development, enhanced cereal productivity (the classic Green Revolution characteristic) represents only a small part of the agricultural opportunities. The best opportunities for sales to growing urban areas are generally found in higher value-added activities, particularly

horticulture (fruits, vegetables, and cut flowers) and aquaculture. These products, along with organic and perhaps Fair Trade versions of some otherwise traditional developing country exports such as coffee and spices, also provide good opportunities for higher-value exports. But small farmers will need special organization and assistance to take advantage of new opportunities. As the 2008 *World Development Report* concludes, "Smallholders can bargain better as a group than as individuals. So a high priority is to facilitate collective action through producer organizations to reach scale in marketing and bargain for better prices."⁶⁰ Otherwise, the risk is large that these developments will benefit mainly the larger farmers.

An opportunity—which also poses a potential threat—is the growing activity of foreign investment in developing country farmland, also known as *land grabbing*. An IFPRI report estimated that from 2006 to 2009, 15 to 20 million hectares of developing country farmland had been transferred. An example is the 2008 deal of South Korea to acquire 690,000 hectares in Sudan. Foreign ownership and long-term leasing of farmland can lead to some better-paying job creation, training, access to better techniques, and new export markets. But there is a real threat that many farmers will lose access to their traditional rights to use land, that there may be net job losses, and that water shortages and environmental degradation of adjacent lands may accelerate, at least without adequate oversight. These and other potential risks are greater when there are governance shortcomings, including corruption, and when women and other poor and vulnerable claimants are not empowered. This is a topic that will be followed closely.⁶¹

One of the biggest constraints looking ahead is the looming environmental problems driven by global warming and climate change, which are expected to most negatively affect sub-Saharan Africa and South Asia. Smaller and poorer farmers are likely to be affected severely, because of their lower access to irrigation and other inputs and generally lesser capacity to adapt—although, ironically, with their smaller use of irrigation and different crop mix, their absolute income declines may be less than those of richer farmers. Although the majority of global warming problems are caused by developed countries, to the extent that cultivated areas in developing countries continue to increase by means of eliminating remaining forested areas, climate change problems will only worsen. This "agricultural extensification," not only in forests but also in drier and other sensitive lands, further brings the risk of local soil degradation and lost environmental services such as maintaining water and air quality. The losses of wetlands and of biodiversity also lead to substantial national (as well as international) costs. Moreover, intensification of agriculture has often brought with it the misuse of agrochemicals, which can entail large human and ecosystem costs.⁶² We return to these problems of environmental sustainability in the next chapter.

Conditions for Rural Development

We can draw three conclusions regarding the necessary conditions for the realization of a people-oriented agricultural and rural development strategy.⁶³

Land Reform

Conclusion 1: Farm structures and land tenure patterns must be adapted to the dual objectives of increasing food production and promoting a wider distribution of the benefits of agrarian progress, allowing further progress against poverty.

Agricultural and rural development that benefits the poor can succeed only through a joint effort by the government and *all* farmers, not just the large farmers. A first step in any such effort, especially in Latin America and Asia, is the provision of secured tenure rights to the individual farmer. The small farm family's attachment to their land is profound. It is closely bound up with their innermost sense of self-esteem and freedom from coercion. When they are driven off their land or they are gradually impoverished through accumulated debts, not only is their material well-being damaged, but so is their sense of self-worth.

It is for these humane reasons as well as for reasons of higher agricultural output and the simultaneous achievement of both greater efficiency and more equity that **land reform** is often proposed as a necessary first condition for agricultural development in many developing countries. In most countries, the highly unequal structure of land ownership is a key determinant of the existing highly inequitable distribution of rural income and wealth. It is also the basis for the character of agricultural development. When land is very unevenly distributed, in quality as well as in quantity, rural peasants can have little hope for economic advancement through agriculture.

Land reform usually entails a redistribution of the rights of ownership or use of land away from large landowners in favor of cultivators with very limited or no landholdings. It can take many forms: the transfer of ownership to tenants who already work the land to create family farms (Japan, South Korea, Taiwan); transfer of land from large estates to small farms or rural cooperatives (Mexico); or the appropriation of large estates for new settlement (Kenya). All go under the heading of "land reform" and are designed to fulfill one central function: the transfer of land ownership or control directly or indirectly to the people who actually work the land. Tenancy reform as in West Bengal can also yield favorable efficiency and distributional benefits.

There is widespread agreement among economists and other development specialists on the need for land reform. Inequality is increasing in Africa. The Economic Commission for Latin America (ECLA) has repeatedly identified land reform as a necessary precondition for poverty-reducing agricultural and rural progress. A Food and Agriculture Organization (FAO) report concluded that in many developing regions, land reform remains a prerequisite for development. The report argued that such reform was more urgent today than ever before, primarily because (1) income inequalities and unemployment in rural areas have worsened, (2) rapid population growth threatens to exacerbate existing inequalities, and (3) recent and potential technological breakthroughs in agriculture (the Green Revolution) can be exploited primarily by large and powerful rural landholders and hence can result in an increase in their power, wealth, and capacity to resist future reform.⁶⁴ Finally, as noted earlier, from a strict view of economic efficiency and growth, there is ample empirical evidence that land redistribution not only increases rural employment and raises rural incomes but also leads to greater agricultural production and more efficient resource utilization. Significant though often limited land reforms have already been implemented in many countries, but some countries have still seen little reform.

Unfortunately, very small or landless farmers cannot directly purchase land from the big landowners because of market failures. Credit markets do not function well enough to provide a potentially efficient family farmer with

Land reform A deliberate attempt to reorganize and transform agrarian systems with the intention of fostering a more equal distribution of agricultural incomes and facilitating rural development.

a loan; even if they did, the price of *latifundio* and other estate and plantation land is too high because land ownership confers many benefits beyond the income from farming activities, such as disproportionate political influence.

If programs of land reform can be legislated and effectively implemented by the government, the basis for improved output levels and higher standards of living for rural peasants will be established. Unfortunately, many land reform efforts have failed because governments (especially those in Latin America) bowed to political pressures from powerful landowning groups and failed to implement the intended reforms.⁶⁵ But even an egalitarian land reform program alone is no guarantee of successful agricultural and rural development.⁶⁶ This leads to our second conclusion.

Supportive Policies

Conclusion 2: The full benefits of small-scale agricultural development cannot be realized unless government support systems are created that provide the necessary incentives, economic opportunities, and access to needed credit and inputs to enable small cultivators to expand their output and raise their productivity.

Though land reform is essential in many parts of Asia and Latin America, it is likely to be ineffective and perhaps even counterproductive unless there are corresponding changes in rural institutions that control production (e.g., banks, moneylenders, seed and fertilizer distributors), in supporting government aid services (e.g., technical and educational extension services, public credit agencies, storage and marketing facilities, rural transport and feeder roads), and in government pricing policies with regard to both inputs (e.g., removing factor price distortions) and outputs (ensuring market-value prices for farmers). Even where land reform is less necessary but where productivity and incomes are low (as in parts of Africa and Southeast Asia), this broad network of external support services, along with appropriate governmental pricing policies related to both farm inputs and outputs, is an essential condition for sustained agricultural progress.⁶⁷

Integrated Development Objectives

Conclusion 3: Rural development, though dependent primarily on small-farmer agricultural progress, implies much more. It encompasses (a) efforts to raise both farm and non-farm rural real incomes through job creation, rural industrialization, and other nonfarm opportunities and the increased provision of education, health and nutrition, housing, and a variety of related social and welfare services; (b) a decreasing inequality in the distribution of rural incomes and a lessening of urban-rural imbalances in incomes and economic opportunities; (c) successful attention to the need for environmental sustainability—limiting the extension of farmland into remaining forests and other fragile areas, promoting conservation, and preventing the harmful misuse of agrochemicals and other inputs; and (d) the capacity of the rural sector to sustain and accelerate the pace of these improvements over time.

The achievement of these four objectives is vital to national development. More than half of the population of the developing world is still located in rural areas. By restoring a proper balance between urban and rural economic opportunities and by creating the conditions for broad popular participation in national development efforts and rewards, developing nations will have taken a giant step toward the realization of the true meaning of development.

Case Study 9

The Need to Improve Agricultural Extension for Women Farmers: Kenya

As noted in Chapter 5, absolute poverty is disproportionately concentrated among women, in rural areas, and in the agricultural sector. Improvements in the productivity and incomes of women farmers are therefore key to a strategy for poverty reduction. The role of women in agriculture is particularly important in sub-Saharan Africa. But this is also the region that has benefited least from the Green Revolution of high-yielding crop varieties and other modern farming practices that have had such a large productivity impact in many parts of Asia over the past half-century.

The crucial importance of a solid agricultural extension program for successful rural development and increased yields has been appreciated by development specialists for decades. Support for agricultural extension has played a central role in the activities of most multilateral and bilateral development agencies. Historically, agricultural extension programs have played a vital development role in the United States, one of the world's great agricultural productivity success stories.

Traditionally, agricultural extension programs in developing countries were aimed almost exclusively at training men, even though women do most of the agricultural work. In sub-Saharan Africa, women are responsible for well over two-thirds of staple food production. They are also active in growing and marketing cash crops, in food processing, and in animal husbandry. But women's roles have expanded in recent years as men have increasingly migrated to urban areas and taken nonagricultural jobs. Where men and women both do agricultural work, there still tends to be a gender-based division of labor. As a result, techniques relevant to the work of men are often not relevant to the work of women. Where they are relevant,

men in the region have, for various reasons, tended to pass on to their wives ("trickle across") surprisingly little of what they have learned.

The focus on training men has generally been more by default than by design. For example, training has been copied from developed countries like the United States, where men do the majority of agricultural work. There may be religious or cultural constraints on men training women, and male extension agents may simply be more comfortable talking to men. A World Bank study showed that most male African extension agents have perceived women as "wives of farmers" rather than as farmers in their own right. And almost all extension agents have been male. Female agents must be trained. A major problem is the segregation and exclusion of women in large parts of Africa and Asia.

The success of women in agriculture in sub-Saharan Africa is at the very core of prospects for genuine development and poverty reduction. But the agricultural extension program response to the problem has been slow. And in some countries, program design is said to reflect a bias against providing women with too much independence.

One important strategy of the past 30 years has been to make use of radio, audiotapes, television, videotapes, DVDs, and more recently SMS (texting). Women may listen to or watch the materials in groups in homes or village centers. Katrin Saito and her colleagues reported that female farmers question extension agents in Ghana about subjects they have heard discussed on the radio.

Agricultural extension programs for women are interconnected with a number of other important rural development and women in development issues. Five key issues are the following:

1. *Human capital.* Women have less education than men on average in most rural developing areas. The bias in agricultural extension programs may in some part be a bias to train the more educated spouse, but the practice has also exacerbated this relative deficiency.
2. *Appropriate technology.* Because women tend to be involved in different farm activities than men, they will often have different technology requirements. Most technology development has been focused on activities of men.
3. *Land reform and agrarian design.* On average, women farm on much smaller, more fragmented plots than men; are less likely to have secure ownership; and often cultivate less fertile soil. This distribution is likely to be inefficient as well as distributionally inequitable.
4. *Credit.* Women have little access, if any, to financial credit, a key input in efficient agriculture.
5. *Work requirements.* Many women who work as many or more hours per day as men in agricultural pursuits also have to perform several hours of domestic work that men do not do. The workday of a poor woman farmer in Africa has been estimated at 16 to 19 hours. The attention mothers can give to their children is limited by long agricultural working hours. The implication may be that women should receive an even higher priority for technical education and technology development and access.

As Rekha Mehra has noted, one intent of structural adjustment programs in many African countries has been to encourage the shift to exportable cash crops. But these are the crops over which men tend to exercise control. A woman's profit share after working with these crops may be as little as 5%. But she is still responsible for growing consumption crops and feeding her children. Mehra concludes that structural adjustment programs tend to place even more time requirements on women already burdened with 16-hour workdays. The irony is that as the husband controls the cash, his "say" in the family may actually *increase* as a result.

Removal of agricultural price controls in Africa, allowing the prices that farmers receive for their crops to move toward world market levels, has provided more accurate price signals to farmers and encouraged a switch to more economically

productive crops. But an IFPRI study showed that after diversification to commercial crops, Kenyan women still try to grow the same amount of consumption crops. Thus, more is needed than price adjustments featured under structural adjustment programs; reform must address structural problems faced by women that will prevent them from responding to price signals efficiently. A good example is the larger profit share taken by the husband and often not shared with his wife or wives.

None of these problems is limited to Africa. For example, Carmen Diana Deere, in a review of 13 Latin American agrarian reform experiences, found that most have benefited only men. This was mostly because farmers were thought of as men and the reforms were designed to target only men as beneficiaries. Her review found that women benefit only in the rare instances when their well-being is a specific objective of the reform and rural women are made an explicit part of the design of programs from the outset.

Taken as a whole, these points show why women farmers need the help of extension programs. It is also efficient to do this because of an application of the law of diminishing returns to training for men. The evidence suggests that the trickle-across theory—that trained husbands will in turn train their wives—all too rarely occurs in practice, at least in sub-Saharan Africa.

In Kenya, the ministry of agriculture operates a national extension system (NES) in concert with its agricultural research efforts. Before 1983, the NES worked almost exclusively with male farmers, while a separate "home economics branch" advised women on household and cottage industry management and domestic hygiene, but only peripherally on farming matters. Research by the Institute of Development Studies in Nairobi and other agencies confirmed that extension programs were much more likely to have reached men than women farmers. In 1983, Kenya's training and visit (T&V) system was established with the express purpose of training women as well as men in efficient agricultural practices. The case provides an example of the necessary ingredients of progress and also of how very much remains to be accomplished.

The design of the T&V system is based on providing "technical messages" to selected "contact farmers," who are regularly visited on their farms.

Unfortunately, resources are insufficient to reach all farmers, and even if the T&V system did try to reach all farmers, the quality of training would be poor. As a result, only 10% of all farmers are chosen to adopt advice brought to them in these messages and then to help spread this new technical knowledge by persuading other farmers in the villages to adopt them as well. A number of "follower farmers" are expected to attend meetings with T&V officials on the contact farmer's land. In this way, it is hoped that technical "diffusion" is maximized in a cost-effective manner. The selection process is vital. Farmers must be selected who are capable, likely to diligently follow through on new information, and locally respected so as to encourage emulation. In choosing contact farmers, T&V officials meet with farmers and consult with local communities and their leaders. In recent years, T&V outreach has focused more on working with traditional community farmer self-help groups, which can provide greater flexibility, better diffusion, and group reinforcement.

At first, messages focused on procedures offering the prospect of significant productivity gains but not requiring cash expenditure, such as ground preparation, spacing, seed varieties, and pruning. The messages being diffused in any one month are linked to farm activities under way in the annual crop cycle, such as planting or harvesting the crops being cultivated at any given point in the course of the year. The training process builds step by step: Simpler messages are imparted in early stages, and more complex messages, later in the program. Moreover, only after farmers see results from this initial advice and so come to trust the T&V messages, are measures requiring modest cash outlays introduced, such as fertilizer use and crop spraying. In a later stage, measures requiring purchase of capital goods may be introduced. Increasing numbers of women function officially as contact farmers. Even more serve unofficially in this role, as their husbands farm only part time or not at all.

The messages of the T&V program, ideally, are supposed to be transmitted in both directions. T&V agents are supposed to gather information about how well previous advice has worked in practice and about continued problems in order to guide research efforts. This is in the spirit of the often touted but seldom fulfilled development participation ideal.

T&V-type programs received substantial encouragement and financial support from the World Bank from the mid-1970s through the 1990s. But in most countries, performance was disappointing.

In 1997, Vishva Bindlish and Robert Evenson reported that T&V-type extension programs operated in more than 30 countries in sub-Saharan Africa. They concluded from their statistical evidence that the experience of "Kenya and Burkina Faso shows that T&V management enhances the effectiveness of extension and that such programs support agricultural growth and produce high returns on investments." They found that "areas served by extension have higher yields and that within these areas the highest yields are achieved by farmers who participate directly in extension activities. As a result, extension helps to close the gap between the yields attainable with existing technologies and those actually realized by farmers." But they found that while this makes improvements in the short run, there are limits to what the program can achieve without "the development of improved technologies that are relevant to local conditions."

A study by Robert Evenson and Germano Mwabu found that the impact of T&V in Kenya on productivity was positive but, interestingly, strongest among farmers of highest and lowest ability (measured by the portion of productivity unexplained by the use of farm inputs). They hypothesized that high ability overcame diminishing returns to inputs. Perhaps extension is complementary with high (unobserved) management ability. But the relatively high impact on the lower-ability farmers is noteworthy, even if data drawing conclusions about possible impacts such as on poverty are not available.

Economic advancement of women farmers is also important for promoting environmentally sustainable development. In addition to their responsibility for agriculture, especially on more marginal and often ecologically fragile lands, women have a customary role in traditional societies as the guardians of natural resources such as the water supply. This is also an important domain for agricultural extension work with women. In Kenya, the T&V system is not yet strongly involved in environmental problems.

Christina Gladwin and Della McMillan argue that much more must be done; for example, women should be consulted at the design stage of technology development, extension specialists should receive training on how to approach a male farmer about training his wife or wives, and governments should target funds to women's organizations and clubs.

Another shortcoming of the T&V system is that it has made too little progress in the field of women's credit. A study by Kathleen Staudt found that of 84 female farm managers interviewed in the Kakamega District in Kenya's Western Province, only one knew about the credit program, and no female manager had received any credit. Informal indications are that this is the area that has improved least over the subsequent years. But rural credit, often run by local NGOs, has recently been expanding in Kenya at a rapid rate that has surprised many long-term observers.

The strategy of involving women in public agriculture initiatives has shown some results in environment and credit as well as agricultural productivity. For example, the United Nations Population Fund reports that "women are now the principal participants in Kenya's National Soil Conservation Program. Since the mid-1980s, women have terraced more than 360,000 small farms, or 40 per cent of the country's total. Rural collectives, run by women, are now getting bank loans and agricultural extension services tailored to their specific needs and interests."

The Women in Development Service of the FAO reports that "in Kenya, following a national information campaign targeted at women under a National Extension Project, yields of corn increased by 28 percent, beans by 80 percent and potatoes by 84 percent." The way forward also includes a greater emphasis on more general knowledge. The FAO also reports on a study in Kenya that showed that farm "yields among rural women could be increased by 24 percent if all women farmers completed primary school."

Nevertheless, the agricultural extension program in Kenya has remained weak by international standards. The World Bank audited its programs in this field in 1999 and found it severely wanting in many respects, including low cost-effectiveness. The audit called for more efficient targeting of extension

services where the impact is likely to be greatest, using improved information systems, and empowering farmer clients by giving them a greater voice in the design of the services. The World Bank also called for more cost recovery, but this is likely to prove controversial. Kenya eliminated user fees on primary education in 2002, making it at least nominally free for all, despite 1980s-era encouragement by the World Bank and other agencies to seek "cost recovery" from impoverished parents of primary pupils. As a vital part of poverty alleviation, cost recovery from impoverished women farmers is a dubious strategy. It may also be noted that structural adjustment in Kenya is cited by other critics as a cause of declining T&V budgets in the late 1980s and 1990s, severely crippling the capacities of this program.

In Kenya and elsewhere in sub-Saharan Africa, public extension programs have also been supplemented in recent years by a growing presence of nongovernmental organizations (see Chapter 11). For example, in western Kenya, the NGO Africa Now is actively recruiting and training farmers to participate in beekeeping as an alternative means of income generation. Broad participation of many civil society actors with diverse knowledge bases and connections with various ethnic and other social groupings is essential to success in an ecologically and socially diverse region such as sub-Saharan Africa.

Regarding government extension, a World Bank evaluation concluded that "progress on gender issues has been mixed. The earlier bias against women farmers has been rectified, but some bias persists in the selection of contact farmers. The proportion of female field-extension agents has remained largely unchanged since 1982." Though a better performance than many African and Asian countries and than Kenya exhibited in the past, it leaves much to be desired. Real progress has been made, but there is a pressing need for systematic follow-up and expansion.

A hopeful sign is that in decentralizing extension to more local levels, opportunities for active participation are increasing. Kenya's National Agricultural and Livestock Program has established stakeholder forums to decide on extension service priorities at the district and subdistrict levels, in which farmers are to be given a substantial say. But it is too early

to determine how much more responsive the new system will be to the needs of women farmers or whether the long-run impact will be greater than past efforts.

In another development, Esther Duflo, Michael Kremer, and Jonathan Robinson presented intriguing evidence, from the Busia district in Kenya, that farmers also have a “commitment problem” in using returns from produce sales to purchase fertilizer for next season. Although still at an early stage, this pioneering research may open up new avenues for more effective agricultural program design.

But the role of women is strengthening throughout Kenya. Thousands of women are taking part in the Green Belt Movement (GBM), established in 1977 by the National Council of Women in Kenya at the behest of the visionary leader Wangari Maathai. Its simple objective, in Maathai’s words, is to “halt desertification by encouraging tree planting and soil and water conservation in rural communities.” The GBM also works to promote sustainable development and poverty alleviation in parallel

projects. Although the program is run through the NGO or citizen sector, seedlings are provided by the government at low prices, and GBM volunteers receive advice and support from government forestry officials. For her work in supporting sustainable agriculture and forestry that benefits women and children, Maathai was awarded the 2004 Nobel Prize for Peace.

The GBM emphasizes grassroots participation and self-help and strives to educate people on the link between deforestation, erosion, poor soil quality, and subsequent low crop yields. With the help of outside funding, women are paid to work at about 1,000 nurseries. Seedlings grown at these nurseries are given to small farmers, schools, and churches, which have planted tens of millions of trees. The estimated survival rate is 70 to 80%. The GBM has had striking success in scalability, that is, bringing the model throughout Kenya and then disseminating it widely in Africa. This success was noted by the Nobel committee when awarding the prize to Maathai. ■

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Concepts for Review

Agrarian system	Landlord	Shifting cultivation
Cash crops	Land reform	Specialized farming
Diversified farming	<i>Latifundio</i>	Staple food
Diversified (mixed) farming	Medium-size farm	Subsistence farming
Family farm	<i>Minifundio</i>	Tenant farmer
Green revolution	Moneylender	Transaction costs
Integrated rural development	Scale-neutral	
Interlocking factor markets	Sharecropper	

Questions for Discussion

1. Why should any analysis of development problems place heavy emphasis on the study of agricultural systems, especially peasant agriculture, and the rural sector?
2. What are the principal reasons for the relative stagnation of developing-country agriculture in Africa? How can this disappointing performance be improved on in the future? Explain your answer.
3. Discuss three main systems of agriculture found in the developing world. To what extent are these systems concentrated in three major developing regions?
4. Compare and contrast the nature of peasant or small-scale traditional agriculture in Asia, Africa, and Latin America. How do overall agricultural systems differ among these regions? What are the common characteristics?

5. Explain the meaning of Gunnar Myrdal's quote at the beginning of this chapter: "It is in the agricultural sector that the battle for long-term economic development will be won or lost."
6. It is sometimes asserted that small, traditional (peasant) farmers are backward and ignorant because they seem to resist agricultural innovations that could raise farm yields substantially. Does this resistance stem from an inherent irrationality on their part, or might it be attributable to some other factors often overlooked by traditional economic analysis? Explain your answer.
7. We described three stages in the transition from subsistence to specialized agriculture. What are the principal characteristics of each of these stages?
8. There appears to be widespread agreement that in regions where the distribution of land ownership is highly unequal (mainly Latin America but also parts of Asia), land reform is a necessary but not sufficient condition for promoting and improving small-scale agriculture. What is meant by this statement and by the concept of land reform? Give some examples of supportive policy measures that might accompany land reform.
9. What is meant by comprehensive or integrated rural development? What criteria would you use to decide whether or not such integrated rural development was or was not taking place?
10. What explains sharecropping? To what extent do you think your explanation justifies the practice?
11. If land reform is efficient, why do you think it is not more commonly implemented?
12. Why is a proper understanding of risks faced by smallholder farmers of such fundamental importance to agricultural development policy?
13. Explain the argument that effective agricultural policies center around the role of women.
14. The poorest farmers tend to work on farms with the poorest soil and water conditions. Do you think this is the cause, the effect, or both?
15. What basic problems does the case study evoke on agricultural extension for women in Kenya? What special strategies may be used to address them?

Notes

1. Regional and national figures are drawn from World Bank, *World Development Indicators 2013*.
2. See United Nations Food and Agriculture Organization, "Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition," 2012, <http://www.fao.org/docrep/016/i2845e/i2845e00.pdf>. In 2009, the UN FAO estimated that for the first time, over 1 billion people did not have enough food to meet their basic nutritional needs as a result of a world food price spike, showing the high vulnerability many people face. See United Nations Food and Agriculture Organization, "The state of food insecurity in the world, 2012, and 2009," <http://www.fao.org/docrep/012/i0876e/i0876e00.htm>. See also, <http://www.fao.org/publications/sofi/en>; and International Food Policy Research Institute, "2012 Global Hunger Index: The challenge of hunger: Ensuring sustainable food security under land, water, and energy stresses," and "2009 Global Hunger Index," <http://www.ifpri.org/publication/2009-global-hunger-index>.
3. Simon Kuznets, "Economic growth and the contribution of agriculture," in *Agriculture in Economic Development*, eds. C. K. Eicher and L. W. Witt (New York: McGraw-Hill, 1964).
4. Ibid. See also John W. Mellor, "Agriculture on the road to industrialization," in *Development Strategies Reconsidered*, eds. John P. Lewis and Valeriana Kallab (Washington, D.C.: Overseas Development Council, 1986), pp. 67–89; Subrata Ghatak, "Agriculture and economic development," in *Surveys in Economic Development*, ed. Norman Gemmell (Oxford: Blackwell, 1987), ch. 10; Charles P. Timmer, "The agricultural transformation," in *Handbook of Development Economics*, vol. 1, eds. Hollis B. Chenery and T. N. Srinivasan (Amsterdam: Elsevier, 1988), pp. 276–331.

5. For data see World Development Indicators, Table 4.1, columns 3 and 4, which show growth in low- and middle-income areas accelerating in the 2001–2011 period over the 1990–2000 period, but slightly decelerating in high-income countries. On successful agricultural development and hunger programs and projects, see International Food Policy Research Institute, “Millions fed,” 2009, <http://www.ifpri.org/publication/millions-fed>. Regarding high developing country productivity gains, see World Bank, *World Development Report, 2008* (New York: Oxford University Press, 2007), p. 69, and Mette Wik, Prabhu Pingali, and Sumiter Broca, “Global agricultural performance: Past trends and future prospects,” WDR background paper, 2007.
6. See the United Nations Food and Agriculture Organization (FAO), *State of Food Insecurity, 2012*, <http://www.fao.org/publications/sofi/2012/en>; the *OECD-FAO Agricultural Outlook 2013–2022*, June 2013, <http://www.oecd.org/site/oecd-faoagriculturaloutlook>; and previous issues of these annual series.
7. Rockefeller Foundation Web page, <http://www.rockfound.org/initiatives/agra/agra.shtml>. The AGRA home page is <http://www.agra-alliance.org>. For information on the NEPAD initiative, goto <http://www.nepad.org/2005/files/documents/172.pdf>.
8. On NERICA, see Office of the Chief Economist, Africa Region, World Bank, *Yes, Africa Can: Success Stories from a Dynamic Continent* (Washington D.C.: World Bank, 2009), p. 9. On the 2008 food price spike and an explanation of short- and long-term forces for price increases, see the OECD-FAO reports, op. cit. (endnote 5). For more analysis on progress and challenges in reducing global hunger, see International Food Policy Research Institute, *2012 Global Food Policy Report* (Washington, D.C.: IFPRI, 2013); and K. O. Fuglie and S. L. Wang, “New evidence points to robust but uneven productivity growth in global agriculture,” *Amber Waves* 10 (September 2012). Note that 30 countries imposed food export restrictions by the peak of the food price spike, at the same time as many food-importing developing nations were making efforts to rebuild stocks. This kind of panic can be expectations driven and raise prices above what is consistent with long-run equilibrium.
9. See Nora Lustig, “Thought for food: The challenges of coping with rising food prices,” CGD Working Paper at <http://www.cgdev.org/content/publications/detail/967250>. Later in the chapter we consider further the impact of food prices on poverty; poor smallholders and agricultural workers may receive benefits from rising demand as well as face higher food costs.
10. E. F. Sczepanik, *Agricultural Capital Formation in Selected Developing Countries* (Rome: FAO, 1970).
11. See World Bank, *World Development Report, 2008*, ch. 11.
12. Stephen C. Smith, *Ending Global Poverty: A Guide to What Works* (New York: Palgrave Macmillan, 2005); Sungil Kwak and Stephen C. Smith, “Regional agricultural endowments and shifts of poverty trap equilibria: Evidence from Ethiopian panel data,” *Journal of Development Studies* 47, No. 7 (July 2013): 955–975.
13. For an excellent survey of recent developments in agricultural development economics, see Alain de Janvry and Elisabeth Sadoulet, “Progress in the modeling of rural households’ behavior under market failures,” in de Janvry and Kanbur, eds., *Poverty, Inequality, and Development: Essays in Honor of Erik Thorbecke* (New York: Kluwer, 2006). See also World Bank, “Pakistan: Promoting rural growth and poverty reduction,” 2007, <http://siteresources.worldbank.org/PAKISTANEXTN/Resources/293051-1177200597243/ruralgrowthandpovertyreduction.pdf>.
14. Beginning in the early 1960s, many countries in Latin America initiated land reform programs that did not alter the highly unequal distribution of land ownership but did do away with some of the more feudal patron-client relationships associated with *latifundios* and *minifundios*. For pedagogical purposes, we will continue to use these terms more as a designation of the dualistic agrarian structure that still permeates Latin America than as a description of contemporary rural social relationships. For an early analysis, see also Celso Furtado, *Economic Development in Latin America* (New York: Cambridge University Press, 1970). The Latin America data in Table 9.3 also reflect the extreme inequality of the region.

15. United Nations Development Programme, *Human Development Report, 1996* (New York: Oxford University Press, 1996), p. 98. For other country estimates, see Keijiro Otsuka, Hiroyuki Chuma, and Yujiro Hayami, "Land and labor contracts in agrarian economies: Theories and facts," *Journal of Economic Literature* 30 (1992): 1965–2018.
16. For a summary of the empirical evidence on this point, see the *World Development Report, 2008*; and R. Albert Berry and William Cline, *Agrarian Structure and Productivity in Developing Countries* (Baltimore: Johns Hopkins University Press, 1979), ch. 3 and app. B; G. A. Cornia, "Farm size, land yields and the agricultural production function: An analysis of fifteen developing countries," *World Development* 13 (1985): 513–534; Nancy L. Johnson and Vernon Ruttan, "Why are farms so small?" *World Development* 22 (1994): 691–705; and United Nations Development Programme, *Human Development Report, 1996*, p. 95.
17. For evidence that land redistribution is likely to lead to greater output and higher productivity levels, see Cornia, "Farm size, land yields and the agricultural production function."
18. Francis M. Foland, "Agrarian unrest in Asia and Latin America," *World Development* 2 (1974): 57.
19. See *World Development Report, 2008*, ch. 10, and Cathy Farnworth and Michael Goodman, "Growing ethical networks: The Fair Trade market for raw and processed agricultural products (in five parts) with associated case studies on Africa and Latin America," November 2006, <http://www.rimisp.org/getdoc.php?docid=6442>.
20. Kenneth L. Sokoloff and Stanley L. Engerman, "History lessons: Institutions, factor endowments, and paths of development in the New World," *Journal of Economic Perspectives* 14 (2000): 217–232, and Stanley L. Engerman and Kenneth L. Sokoloff, "Colonialism, inequality, and long-run paths of development," in *Understanding Poverty*, eds. Abhijit V. Banerjee, Roland Benabou, and Dilip Mookherjee (New York: Oxford University Press, 2006), pp. 37–62. On Colombia, see *World Development Report, 2008*, box 11.1, and Klaus Deininger, Ana Maria Ibañez, and Pablo Querubin, "Determinants of internal displacement and desire to return: Micro-level evidence from Colombia," working paper, World Bank, 2007.
21. See World Bank, *World Development Report, 2003*, ch. 10.
22. Gunnar Myrdal, *Asian Drama* (New York: Pantheon, 1968), pp. 1033–1052.
23. *Ibid.*, p. 1035.
24. *Ibid.*
25. Otsuka, Chuma, and Hayami, "Land and labor contracts," tab. 1.
26. A somewhat more positive view of the efficiency of land leases and access to credit through moneylenders and other informal sources of credit in Asia (and Latin America) was the focus of the "new agrarian economics" of the late 1970s and 1980s. In general, the position of this school of thought was that land contracting and usurious moneylending are efficient given the existence of other market failures, imperfect information, high transaction costs, moral hazards, and the like. Whether or not they were as efficient as these theorists claimed was far from clear, but their ultimate exploitive nature is difficult to deny. For examples of this literature, see Pranab K. Bardhan, *Land, Labor, and Rural Poverty: Essays in Development Economics* (New York: Columbia University Press, 1984); Keijiro Otsuka and Yujiro Hayami, "Theories of shared tenancy: A critical survey," *Economic Development and Cultural Change* 37 (1988): 31–68; Karla Hoff and Joseph E. Stiglitz, "Imperfect information and rural credit markets: Puzzles and policy perspectives," *World Bank Economic Review* 4 (1990): 235–250; and Timothy Besley, "How do market failures justify interventions in rural credit markets?" *World Bank Research Observer* 9 (1994): 27–47.
27. Myrdal, *Asian Drama*, p. 1048.
28. For a discussion of the phenomenon of landlessness in developing countries with a particular emphasis on Asia, see Mahmood H. Khan, "Landlessness and rural poverty in underdeveloped countries," *Pakistan Development Review* 25 (1986): 371–394.
29. Abhijit V. Banerjee and Lakshmi Iyer, "History, institutions, and economic performance: The legacy of colonial land tenure systems in India," *American Economic Review* 95 (2005): 1190–1213.
30. World Bank, *World Development Report, 2008*, p. 233 and fig. 2.2.

31. See World Bank, *World Development Indicators*, 2003, p. 131, and 2004, tabs. 2.1, 3.3, and 4.1 (Washington, D.C.: World Bank, 2003, 2004) and Figure 9.2 in this chapter.
32. World Resources Institute, *World Resources*, 1996–97, tab. 10.1, and *World Resources*, 1987 (New York: Basic Books, 1987).
33. See Carolyn Sachs, *The Invisible Farmers: Women in Agriculture* (Totowa, N.J.: Rowman & Littlefield, 1983). The classic and still influential treatment of the subject can be found in Ester Boserup, *Women's Role in Economic Development* (New York: St. Martin's Press, 1970).
34. Boserup, *Women's Role*. For a valuable collection of reviews and studies, see C. Mark Blackden and Quentin Wodon, eds., *Gender, Time Use, and Poverty in Sub-Saharan Africa* (Washington, D.C.: World Bank, 2006).
35. See Christopher Udry, "Gender, agricultural production, and the theory of the household," *Journal of Political Economy* 104 (1996): 1010–1046; Udry examines detailed data from Burkina Faso and finds that "plots controlled by women have significantly lower yields than similar plots within the household planted with the same crop in the same year, but controlled by men. The yield differential is attributable to significantly higher labor and fertilizer inputs per acre on plots controlled by men. These results contradict the Pareto efficiency of resource allocation within the household. Production function estimates imply that about six percent of output is lost due to the misallocation of variable factors across plots within the household." See also Christopher Udry, John Hoddinott, Harold Alderman, and Lawrence Haddad, "Gender differentials in farm productivity: Implications for household efficiency and agricultural policy," *Food Policy* 20 (1995): 407–423; Michael Carter and Elizabeth Katz, "Separate spheres and the conjugal contract: Understanding gender-biased development," in *Intrahousehold Resource Allocation in Developing Countries: Methods, Models, and Policy*, eds. Lawrence Haddad, John Hoddinott, and Harold Alderman (Baltimore: Johns Hopkins University Press, 1997); Pierre Chiappori, Lawrence Haddad, John Hoddinott, and Ravi Kanbur, "Unitary versus collective models of the household: Time to shift the burden of proof?" World Bank Policy Research Working Paper No. 1217; James Warner and D. A. Campbell, "Supply response in an agrarian economy with non-symmetric gender relations," *World Development* 28 (2000): 1327–1340; and Kaushik Basu, "Gender and say: A model of household behavior with endogenous balance of power," *Economic Journal* 116 (2006): 558–580.
36. For the classic treatment, see Raanan Weitz, *From Peasant to Farmer: A Revolutionary Strategy for Development* (New York: Columbia University Press, 1971), pp. 15–28, from which much of the following material is drawn. The three stages of farm evolution outlined in this section should not be interpreted as inevitable periods or sequences implying that all farms are in one of these stages before moving on to the next. In reality, of course, all three types of farms exist in every developing country at all points in time.
37. See Carmen Diana Deere and Alain de Janvry, "A conceptual framework for the empirical analysis of peasants," *American Journal of Agricultural Economics* 61 (1979): 602–612. See also Alain de Janvry, Elisabeth Sadoulet, and Linda Wilcox Young, *Rural Labor in Latin America* (Geneva: International Labor Organization, 1986), tab. 24.
38. See World Bank, *World Development Report 2014, Risk and Opportunity: Managing Risk for Development*, Washington DC: World Bank, 2013; and Marcel Fafchamps, *Rural Poverty, Risk, and Development* (Northampton, Mass.: Elgar, 2004). Important earlier contributions include Alain de Janvry, Marcel Fafchamps, and Elisabeth Sadoulet, "Peasant household behavior with missing markets: Some paradoxes explained," *Economic Journal* 101 (1991): 1400–1417, and Alain de Janvry and Elisabeth Sadoulet, "Structural adjustment under transaction costs," in *Food and Agricultural Policies under Structural Adjustment*, eds. F. Heidhues and B. Knerr (Frankfurt, Germany: Lang, 1995).
39. See Marvin P. Miracle, "Subsistence agriculture: Analytical problems and alternative concepts," *American Journal of Agricultural Economics* 50 (1968): 292–310.
40. For a rigorous analysis of how related farmer productivity traps operate, see Frederick J. Zimmerman

- and Michael R. Carter, "Asset smoothing, consumption smoothing, and the reproduction of inequality under risk and subsistence constraints," *Journal of Development Economics* 71 (2003): 233–260. See also the two special issues on poverty traps in *Journal of Development Studies* in 2006 (Volume 42, No. 2) and 2013 (Volume 47, No. 7).
41. We are grateful to Professor Frank Thompson for this suggestion.
 42. See Marcel Fafchamps and John Pender, "Precautionary saving, credit constraints, and irreversible investment: Theory and evidence from semiarid India," *Journal of Business and Economic Statistics* (1997): 180–194; Hans P. Binswanger and Mark Rosenzweig, "Wealth, weather risk, and the composition and profitability of agricultural investments," *Economic Journal* 103 (1993): 56–78; and Harold Alderman and Christina Paxson, "Do the poor insure? A synthesis of the literature on risk and consumption in developing countries," World Bank Policy Research Paper No. 1008, 1994.
 43. Hanan G. Jacoby, Guo Li, and Scott Rozelle, "Hazards of expropriation: Tenure insecurity and investment in rural China," *American Economic Review* 92 (2002): 1420–1447. For broader background, see also Keith Griffin, "Agrarian policy. The political and economic context," *World Development* 1 (1973): 6.
 44. Joseph E. Stiglitz first formulated the argument that sharecropping represents a compromise between landlord and tenant in which the landlord assumes some of the production risk but the tenant accepts some degree of work incentive given that monitoring is costly; see Stiglitz, "Incentives and risk sharing in sharecropping," *Review of Economic Studies* 41 (1974): 219–255.
 45. Alfred Marshall, *Principles of Economics*, 8th ed. (London: Macmillan, 1920).
 46. Steven N. S. Cheung, "Private property rights and sharecropping," *Journal of Political Economy* 76 (1968): 1107–1122. Of course, the contract would somehow have to provide an effective total compensation to the employee that matched the opportunity cost of providing the efficient level of effort, or the potential sharecropper would choose an alternative activity instead.
 47. The classic article in this literature is William S. Hallagan, "Self-selection by contractual choice and the theory of sharecropping," *Bell Journal of Economics* 9 (1978): 344–354.
 48. Radwan Ali Shaban, "Testing between competing models of sharecropping," *Journal of Political Economy* 95 (1987): 893–920. Some of the input results may not be fully free of confounding of expropriation risk.
 49. See, for example, Nirvikar Singh, "Theories of sharecropping," in *The Economic Theory of Agrarian Institutions*, ed. Pranab K. Bardhan (Oxford: Clarendon Press, 1989), pp. 33–72; David M. Newberry, "Risk-sharing, sharecropping, and uncertain labor markets," *Review of Economic Studies* (1977): 585–594; and Joseph E. Stiglitz, "Sharecropping," in *Economic Development*, eds. John Eatwell, Murray Milgate, and Peter Newman (London: Macmillan, 1989), pp. 308–315.
 50. A succinct but rather technical overview of the competing theories is found in Singh, "Theories of sharecropping." The point that sharecropping results from inequality and that it remains inefficient in the Marshallian sense despite the potentially reduced inefficiency relative to straight wage or rental contracts was made by Joseph Stiglitz at a World Bank lecture in Washington, D.C., September 1997.
 51. See Abhijit V. Banerjee, Paul Gertler, and Maitresh Ghatak, "Empowerment and efficiency: Tenancy reform in West Bengal," *Journal of Political Economy* 110 (2002): 239–280. Of course, in general, enforcement of tenancy and land reform is problematic in settings in which large landowners wield substantial power. For a simple and intuitive model of investment incentives (including fertilizer that is effective for more than one growing season) in the face of eviction risk, see Jacoby, Li, and Rozelle, "Hazards of expropriation."
 52. Pranab K. Bardhan and Christopher Udry, *Development Microeconomics* (New York: Oxford University Press, 1999), p. 111.
 53. See Pranab K. Bardhan, "Interlocking factor markets and agrarian development: A review of issues," *Oxford Economic Papers* 32 (1980): 82–98. See also Bardhan and Udry, *Development Microeconomics*. They note that while interlinkage can have

- some positive efficiency implications in informal rural markets, “personalized interlinking may at the same time act as a formidable barrier to entry for other parties and may give the dominant partner in a transaction some additional leverage” (p. 111). Note that other forms of interlinkage exist in which the peasant retains ownership of his land. An example is contract farming in parts of Africa, in which a contractor who has “cultivated” export marketing channels provides seeds, fertilizer, and other inputs to a farmer to produce an output such as legumes that the contractor buys at an agreed price at harvest time.
54. For an interesting analysis of the process of agricultural specialization, see M. Shahe Emran and Forhad Shilpi, “The extent of the market and stages of agricultural specialization,” *Canadian Journal of Economics* 45, No. 3 (2012): 1125–1153. An analysis of the impact of market access is presented in M. Shahe Emran and Zhaoyang Hou, “Access to markets and rural poverty: Evidence from household consumption in China,” *Review of Economics and Statistics* 95, No. 2 (2013): 682–697. For a detailed analysis of the responsiveness of farmers in developing countries to price incentives, see World Bank, *World Development Report, 1986* (New York: Oxford University Press, 1986), chs. 4 and 5. A more cautious assessment is found in the 2008 *World Development Report*, however. For an analysis of the role of risk, see also Fafchamps, *Rural Poverty, Risk, and Development*, p. 28.
 55. For an analysis of the adverse effects of premature mechanization, see Yujiro Hayami and Vernon Ruttan, *Agricultural Development: An International Perspective* (Baltimore: Johns Hopkins University Press, 1985).
 56. Two informative articles on appropriate mechanization for development are Hans P. Binswanger, “Agricultural mechanization: A comparative historical perspective,” *World Bank Research Observer* 1 (1986): 81–98, and Hans P. Binswanger and Prabhu Pingali, “Technological priorities for farming in sub-Saharan Africa,” *World Bank Research Observer* 3 (1988): 81–92.
 57. See World Bank, *World Development Report, 2008*, esp. chs. 6 and 11. An excellent analysis of the role of institutions in rural development can be found in Brian van Arkadie, “The role of institutions in development,” *Proceedings of the World Bank Annual Conference on Development Economics, 1989* (Washington, D.C.: World Bank, 1989), pp. 153–192.
 58. For an early analysis of the impact of the green revolution in the developing world, see Keith Griffin, *The Political Economy of Agrarian Change* (London: Macmillan, 1974); Chris Manning, “Rural employment creation in Java: Lessons from the green revolution and oil boom,” *Population and Development Review* 14 (1988): 17–18; and Donald K. Freebairn, “Did the green revolution concentrate incomes? A quantitative study of research reports,” *World Development* 23 (1995): 265–279.
 59. World Bank, *World Development Report, 2008*, ch. 11. An informative discussion of the important role of appropriate pricing policies in stimulating agricultural production can be found in A. Drazen and Z. Eckstein, “On the organization of rural markets and the process of economic development,” *American Economic Review* 78 (1988): 431–443. A massive five-volume research report, *The Political Economy of Agrarian Pricing Policy*, published by the World Bank in 1991, found similar results in the 18 developing countries investigated. For an extensive critique of inappropriate government policies hindering agricultural development in sub-Saharan Africa as well as elsewhere in the developing world, see Hans P. Binswanger and Klaus Deininger, “Explaining agricultural and agrarian policies in developing countries,” *Journal of Economic Literature* 35 (1997): 1958–2005.
 60. World Bank, *World Development Report, 2008*, p. 338.
 61. See Oxfam UK, “Our land, our lives: Time out on the global land rush,” Oxfam Briefing Note, October 2012, http://www.oxfam.org/sites/www.oxfam.org/files/bn-land-lives-freeze-041012-en_1.pdf; and Joachim von Braun, and Ruth Suseela Meinzen-Dick, “‘Land grabbing’ by foreign investors in developing countries: Risks and opportunities,” *IFPRI Policy Briefing No. 12*, 2009.
 62. For a survey of the connections between agriculture and environmental sustainability issues, see World Bank, *World Development Report, 2008*, ch. 8 and the references cited therein.

63. For a more comprehensive review of integrated programs for rural development, see World Bank, *World Development Report, 2008*, ch. 6, and Alain de Janvry, *The Economics of Investment in Rural Development: Private and Social Accounting Experiences from Latin America* (Berkeley: Department of Agricultural and Resource Economics, University of California, 1988).
64. United Nations Food and Agriculture Organization, "Land reform: Land settlement and cooperatives," 2007, <http://www.fao.org/sd/Ltdirect/landrF.htm>. For the seminal analysis see Myrdal, Gunnar, "The equality issue in world development," in *Nobel Lectures, Economics, 1969–1980*, ed. Assar Lindbeck (Singapore: World Scientific Publishing, 1992).
65. See Alain de Janvry, *The Agrarian Question and Reformism in Latin America* (Baltimore: Johns Hopkins University Press, 1981).
66. For an analysis of the successes and failures of various reform efforts, see World Bank, *World Development Report, 2008*; World Bank, *World Development Report, 1990* (New York: Oxford University Press, 1990), pp. 64–73; and Peter Dorner, *Latin American Land Reforms in Theory and Practice: A Retrospective Analysis* (Madison: University of Wisconsin Press, 1992).
67. See, for example, World Bank, *World Development Report, 2008*, and Jock R. Anderson, "Agricultural advisory services," Background paper for 2008 World Development Report. World Bank, 2007.

10

The Environment and Development

The poorest developing countries will be hit earliest and hardest by climate change, even though they have contributed little to causing the problem.

—*Nicholas Stern, The Stern Review on the Economics of Climate Change, 2006*

Inequality in capacity to adapt to climate change is emerging as a potential driver of wider disparities in wealth, security and opportunities for human development.

—*United Nations Development Programme, Human Development Report, 2007/2008*

Development co-operation should promote “pro-poor green growth,” i.e., environmentally sustainable growth in which poor women and men can participate, contribute and benefit.

—*Organization for Economic Cooperation and Development, Development Assistance Committee, 2010*

Each generation shall reap what the former generation has sown.

—*Ancient Proverb of China*

The road ahead is long and hard.

—*UN Secretary General Ban Ki-Moon, at Rio+20 Earth Summit, 2012*

The livelihood of more than half of the economically active population in the developing world directly depends in whole or part on the environment through agriculture, as well as animal husbandry, hunting, fishing, forestry, and foraging. This alone underscores the importance of the seventh Millennium Development Goal MDG: to “ensure environmental sustainability,” and the central place of environment in the emerging post-2015 Sustainable Development Goals. Environmental quality strongly affects, and is affected by, economic development.

10.1 Environment and Development: the Basic Issues

Economics and the Environment

In recent years, economists have increasingly focused on the important implications of environmental issues for the success of development efforts. It is clear that classic market failures lead to too much environmental degradation. We now also understand that the interaction between poverty and

environmental degradation can lead to a self-perpetuating process in which, as a result of ignorance or economic necessity, communities may inadvertently destroy or exhaust the resources on which they depend for survival. Rising pressures on environmental resources in developing countries can have severe consequences for self-sufficiency, income distribution, future growth potential, and the fundamental quality of life.

Environmental degradation can also detract from the pace of economic development by imposing high costs on developing countries through health-related expenses and the reduced productivity of resources. The poorest 20% of the poor in both rural and urban areas will experience the consequences of environmental ills most acutely. Severe environmental degradation, due to population pressures on marginal land, has led to falling farm productivity and per capita food production. Since the cultivation of marginal land is largely the domain of lower-income groups, the losses are suffered by those who can least afford them. Similarly, the inaccessibility of sanitation and clean water mainly affects the poor and is believed to be responsible for a preponderance of infectious disease worldwide. Because the solutions to these and many other environmental problems involve enhancing the productivity of resources and improving living conditions among the poor, achieving environmentally sustainable growth is synonymous with our definition of economic development.

Although the environmental costs associated with various economic activities are disputed, development economists agree that environmental considerations should form an integral part of policy initiatives.¹ Damage to soil, water supplies, and forests resulting from unsustainable methods of production can greatly reduce long-term national productivity but paradoxically can show up as having a positive impact on current GNI figures. It is thus very important that the long-term implications of environmental quality be considered in economic analysis. Rapid population growth and expanding economic activity in the developing world are likely to do extensive environmental damage unless steps are taken to mitigate their negative consequences.

The growing consumption needs of people in developing countries may have global implications as well. There is increasing concern that the destruction of the world's remaining forests, which are concentrated in a number of highly indebted developing countries in Africa as well as such countries as Indonesia, Brazil, Peru, and the Philippines, will greatly contribute to climate change caused by **global warming** through the greenhouse effect. At the same time, developing countries, particularly those in sub-Saharan Africa and South Asia, are predicted by climate models to suffer most from future global warming and **climate change**. Yet to date, most of the greenhouse gases causing the problem have been emitted in developed countries, creating what may be termed *environmental dependence*: Developing nations will be reliant on the developed world to take immediate steps to reduce emissions, as well as to develop new technologies that will enable further reductions and successful adaptation to the already inevitable warming and resulting climate change. However, developing countries, most prominently China at this stage, will also have to reduce emissions well below current forecasts, or any reductions in the developed world will only delay the possibly catastrophic consequences.

In this chapter, we examine the economic causes and consequences of environmental crises and explore potential solutions to the cycle of poverty

Global warming Increasing average air and ocean temperatures. Used in reference to the trend that began in the mid-twentieth century and attributed largely to human industrial, forestry, and agricultural activities emitting greenhouse gases.

Climate change Nontransient altering of underlying climate, such as increased average temperature, decreased annual precipitation, or greater average intensity of droughts or storms. Used in reference to the impact of the global warming phenomenon. Note the distinction between changes in weather (which varies within a climate) and changes in climate that alter underlying probabilities of weather outcomes.

and resource degradation. We begin with a survey of basic issues, including discussions of sustainable development and the linkages among population, poverty, economic growth, rural development, urbanization, and the environment in developing countries. We next look at the applicability of traditional economic models of the environment, depict some typical environmental situations, and provide some relevant data. We then broaden our scope to examine the global environment and explore policies for seeking worldwide sustainable development. The end-of-chapter comparative case study of Haiti and the Dominican Republic—two nations sharing one island—examines the role of environment as one of the dimensions of their very different development outcomes.

Eight basic issues define the environment of development. Many grow out of the discussions in the preceding chapters. The first is the concept of sustainable development; the others involve linkages between the environment and population and resources, poverty, economic growth, rural development, urbanization, the global economy, and the nature and pace of greenhouse gas-induced climate change. We briefly discuss each in turn.

Sustainable Development and Environmental Accounting

The term *sustainability* reflects the need for careful balance between economic growth and environmental preservation. Although many definitions exist,² *sustainability* generally refers to “meeting the needs of the present generation without compromising the needs of future generations.”³

Sustainable development can be studied using long-standing concepts of economic analysis. These include three tools: using an appropriate valuation of future social benefits (generally placing more weight on the future than does the market); paying proper attention to market failures (focusing on externalities and public goods); and explicitly valuing natural resources as a form of capital stock rather than just a stream of consumption. We turn first to the problem of properly valuing the environment in national income accounting.

In a classic definition, a development path is sustainable “if and only if the stock of overall capital assets remains constant or rises over time.”⁴ But in this regard, natural resources and other forms of capital are substitutes only at a limited scale and to a limited degree. Rather, after the environment has been degraded to some extent, *natural resources and other forms of capital likely act as complements*. Manufactured capital is generally unproductive without a minimum of available environmental services. While future technological fixes may be imagined, there is certainly no guarantee that they will emerge.⁵

Implicit in these statements is the fact that future growth and overall quality of life are critically dependent on the quality of the environment. The natural resource base of a country and the quality of its air, water, and land represent a common heritage for all generations. To destroy that endowment indiscriminately in the pursuit of short-term economic goals penalizes both present and, especially, future generations. It is therefore important that development policymakers incorporate some form of **environmental accounting** into their decisions. For example, the preservation or loss of valuable environmental resources should be factored into estimates of economic growth and human well-being. Alternatively, policymakers may set a goal of no net loss

Environmental accounting

The incorporation of environmental benefits and costs into the quantitative analysis of economic activities.

of environmental assets. In other words, if an environmental resource is damaged or depleted in one area, a resource of equal or greater value should be regenerated elsewhere.

Overall capital assets are meant to include not only manufactured capital (machines, factories, roads) but also human capital (knowledge, experience, skills) and **environmental capital** (forests, soil quality, rangeland). By this definition, **sustainable development** requires that these overall capital assets not be decreasing and that the correct measure of **sustainable net national income (NNI*)** is the amount that can be consumed without diminishing the capital stock. Symbolically,

$$\text{NNI}^* = \text{GNI} - D_m - D_n \quad (10.1)$$

where NNI^* is sustainable national income, D_m is depreciation of manufactured capital assets, and D_n is depreciation of environmental capital—the monetary value of environmental decay over the course of a year. NNI^* includes costs of activities to reverse or avert environmental decay.

An even better measure, though more difficult to calculate with present data collection methods, would be

$$\text{NNI}^{**} = \text{GNI} - D_m - D_n - R - A \quad (10.2)$$

where D_m and D_n are as before, R is expenditure required to restore environmental capital (forests, fisheries, etc.), and A is expenditure required to avert destruction of environmental capital (air pollution, water and soil quality, etc.). (Note that NNI includes R and A as economic activities, but these are then subtracted as forms of “allowance for depreciation” in arriving at NNI^{**} .)⁶

In light of rising consumption levels worldwide, combined with high rates of population growth, the realization of sustainable development will be a major challenge. We must ask ourselves, “What are realistic expectations about sustainable standards of living?” From present information concerning rapid destruction of many of the world’s resources, it is clear that meeting the needs of a world population that is projected to grow by about 2 billion in the next 35 years will require radical and early changes in consumption and production patterns. We discuss these needed changes later in the chapter.

Environment Relationships to Population, Poverty, and Economic Growth

Population, Resources, and the Environment Much of the concern over environmental issues stems from the perception that we may reach a limit to the number of people whose needs can be met by the earth’s finite resources. We may or may not reach this point, given the potential for new technological discoveries, but it is clear that continuing on our present path of accelerating environmental degradation would severely compromise the ability of present and future generations to meet their needs. A slowing of population growth rates would help ease the intensification of many environmental problems. However, the rate and timing of fertility declines, and thus the eventual size of world population, will largely depend on the commitment of governments to creating economic and institutional conditions that are conducive to limiting fertility (see Chapter 6).

Environmental capital The portion of a country’s overall capital assets that directly relate to the environment—for example, forests, soil quality, and ground water.

Sustainable development A pattern of development that permits future generations to live at least as well as the current generation, generally requiring at least a minimum environmental protection

Sustainable net national income (NNI*) An environmental accounting measure of the total annual income that can be consumed without diminishing the overall capital assets of a nation (including environmental capital).

Rapidly growing populations have led to land, water, and fuelwood shortages in rural areas and to urban health crises stemming from lack of sanitation and clean water.⁷ In many of the poorest regions of the globe, it is clear that increasing population density has contributed to severe and accelerating degradation of the very resources that these growing populations depend on for survival. To meet expanding needs in developing countries, environmental devastation must be halted and the productivity of existing resources stretched further so as to benefit more people. If increases in GNI and food production are slower than population growth, per capita levels of production and food self-sufficiency will fall. Ironically, the resulting persistence of poverty would be likely to perpetuate high fertility rates, given, as noted in Chapter 6, that the poor are often dependent on large families for survival.

Poverty and the Environment The poor are usually the main victims of environmental degradation. The poor suffer more from environmental decay because they must often live on degraded lands that are less expensive because the rich avoid them. Moreover, people living in poverty have less political clout to reduce pollution where they live. And living in less productive polluted lands gives the poor less opportunity to work their way out of poverty. But in some cases they are also its agents, typically as a result of the constraints of their poverty. Too often, again, high fertility is blamed for problems that are attributable to poverty itself. For example, China's population density per acre of arable land is twice that of India, yet yields are also twice as high. Though it is clear that environmental destruction and high fertility go hand in hand, they are both direct outgrowths of a third factor, absolute poverty. For environmental policies to succeed in developing countries, they must first address the issues of landlessness, poverty, and lack of access to institutional resources. Insecure land tenure rights, lack of credit and inputs, and absence of information often prevent the poor from making resource-augmenting investments that would help preserve the environmental assets from which they derive their livelihood. Hence, preventing environmental degradation includes as a key component the provision of institutional support to the poor, rather than fighting an inevitable process of decay.⁸ For this reason, many goals on the international environmental agenda are very much in harmony with the three objectives of development articulated in Chapter 1.

Growth versus the Environment? If, in fact, it is possible to reduce environmental destruction by increasing the incomes of the poor, is it then possible to achieve growth without further damage to the environment? Evidence indicates that the very poor cause considerable environmental destruction as a direct result of their poverty. It follows that increasing the economic status of the poorest group would provide an environmental windfall. However, as the income and consumption levels of everyone else in the economy also rise, there is likely to be a net increase in environmental destruction. Meeting increasing consumption demand while keeping environmental degradation at a minimum will be no small task.

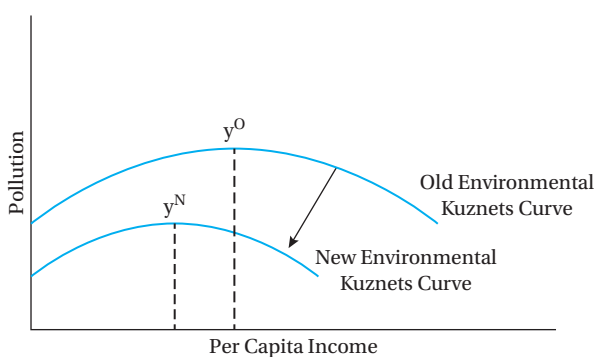
At one point, it was widely believed that as per capita incomes rose, pollution and other forms of environmental degradation would first rise and then fall in an inverted-U pattern. (This idea is referred to as the **environmental Kuznets curve** because Kuznets's hypothesis that inequality would first rise and then fall as incomes increased, as detailed in Chapter 5, also traces such an inverted-U pattern.) According to the theory, as incomes rise, societies will have both the means and the willingness to pay for environmental protection. Indeed, there is evidence that this inverted-U relationship holds for at least some local pollutants, such as particulate matter in the air, sulfur dioxide, and nitrogen oxides. Other environmental problems, such as unsafe water and poor sanitation, begin to improve as income rises even from very low levels.

These are average patterns that vary across countries. And to the extent an income-pollution relationship holds, the patterns by themselves are not informative about causality. Environmental pollution itself may cause slow economic growth; or third factors, such as bad institutions, can lead to both high pollution and low income per capita. Moreover, better environmental regulation does not spring into existence automatically with higher income; this largely depends on the political process. Nevertheless, whatever the shape—inverted-U, or falling, or even rising—more effective environmental policies can shift the pollution curve downward (illustrated for the case of the inverted-U pattern in Figure 10.1).⁹

Moreover, we note that there is no convincing evidence that other environmental damage decreases with higher incomes. As we will see, this is a particular problem when it comes to global public goods, such as greenhouse gases. Finally, even if the inverted-U environmental Kuznets curve relationship does hold for such global public goods in the very long term, some damage, such as loss of biodiversity, may well prove to be irreversible. Active international policy will be needed.

Environmental Kuznets curve A graph reflecting the concept that pollution and other environmental degradation first rises and then falls with increases in income per capita. There is evidence that this holds for some pollutants, such as sulfur dioxide and particulate matter in the air, but not for others, such as emissions of greenhouse gases.

FIGURE 10.1 Hypothetical Income-Pollution Relationship: Environmental Kuznets Curves



Environment and Rural and Urban Development

Rural Development and the Environment To meet the expanded food needs of rapidly growing populations, it is estimated that food production in developing countries will have to increase by at least 50% in the next three decades. Because land in many areas of the developing world is being unsustainably overexploited by existing populations, meeting this output target will require radical changes in the distribution, use, and quantity of resources available to the agricultural sector. And because women are frequently the caretakers of rural resources such as forests and water supplies and provide much of the agricultural supply of labor, it is of primary importance that environmental programs be designed around their role—not considered as an afterthought. In addition, poverty alleviation efforts must target women's economic status, in particular, to reduce their dependence on unsustainable methods of production.

The increased accessibility of agricultural inputs to small farmers and the introduction (or reintroduction) of sustainable methods of farming will help create attractive alternatives to current environmentally destructive patterns of resource use. Land-augmenting investments can greatly increase the yields from cultivated land and help ensure future food self-sufficiency.

Urban Development and the Environment Chapter 7 demonstrated that rapid population increases, accompanied by heavy rural-urban migration, are leading to unprecedented rates of urban population growth, sometimes at twice the rate of national growth. Consequently, few governments are prepared to cope with the vastly increased strain on existing urban water supplies and sanitation facilities. The resulting environmental ills pose extreme health hazards for the growing numbers of people exposed to them. Such conditions threaten to precipitate the collapse of the existing urban infrastructure and create circumstances ripe for epidemics and national health crises. These conditions are exacerbated by the fact that under existing legislation, much urban housing is illegal. This makes private household investments risky and renders large portions of urban populations ineligible for government services.

Congestion, vehicular and industrial emissions, and poorly ventilated household stoves also inflate the tremendously high environmental costs of urban crowding. Lost productivity of ill or diseased workers, contamination of existing water sources, and destruction of infrastructure, in addition to increased fuel expenses incurred by people's having to boil unsafe water, are just a few of the costs associated with poor urban conditions. Research reveals that the urban environment appears to worsen at a faster rate than urban population size increases, with the result that the marginal environmental cost of additional residents rises over time. However, for a given income, the carbon footprint of a city resident tends to be lower than that of a suburban or rural resident.¹⁰ The importance of urban as well as rural environmental protection is recognized in the seventh Millennium Development Goal (see Chapter 1).

The Global Environment and Economy

As total world population grows and incomes rise, net global environmental degradation is likely to worsen. Some trade-offs will be necessary to achieve

sustainable world development. By using resources more efficiently, a number of environmental changes will actually provide economic savings, and others will be achieved at relatively minor expense. However, because many essential changes will require substantial investments in pollution abatement technology and resource management, significant trade-offs between output and environmental improvements will occasionally become necessary. The poorer the country, the more difficult it will be to absorb these costs. Yet a number of issues, including biodiversity, rain forest destruction, and population growth, will focus international attention on some of the most economically strapped countries in the world. In the absence of substantial assistance to low-income countries, environmental efforts will necessarily have to be funded at the expense of other social programs, such as education, health services, and employment programs, which themselves have important implications for the preservation of the global environment.

Most cumulative environmental destruction to date has been caused by the developed world. However, with high fertility rates, rising average incomes, and increasing greenhouse gas emissions in the developing world, this pattern is likely to reverse in the coming years. China is now the world's largest greenhouse gas emitter, albeit still lower on a per capita basis than most rich countries.¹¹ It is a matter of ongoing debate how the costs of global reform should be divided.

The divisions were very clear at Earth Summit 2012, also known as Rio+20, as it occurred 20 years after the original 1992 Earth Summit, which also took place in Rio de Janeiro, Brazil. The summit was intended to be a milestone meeting with most UN member states participating, but although some 57 heads of state and 31 heads of government attended, along with many private-sector and nongovernmental organization (NGO) observers, many key leaders including U.S. President Barack Obama and U.K. Prime Minister David Cameron did not. Despite some optimistic rhetoric, many analysts concluded the summit was a disappointment if not a major failure. The final statement, "The Future We Want," covered important areas such as increased protection of oceans and food security but was nonbinding and added little to previous declarations that had led to few results. And although hundreds of voluntary commitments for sustainable development were made by various UN member states, many were essentially restatements of existing policies. There was confirmation of plans to follow up on the MDGs, expiring in 2015, with new Sustainable Development Goals (see Chapter 1). Ban Ki-moon, the UN secretary general, summarized the mood when he said, "The road ahead is long and hard."

The Nature and Pace of Greenhouse Gas-Induced Climate Change Environmental scientists and economists are increasingly appreciating that the impacts of global warming are likely to be felt earlier than expected—indeed, are already beginning to be felt in parts of Africa—and that the window within which very large future costs can be averted is starting to close. The developed countries will have to take the lead and bear most of the costs in funding both remediation and adaptation in low-income countries, but developing countries will also need to play a significant role in limiting global warming to safeguard their own futures. We examine this issue in greater depth later in the chapter.

Natural Resource–Based Livelihoods as a Pathway Out of Poverty: Promise and Limitations

As noted at the start of this chapter, more than half of the economically active people in the developing world depend on agriculture, hunting, fishing, or forestry.¹² This environmental income, along with foraging and other activities, is vitally important to a majority of the poor and under the right policy conditions can offer a pathway out of poverty. But access to the benefits of environmental resources is often highly inequitable and in some cases increasingly so. In many countries, the poor have been losing control of some of their traditional natural resource commons, including forests, fields, and fishing areas, to new private property rights arrangements or to corrupt public land management. This trend is being widely resisted by communities and their supporters in NGOs, agencies, and local governments. Many of the rural poor lacking access to adequate farmland or to resources for earning adequate livelihoods from nature, such as access to forests, cattle to graze, or boats and equipment for fishing, have seen few gains or have suffered setbacks.¹³

In developing countries, much natural resource exploitation has been locally unsustainable and has occurred in a manner and on a scale that often bypasses the poor. In Africa and Asia, what had been common village lands may be “spontaneously” privatized. Governments may grant or allow (or overlook) foreign or national companies’ logging, fishing, and mining without regard to the people who depend on these lands and resources for their livelihoods and way of life. Or they may designate common lands used by the poor to be “protected” areas—although corruption and poaching may negate any ecological gains—thereby banning the livelihood and way of life of the poor, giving them no incentive to take part in protection. Part of the solution is “pro-poor governance,” with the genuine empowerment of poor people and their communities to assert their rights. This magnifies the impact of training that helps fuse scientific management with traditional community practices.¹⁴ The empowerment of women in their communities is often a key aspect of program success. Many outstanding examples, such as the Suledo Forest Community and the HASHI project in Tanzania, are found among winners and runners-up of the United Nations Equator Prize, which recognizes “local efforts to reduce poverty through the conservation and sustainable use of biodiversity.”¹⁵

The Centrality of Water In policy circles, it has become common to hear the view that “water is the new oil.” Clearly, water has become increasingly scarce and valuable.

The poor often talk about problems of water availability and quality in ways that make it clear that they think of water problems at the center of their experience of poverty. They speak of the lack of clean water, of what happens when people in their family and village drink contaminated water, of the large fraction of their time spent collecting water, of the high cost per liter of water when they have to buy it.

Conflict over water has also become a source of friction between developing countries, which otherwise have so much to gain through cooperation. One of the most serious and disconcerting examples is the growing tension between China and India. Other potential flashpoints include Ethiopia and Egypt.¹⁶

The Scope of Domestic-Origin Environmental Degradation

Environmental challenges in developing countries caused by poverty include health hazards created by lack of access to clean water and sanitation, indoor air pollution from biomass stoves, and deforestation and severe soil degradation—all most common where households lack economic alternatives to unsustainable patterns of living. The principal health and productivity consequences of environmental damage include water pollution and scarcity, air pollution, solid and hazardous wastes, soil degradation, deforestation, loss of biodiversity, and global warming—caused climate change.

It is estimated that over 60% of the poorest people residing in developing countries struggle for survival on agriculturally marginal soils. This trend is greatly worsened in some areas of the developing world by strong inequalities in the distribution of land, which force landless workers onto increasingly taxed, ecologically sensitive soils. The growing intensification of cultivation on fragile lands leads to rapid soil degradation and loss of productivity. It has been estimated that roughly 270,000 square kilometers of soil lose virtually all of their productivity each year. An area greater than the size of India and China combined has been significantly degraded. The resulting annual loss in agricultural productivity is estimated to be between 0.5% and 1.5% of annual worldwide GNI. As a result of rapid population increases and the failure of agricultural production to keep pace, per capita food production declined in sub-Saharan Africa during the 1980s and 1990s (see Chapter 9).¹⁷

The higher commodity prices of this century have apparently encouraged poaching and illegal logging in countries such as Indonesia. High fish prices have been associated with overfishing in restricted areas and environmentally destructive fishing practices. Runoffs and collateral damage have resulted from expansion of mining activities into sensitive areas. In many of these cases, indigenous and poor people dependent on natural resources for their survival have suffered.

An environmental problem shared by both the urban and the rural poor is the prevalence of unhealthy conditions created by the lack of clean water and sanitation. This in turn contributes greatly to the spread of infectious diseases. It has been estimated that waterborne pathogens that cause typhoid, cholera, amoebic infections, bacillary dysentery, and diarrhea account for 80% of all disease in developing countries and at least in part for up to 90% of the approximately 7 million child deaths each year. Deteriorating environmental conditions were cited as a contributing factor to the spread of cholera epidemics and other health problems in a number of countries in Latin America and Africa in the 1990s (see Chapter 8). And as noted in Chapter 7, rapid population growth and heavy rural-urban migration make it difficult to extend urban services to many people who need them.

Airborne pollutants also take a high toll on the health of citizens in developing countries. Dependence on **biomass fuels** such as wood, straw, and manure is closely related to poverty. The burning of biomass fuels for cooking and the boiling of water create dangerously high levels of indoor pollution to which 400 million to 700 million people, mostly women and children, are exposed each year. Smoke and fumes from indoor stoves are

Biomass fuels Any combustible organic matter that may be used as fuel, such as firewood, dung, or agricultural residues.

believed to contribute significantly to some 4 million childhood deaths each year from respiratory diseases and to an ever-larger number of chronic respiratory illnesses.¹⁸

In urban areas, other sources of pollution pose serious threats to physical well-being. According to the World Health Organization, 1.3 billion people live in urban areas with unsafe levels of airborne pollutants. Yet it has been projected that by 2030, manufacturing in developing countries will expand to 600% of 2000 levels, vastly increasing potential concentrations of pollutants. Just to maintain current urban air standards until 2030 (which means conceding to conditions much worse than those existing in the urban centers of developed countries), average emissions from industries and electric generators in developing countries would have to be reduced by 90 to 95% per unit of output.

Rural Development and the Environment: A Tale of Two Villages

To clarify how rural poverty and environmental degradation interact, let us take a brief look at two hypothetical developing-world villages, one in Africa and the other in South America.

A Village in Sub-Saharan Africa The residents of the African village, located in a semiarid landscape, have been warned by international experts that cutting the remaining trees and cultivating marginal land will only worsen the hardships that they already endure. The advice runs counter to each family's first priority, which remains obtaining the basic necessities for survival. Here trees serve many functions, the most important of which is to provide firewood for cooking. Without wood, it would be impossible to prepare many foods, make cornmeal, or boil water. As a result of the intensification of land use by a rapidly growing population, the cutting of trees for firewood, and the clearing of marginal land for cultivation, the soil is increasingly exposed to destructive environmental forces. The loss of vegetation, which helps mitigate the destructive impact of heavy winds, rain, and desiccation by the sun, leads to more rapid erosion of precious topsoil needed for cultivation. Good yields are more difficult to obtain, and the consequences of drought years are more intense.

Desertification—encroachment of the desert into areas where erosion has been most severe—threatens to consume even the more productive land.

As a result of the loss of precious topsoil and declining output, there are fewer crops to bring to market to barter for necessities. In many households, there is less food for the children. Yet the family must spend longer hours trying to obtain enough income to survive. Paid work is scarce, although some households earn a small amount of additional income by sending family members to work on larger, more prosperous farms.

It is generally the job of women to collect enough firewood for the day's cooking. It may take hours to walk to and from an area where it is available, adding considerably to the day's work. But no alternative forms of fuel are available in the local market, and even if they were, household funds would be insufficient to purchase them. In fact, many women spend additional time collecting precious firewood to make charcoal, which can then be sold in the

Desertification The transformation of a region into dry, barren land with little or no capacity to sustain life without an artificial source of water.

cities for the equivalent of a few pennies, which helps buy household necessities. The low opportunity cost of a woman's time perpetuates the wasteful use of forests and worsens local environmental conditions.¹⁹

A Settlement Near the Amazon Consider now the other hypothetical village, on the edge of a vast rain forest in South America. The great majority of farmers here are newcomers, drawn by government promises of land and prosperity. The public resettlement program, which distributes property titles to settlers willing to clear the land, is designed to reduce the overcrowding of cities and stem the flow of rural-to-urban migrants. In contrast to the African village, this settlement has no shortage of rainfall, wildlife, or trees. In fact, the forest is an obstacle for migrant farmers and is regularly burned to make room for cultivation.

Though burning the forest may temporarily provide the landless with a modest source of income, the land, like 90% of rain forest soil worldwide, is not very fertile and can sustain intensive cultivation for only a few years. Complementary inputs and farming know-how that might help improve levels of output are in short supply, and yields begin to drop rapidly after the first few years. Settlers are then forced to burn their way deeper into the forest. Because the settlers are located on marginal soils and must constantly seek new arable ground, with little prospect of rising above a subsistence existence, the government program may be antidevelopmental in the long run. Household incomes remain low and unstable, there is little gain in average productivity, and the migrating population leaves environmental devastation in its wake, further reducing the productivity of all.

Environmental Deterioration in Villages

Although heavy urbanization is leading to rapid demographic changes, the majority of the very poor live in rural areas similar to the two villages just described. Economic necessity often forces small farmers to use resources in ways that guarantee short-term survival but reduce the future productivity of environmental assets. Unsustainable patterns of living may be imposed by economic necessity. In periods of prolonged and severe food shortages, desperately hungry farmers have been known to eat the seeds with which they would have planted the next year's crop, knowingly paving the way for future disaster. Because it happens more slowly, the tendency of impoverished people to degrade agricultural resources on which they depend for survival is less dramatic, but it is motivated by similar circumstances.

The causes and consequences of rural environmental destruction vary greatly by region. However, persistent poverty is frequently the root of much locally caused damage. The majority of the poor in developing countries survive on the meager yield obtained from cultivation of small plots of land whose soil may be too shallow, too dry, or too sandy to sustain permanent agriculture. If the land is not in some way replenished through either shifting cultivation or the use of manufactured fertilizers, it becomes exhausted, and yields decrease with successive harvests. But the poor generally do not have the wherewithal to increase the productivity of the land by allowing it to lay fallow or by making investments in irrigation and fertilizer. In addition, where fertility rates

are high and children provide a vital economic contribution through wages or on-farm labor, population and the intensity of cultivation are likely to increase over time, speeding the rate at which the soil becomes exhausted.

Soil erosion Loss of valuable topsoils resulting from overuse of farmland, and deforestation and consequent flooding of farmland.

One immediate result of this type of environmental pressure is **soil erosion**. With little plant cover to protect it from wind and water, precious topsoil may be blown or washed away, further reducing the productivity of the land. This process of environmental degradation leads to persistent declines in local per capita food production and may eventually lead to desertification. This phenomenon is likely to spur increases in rural-to-urban migration or may force the remaining local population onto even less fertile land, where the process is repeated.

Deforestation The clearing of forested land either for agricultural purposes or for logging and for use as firewood.

Another factor in the cycle of rural poverty and environmental destruction is **deforestation**. The vast majority of wood cut in the developing world is used as fuel for cooking. Loss of tree cover has two potentially devastating environmental implications for predominantly poor rural populations. Deforestation can lead to a number of environmental maladies that over time can greatly lower agricultural yields and increase rural hardships. On a day-to-day basis, however, the increasing scarcity of firewood means that women must spend large portions of the day in search of fuel, diverting time from other important activities such as income generation and child care. In the worst cases, fuel shortages are sufficient to require the burning of biomass or natural fertilizers, such as manure, which are important farm inputs for maintaining crop yields. In extreme cases, deforestation can facilitate the spread of disease, such as malaria in Borneo.

Environmental degradation that begins on a local scale can quickly escalate into a regional problem. For example, clearing of vegetation at high elevations may increase the exposure of cultivated lands at lower altitudes. Soil that has been carried away by heavy rains may silt rivers and pollute drinking water. Plants help retain rainfall, which percolates down through the soil into underground reserves of groundwater. The water is, in turn, tapped by a variety of plants during dry seasons in arid regions. The loss of vegetation and forest leads to a decrease in the rate at which groundwater is replenished and can even cause a decrease in local rainfall. The subsequent drop in the water level leads to the death of plants with shallow root systems, including young trees. This self-perpetuating process can spread the malady to previously unaffected regions. Not surprisingly, the increase in natural disasters associated with local environmental degradation, including floods, droughts, and mudslides, can have a devastating impact on both the local and the regional agricultural economy. These problems are expected to be severely exacerbated by climate change associated with global warming in coming decades.

10.2 Global Warming and Climate Change: Scope, Mitigation, and Adaptation

Scope of the Problem

The Intergovernmental Panel on Climate Change (IPCC)²⁰ is the United Nations–sponsored international scientific body analyzing climate change and its impacts. In late 2013 the IPCC released *Climate Change 2013: The*

Physical Science Basis, which reinforced its earlier conclusions; and new reports on *Impacts, Adaptation and Vulnerability*, and *Mitigation of Climate Change*, are coming out in 2014.

In 2007, the IPCC released its fourth assessment report. It concluded that the developing world, particularly the poorest countries, can expect major consequences from global warming, involving larger and more severe heat waves and higher average temperatures, hurricanes, floods from heavy rains, prolonged droughts, losses of valuable species, and crop and fishing losses. These conclusions have been strongly reinforced by subsequent research. The IPCC identified four zones highly vulnerable to greenhouse gas-induced climate change: sub-Saharan Africa because of drying, Asian megadeltas because of flooding, small islands due to multiple sensitivities, and the Arctic.

Sub-Saharan Africa will be hit particularly hard. The IPCC report concluded that by 2020, although adaptations would help, and certain regions such as Ethiopian highlands would gain from lengthened growing seasons, conditions will already worsen:

agricultural production, including access to food, in many countries and regions in Africa is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.

The study projected that 75 to 250 million people in Africa will be exposed to increased “water stress due to climate change” by 2020.²¹ Coastal fisheries, mangroves, and coral reefs will be further degraded and threatened by projected rises in sea level and storms. Freshwater lakes will also be negatively affected.

In Asia, millions of people live in low-lying areas in the path of typhoons of expected increasing frequency and intensity or otherwise at greater risk of ocean or river flooding.²² Glacier melting is projected to increase flooding, but after a few decades, once the glaciers have receded, there will be decreased flow, especially in the summer, when seasonal melt had been normal and beneficial. Decreased freshwater availability could affect a billion people in Asia by the 2050s. With moderate warming, crop yields are projected to rise in some northern areas in Asia but fall in many tropical and subtropical areas. Increased flooding also threatens both rural and urban infrastructure. Later in the century, South Asia faces further droughts, water shortages, and declines in agricultural productivity.²³

In Latin America, warming was projected to cause further losses of Amazon forest and biodiversity by midcentury, while agriculture will be harmed in drier areas. Finally, many small islands are at risk because of sensitivity and vulnerability to ocean flooding, erosion, and loss of freshwater, fishing, and tourism.

In sum, prolonged droughts; expanded desertification; increased severity of storms with heavy precipitation and flooding and consequent erosion; longer and more severe heat waves; reduced summer river flow and water shortages; decreased grain yields; climate-induced spreading ranges of pests

and disease; lost and contaminated groundwater; deteriorated freshwater lakes, coastal fisheries, mangroves, and coral reefs; and coastal flooding—one or more of these impacts are expected to affect most of the world's poorest countries during this century, and sooner than once believed. Other likely ecological damage includes loss of essential species such as pollinators and soil organisms, forest and crop fires, and rising surface ozone levels.²⁴ These problems mean that productivity gains can be lost just trying to keep pace with the deterioration.

That greenhouse gas-induced climate change has arrived and that much more is coming are beyond any reasonable doubt. While weather and average annual temperatures fluctuate, as an average, there is confirmation that some of these changes have already arrived. In 2010, the U.S. National Oceanic and Atmospheric Administration (NOAA) released a study drawing on 11 indicators of climate and found that each one showed evidence of global warming due to the influence of greenhouse gases. The study was able to draw on data not yet available when the IPCC released its report. A 2013 study in the journal *Science* concluded that climate change can now be expected to unfold at a rate "orders of magnitude more rapid" than at any other time over the past 65 million years.²⁵

And as the World Bank concluded in its 2009 *World Development Report*:

The effects of climate change are already visible in higher average air and ocean temperatures, widespread melting of snow and ice, and rising sea levels. Cold days, cold nights, and frosts have become less frequent while heat waves are more common. Globally, precipitation has increased even as Australia, Central Asia, the Mediterranean basin, the Sahel, the western United States, and many other regions have seen more frequent and more intense droughts. Heavy rainfall and floods have become more common, and the damage from—and probably the intensity of—storms and tropical cyclones have increased.²⁶

Global warming is likely to present an unprecedented environmental challenge for the developing world. The 2006 *Stern Review on the Economics of Climate Change* concluded that "the poorest developing countries will be hit earliest and hardest by climate change, even though they have contributed little to causing the problem. Their low incomes make it difficult to finance adaptation. The international community has an obligation to support them in adapting to climate change. Without such support there is a serious risk that development progress will be undermined."²⁷ The *Review* also concluded, consistent with other studies, that food production in the tropics would be harmed: "In tropical regions, even small amounts of warming will lead to declines in yield." The greater the degree of warming, the larger the predicted global agricultural and water impact will be. But generally, the *Review* found that effective remediation is surprisingly affordable—if decisive action is taken soon.

The World Bank published a sobering 2012 study, *Turn Down the Heat*, which presented a case that the world will face a 4-degree increase in average global temperatures this century, which will result in dire consequences. Its 2013 follow-up study, *Turn Down the Heat II: Climate Extremes, Regional Impacts, and the Case for Resilience*, focused on impacts already felt after just a 0.8 degree (Celsius) temperature rise to date, such as extreme weather events and sea level rise. The report also highlighted that the expected 2 degree rise

in 20 to 30 years will create food shortages in Africa and water crises in South Asia. As the temperature rises above 2 degrees, approaching 4 degrees, there will be extreme heat waves, rising sea levels, storms, droughts, floods, and losses of grasslands, farmlands, and marine ecosystem.²⁸

The worst impact will likely be felt by the very poor, who depend most on natural resources, including rain-fed agriculture. Moreover, the housing of the poor in urban as well as rural areas is often poorly constructed and located in the most environmentally stressed and risky areas—largely because the rich do not want to live there. Houses of the poor constructed of mud, bamboo, straw, and other inexpensive or gatherable materials are the most vulnerable to extreme weather events. They are vulnerable to heat waves, flooding, mudslides, and diseases. Floods on the scale of the 2010 humanitarian disaster in Pakistan could become common. The poor cannot get insurance against the risks to which they are most exposed. The World Health Organization estimated that by 2004, over 140,000 excess deaths per year had been caused by the global warming that had taken place since the 1970s, largely due to diarrhea, malaria, and malnutrition. Mosquito-carried malaria is expected to migrate further to higher altitudes, newly threatening Nairobi, Harare, and other cities. Already, heat waves have claimed more lives in many developing nations such as India.²⁹

Some analysts predict that in addition to the direct environmental impacts, social strains caused by increased resource scarcity may lead to greater conflict, with the poor again being the most likely victims. The crisis in the Darfur region of Sudan is believed by some analysts to have been triggered by environmental stress.³⁰

Thus, environmental catastrophe would have sweeping consequences for the poor and their human development. The *2013 Human Development Report* compares the UNDP's baseline forecasts with those living under environmental disaster. They projected that "some 2.7 billion more people would live in extreme income poverty under the environmental disaster scenario than under the base case scenario," reflecting about 1.9 billion people entering poverty and 800 million failing to escape poverty who otherwise would likely have done so.

Mitigation

Many strategies have been proposed for mitigation of emissions, including development of "carbon markets," taxes on carbon, and subsidies to encourage faster technological progress. For regulation, given uncertainties in both benefits and costs of emissions reductions, there are difficult economic questions in devising the most efficient permit or emissions tax regimes. As a policy strategy, the *Stern Review* suggests establishing a long-term quantity cap on greenhouse gases in the atmosphere to guard against environmental catastrophe. This would involve long-term limits on the amount of greenhouse emissions equal to a quantity that the earth could absorb. In the short term, policies could be designed to limit the economic burden if abatement costs turned out initially to be unexpectedly high.³¹

Global warming is primarily but not exclusively a developed-country-caused problem. Although much of the accumulated greenhouse gases to date

has been emitted by the high-income countries, even if the developed world were to drastically reduce greenhouse gas pollution now, we would still have to act to contain greenhouse gas emissions of the developing world, which are projected to grow at alarming rates. This has many causes, but the rapid industrial growth in Asia is already a major contributor, and this is expected to worsen substantially with the planned expansion of coal-fired electrical generation in China, India, and elsewhere. Policies and mechanisms have been introduced essentially to pay for costs of avoiding emissions in developing countries. Deforestation in developing countries contributes over 20% of harmful greenhouse gases, in addition to the losses it causes of valuable biodiversity and the environmental services of cleaning air and water. Helping developing countries reduce greenhouse gas emissions has emerged as an important dimension for foreign aid. Indeed, the need to develop and implement a mechanism for paying developing countries for forest preservation has long been an active topic of international negotiations on climate change. The Reducing Emissions from Deforestation and Forest Degradation (REDD) mechanism, along with enhanced incentives for reestablishing and maintaining forests with engagement of indigenous communities that depend on them (known as REDD-plus), has slowly made some progress.³²

Adaptation

While immediate action on mitigation is necessary, a significant amount of climate change is now essentially inevitable. Even if drastic mitigation begins immediately, lags in the climate system mean change will unfold for many years. Thus, adaptation to climate change in developing countries is critical for protecting livelihoods and continuing to make development gains.

The UNDP has defined climate change adaptation as “a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed and implemented.”

Adaptation takes place in two forms: “planned” (or policy) adaptation undertaken by governments and “autonomous” (or private) adaptation undertaken directly by households, farms, and firms in response to climate change they experience or anticipate. The distinction between autonomous or private and planned or policy adaptation is not a sharp one—governments respond to citizens, and government incentives affect what individuals choose to do—but the categories are useful for analysis of adaptation. These responses are in some ways complements and in other ways substitutes. If autonomous adaptation increases the marginal benefit of planned adaptation and vice versa, they are considered complements—for example, when farmers respond to increasing temperature by planting new varieties and government research institutes develop new heat-resistant seeds. But if autonomous adaptation reduces the need for planned adaptation and vice versa, then they are substitutes—for example, if government builds reservoirs and irrigation systems, farmers have less incentive to change crops or conserve water.³³

As suggested by Arun Agrawal and Nicolas Perrin, depending on how risks are reduced or avoided, four classes of adaptation strategies can be

identified. Mobility avoids risks across space. Storage reduces risks experienced over time. Diversification reduces risks across assets owned by households or collectives. Communal pooling involves joint ownership of assets and resources; sharing of wealth, labor, or incomes from particular activities across households or mobilization and use of resources held collectively during time of scarcity. Exchange can substitute for any of these four classes of adaptation strategies.³⁴

National and local public health agencies can respond with citizen awareness campaigns to build public knowledge of how to adapt as well as emergency health infrastructure. For example, in Odisha state in India, ongoing emergency preparedness efforts implemented with UN assistance are credited for reducing loss of life from heat waves and from the massive Cyclone Phailin that hit the region in October 2013.³⁵

Policy adaptations can help make the “livelihood assets” of the poor more resilient to environmental stresses while providing other development benefits; examples include³⁶

- Inventorying and tracking ecological resources of the poor; addressing environmental deprivations including susceptibility to ecological stresses in poverty assessments and programs
- Implementing early warning systems to anticipate environmental emergencies and to prevent disasters (preserving funds for development efforts)
- Restoring and expanding natural ecosystem barriers (such as reforestation and mangrove expansion) to extreme events such as flooding and water shortages
- Constructing infrastructure to serve the poor while accounting for likely climate change (including storm shelters and flood barriers as well as protected roads and bridges, with a margin for safety); and establishing microinsurance systems for farmers
- Ensuring better voice and empowerment of the poor and their organizations—in part, to get information about the environmental stresses they face to government, media, and the public and to make it more likely that the poor will get a fair share of government services; sharing economic growth more equitably
- And supporting all this, demanding more government transparency and accountability

In addition to the long-term trends caused by global warming, climate also fluctuates and changes for other reasons, and rural people in developing countries naturally take steps to adapt. Many adaptations to the different types of climate change have already been observed; some of these are described in Box 10.1.

Governmental and international efforts to adapt to climate change will remain indispensable; Box 10.2 reviews the efforts of Niger to adapt to climate change and the modest but growing assistance role being played by development agencies.



BOX 10.1 Autonomous Adaptation to Climate Change by Farmers in Africa

Siri Eriksen, Karen O'Brien, and Lynn Rosentrater observed a number of "indigenous" adaptation strategies to climate change impacts in eastern and southern Africa. First is livelihood diversification; for example, fishers in Uganda also cultivate crops, raise livestock, collect firewood, engage in trade, and practice temporary migration. Second, livestock herding is an adaptation to frequent droughts in Namibia and Botswana. Third is ecological diversification—for example, farmers in Mozambique use plots on high ground when there is a lot of rain and on low ground when there is little rain.

David Thomas and his colleagues found several adaptation strategies by farmers in South Africa. Many change farming practices by planting drought-resistant varieties, switching to more livestock and less crops, and building cattle shelters. Others diversify livelihood sources by getting off-farm work and starting small businesses or using networks, including cooperatives and community horticultural projects.

Ariel Dinar and his colleagues examined adaptation activities in 11 African countries and found that changing planting dates, adopting shorter growing seasons, increasing the use of irrigation, and actively practicing water conservation and soil conservation

techniques were found in several countries. In addition, farmers in Egypt reported increased use of weather insurance, in addition to moving to nonfarming activities. The researchers found that more experienced and better-educated farmers were more likely to take adaptive measures. Farmers working on rented land were less likely to adapt, at least partly because of tenure insecurity (see Chapter 9). Heads of household were also more likely to practice adaptation, possibly because they controlled household resources. David Maddison noted that using different varieties of the same crop was considered one of the most important adaptation activities in 9 of the 11 countries.

Sources: Siri Eriksen, Karen O'Brien, and Lynn Rosentrater, *Climate Change in Eastern and Southern Africa: Impacts, Vulnerability and Adaptation*, Global Environmental Change and Human Security Report No. 2008:2 (Oslo, Norway: University of Oslo, 2008), <http://www.gechs.org/downloads/reports/2008-2.pdf>; David S. G. Thomas et al., "Adaptation to climate change and variability: Farmer responses to intra-seasonal precipitation trends in South Africa," *Climatic Change* 83 (2007): 301–322; David Maddison, *The Perception of and Adaptation to Climate Change in Africa*, CEEPA Discussion Paper No. 10 (Pretoria, South Africa: Centre for Environmental Economics and Policy in Africa, 2006), <http://www.ceepa.co.za/docs/CDPNo10.pdf>; Ariel Dinar et al., *Climate Change and Agriculture in Africa: Impact Assessment and Adaptation Strategies* (London: Earthscan, 2008).

10.3 Economic Models of Environmental Issues

Privately Owned Resources

We will review some common economic models of the environment. In each model, the market's failure to account for environmental externalities is the exception rather than the rule, and neoclassical theory is then applied in order to cure or circumvent an inefficiency.³⁷ Neoclassical theory has been applied to environmental issues to determine what conditions are necessary for the efficient allocation of resources and how market failures lead to inefficiencies, and to suggest ways in which these distortions can be corrected.



BOX 10.2 One of the World's Poorest Countries Tries to Prepare for Climate Change: Niger

Niger is one of the world's poorest nations, as measured by almost any indicator of well-being and as seen at a glance in the following table.

Niger also has a very challenging natural environment. Almost twice the size of France, Niger is subtropical, hot, and dry. A majority of its land is in

Niger Indicators

Indicator	Value
Income per capita	\$330 (WDI, 2011)
PPP income per capita	\$600 (WDI, 2011)
Percent below \$1.25 per day	43.6% (WDI, 2008)
Mean years of schooling (Adults)	1.4 (WDI, 2010)
Literacy, male	42.9% (CIA, 2005)
Literacy, female	15.1% (CIA, 2005)
Primary completion rate (2011)	46% (WDI, 2011)
Life expectancy at birth	58 (PRB, 2012)
Malnutrition (under-5 underweight)	39.9 (WDI, 2005–2011)
Under-5 mortality rate (per 1,000 live births)	125 per thousand (WDI, 2011)
Total fertility rate (births per woman)	7.2 (world's highest, PRB, 2012)
Crude birth rate	46 (among 3 highest) (PRB, 2012)
New Human Development Index (New HDI)	0.304 (lowest in world, HDR, 2013)
Multidimensional Poverty Index (MPI)	0.642 (world's poorest, HDR, 2013)
Population	16.3 million (2012, PRB)
Projected population, 2050	54.2 million (3.3x increase, PRB)
Percent rural	82% (PRB)

Note: Data from 2013 World Development Indicators, except where otherwise noted.

Niger faces many other conditions that make development challenging. It is landlocked and borders seven countries, most of them also having stability, development, and environmental challenges: Nigeria, Benin, Burkina Faso, Mali, Algeria, Libya, and Chad. Niger struggles with needed improvements in governance, the private sector, and civil society. The colonial period left Niger with a difficult institutional legacy. French colonizing efforts began before 1900 with “pacification campaigns,” and the nation became an official colony of France from 1922 until its formal independence in 1960. Despite some periods of democratic openings, the country has been under military or single-party rule, or unstable, including a series of coups and regional rebellions at least until the 2011 elections. But risks continue, including from ethnic strife, spillovers from conflicts in Mali and potentially Libya, and unresolved border issues.

the Sahara desert, and the remaining area has been plagued by recurring droughts. Yet it has a predominantly rural and agricultural economy. Now, its already precarious natural environment is deteriorating. As in most countries, some impacts are due to poor domestic practices, while some of Niger's problems reflect secular desertification along the Sahel. But an increasingly prominent factor is the worsening impact of climate change brought about by global warming. Temperatures have already increased in Niger by over 0.7 degrees Celsius (1.25 degrees Fahrenheit). Climate change is worsening water scarcity and food insecurity. Most farmers in Niger understand something about climate change and say they are experiencing it in decreasing rainfall. Yet at the same time, research suggests that Niger has considerable potential for improved agricultural and livestock practices and increased productivity.

Niger has been actively trying to respond to threats of climate change. By 1997, Niger first set up its National Technical Committee on Climate Changes and Variability (CNCVC). From there, Niger worked with support from the Global Environment Fund and other agencies to complete in 2006 its National Adaptation Program of Action (NAPAs), an official United Nations Framework Convention on Climate Change (UNFCCC) process for least developed countries like Niger to “identify priority activities that respond to their urgent and immediate needs to adapt to climate change” for which delay would increase vulnerability and costs. NAPAs then provide a basis for special assistance. Niger’s NAPA priorities include introducing fodder crops in pastoral areas, creating livestock food banks, improving crop irrigation, promoting peri-urban market gardening, promoting income-generating activities and mutual benefit societies, water control, and producing and disseminating meteorological data.

Niger applied and became one of the 20 developing countries in the Pilot Program for Climate Resilience (PPCR). Building on its NAPA, in 2010 Niger developed a Strategic Program for Climate Resilience (SPCR) with PPCR funding and assistance, to identify and justify the uses to be made of PPCR grants and loans. Niger’s SPCR has three parts: a climate resilience Community Action Project (CAPCR); sustainable management and control of water resources; and climate forecasting and early warning systems. CAPCR has two major focuses; first, to make climate change and variability resilience a “mainstream” part of development strategies at national and local levels; second, to integrate resilience practices into local populations’ combined forestry, grazing, and agriculture activities, with a goal of improved productivity and sustainability, while creating needed social protection measures for people working in these activities.

PPCR does not administer funds directly; to save money and speed implementation, it works through existing multilateral development agencies. For example, for Niger the World Bank is channeling \$35 million in PPCR grants and \$28 million in PPCR loans

for the CAPCR program. Each use is matched with a funding source and financing “modality.”

The CAPCR project targets areas that face severe climate risks, promotes use of climate-sensitive technologies, combines sustainable land and water management with social protection measures, and emphasizes local government planning leadership. Investment activities include soil/moisture conservation methods, water harvesting, reduced tillage, agro-forestry, nutrient-enhancing rotation systems, and animal health and nutrition. Nigerien women traditionally play an important role in natural resource management, and part of the program is to be specially focused on improvements for women working in these activities. Planned assistance for people living in poverty as part of the overall program includes matching grants for targeted communes, a cash transfer system for vulnerable households, workfare, and food stamp distribution.

Most farming in Niger is rain-fed, despite the great variability of rainfall; improved irrigation will be an essential part of climate adaptation. PPCR is also planning to fund water resource activities, including large- and small-scale irrigation development, and related expansion of agricultural extension and funding sources for farmers.

Meanwhile, the International Finance Corporation (IFC) is working with Niger to fund its climate information platform through PPCR loans; the program is predicted to more than pay for itself with subscriptions and indirect benefits, and the results will be watched closely. The IFC found that most farmers and pastoralists in Niger already seek and use forecasts, particularly of rain, but also of temperature, wind, and pests; an IFC survey found a majority of farmers would benefit from more weather information and might be willing to pay for it. The IFC is also planning for a weather index insurance program.

Niger is eligible to accept PPCR loans as well as grants because it is not deemed to be in debt distress. The loans are highly “concessionary,” typically at one-tenth of 1% interest over 40 years, with a 10-year grace period—yet they must eventually be repaid. Thus, it makes sense for loan uses to be matched with

activities that have a revenue stream and where there are clear assurances that benefits will not go to the rich while the burden of repayment falls upon the poor. Thus far at least, there do not seem to be any reasons for concern.

The experience in Niger raises many questions about environment and development—the problems, their impact on the poor, and potential solutions; and who will benefit from the responses, and who will pay. Niger's initiative offers a model for other countries in the region.

Sources: African Development Bank Group, *Water Resources Mobilization and Development Project, Republic of Niger, Project Appraisal Report*, March 2012; Climate Investment Funds, PPCR page, <https://www.climateinvestmentfunds.org/cif/node/4>; International Finance Corporation, *Niger Climate Information Platform Final Report*, 2011; United Nations Framework Convention on Climate Change, National Adaptation Programmes of Action (NAPAs) page, https://unfccc.int/national_reports/napa/items/2719.php; World Bank Group, *Project Appraisal Document, Republic of Niger Community Action Project for Climate Resilience (CAPCR)*, December 19, 2011.

Figure 10.2 demonstrates how the market determines the optimal consumption of a natural resource. Finding the optimal market outcome involves maximizing the total net benefits to society from a resource, which is the difference between the total benefits derived from a resource and the total costs to producers of providing it. This is equal to the shaded area in Figure 10.2. **Total net benefit** is maximized when the **marginal cost** of producing or extracting one more unit of the resource is equal to its marginal benefit to the consumer. This occurs at Q^* , where the demand and supply curves intersect. In a perfectly competitive market, the “invisible hand” will ensure that Q^* is the quantity produced. The marginal cost curve in Figure 10.2 is upward-sloping because extraction costs increase as a resource becomes more scarce. The resulting **producer surplus** is area aPb , and the **consumer surplus** is area DPb . Together they yield a maximum net benefit equal to Dab .

If resources are scarce and are rationed over time, **scarcity rents** may arise; these may obtain even when the marginal cost of production is constant, as

Total net benefit The sum of net benefits to all consumers.

Marginal cost The addition to total cost incurred by the producer as a result of increasing output by one more unit.

Producer surplus Excess of what a producer of a good receives and the minimum amount the producer would be willing to accept because of a positive-sloping marginal cost curve.

Consumer surplus Excess utility over price derived by consumers because of a negative-sloping demand curve.

Scarcity rent The premium or additional rent charged for the use of a resource or good that is in fixed or limited supply.

FIGURE 10.2 Static Efficiency in Resource Allocation

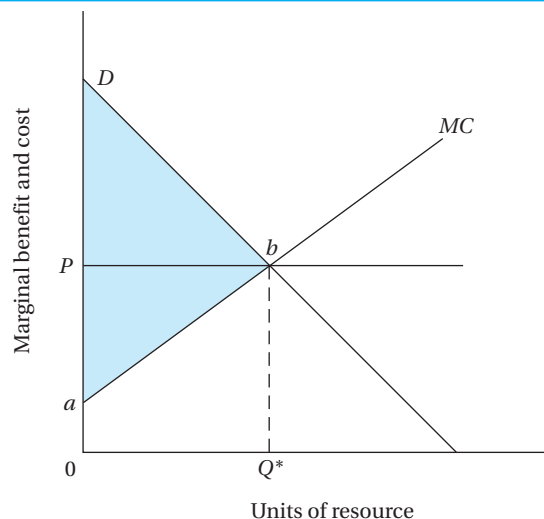
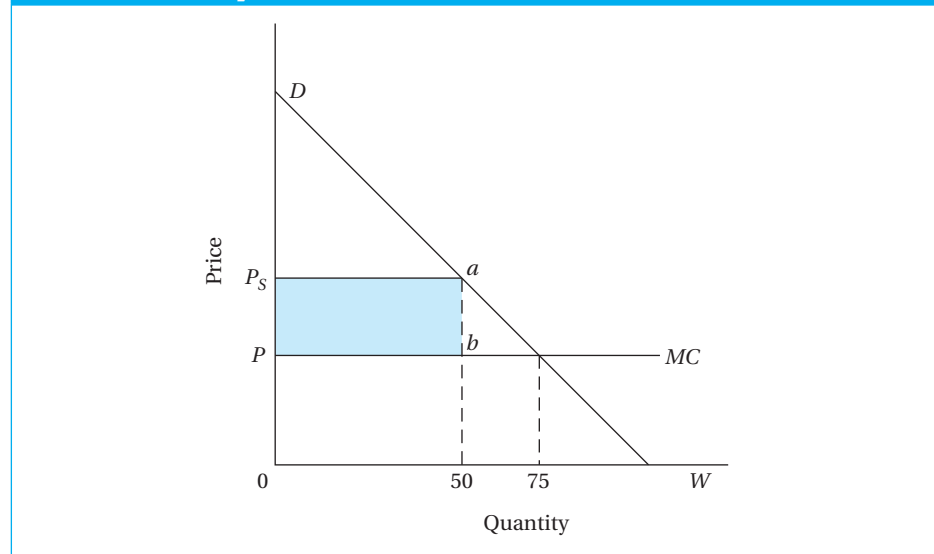


FIGURE 10.3 Optimal Resource Allocation over Time



Present value The discounted value at the present time of a sum of money to be received in the future.

Marginal net benefit The benefit derived from the last unit of a good minus its cost.

in Figure 10.3. The owner of a scarce resource has a finite volume of a resource X to sell (75 units) and knows that by saving a portion of it for future sales, he or she can charge a higher price today. The price of a good that is being rationed intertemporally (over time) must equate the **present value** of the **marginal net benefit** of the last unit consumed in each period. That is, the consumer must be indifferent between obtaining the next unit today and obtaining it tomorrow. In Figure 10.3, assume that a resource owner has 75 units available. If he or she is willing to offer only 50 units for sale today, the market price for the scarce resource is P_s . The scarcity rent collected by the owner of the resource is equal to $P_s abP$, the shaded region in the diagram between price and marginal cost. It is the owner's ability to collect this rent that creates the rationing effect to ensure the efficient allocation of resources over time. In the absence of scarcity, all of the resource will be sold at the extraction cost $P = MC$, 75 units will be consumed at one time, and no rent will be collected.

The proponents of neoclassical free-market theory stress that inefficiencies in the allocation of resources result from impediments to the operation of the free market or imperfections in the property rights system. So long as all resources are privately owned and there are no market distortions, resources will be allocated efficiently. Perfect **property rights** markets are characterized by four conditions:

Property rights The acknowledged right to use and benefit from a tangible (e.g., land) or intangible (e.g., intellectual) entity that may include owning, using, deriving income from, selling, and disposing.

1. *Universality*—all resources are privately owned.
2. *Exclusivity* or “excludability”—it must be possible to prevent others from benefiting from a privately owned resource.
3. *Transferability*—the owner of a resource may sell the resource when desired.
4. *Enforceability*—the intended market distribution of the benefits from resources must be enforceable.

Under these conditions, the owner of a scarce resource has an economic incentive to maximize the net benefit from its sale or use. For example, a farmer who owns his land will choose the levels of investment, technology, and output that maximize the net yield from the land. Because the value of the land may be used as collateral, any viable farm investment can be financed by obtaining a loan at the prevailing market rate of interest.

If the forgoing conditions are not met simultaneously, inefficiencies are likely to arise. Thus, the way to correct the misallocation of resources is generally to remove any market distortions. A number of models have been designed to explain apparent inefficiencies in resource allocation and to evaluate alternative remedies. We next look at two simple models of inefficiency arising from imperfections in property markets.

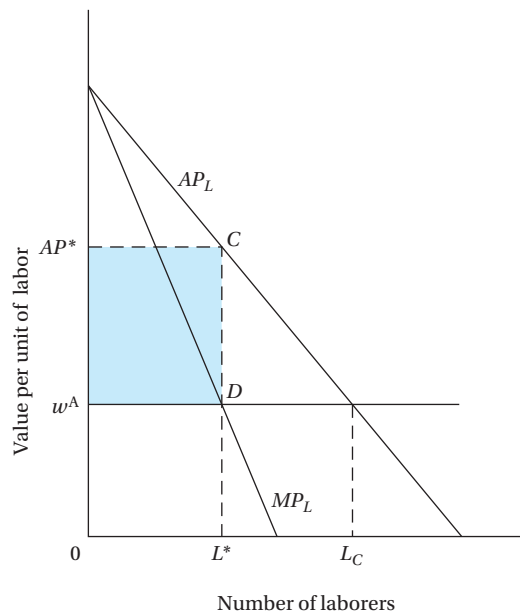
Common Property Resources

If a scarce resource (such as arable land) is publicly owned and is freely available to all (for, say, farming or grazing animals), as is the case with a **common property resource**, any potential profits or scarcity rents will be competed away (unless efficient social conventions are binding, as will be discussed shortly). As we have noted, neoclassical theory suggests that in the absence of scarcity rents, inefficiencies will arise. Using a somewhat different framework, we will investigate the misallocation of resources under a common property system. Figure 10.4 describes the relationship between the value per unit of labor on a given piece of land and the number of laborers cultivating it.

Suppose for the moment that this piece of land is privately held. Conventional wisdom tells us that the landowner will hire additional labor to work the land until the marginal product of the last worker is equal to the market or alternative wage, w^A , at point L^* . The workload is shared equally among the

Common property resource A resource that is collectively or publicly owned and allocated under a system of unrestricted access, or as self-regulated by users.

FIGURE 10.4 Common Property Resources and Misallocation



employees, each of whom produces the *average* product. However, assuming decreasing returns to labor, each new worker hired reduces the average product of all workers. The *marginal* product of each additional worker is thus equal to his average product minus the decrease in the average product across all other workers. If an additional employee is hired beyond L^* , his cost to the producer, W^A , will be greater than his marginal product, and the difference will represent a net loss to the landowner. A profit maximizer will thus hire L^* workers, with a total output equal to average product, AP^* , multiplied by the number of workers, L^* . Scarcity rents collected by the landowner will equal AP^*CDW_A .

Society's total net benefit from land will be lower under a system of common property unless workers can coordinate their resource use decisions in a cooperative manner. Generally, if land is commonly owned, each worker is able to appropriate the entire product of his work, which is equal to the average product of all workers. Worker income will continue to exceed the wage until enough workers are attracted so that the average product falls to the level of the wage, at which point the labor force equals L_C . Though total output may either rise or fall (depending on whether MP_L is positive or negative—it is negative as drawn in Figure 10.4), the marginal product of the additional workers is below the wage. Because we are assuming that all workers can be employed elsewhere with productivity equal to or greater than W_A , it follows that social welfare must fall when marginal product falls below W^A . This situation is sometimes referred to as the "tragedy of the commons." No scarcity rent is collected at L_C . The implication of the common property resource model is that where possible, privatization of resources will lead to an increase in aggregate welfare and an efficient allocation of resources.

Note that these neoclassical models are strictly concerned with efficiency and do not address issues related to equity. Income distribution is not considered, and the theory is unconcerned with the distributional issues arising when all scarcity rents from national resources accrue to a few private owners. Although neoclassical theorists have sometimes suggested that an optimal outcome may be achieved through the taxation and then "lump sum" redistribution of the gains accruing to the owners of scarce natural resources, the historical record for such efforts is not encouraging. This is especially true where the authorities responsible for legislating and coordinating such redistributions are also the owners. Thus, the large-scale commercial privatization of resources does not necessarily ensure an improvement in standards of living for the impoverished majority.

There are a number of additional reasons why individuals making use of publicly owned resources may make inefficient use of them within the context of farming systems in developing countries. Family farmers, who, as noted in Chapter 9, are generally the most efficient cultivators of land, may be reluctant to make land-augmenting investments if they are afraid of losing tenure on the common property plot. They may also have insufficient funds to hire additional labor or purchase complementary resources due to a lack of collateral, a factor that frequently excludes the poor from competitive credit markets (see Chapter 15). It is therefore possible that conferring extended tenancy rights or ownership of land to family farmers would raise productivity. The relevant question for the property rights structure is then, who should obtain title to the land if privatization were to occur? A simple auction of publicly owned land to the highest bidder is unlikely to be consistent with development objectives.

Elinor Ostrom, the 2009 Nobel laureate in economics, discovered that under some conditions, a fair and efficient management of common property can be achieved by the people who depend on it. She and other researchers have also found thousands of historical and contemporary examples where this is achieved in practice. Out of this experience she drew out the “design principles” found in Box 10.3. Traditional societies have often been successful at devising and enforcing stable social norms and formal rules for cooperative natural resource management and even restoring cooperation after it has broken down. However, vigilance is needed because the underlying incentives for defection remain. In fact, as development proceeds, there are generally greater opportunities and incentives for individuals to appropriate common property for their own use, so in some cases, increased vigilance and external support could play a vital role; a subset of common property systems will be unlikely to endure.³⁸

Public Goods and Bads: Regional Environmental Degradation and the Free-Rider Problem

In the preceding discussion, the core economic problem was that each additional worker who joined those cultivating commonly held land created a negative **externality** by lowering the returns to all other workers without providing any compensation. An externality occurs when one person’s consumption or production behavior affects that of another without any compensation. The benefits and costs of one’s actions are said to be internalized when one is made to bear them in full. In the previous common property problem, the externalities associated with decreasing average product were easily internalized by reestablishing perfect property markets through the privatization of public property. In many cases, the **internalization** of externalities is not so easily accomplished. This is especially the case where the consequences of an individual’s actions constitute a public good or a public bad. A **public good** is anything that provides a benefit to everyone and the availability of which is in no way diminished by its simultaneous enjoyment by others. Common examples include clean air, economic institutions, and national defense. A **public bad** is any product or condition that decreases the well-being of others in a nonexhaustive manner. Air pollution and water pollution are examples. Intuitively, it is clear that given the fact that individuals do not pay the full costs associated with their actions, too much of a public bad will be produced. The result is a socially nonoptimal outcome. We will demonstrate this shortly using a diagrammatic representation. Public goods can be local, national, or, as with greenhouse gases, even global in scope.³⁹

Let us consider the case of a particular public bad, regional environmental degradation caused by deforestation. Increased exposure to the forces of erosion, excessive drying of the soil, regional loss of groundwater, silting or pollution of public water supplies, and potential climatic changes are all public bads associated with the clear-cutting or burning of trees. Whether these trees are on private or commonly held property, the clearing of protective ground cover, either for cultivation or for the extraction of timber, may lead to more widespread regional environmental degradation. To simplify our analysis, we will translate this public-bad problem into a public-good framework. Environmental conservation through the protection of trees provides a benefit to all and is thus a public good.

Externality Any benefit or cost borne by an individual economic unit that is a direct consequence of another’s behavior.

Internalization The process whereby external environmental or other costs are borne by the producers or consumers who generate them, usually through the imposition of pollution or consumption taxes.

Public good An entity that provides benefits to all individuals simultaneously and whose enjoyment by one person in no way diminishes that of another.

Public bad An entity that imposes costs on groups of individuals simultaneously. Compare with public good.



BOX 10.3 FINDINGS Elinor Ostrom's Design Principles Derived from Studies of Long-Enduring Institutions for Governing Sustainable Resources

Elinor Ostrom, 2009 Nobel laureate in economics, has summarized findings from research on common property resource management, in the form of eight conditions facilitating fair and efficient management of common property by those who depend upon it. These are:

1. *Clearly defined boundaries.* The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.
2. *Proportional equivalence between benefits and costs.* Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labor, materials, and money inputs.
3. *Collective-choice arrangements.* Many of the individuals affected by the harvesting and protection rules are included in the group who can modify these rules.
4. *Monitoring.* Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to the users or are the users themselves.
5. *Graduated sanctions.* Users who violate rules are likely to receive graduated sanctions (depending on the seriousness and context of

the offense) from other users, from officials accountable to these users, or from both.

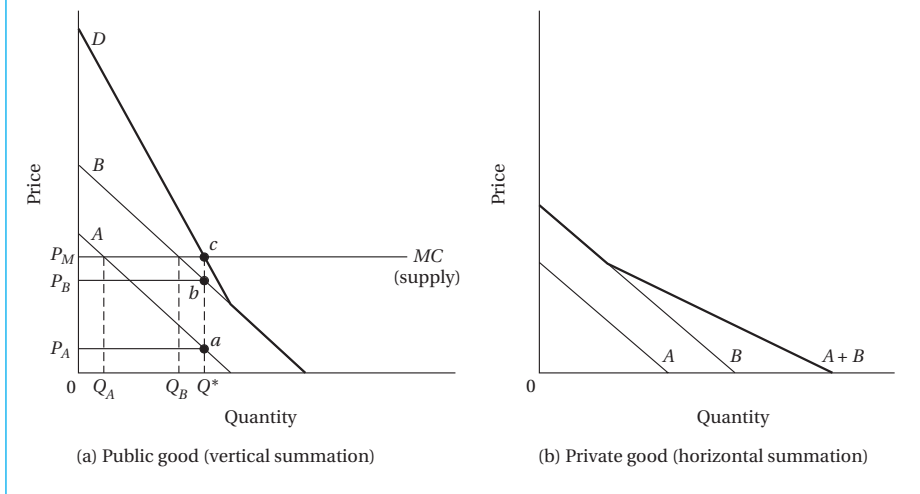
6. *Conflict resolution mechanisms.* Users and their officials have rapid access to low-cost, local arenas to resolve conflicts among users or between users and officials.
7. *At least minimal recognition of rights to organize.* The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.
8. *For resources that are parts of larger systems: nested enterprises.* Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Ostrom notes, "The design principles are not blueprints....They describe the broad structural similarities among those self-organized systems that have been able to adapt and learn so as to be robust to the many social, economic and ecological disturbances that occur over time."

Source: Ostrom, Elinor. *Understanding Institutional Diversity*. Princeton, N.J.: Princeton University Press, 2005. © 2005 by Princeton University Press. Reprinted by permission of Princeton University Press.

The most obvious difference between a public good and a purely private good is that aggregate demand for the public resource is determined by summing individual demand curves vertically, as in Figure 10.5a, rather than horizontally, as is the case for private goods as illustrated in Figure 10.5b. The difference results from the fact that many individuals may enjoy the same unit of a public good but only one may benefit from a unit of a normal, private-consumption good. Through vertical summation, we are sure to capture all benefits accruing to all individuals from each unit of a public good. The marginal cost associated with the preservation of an additional tree is equal to the forestry maintenance cost plus the opportunity cost of the tree, that is, the most valuable alternative use of the tree, such as for firewood, charcoal, animal fodder, or lumber. Figure 10.5 illustrates the problem of pricing public goods.

FIGURE 10.5 Public Goods, Private Goods, and the Free-Rider Problem



In Figure 10.5a, the socially optimal number of trees is Q^* . It is determined by the intersection of the (vertically summed) aggregate demand curve with the supply (MC) curve. At Q^* , total net benefits to society from the public good are maximized. However, due to what we call the **free-rider problem**, the free market will not lead to this optimal quantity. Because individuals are able to enjoy the benefits of trees provided by others, each will contribute less than what he or she would if acting independently. At a price of P_M , the free market will satisfy person B's demand, Q_B , while not denying person A's requirements of Q_A ; that is, A can free ride on B's contribution. The market will therefore provide a suboptimal level of forest preservation, Q_B . To restore optimality (Q^* of the public good), some form of government intervention is required. The most effective solution is to charge each consumer just enough per unit, P_A and P_B for individuals A and B, respectively, to entice each of them to demand the preservation of the optimal quantity of trees, Q^* . Their joint payments, $P_A \times Q^*$ for A plus $P_B \times Q^*$ for B, represent a total contribution equal to $P_M \times Q^*$, exactly the sum required to purchase the socially optimal level of preservation.

Free-rider problem The situation in which people can secure benefits that someone else pays for.

Limitations of the Public-Good Framework

The problem with the public-good pricing mechanism is, of course, how to know which prices to charge. People have no incentive to divulge how much they really benefit from a public good because by shirking they may free ride on the contributions of others and avoid paying their full share. A government may be capable of reducing market inefficiencies, but it is unlikely to be able to produce a perfect allocation of resources due to deficiencies in the information available to it. Hypothetically, collected fees can be used to provide a public good by preserving existing forests or managing a sustainable timber production program that will supply the community's needed timber. Although charging fees to the people benefiting from the preservation of a resource may sound practical, it is exceedingly difficult. In a development context, the problems become even more complicated. When the collection of fees

entails taxing deeply impoverished populations with little or no cash income, such a program becomes an impossibility. It would be equally difficult to collect payment from people who were cutting trees to meet subsistence needs. However, neoclassical theory can be useful for explaining why market failures lead to the inefficient allocation of resources in highly commercialized economies and how these inefficiencies may be mitigated.

10.4 Urban Development and the Environment

Environmental Problems of Urban Slums

In some ways, life among the poor in urban slums is similar to that of the poor in rural villages: Families work long hours, income is uncertain, and difficult trade-offs must be made between expenditures on nutrition, medical care, and education. Though on average, urban dwellers are likely to have higher incomes, the poorest are frequently at greater risk of being exposed to dangerous environmental conditions. Let us contrast our earlier look at environmental conditions in an African and a South American rural community with those of an Asian urban shanty.

In a typical urban slum in an Asian metropolis, health-threatening pollutants are commonplace both inside and outside the home. Many women are unaware that the smoke from the fuels they burn in the home to cook and boil water may have severe long-term consequences for the health of their children (though public health programs and NGOs have recently been encouraging cooking with better alternatives, with some success). Conditions resulting from poor ventilation in the home can be equivalent to smoking several packs of cigarettes per day, and women and their children are exposed to these fumes for long portions of each day. Though some children actually avoid much of this exposure by attending school, many are kept out of school to assist their mothers in market work or the production of goods at home. Thus, from an early age, chronic and acute bronchitis is a cruel fact of life. Debilitating and ultimately fatal respiratory infections among the poor are commonplace.

But it is not only in the home that individuals are exposed to harmful pollutants. Street vendors and market workers are constantly exposed to high levels of other pollutants. Untreated sewage runs in open drains along the roads, providing a conduit for infectious diseases. Because food and drinking water are frequently contaminated, diarrhea is common, especially in young children. Frequent spells of the illness cause malnourishment, even when food is more plentiful, making the young more susceptible to other diseases. Many of the weakest children die from severe dehydration. Because the fuels used to cook foods and boil water must be purchased in the market and consume a large portion of the daily earnings, there is sometimes insufficient fuel to boil the household's drinking water, increasing the chance of infection. The costs associated with obtaining medical treatment for sick children may be very high, involving the opportunity cost of time spent traveling to and from clinics and long hours in crowded waiting rooms, in addition to medical fees. For many households, the forgone earnings can be ill afforded. In many of the poorest households, only boys receive medical attention because they are

expected to contribute more to household income. It is thus not surprising that they are more likely than their sisters to survive to adulthood.

Children playing in the streets and others working outdoors are also exposed to the combined emissions from automobiles and factories. Dangerously high levels of atmospheric lead are common because few cars are equipped with the expensive catalytic converters now mandated in the West. Due both to physical and mental impairments suffered as a result of exposure to environmental factors and to repeated absence from school, children in the poorest neighborhoods may find it difficult to meet basic academic standards. It is no wonder that improvement in the lives of slum dwellers is a key part of the Millennium Development Goals.

Because the urban poor are much less able than the wealthy to insulate themselves from the negative effects of a tainted environment, they are more likely to suffer serious consequences resulting from environmental degradation. In addition, malnutrition and poor health among a large proportion of urban dwellers in shantytowns tend to reduce individual resistance to environmental hazards.⁴⁰

To explore viable solutions, it is necessary to have a clear understanding of the sources of problems and the ways in which they interact. The causes of severe urban environmental problems are numerous, but for simplicity of analysis, we will divide these factors into two categories: those associated with urbanization and industrial growth, and those that must be dealt with in any community but tend to be exacerbated by the congestion of urban settings.

Industrialization and Urban Air Pollution

The early stages of urbanization and industrialization in developing countries are generally accompanied by rising incomes and worsening environmental conditions. Cross-sectional analysis of numerous countries at different levels of income suggests that some types of urban pollution tend first to rise with national income levels and then to fall.⁴¹ As noted earlier, this effect has been dubbed the *environmental Kuznets curve*. According to the World Bank, pollution levels for even the worst quartile of high-income cities are better than for the best quartile of low-income cities.⁴² Indeed, at higher incomes, it is easier to afford expensive **clean technologies**. However, there is nothing inevitable about the trend. Air (and water) quality is closely related to the extent of government regulation, in both high- and low-income countries. Moreover, some environmental resources may be irretrievably lost unless action is taken immediately.

The principal sources of air pollution, which pose the greatest health threat associated with modernization, are energy use, vehicular emissions, and industrial production. Industrialization can lead to increases in waste either directly through emissions or indirectly by altering patterns of consumption and boosting demand for manufactured goods. The production of manufactured goods generally entails the creation of by-products that may be detrimental to the environment. The extent to which they degrade the environment will depend on a number of factors, including the type of by-products produced, their quantities, and their means of disposal. Unfortunately, in the absence of regulation, the cheapest way to dispose of unwanted by-products is usually to release them untreated into the air and waterways or to dump

Clean technologies Technologies that by design produce less pollution and waste and use resources more efficiently.

them on the ground where runoff is free to sink into groundwater or wash into rivers. Due to the broader transmission of ideas, greater availability of goods, and increased incomes, changes in patterns of consumption and their environmental consequences are likely to appear first in cities. Until technologies and infrastructures capable of coping with environmental consequences are introduced, modernization is likely to lead to high urban environmental costs.

We have already looked briefly at the issue of externalities and the fact that many of the costs of pollutants are borne by someone other than the polluter. This suggests that the price paid for the consumption of a good is below the social cost associated with the good. Figure 10.6 depicts the typical supply and demand curves. In this case, however, we have labeled the supply curve $S = MC_P$ because it represents the marginal **private costs** associated with producing good X. The free-market equilibrium output and price are Q_M and P_M , respectively. If there are externalities associated with the consumption or production of each unit of good X, the MC_P curve does not represent the true costs of the good to society. If each unit of good X imposes a cost of \$2 on a third party, we can obtain the true marginal social cost curve, MC_S , by legislating a \$2-per-unit sales tax on the output. This **pollution tax** shifts the private cost curve upward by \$2 at every point to MC_S in Figure 10.6. At the new intersection between the demand curve and the marginal **social cost** curve, Q^* is the efficient outcome and P^* is the price. Therefore, by incorporating the social costs of pollution into the analysis, the actual output of the polluting product is reduced to the socially optimal level, while the price charged to the consumer rises from P_M to P^* and the price received by the producer falls from P_M to P_C . Depending on the relative elasticities of the demand and supply curves, the burden of the pollution tax is shared by both consumers and producers. In Figure 10.6, the consumer pays ab and the producer pays bc of the ac tax.

Private costs The direct monetary outlays or costs of an individual economic unit.

Pollution tax A tax levied on the quantity of pollutants released into the physical environment.

Social cost The full cost of an economic decision, whether private or public, to society as a whole.

FIGURE 10.6 Pollution Externalities: Private versus Social Costs and the Role of Taxation

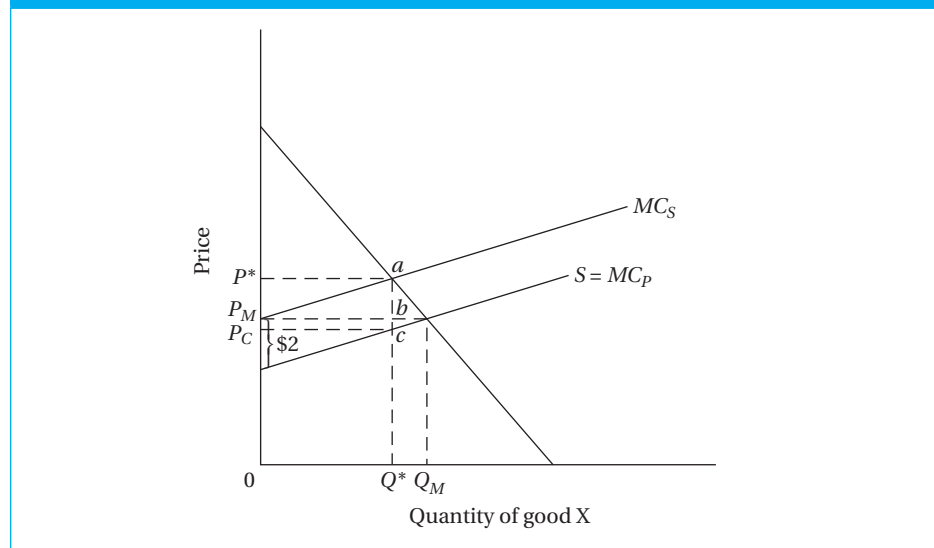
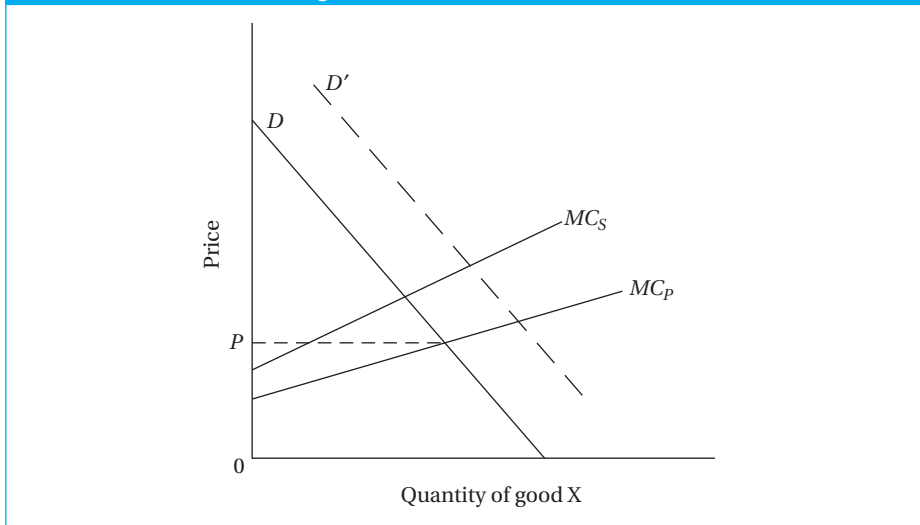


FIGURE 10.7 Increasing Pollution Externalities with Economic Growth



At sufficiently high levels, most emissions will be toxic to humans or otherwise damaging to the environment, whereas at low levels, per-unit costs may be insignificant. This is due to the fact that humans have some tolerance for most toxins, although the ability to tolerate exposure may rapidly decline as concentrations in drinking water and air increase. The environment also has an **absorptive capacity** that enables it to assimilate a quantity of most pollutants. Once this critical quantity has been exceeded, however, concentrations and hence toxicity are likely to rise rapidly. A more realistic marginal social cost curve is drawn in Figure 10.7. As concentrations of pollutants increase (as total output increases), the gap between the social and private cost curves increases. While aggregate demand remains low, this differential will be small. However, as the demand curve shifts outward from D to D' with rapid urbanization and rising incomes, the importance of externalities rises at an increasing rate. This suggests that the costs associated with curing urban ills caused by congestion will increase faster than the rate of increase of the population.

Health hazards are created by toxic air emissions as well as increasing volumes of waste that contaminate water supplies and land. The World Health Organization (WHO) has estimated that 1.5 billion people live in cities with unsafe levels of airborne particulate matter and 1 billion have been exposed to unacceptably high levels of sulfur dioxide.⁴³ Other compounds, such as nitrous oxides and organic compounds, rise in importance as industrialization proceeds. By contaminating water supplies, contributing to dangerous levels of air pollution, and damaging public and private property, industrial pollution can exact a high toll in terms of human health and economic prosperity.

A number of case studies indicate the potential severity of industrial pollution. In Bangkok, high levels of airborne lead caused such severe consequences for the development of small children that the average child's IQ was lowered by four or more points by the age of 7. Seventy percent of children

Absorptive capacity The capacity of an ecosystem to assimilate potential pollutants.

in Mexico City had abnormally high blood levels of lead. Health complications caused by smog tend to be worse in developing countries, where poor nutrition and general ill health greatly lower individual tolerance to pollutants. The implications for health are the worst for young children, who inhale roughly twice as many pollutants per unit of body weight as adults do.

Problems of Congestion, Clean Water, and Sanitation

As serious as the threat of rising levels of industrial emissions of pollution may be to the health of urban inhabitants in developing countries, the two most important environmental factors affecting the health of the urban poor are the inaccessibility of clean water and the lack of sanitation. Although much progress has been made, in 2009, over a billion people still had no access to an improved water source, and 1.5 billion had no improved sanitation. The lack of sanitary conditions in urban slums often presents severe threats to human health. The urban statistics can be somewhat misleading because millions of urban residents are counted as having access if they share a single faucet with over 1,000 residents at a considerable distance from their homes. Because there are no alternative sources, many of the poor collect drinking water from rivers, streams, and canals that are polluted with human excreta and chemicals.

Although the poorest urban dwellers experience many of the same adverse environmental conditions as the rural poor, including heavy indoor pollution and unsanitary conditions, crowding can intensify exposure. Raw sewage runs in many streets, mixing with garbage and contributing to the spread of disease. This is reflected in the fact that death rates in urban shanties are occasionally higher than in rural areas, even though the latter generally have fewer services.

The health and economic costs associated with these conditions are enormous (see Chapter 8) and represent formidable obstacles to the improvement of living standards. But children in households with adequate facilities are 60% less likely to die from diarrhea than those in households without such facilities.

The enormous economic costs resulting from lost productivity and expensive medical care represent a drag on economic development. Chronic ill health is both a consequence and a cause of poverty. It can contribute to poor nutrition, poor school performance, reduced productivity, and permanent disability, and thus give little hope for economic advancement (see Chapter 8). In addition to averting fatalities, improvements in the supply of water and sanitation reduce the incidence and severity of illnesses, thereby reducing other costs associated with waterborne disease.

Although higher-income households generally have access to either publicly or privately provided services, the poorest are generally without services. This is frequently due to the illegal status of much low-income housing, which renders it ineligible for government services and makes it risky for private individuals to invest in upgrading equipment. As a result, the majority of the poor must purchase water, often contaminated, from vendors at an average of 10 times the cost of piped water.

Postponement of investments in the infrastructure required for provision of urban water and sanitation can lead to much greater costs in the future. Poor access to water has led to widespread systems of private wells, which can overtax existing groundwater supplies. In a number of large cities, including Bangkok,

Mexico City, and Jakarta, this phenomenon has led to the collapse of existing infrastructure and the destruction of property through subsidence of the land and flooding. In coastal areas, overuse can draw salt water into supplies, leading to their permanent salinization. Where raw sewage is untreated and is improperly disposed of, underground and surface water is frequently contaminated, creating long-term shortages of clean water and threatening public health.

Foreign-exchange earnings may also be severely threatened by contaminated water supplies. Health standards in developed countries may prohibit the importation of agricultural goods produced with potentially contaminated water.

In light of these problems, it is not surprising that the costs of preventive measures are typically lower than those associated with lost revenues, resources, and infrastructure.

10.5 The Local and Global Costs of Rain Forest Destruction

Changes in patterns of land use in the developing countries currently make their largest contribution to global concentrations of **greenhouse gases**. It is estimated that deforestation alone accounts for roughly 20% of carbon dioxide (CO₂) emissions worldwide.⁴⁴ Because trees consume carbon dioxide and release oxygen during the process of photosynthesis, the tropical rain forests represent an important mechanism through which the ecosystem regenerates itself. Clearing rain forests reduces the environment's absorptive capacity for CO₂. In addition, accelerating extinctions pose a dangerous threat to **biodiversity**, with an estimated 12% of the world's bird species, 24% of mammal species, and 30% of fish species vulnerable or in immediate danger of extinction, largely in rain forest areas.⁴⁵

Deforestation continues at a massive scale. Globally, the loss of forests can stem from several causes, including severe droughts with fires, and invasive pest species. However, most deforestation is caused by the clearing of tropical rain forests for agricultural purposes.

The UN Food and Agriculture Organization estimates that about 13 million hectares of forest were lost each year on average for the decade 2000–2010, which represents some improvement when compared to the annual loss of 16 million hectares in the historical peak decade of deforestation in the 1990s. Forest expansion, including large-scale tree planting and natural expansion in other areas of the world, partially compensates (these are usually not rain forests), but the net annual global loss remains a very high 5.2 million hectares.⁴⁶

The majority of tropical rain forest destroyed, about 60%, is cleared for cultivation by small farmers. Much of it, like 90% of rain forest land worldwide, is so infertile that it will be cultivable for no more than a few years. The land is then frequently sold to large farmers who use it for grazing cattle, often under heavy government subsidy, leading to further desertification. The previous tenants are then forced to clear additional forest areas in a desperate attempt to derive a livelihood for the next few years. In the past, rain forest settlement programs have regularly been encouraged and financed by governments in several developing nations, often with the assistance of international development banks. A review by the World Bank of its own support for settlement

Greenhouse gases Gases that trap heat within the earth's atmosphere and can thus contribute to global warming.

Biodiversity The variety of life forms within an ecosystem.

programs found that they were exceptionally expensive—on average, \$10,000 per household—and could be environmentally destructive. Policymakers in countries with large rain forests, including Brazil, Bolivia, the Philippines, and Ecuador, are therefore experiencing increasing pressure from foreign public and private agencies to implement policies that will reduce the rate of tropical forest destruction. It is argued that the resulting decrease in the growth of concentration of greenhouse gases and protection of biodiversity will be in everyone's interests. Thus, rain forest preservation provides a public good.

Because the political and economic costs of preserving the rain forests are often masked or ambiguous, maintaining a rain forest may appear to be an almost costless venture. In fact, because of the important roles that rain forests play in the domestic economies of many developing nations, the true costs of preserving all remaining rain forest may be extraordinarily high. The opportunity costs arising from the preservation of rain forests will involve the loss of an important source of domestic fuel, forgone foreign-exchange earnings from timber and beef, and the loss of a temporary solution to the problem of land shortages and population pressures. It is therefore unreasonable to assume that the few developing countries that contain the majority of remaining rain forests should be responsible for single-handedly providing this **global public good**. Indeed, when foreign countries are allowed a free ride—that is, if they are allowed to benefit from rain forest preservation without contributing to it—deforestation will continue at an undesirable pace. To reduce the resulting inefficiencies, the public-goods model would suggest lowering the relative price per unit of protected forest for the developing country and increasing it for the outside beneficiaries. For the latter, this would entail the contribution of fees earmarked for the preservation of rain forests.

Several steps must be taken to preserve the rain forests. Long-term solutions include increasing the accessibility of alternative fuels, managing sustainable timber programs, and providing economic opportunities for impoverished peoples now resorting to clearing tracts of fragile rain forest land. Developing countries could vastly increase the efficiency of their economic use of rain forests by managing them (less than 1% of rain forests have been replanted or cut in a sustainable manner) and by developing alternative markets for other rain forest products, such as nuts, fruits, oils, sweeteners, resins, tannin, fibers, construction materials, and natural medicinal compounds. Much of the timber burned to open land for cultivation could be harvested for financial gain. For example, it was estimated that in the 1990s, Brazil lost some \$2.5 billion annually in the burning of rain forest timber. Sustainable timber production for fuel or export can be achieved through the restriction of cutting cycles to 30-year intervals and the careful maintenance of new growth. It is extremely costly, if not impossible, to regenerate a rain forest that has been clear-cut, so proper maintenance and supervision of logging are necessary. More careful oversight of timber concessions by developing country governments can prevent clear-cutting, reduce careless destruction of uncut trees, and increase the efficiency of revenue collection from concessions. There are also undervalued services from forests, including climate regulation, rain (and water cycling), flood control, and soil conservation.

The international community should also assist in the preservation effort. By reducing trade barriers to the alternative goods just mentioned, developed

Global public good A public good, whose benefits reach across national borders and population groups.

countries reduce the dependence of many developing countries on unsustainable modes of production. Debt-for-nature swaps (to be explained shortly) also reduce the need for the rapid exploitation of forests to raise foreign exchange. Finally, funds for the preservation and maintenance of tropical rain forests are necessary to guarantee the success of conservation programs that provide global public goods. It is important that such funds not be viewed as aid, because the ultimate benefits are to be shared by all in natural heritage, biodiversity, and containment of global warming. The Global Environmental Facility has played a significant role in rain forest protection. The global REDD-plus program to help developing countries preserve forests was discussed earlier in the chapter. The continued indebtedness of a number of developing nations with substantial forests, particularly in Africa, may make it exceptionally difficult for governments with large debt burdens to finance the expenses of environmental programs designed to protect natural resources.

In recent years, a number of international assistance agencies have established environmental divisions to promote more environmentally conscientious patterns of lending. They have also initiated programs to address environmental issues directly. Their success in the future may largely depend on the compatibility of such efforts with the economic realities confronting governments in the developing world.⁴⁷

People from countries with significant rain forests sometimes object to the strong pressure they feel to protect rain forests by asking, "Didn't developed countries grow by cutting down forests? So why should you pressure us in the developing world not to do so now? Do you want us not to develop?" To the first question, development probably did not arise from cutting forests; productivity gains were primarily responsible, not unsustainable timbering and extended use of more land. But even so, there are many technology alternatives not available in past decades. Of course, it would indeed be better to emphasize local benefits and pay for global costs, rather than to pressure or bully developing countries, which have a long history of unequal relations with the developed world. But there are indeed at least four other significant differences:

- First, tropical and deciduous forests differ in nutrients and restorability—in the former, nutrients are more in the biomass, less in the soil; rain forests do not regenerate the way deciduous forests do.
- Second, tropical rain forest destruction generates much larger externalities—local and especially global.
- Third, forests have more value now due to opportunities for payments for carbon protection and genetic diversity funds.
- Fourth, there is also more value now in fields, such as sources of new antibiotics and other drugs. In addition, expanded forest use and elimination is a strange target for industrial policy because productivity gains are focused in the manufacturing sector; from a fiscal standpoint, it makes basic economic sense to eliminate subsidies and tax breaks for doing so. And carving bean farms out of rain forests is an unfortunate substitute for land reform (for example, indigenous people already live and depend on these forests).

10.6 Policy Options in Developing and Developed Countries

What Developing Countries Can Do

A range of policy options is available for governments in developing countries. Seven stand out: (1) proper resource pricing, (2) community involvement, (3) clearer property rights and resource ownership, (4) improving economic alternatives for the poor, (5) raising the economic status of women, (6) policies to abate industrial emissions, and (7) taking a proactive stance toward adapting to climate change. Let's briefly examine each in turn.⁴⁸

Proper Resource Pricing The most obvious area for reform is probably government pricing policy, including subsidies, which can exacerbate resource shortages or encourage unsustainable methods of production. Often programs that were ostensibly designed to reduce hardships for the very poor have had little impact on poverty and have worsened existing inequalities. High-income households have frequently been the predominant beneficiaries of environmentally damaging energy, water, and agricultural subsidies. For example, on average in developing countries, the price paid for piped water is less than the total cost of supplying it. Due to rationing, such subsidies frequently benefit only people with higher incomes. Much public water is simply stolen—often by wealthy individuals. The result has often been a wasteful and unsustainable use of resources. Even though elimination of misdirected subsidies is a relatively costless (or profitable) way of protecting the environment, the political stakes are high where powerful elites stand to lose lucrative government transfers.

Community Involvement Programs to improve environmental conditions are likely to be most effective when they work in tandem with community networks, ensuring that program design is consistent with both local and national objectives. The experience of development agencies has demonstrated that grassroots efforts can be more cost-effective because they generally involve the use of low-cost alternatives and provide jobs to local populations. When poor communities truly benefit from public-works programs, residents are often willing and able to contribute much of the program costs. Institutions facilitating cooperative management of common property resources can also be encouraged.

Clearer Property Rights and Resource Ownership Investments in household sanitation and water and on-farm improvements often represent a large portion of lifetime savings for the poor, the loss of which can impose harsh economic consequences on households. Hence, the lack of secure tenure on rural or urban property can greatly hinder investment in environmental upgrading. Legalization of tenure can lead to improved living conditions for the poor and increases in agricultural investments.

In many cases, however, land reform may be necessary (see Chapter 9). It is not uncommon for renters or sharecroppers to lose the economic gains from their farm investments because it is relatively easy for landlords to extract higher rents once the productivity of the land has been improved. Transferring

title to tenants may be the only means of ensuring that financial rewards from land-augmenting investments accrue to the investor. Land reform may also be required where unequal distribution of land has led to large tracts of uncultivated high-quality land in close proximity to overexploited marginal lands cultivated by large numbers of landless workers. If equitable and efficient common property resource use is to continue, well-designed facilitating policies will be needed, taking into account what has been learned about the conditions in which they are most effective (see Box 10.3).

Programs to Improve the Economic Alternatives of the Poor Further environmental devastation in rural areas may be avoidable in many cases through on-farm investments in irrigation and sustainable farming techniques, the use of alternative fuels, and the creation of barriers to erosion. However, the economic costs of each of these alternatives are prohibitive for the vast majority of impoverished family producers. Ironically, the greater the environmental devastation, the less likely that a rural population will be able to afford alternative methods of production. It is therefore important that government programs make credit and land-augmenting inputs accessible to small farmers. By providing rural economic opportunities outside the home, governments can also create alternative employment opportunities so that the very poor are not forced to cultivate marginal lands; for example, programs to build rural infrastructure (roads, storage facilities, etc.) create local jobs, alleviate population pressures on ecologically sensitive land, stimulate rural development, and reduce the flow of rural-to-urban migration.

Raising the Economic Status of Women Improving the educational attainment of women and increasing their range of economic alternatives raise the opportunity cost of their time and may lead to decreases in desired family size (see Chapter 6). Education also tends to increase women's access to information concerning child nutrition and hygiene, a factor that has been linked to rapid declines in child mortality. It is important that community-based environmental programs work closely with women because their own day-to-day activities may largely determine patterns of resource use and their ability to meet the needs of their families is dependent on the sustainable management of water and fuel supplies.

Industrial Emissions Abatement Policies A range of policy options is available to developing-country governments for the purpose of limiting industrial pollution, including the taxation of emissions, tradable emissions permits, quotas, and standards. There is some evidence to suggest that the first two policies, which are market-based, are more effective because they tend to reward the more efficient producers, allow greater flexibility for firms, and are generally easier to enforce. Regulations should be as simple as possible and must be enforceable. Additional incentives to adopt clean technologies may be provided through tax credits and subsidies specifically tied to the purchase or development of pollution abatement technologies. Ironically, the hardest industries to regulate are those run by governments themselves because the profit motive is often not a consideration and, as a general rule, it is difficult for any group to regulate itself.⁴⁹

Proactive Stance toward Climate Change and Environmental Degradation

Proactive policies can help make the developing economy, in general, and the poor, in particular, more resilient and able to adapt to climate change, much of which is already inevitable. Developing nations can implement and continuously improve early warning systems to anticipate environmental emergencies; promote reforestation; restore natural ecosystem barriers such as mangroves; improve microinsurance programs; and construct storm shelters, flood barriers, and protected roads and bridges. To protect forest cover, it may be effective to employ the poor as guardians of these resources. Living on site, they are more likely than absentee owners to pay attention to poaching and illegal logging. In many countries, more government transparency and accountability are also needed. The empowerment of the poor and their organizations can play an important role in protecting the natural resources on which many of the poor depend for their livelihoods and in seeing that government helps meet their generally greater needs for assistance with adaptation.

How Developed Countries Can Help Developing Countries

Industrial countries can help developing nations in their efforts to improve the environment of development in three areas: (1) trade liberalization, (2) debt relief, and (3) financial and technological assistance.

Trade Policies The focus of much current discussion concerning the environment is the desperate need to break the cycle of poverty and environmental destruction in developing countries. However, protectionism in agricultural and other goods has caused international markets and thus earning capacity for these developing-country products to shrink dramatically (see Chapter 12).⁵⁰ Eliminating trade barriers against developing-country exports by stimulating economic growth in the developing world, creating new jobs, and encouraging rural development could significantly reduce the level of absolute poverty.

In addition to trade barriers, the industrialized countries penalize developing-country exports by heavily subsidizing their own agricultural sectors. The resulting large surpluses are often dumped on international markets, unfairly undercutting the agricultural exports of developing countries in markets for which they are presumed to have a comparative advantage. Reducing the estimated \$500 billion in annual agricultural subsidies in developed countries could help guarantee the success of rural development efforts in developing nations by reducing poverty and the environmental decay that it causes. Developing countries would thereby reduce their dependence on the unsustainable exploitation of rain forests and other resources to raise foreign exchange.

Debt Relief Wider access to international markets not only raises incomes but also improves the ability of heavily indebted countries to service their debt. Heavy debt servicing drastically reduces funds available to developing-country governments for domestic social programs, including those designed to alleviate poverty and reduce environmental degradation (see Chapter 13). Debt forgiveness may be required if governments particularly in heavily indebted poor countries are to be given the flexibility to make the sweeping changes necessary to achieve sustainable development.

Debt-for-nature swaps offer an attractive and mutually beneficial way for the developing world to retire its foreign-denominated debt while guaranteeing the protection of tropical rain forests.⁵¹ In a debt-for-nature swap, a foreign, private environmental organization such as the U.S.-based Rainforest Alliance or the Nature Conservancy, working in conjunction with a local environmental organization, purchases developing-country debt on financial markets at a fraction, say, 30%, of the face value. The debt is then exchanged for government bonds denominated in the debtor-country currency but worth the full value of the original foreign debt. The environmental organization purchasing the debt is thus able to leverage its funds by 230%. Income from the securities is used to maintain rain forest or wildlife reserves. In this way, the developing country no longer owes debt in scarce hard currencies and is able to set up endowments for the preservation of national resources. The foreign donor is able to make an effective contribution several times larger than the actual outlay of cash and obtains a verbal guarantee that the endowment will be used to protect natural resources. Although debt-for-nature swaps provided an exciting, albeit partial, solution to tropical deforestation, a number of persistent economic and political obstacles has limited the potential scope of such programs, not the least of which is fear of foreign control over domestic resource decisions.⁵²

Debt-for-nature swap The exchange of foreign debt held by an organization for a larger quantity of domestic debt that is used to finance the preservation of a natural resource or environment in the debtor country.

Development Assistance Substantial new development assistance is necessary in developing countries to achieve sustainable development. These investments would be used for a variety of programs to alleviate poverty, provide services, and promote sustainable patterns of production. Additional aid from developed countries earmarked for these purposes could have a positive impact on developing-country environments (see Chapter 14). Even greater sums would be necessary to maintain tropical rain forests, which provide benefits to the entire international community through reduced CO₂ emissions. There are many tactics that can be evaluated on a case-by-case basis for cost-effectiveness. The most general approach is to support programs to alleviate landlessness and poverty, to help eliminate the socioeconomic causes of some of the tropical deforestation. Specific tactics include purchase of timber rights by national and international agencies, together with paying indigenous communities to monitor forest preservation (as originally proposed by Conservation International, an NGO). Preservation efforts could be paid for by the international community as a global public good.

Assistance with adaptation to climate change is a critical element where assistance is needed. Provision of greener technology to developing countries can help reduce greenhouse gases generally but will not in themselves help developing countries adapt to climate change. Programs such as the GEF (Global Environment Facility) and REDD-plus, discussed earlier, are important steps.

What Developed Countries Can Do for the Global Environment

Perhaps most important, developed countries, which currently consume over 70% of the earth's resources, can directly contribute to global environmental improvement through their own efforts to (1) reduce harmful emissions,

FIGURE 10.8 The Earth at Night, Reflecting Inequality of Energy Use across High-, Middle-, and Low-Income Countries; and Concentration of Economic Activity along Seacoasts



Craig Mayhew and Robert Simmon, NASA GSFC

including greenhouse gases, (2) undertake R&D to develop green technologies and pollution control for themselves and for developing countries, and (3) alter their own environmentally harmful patterns of demand.

The composite photo in Figure 10.8 dramatically illustrates the unequal global pattern of resource use. This image is a composite of hundreds of photos of the earth at night taken by satellite. Human-made lights draw attention to high-income (as well as densely populated) regions, particularly Europe, the United States, and Japan. Highly populated and now upper-middle-income coastal China also stands out. India is clearly seen, if less brightly; India is a lower-middle-income country, but with high population density. The lack of electric lighting in sub-Saharan Africa, the poorest region, compares dramatically with other population centers. Middle-income areas of very low population density, such as the central parts of South America and Asia, are also dark. As the map suggests, much economic activity is located near seacoasts largely for the simple economic reason that people can exchange goods utilizing low-cost shipping; for example the big cities of Brazil stand out. Differences in economies with good and poor institutions also show up—most vividly across the border between North and South Korea. Note that the per capita use of lighting parallels the overall use of electric power and other resources. Thus, the image also provides a vivid picture of the extraordinary unequal distribution of resource use that still prevails across high-, upper-middle-, lower-middle-, and low-income countries.

The United States and other developed countries produce a majority of the greenhouse gas emissions and consume a disproportionate share of environmentally sensitive products such as ocean fish; their consumption of energy, wood products, and raw materials is even more strikingly disproportionate.⁵³ A substantial part of developed-country consumption is wasteful. It seems clear that the world as a whole cannot consume at current U.S. or other developed-country levels; responsible consumption on the part of

the developed countries is not just setting a good example but an ecological necessity. This does not mean that economies cannot continue to grow indefinitely—clearly they can, as more consumption becomes knowledge-based and more modest in its use of raw materials. It is rather that the patterns of consumption must change. As we have seen, price signals alone will not guide resource use when substantial externalities and public goods are involved.

Emission Controls Beyond responsible consumption, perhaps the greatest contribution that the developed world can make to the global environment will be through a clear demonstration of their own commitment to a cleaner environment. Because they remain the main polluters of air and sea, developed countries must lead the way to global changes in current and future patterns of production. If wealthy nations do not achieve significant and sustained reductions in the production of greenhouse gases, it will be difficult to convince the developing world to do so, considering that per capita emissions levels are far below those in the industrialized countries.

Research and Development The high-income countries must also take a leadership role in research and development efforts. Growing public support for stricter environmental regulation in the industrialized world is likely to lead to the development of both cheaper emissions abatement technologies and cleaner (or “greener”) production processes. Innovations resulting from research and development will enhance efforts to reduce emissions if they are adopted in developing countries. Currently, many clean technologies are prohibitively expensive for the developing world’s industries. It is thus unrealistic to expect low-income countries to attain standards set in high-income countries. However, it is not necessary for developing countries to reproduce environmental debacles endured during the onset of industrialization in the developed world. Making cheaper, cleaner abatement technologies accessible to developing countries can help limit a principal source of global emissions—the rapid industrialization of the developing world. Availability of low-carbon technologies will be crucial in the fight to limit climate change.

Import Restrictions Through its importation of products that are associated with environmentally unsustainable production, the developed world has an indirect but important impact on the global environment. International treaties to limit the destruction of endangered resources will have little effect if wealthy nations continue to provide lucrative markets for the sale of such goods. Import restrictions are an effective way of reducing undesired international trade. Consumer sovereignty expressed through boycotts and other forms of pressure on corporations can be effective. However, they require strong leadership and tend to focus on large firms, which represent only a relatively small portion of the overall problem.

Of course, it is important to make certain that such environmental restrictions applied by government or civil society are not merely disguised protectionism against developing countries and to ensure that the poor are provided opportunities to preserve their livelihoods through their environmental wealth in a sustainable and equitable manner.

Case Study 10

A World of Contrasts on One Island: Haiti and the Dominican Republic

The terrible earthquake that struck Haiti in January 2010 brought to public awareness an immediate crisis of horrific proportions—and also an ongoing slow-motion disaster of poverty and suffering in a nation of 10 million people, including an environmental crisis. News reports showed its neighbor, the Dominican Republic (DR), also with a population of just over 10 million in 2012, with higher incomes, less poverty, and much better environmental conditions.

Haiti's environmental disaster could have been substantially averted with better domestic policies. And so it is not the root cause of Haiti's problems. But why were better environmental (and other supporting) policies not in place? That is, what were the limits of Haiti's institutions in this respect? And are Haiti's environmental problems caused by the country's great poverty? Has environmental degradation itself now also become one of the causes of continued economic and human development stagnation? What could have been done with well-targeted aid, and what role can aid play now?

Travelers to Haiti who flew across the border from the DR saw an astonishing contrast: Haiti to the west is barren, while the DR to the east is lush forest—except where Haitians desperate for fuelwood for income from charcoal production have made forays across the border. In 2004, the United Nations Development Programme (UNDP) commented on this scene, noting “a cycle of poverty and environmental destruction has denuded hill-sides.” In 2005, Jared Diamond wrote eloquently that “the border looks like a sharp line with bends, cut arbitrarily across the island by a knife, and abruptly dividing a darker and greener landscape east of the line (the Dominican side) from a paler and browner landscape west of the line (the Haitian

side).” He added, “On the ground, one can stand on the border at many places, face east, and look into pine forest, then turn around, face west, and see nothing except fields almost devoid of trees.” Years after this helpful publicity, little to address the problems was being accomplished.

On the eastern (nearly) two-thirds of the island of Hispaniola that the two nations share, the DR finds itself with a medium human development ranking, at number 96 on the 2012 New HDI. On the western third of Hispaniola, Haiti has a low human development ranking, at number 161—using data that do not yet reflect the full impact of the earthquake.

The contrasts between the two nations sharing the island of Hispaniola were not always as stark as today. In 1960, real incomes in these two countries were not very far apart, about \$2,345 for the DR and \$1,877 for Haiti in the Penn World Table estimates—that is, approximately 25% higher in the DR. Haiti had about 12% of average U.S. income levels at the time, while the DR had 16% of average U.S. income. But by 2007, real GDP in the DR had risen to \$9,664; but it actually fell in Haiti to \$1,581. That is, income in the DR is now over *six times* that of Haiti. U.S. incomes grew in this period such that Haiti's average income by 2007 was less than 4% of U.S. levels. But the DR, which had grown somewhat faster than the United States, now reached an average income that was more than 22% of that in the United States. (While estimates differ across methods, the qualitative comparisons are similar; Angus Maddison's research indicates almost identical incomes for the two countries in 1950, but by 2008, the DR incomes were over *seven times* that of Haiti.) This fact suggests that important clues are to be found in events and policies since 1960. On the other hand, to understand opportunities and

constraints so that it becomes clearer why policies diverged, it is often helpful to start with the beginnings of colonial times.

Hispaniola was “discovered” in 1492 by Christopher Columbus, but a large majority of its hundreds of thousands of Arawak and Taino people soon died—of diseases brought by the Spaniards, overwork in enslavement, and genocide. Slaves were then forcibly brought in from Africa. Since that hideous period, the economic histories of Haiti and the DR have been a tale of contrasts.

Haiti soon became one of the highest-income countries in the world, albeit with one of the highest extremes of inequality in history, with a large, impoverished, and brutalized slave population supporting a small, wealthy elite. In contrast, the DR, with fewer slave plantations, was more the tortoise to Haiti’s hare. The better performance of the DR seems to offer further confirmation of the analysis of Chapter 2 (and of the case study for Chapter 5) of how differences in earlier institutions can have a big effect on economic development outcomes. This experience also reveals how influences of deep, structural inequality and education (or its lack) can shape the evolution of institutions over time, as was also first introduced in Chapter 2 and explored in Chapters 5 and 8. And it is also suggestive as to how each of these three factors can, through the quality of policies, affect the extent of environmental decay and how that can, in turn, worsen human capabilities and development prospects. What can we learn from the long-term record?

Geography and Original Environments

Hispaniola is a subtropical island of about 76,482 square kilometers—smaller than Cuba but larger than Jamaica or Puerto Rico. Sharing the same island, both Haiti and the DR seem to have started with similar geographies and environments, with some modest differences. The DR occupies about 64% of the land area; with the remaining 36%, Haiti is about the size of the Hawaiian Islands. Rainfall is slightly higher in the DR because the rain typically comes from the east; Haiti is more mountainous, and its mountains block the rain. The rivers flow mostly eastward from these mountains, providing water for the DR. These modest initial environmental differences may have put Haiti at some disadvantage, but Haiti has done

well economically in comparison to the DR in some periods. Both countries were once largely covered with forests. But environmental damage was already under way under colonial rule, with deforestation due to extensive logging and overuse of the soil. Adverse human influence has had a bigger impact in Haiti.

Institutions: Historical Legacy

Clearly, neither country started with favorable institutions. The abundance of resources and the island’s suitability for sugar production led the Spanish to create institutions designed for extraction. The Spanish New World *repartimiento* system, in which Spanish-born *peninsulares* received land tracts and the right to use native labor, was first implemented in Hispaniola. When importing slaves became too expensive for the Spanish, the French gained control of Haiti in 1697. The colony became a major slaveholding plantation economy and the wealthiest European colony in the New World. But a large majority of the population were slaves. A slave revolt led Haiti to independence in 1804. Both Haiti and the DR suffered subsequent attempts to reinstate slavery and fought wars against each other, including an 1821–1843 attempt at reunification (known as the Haitian occupation in the DR, whose Independence Day celebrates freedom from Haiti).

The period of revolt in Haiti led to much death and to the destruction of wealth as sugar plantations burned. And while the brutality of slavery ended, extreme inequality persisted in Haiti under a new mulatto and black privileged class for whom the French elite were the cultural reference point. But the French invaded and received a huge ransom, allegedly for lost wealth from expropriation. Fear of invasion and alienation from white slaveholding countries and colonies kept the country inward looking; this was reinforced by a policy of isolation imposed by slaveholding countries, including the United States. The mutual distrust between Haiti and its potential trading partners is one cause of the resulting autarkic development, including reluctance to allow foreign ownership. The people of Haiti also spoke Creole, an obstacle for potential trading partners; Spanish was spoken in the DR. Europeans tended to view the DR as Spanish but Haiti as African and hence “inferior.”

Haiti then evolved into a subsistence farming economy but continued to have a larger population than the DR on far less land. The DR had more extensive cattle-based activities.

The DR became fully independent only after 1843. It was undermined by war and intrigue, such as restoration of Spanish authority briefly in the 1860s and occupation by the United States from 1916 to 1924. During the occupation, significant infrastructure was built, including schools, roads, and ports—projects continued and extended to hydropower under the subsequent brutal Trujillo dictatorship; this helped facilitate a relatively higher growth rate, though inequality was reinforced while freedoms were repressed.

The United States occupied Haiti from 1915 to 1934. Basic security and order were restored, and road construction, expanded public health, education services, and other infrastructure improved. However, after U.S. occupation, the dictator François “Papa Doc” Duvalier—a brutal ruler like Trujillo in the DR—did not focus on modernizing Haiti, in some contrast to Trujillo. As Laura Jaramillo and Cemile Sancak concluded, Duvalier was only interested in short-term rent-seeking opportunities instead of maintaining the country’s infrastructure. The DR has emerged as a much more democratic nation since the 1978 elections, while at least until very recently Haiti has made far less progress.

Human Capital

Haiti has the highest illiteracy rate in the western hemisphere, estimated at more than half the population. The school system is badly underfunded and disorganized. Health conditions are equally bad and include high under-5 mortality, hunger, and a large HIV/AIDS problem. The 2010 cholera outbreak was a symptom of a broken health system. The DR, although not without serious education problems, has done a far better job than Haiti at providing its people with the human capital they need to compete in a globalizing economy.

Policy Effects

In the 1990s, growth rates accelerated in the DR due to improvements in education, trade policies, and infrastructure. Remittances and tourism grew to become nearly a quarter of the country’s

GDP, and net manufacturing exports per capita doubled. Haiti, however, suffered from political instability during the same period. The army overthrew President Aristide in 1991 and began a violent regime that damaged the economy directly and also indirectly through subsequent UN and U.S. trade embargoes. Haiti also failed to diversify its economy; its continued focus on sugar has left Haiti not only contending with volatile sugar prices but also competing against sugar-subsidizing rich countries (most prominently the United States). The DR’s diversification into tourism depended on a clean environment—both on its beaches and in its forests—for ecotourism. Policy in the DR actively sought out foreign investment for manufacturing that provided higher-wage employment. The DR has long had far more nature reserves and national parks; Trujillo’s insistence on forest preservation had long-run positive effects on the environment and development. The DR has clearly had better policies, and apparently, a long legacy of institutions mattered for the policy differences between the DR and its neighbor.

Poverty can cause environmental damage, and the poor can, in turn, become its victims. Haiti’s agricultural expansion has been poorly managed. Deforestation has, in turn, led to the massive loss of fertile soil, lowering productivity of farms. Currently, more than a quarter of the DR is forested, compared to only 1% forest cover in Haiti. A similar cover existed in Haiti as in the DR just a few decades ago. Other low-income countries have introduced and enforced helpful environmental regulations; had Haiti done the same, despite deep historical roots, the environmental disaster might at some level have been averted. The case of Haiti adds to the growing evidence that environmental destruction can retard the development process more generally and needs to be a bigger priority.

Both countries have faced serious environmental challenges, including hurricanes and earthquakes. It is critical to manage the risk of extreme events before they become full-blown humanitarian disasters; this is something the DR has done much more effectively than Haiti. The UNDP explained it this way in its 2007–2008 *Human Development Report*:

In 2004, the Dominican Republic and Haiti were simultaneously struck by Hurricane Jeanne. In the Dominican Republic, some 2 million people were affected and a

major town was almost destroyed, but there were just 23 deaths and recovery was relatively swift. In Haiti, over 2,000 people were killed in the town of Gonaives alone. And tens of thousands were left trapped in a downward spiral of poverty. The contrasting impacts were not the product of meteorology. In Haiti, a cycle of poverty and environmental destruction has denuded hillsides of trees and left millions of people in vulnerable slums. Governance problems, low levels of finance and a limited disaster response capacity left public agencies unable to initiate rescue and recovery operations on the scale required. In the Dominican Republic, national laws have limited deforestation and the civil defence force has a staff 10 times larger than its counterpart in Haiti to cater for a population of similar size.

Poverty cannot always be contained by national boundaries. There is a large-scale emigration of Haitians over the border to the DR, despite the harsh welcome they often receive there. Dominicans, in turn, are emigrating to the United States in significant numbers. The reported illegal logging by Haitians across the border in the DR, believed to be largely for charcoal production, is a challenge for the DR's emphasis on environmental preservation as a development strategy. Currently, the DR is investing in replanting trees along its border with Haiti.

It is clear that environmental deterioration results from bad economic and regulatory policies. Poverty, too, remains severe in significant measure due to poor policies. Severe poverty, in turn, leads to environmental deterioration, which perpetuates poverty directly and through reduced overall growth.

Most of the causality has run from poverty to environment (as well as from rapacious, unsustainable economic policies dating from the French colonial period). But today, addressing environment is a vital step in Haiti's start toward development. Improved environmental policies have greatly aided countries such as Costa Rica—and increasingly the DR—that have invested in the land. Unfortunately, as noted in this chapter, global warming will bring much more substantial climate change. The future is expected to see more and deadlier hurricanes and other challenges that will require adaptation and resilience. To the extent that adaptation capacity and resilience are synonymous with human development, this gives the edge for the DR to build on its already large lead going forward. There is a strong case for the international

community to respond to Haiti's plight with well-implemented aid, with attention that does not dissipate as the earthquake disaster recedes in the world's memory. ■

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Concepts for Review

Absorptive capacity
 Biodiversity
 Biomass fuels
 Clean technologies
 Climate change
 Common property resource
 Consumer surplus
 Debt-for-nature swap
 Deforestation
 Desertification
 Environmental accounting
 Environmental capital

Environmental Kuznets curve
 Externality
 Free-rider problem
 Global public good
 Global warming
 Greenhouse gases
 Internalization
 Marginal cost
 Marginal net benefit
 Pollution tax
 Present value
 Private costs

Producer surplus
 Property rights
 Public bad
 Public good
 Scarcity rent
 Social cost
 Soil erosion
 Sustainable development
 Sustainable net national income (NNI*)
 Total net benefit

Questions for Discussion

1. Is sustainable development a practical and feasible goal for nations? What might be some of the difficulties and possible trade-offs? Explain your answer.
2. In what ways does poverty lead to environmental degradation? In what way are the poor victims? Specifically, provide two examples of how the poor sometimes degrade the natural resources on which they depend. Why does this happen, and what might be done to escape this trap?
3. What types of environmental problems do the rural and urban poor share? What are some differences in the conditions they face?
4. How are population growth, poverty, and land pressures interrelated? Explain how these problems can create a vicious circle of events.
5. What steps might governments in less developed countries take to reduce overexploitation of natural resources? What impact do pricing policies have?
6. Why are national environmental concerns in developing countries likely to focus increasingly on urban problems in the future? How are urban conditions related to rural-to-urban migration?
7. Why are the objectives of economic development and sustainable growth mutually reinforcing?
8. In what ways does neoclassical theory provide a useful framework for analyzing environmental issues? What are some of its limitations?
9. What are some of the costs associated with environmental degradation? How might they detract from economic growth? What are the developmental implications?

10. Why are children more susceptible than adults to health risks posed by their environment?
11. In what ways can developed nations best contribute to the alleviation of global and domestic environmental problems? Be specific.
12. Explain the difference between purely private and public goods and how it applies to environmental problems faced by developing countries. What are the implications of the free-rider problem for allocation of a public good?
13. What is the environmental Kuznets curve? What factors may make it plausible? In what cases does it seem implausible?
14. How is climate change expected to impact countries in Latin America, Asia, and Africa? What policies in developed and developing countries may help address these problems?
15. How do farmers in developing countries adapt to climate change that they experience?
16. What are the main ideas of environmental accounting? If practiced, what effects would you expect to see?
17. What are natural resources–based livelihoods, and how are they threatened?
18. What are common property resources; what economic incentive problems do they face; and how have some communities successfully overcome these problems?
19. What is the international community doing to assist the least developed countries (such as Niger) with resilience to climate change? Can you identify any limitations to this assistance?
20. What insights can be found from a comparison of Haiti and the DR for the potential role of environment in economic development?

Notes

1. For a comprehensive view of the range of issues linking the environment to economic development, see World Bank, *World Development Report, 1992 and 2003* (New York: Oxford University Press, 1992, 2003); John M. Antle and Gregg Heidebrink, “Environment and development: Theory and international evidence,” *Economic Development and Cultural Change* 43 (1995): 603–625; and Herman E. Daly, *Beyond Doubt: The Economics of Sustainable Development* (Boston: Beacon Press, 1996).
2. For a comparative analysis of various definitions of sustainable development, see Sharachandra A. Lele, “Sustainable development: A critical review,” *World Development* 19 (1991): 607–621, and Lance Taylor, “Sustainable development: An introduction,” *World Development* 24 (1996): 215–225.
3. World Commission on Environment and Development, *Our Common Future* (New York: Oxford University Press, 1987), p. 4.
4. David W. Pearce and Jeremy J. Warford, *World without End: Economics, Environment, and Sustainable Development—A Summary* (Washington, D.C.: World Bank, 1993), p. 2. As we will see, policies for achieving sustainable development also involve utilizing an appropriate social discount rate and creating incentives internalization of negative environmental and health externalities.
5. See World Bank, *World Development Report, 2003* (New York: Oxford University Press, 2003), pp. 18 ff. for a brief introduction to the complementarity of environmental assets with other assets.
6. David Pearce and Jeremy Warford provide a good example of environmental accounting, on which this presentation is largely based, in *World without End*, pp. 2–3. See also World Bank, *ibid.*, ch. 2. Regarding the reformulation of NNI**, note that R and A are also part of basic net national income (NNI) because they represent economic activity (for which labor and other factors are paid). Thus, while R and A were also included as part of NNI*, they are being subtracted to arrive at NNI**, because R and A are now treated as part of the broader allowance for depreciation. Their deployment may be highly cost-effective, however.
7. See United Nations Population Fund, *Population, Resources, and the Environment: The Critical*

- Challenge* (New York: United Nations, 1991), for a review and an analysis of these critical population-environment linkages. See also Maureen L. Cropper and Charles Griffiths, "The interaction of population growth and environmental quality," *American Economic Review* 84 (1994): 250–254, and World Bank, *World Development Report*, 2003.
8. For analysis of these issues, see Karl-Göran Mäler, "Environment, poverty and growth," in World Bank, *Annual World Bank Conference on Development Economics, 1997* (Washington, D.C.: World Bank, 1998), pp. 251–284, and, in the same volume, Ramon E. Lopez, "Where development can or cannot go: The role of poverty-environment linkages," pp. 285–306.
 9. Cynthia C. Y. Lin, "Endogeneity in the environmental Kuznets curve: An instrumental variables approach," *American Journal of Agricultural Economics* 95, No. 2(2013): 268–274; and Susmita Dasgupta, Benoit Laplante, Hua Wang and David Wheeler, "Confronting the Environmental Kuznets Curve," *Journal of Economic Perspectives*, 16, 1, Winter 2002, Pages 147–168.
 10. See World Resources Institute, *World Resources, 1996–97: The Urban Environment* (New York: Oxford University Press, 1996).
 11. A description of the factors leading to the production of greenhouse gases in developing countries is offered in World Bank, *World Development Report, 2009* (New York: Oxford University Press, 2009), and John Bongaarts, "Population growth and global warming," *Population and Development Review* 18 (1992): 299–319.
 12. See United Nations Food and Agriculture Organization, *The State of Food and Agriculture, 2006* (Rome: United Nations Food and Agricultural Organization, 2006), tab. A-4, p. 127.
 13. For an excellent overview, see United Nations Development Programme, United Nations Environment Program, World Bank, and World Resources Institute, *World Resources, 2005: The Wealth of the Poor: Managing Ecosystems to Fight Poverty* (Washington, D.C.: World Resources Institute, 2005).
 14. *Ibid.*
 15. For reports on these and other projects, go to the Equator Initiative Web site, <http://www.equatorinitiative.org>. A fine review of the HASHI project can be found in United Nations Development Programme et al., *World Resources, 2005*, pp. 131–138; other informative case studies are also presented there in ch. 5.
 16. See e.g. <http://www.circleofblue.org/waternews/2012/world/choke-point-china-ii-introduction/Poor>.
 17. United Nations Development Programme et al., *World Resources, 2005*. See also World Resources Institute, *World Resources, 1994–95 and 1998–99* (New York: Oxford University Press, 1994, 1998); World Bank, *World Development Report, 1992, 2003, and 2009*; United Nations, *Population, Resources, and the Environment*; and World Resources Institute, *World Resources, 2000–2001* (New York: Oxford University Press, 2000). For likely impacts due to global warming, see the references in notes 18, 22, and 28.
 18. An interesting analysis of the market for biomass fuels is Elizabeth M. Remedio and Terrence G. Bensele, "The woodfuel supply system for Cebu City, Philippines: A preliminary analysis," *Philippine Quarterly of Culture and Society* 20 (1992): 157–169. See also World Bank, *World Development Report, 1992*, tab. 1.
 19. For a provocative look at the issue of gender and the environment, see Cecile Jackson, "Doing what comes naturally: Women and environment in development," *World Development* 21 (1993): 1947–1963.
 20. The World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to address the problem of potential global climate change. It is open to all members of the United Nations and WMO. The IPCC won the Nobel Peace Prize in 2007. The impact study referred to in the text is *Fourth Assessment Report: Climate Change, 2007*, available at <http://www.ipcc-wg2.org>. This site also provides links to other IPCC reports on climate change.
 21. *Ibid.*, pp. 13, 435. This assessment has been subject to some debate. Timing and details of rainfall changes remain subject to uncertainty.
 22. The IPCC identifies as at risk the megadeltas of the Huanghe/Yellow (China), Changjiang/Yangtze (China), Pearl (China), Red (Vietnam), Mekong

- (Indochina), Chao Phraya (Thailand), Irrawaddy (Burma), Ganges-Brahmaputra (India and Bangladesh), and Indus (Pakistan) river systems.
23. IPCC, *Fourth Assessment Report*, pp. 479–482. Some crops may show some temporarily increased productivity, but these gains are not expected to last.
 24. See *ibid.* and also Nicholas Stern, *The Stern Review on the Economics of Climate Change*, http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm.
 25. Although climate has changed as drastically in the distant past as that now predicted for the coming century, those past changes unfolded over many thousands or millions of years; see Noah S. Diffenbaugh and Christopher B. Field, “Changes in ecologically critical terrestrial climate conditions,” *Science* 341, No. 6145 (August 2, 2013): 486–492. For details of the NOAA study and recent results of ongoing monitoring see <http://www.noaa.gov>.
 26. World Bank, *World Development Report, 2009*, p. 4.
 27. Stern, *Stern Review*.
 28. See World Bank, *Turn Down the Heat, Why a 4°C Warmer World Must Be Avoided*, 2012, <http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided>; and *Turn Down the Heat II: Climate Extremes, Regional Impacts, and the Case for Resilience*, 2013, <http://documents.worldbank.org/curated/en/2013/06/17862361/turn-down-heat-climate-extremes-regional-impacts-case-resilience-full-report>.
 29. For details, see World Bank, *Turn Down the Heat* reports; World Health Organization, *Climate Change and Human Health*, <http://www.who.int/globalchange/en/index.html>, accessed August 13, 2013; Juliet Eilperin, “Climate shift tied to 150,000 fatalities; most victims are poor, study says,” *Washington Post*, November 17, 2005, p. A20; IPCC, *Fourth Assessment Report*, pp. 446–447; and United Nations Economic and Social Council, Economic Commission for Africa, “State of the environment in Africa,” November 2001, http://www.uneca.org/panafcon/State_Environ_Afri.pdf.
 30. See United Nations Environment Programme, “Sudan: Post-conflict environmental assessment, 2007,” http://sudanreport.unep.ch/UNEP_Sudan.pdf.
 31. Stern, *Stern Review*, pp. 312–322.
 32. See the official REDD Web site at <http://www.un-redd.org>.
 33. See “Adaptation policy frameworks for climate change: Developing strategies, policies and measures: Annexes,” 2010, <http://www.undp.org/gef/documents/publications/apf-annexes-a-b.pdf>. See also World Bank and others, *Economics of Adaptation to Climate Change Social Synthesis Report*, Final Consultation Draft, August 2010, available at <http://siteresources.worldbank.org>. In addition, see Arun Malik and Stephen C. Smith, “Adaptation to climate change in low-income countries: Lessons from current research and needs from future research,” *Climate Change Economics* 3, No. 2 (May 2012). See also Arun Malik, Jonathan Rothbaum, and Stephen C. Smith, “Climate change, uncertainty, and decision-making,” IIEP Working Paper 2010-4, at <http://www.gwu.edu/~iiep/adaptation>.
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38. See Elinor Ostrom, "Beyond markets and states: Polycentric governance of complex economic systems," *American Economic Review* 100 (2010): 641–672, *Understanding Institutional Diversity* (Princeton, N.J.: Princeton University Press, 2005), and *Governing the Commons: Evolution of Institutions for Collective Action* (New York: Cambridge University Press, 1990). See also Jean-Marie Baland and Jean Philippe Plateau, *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* (Rome: United Nations Food and Agricultural Organization, 1996). For a case example of restored cooperative resource management in Tanzania, see Stephen C. Smith, *Ending Global Poverty*, pp. 117–120.
 39. For an excellent overview of global public goods, see Inge Kaul, Isabelle Grunberg, and Marc A. Stern, eds., *Global Public Goods: International Cooperation in the 21st Century* (New York: Oxford University Press, 1999).
 40. See UN-Habitat, *The Challenge of Slums: Global Report on Human Settlements, 2003* (New York: United Nations, 2003).
 41. World Bank, *World Development Report, 1992*, fig. 4. Note that for the most part, the Coase theorem does not apply to these discussions due to the high transaction costs involved.
 42. Ibid.
 43. Ibid., fig. 2.4.
 44. World Bank, *World Development Indicators, 2010* (New York: Oxford University Press, 2010), tab. 1.3 and pp. 20–21. See also United Nations, *Millennium Development Goals Report, 2005* (New York: United Nations, 2005).
 45. Excellent sources of information concerning tropical deforestation drawn on in this section are World Resources Institute, *World Resources, 1994–95*, ch. 7; 2005 *Millennium Ecosystem Assessment*, <http://www.millenniumassessment.org/en/Synthesis.aspx>; Lester Brown, *Eco-Economy: Building an Economy for the Earth* (New York: Norton, 2001); and World Bank, *World Development Report, 1992 and 2003*.
 46. See the FAO's excellent *Global Forest Resources Assessment 2010*, accessed August 12, 2013, at <http://www.fao.org/forestry/fra/fra2010/en>.
 47. United Nations Development Programme et al., *World Resources, 2005*. For an analysis of the effects of changes in economic policies and parameters on deforestation, see Joachim von Amsberg, "Economic parameters of deforestation," *World Bank Economic Review* 12 (1998): 133–153. For more on the Global Environmental Facility, go to <http://www.thegef.org/gef>.
 48. For extensive discussions of public environment policies that in developing countries governments might pursue, see World Bank, *World Development Report, 1992*, chs. 3 and 7; World Resources Institute, *World Resources, 1992–93*, chs. 3 and 14; World Bank, *World Development Report, 2003*; and Stern, *Stern Review*.
 49. An interesting discussion of government policy options in this area can be found in Stephen W. Salant, "The economics of natural resource extraction: A primer for development economists," *World Bank Research Observer* 10 (1995): 93–111.
 50. According to a 2001 UN estimate, annual losses in the developing world due to the lack of access to the goods markets of the developed world were more than double the total amount of aid received in 2000 from all sources. If lack of access to capital and labor markets is also included, losses totaled about \$500 billion.
 51. For more information concerning debt-for-nature swaps, see World Resources Institute, *World Resources, 1992–93*, pp. 122–123 and tab. 20.6. See also Chapter 14.
 52. See World Bank, *Global Development Finance, 1998* (Washington, D.C.: World Bank, 1998).
 53. The reports of the World Resources Institute and its Web site (<http://earthtrends.wri.org>) are excellent sources of data and information on global environmental and resource trends.