CHAPTER ONE

Land Expansion: Drivers, Underlying Factors, and Key Effects

Land acquisition has evolved over time with variations across regions and commodities in the balance between area expansion and intensification, the role of large-scale and small-scale farming, and the resulting social and environmental impacts. To set the context for recent processes of large-scale land acquisition, this chapter discusses three issues.

- It identifies the magnitude and key drivers of demand growth and area expansion in major commodities over the last decade and reviews estimates of how these may evolve in the near and medium terms. Land expansion, much of it through commercial farming in owner-operated units, is not new and is expected to continue. Given their relative land abundance, such land expansion is likely to be concentrated in Sub-Saharan Africa and Latin America and the Caribbean.
- To illustrate how natural endowments (such as climate or terrain), infrastructure, technology, and institutions affected nature and social as well as economic impacts of land expansion across the main regions, it differentiates structural change in the agricultural sector by region and reviews large-scale cultivation trends across regions.
- To provide the basis for assessing social impacts, it reviews key determinants of the structure of agricultural production—particularly the factors determining the competitiveness of owner-operated family farms and large corporate units—and the implications for determining fair land values and integrating large-scale agricultural investment into country strategies.

PAST AND LIKELY FUTURE PATTERNS OF COMMODITY DEMAND AND LAND EXPANSION

To assess whether the drive toward land acquisition seen after the 2008 commodity price spike is a temporary aberration or part of a longer-term pattern, we review patterns of past land expansion and predictions of future demand for commodities as well as land. Expansion of cultivated area is not a new phenomenon and is likely to continue, although the regional emphasis may shift slightly over time.

Past Processes of Land Expansion

Between 1961 and 2007, the area of cultivated land expanded at some 3.8 million hectares per year (ha/year) globally, compared with a total cultivated area of 1,554 million ha in 2007. This increase was unevenly distributed between developed and developing countries, with small declines in industrial and transition economies and an increase of 5.0 million ha/year in developing countries (table 1.1). Regionally, expansion was most pronounced in Sub-Saharan Africa, Latin America and the Caribbean, and East Asia.

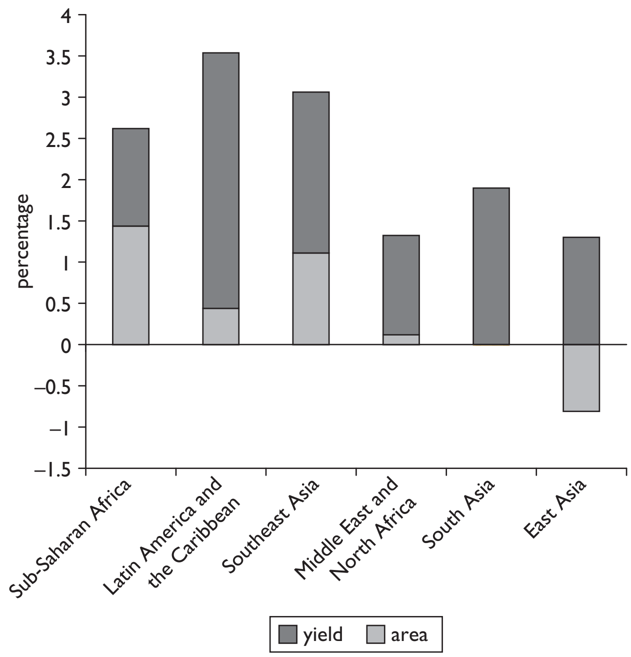
Were it not for advances in productivity, especially the development of land-saving technology, much larger areas would have been brought under cultivation. In fact, 70 percent of the increase in crop production between 1961 and 2005 was due to yield increases, 23 percent to the expansion of arable area, and 8 percent to the intensification of cropping (Bruinsma 2009). Area growth dominated in Sub-Saharan Africa and, though less relevant than yield growth,

Table 1.1 Changes in Arable Area Used for Farming (million ha)

	Total area			Change/a	
Region	**1961–63**	**1989–91**	**2007**	**1961–2007**	**1990–2007**
East Asia	176	223	256	1.7	1.9
Latin America and the Caribbean	104	148	164	1.3	1.0
Middle East and North Africa	86	97	97	0.2	0.0
South Asia	191	204	205	0.3	0.0
Southeast Asia	71	92	103	0.7	0.7
Sub-Saharan Africa	148	179	221	1.5	2.4
Developing countries	704	850	940	5.0	5.3
Industrialized countries	385	395	360	–0.5	–2.1
Transition countries	286	275	254	–0.7	–1.3
World	1,376	1,521	1,554	3.8	1.9

Source: FAOSTAT 2009.

Figure 1.1 Area Expansion and Yield Growth



Source: Authors based on FAO figures.
Note: Data are for 1990–2007.

was also a key factor in Latin America and the Caribbean and Southeast Asia (figure 1.1).

Three factors underpin this expansion of cultivated area:

- Demand for food, feed, pulp, and other industrial raw materials, driven by growth of population and income
- Demand for biofuel feedstocks as a reflection of policies and mandates in key consuming countries
- Shifts of production of bulk commodities to land-abundant regions where land may be cheaper and the scope for productivity growth higher than in traditional producing regions already operating at the productivity frontier.

From 1990 to 2007, growth of harvested area for different crops, which could come about either via substitution for other crops or via expansion into previously uncultivated areas, was narrowly concentrated in a few key commodities (table 1.2). With an increase in harvested area of more than 55 million ha, soybean, rapeseed, sunflower (much of it in large-scale operations) and oil palm (about half under large and half under small-scale operations) accounted for

Table 1.2 Key Commodities Driving Land Use Change, 1990–2007

Commodity	Area 2007	Change 1990–2007	Annual change	% large-scale	Key contributors (% of net increase)[a]
Maize	158	27.3	1.6	52	China (29) United States (29) Brazil (9)
Oil palm	14	7.8	0.5	55	Indonesia (50) Malaysia (26) Nigeria (11)
Rice	156	9.0	0.5	4	Myanmar (38) Thailand (21) Indonesia (18)
Rapeseed	30	12.1	0.7	85	Canada (32) India (15) France (8)
Soybean	90	32.9	1.9	78	Argentina (33) Brazil (28) India (19)
Sunflower	27	4.1	0.2	90	Russian Federation (41) Ukraine (38) Myanmar (10)
Sugarcane	23	5.9	0.3	55	Brazil (47) India (29) China (9)
Plantation forestry	139	37.1	2.5	n.a.	China (35) United States (18) Russian Federation (12)

Source: Authors' tabulations from FAOSTAT 2009. Plantation forestry is from FAO 2007 for the 1990–2005 period. Large-scale is based on authors' classification of the most common production scales in the 20 countries with the fastest expansion.

a. This column refers to net changes in cultivated area of a crop that may be due to substitution for other crops rather than area expansion.

more than half of total growth. Demand for these oil crops grew significantly as a result of higher consumption of cooking oil in developing country markets of Asia, greater use of soybeans as feed, and production of biodiesel in the European Union. More than two-thirds of the increase in soybean area was in Argentina and Brazil, while oil palm expansion was concentrated in Southeast Asia. Rising developing-country incomes increased demand for maize as animal feed in Asia (mainly grown by smallholders) and as an input for bioethanol to satisfy biofuel mandates in the United States. Rice is used mainly for human consumption, with changes in area driven by population growth in Asia, and income growth and urbanization in the Middle East and North Africa. Virtually all of the rice expansion was concentrated in small farms. Pastures, natural or improved, account for 3,400 million ha of land use globally and have expanded at about 2.5 million ha/year between 1990 and 2007, with implications for deforestation, biodiversity, and the global carbon balance.[1]

Rising energy prices and public subsidies and mandates, with second-generation (cellulosic) biofuels still at least a decade away, led to rapid increases in the demand for biofuel feedstock starting in 2003. In 2008, the total area under biofuel crops was estimated at 36 million ha, more than twice the 2004 level, with 8.3 million ha in the European Union (mainly rapeseed), 7.5 million ha in the United States (mainly maize), and 6.4 million ha in Latin America and the Caribbean, mainly sugarcane (UNEP 2009). Experts have long been concerned that, by affecting prices, biofuel mandates will have sizable impacts on land use far beyond the countries where they operate (Renewable Fuels Agency 2008). General equilibrium models that allow for trade, substitution among crops, and land use conversion suggest that biofuel mandates may have large indirect effects on land use change, particularly converting pasture and forest land.[2]

Greater global integration and reduction of trade barriers, together with large preexisting differences in productivity across regions prompted shifts of production toward developing countries. Between 1990 and 2007 soybean yields in Latin America and the Caribbean grew at twice the U.S. rate from a much lower base, prompting much new production to shift to countries in Latin America and the Caribbean. Similarly, for wood and pulp, tree productivity is less than 15 m^3/ha/a in the United States and less than 10 in northern Europe, compared with 45 m^3/ha/a in Brazil, suggesting potential for large future investment in pulp production in the tropics and subtropics.

In addition to food and industrial crops, area used for plantation forestry expanded at some 2.5 million ha/year in 1990–2005. Forest plantations now account for between half and two-thirds (if pulp/fiber is included) of global wood production (Carle and Holmgren 2008) and occupy some 140 million ha globally, 54 percent of it (75 million ha) in developing and transition economies. Developing countries entered the sector late but increased areas dramatically, by 1.5 million ha/a in 1990–2005, to take advantage of high productivity and short production cycles. Some of this expansion has been controversial, as summarized by the characterization of these as "green deserts" with monoculture and limited biodiversity (Cossalter and Pye-Smith 2003). Plantation forestry also expanded in China and in industrial and transition economies where agricultural area declined, partly as marginal lands were removed from agricultural production.

FUTURE DEMAND FOR AGRICULTURAL COMMODITIES AND LAND

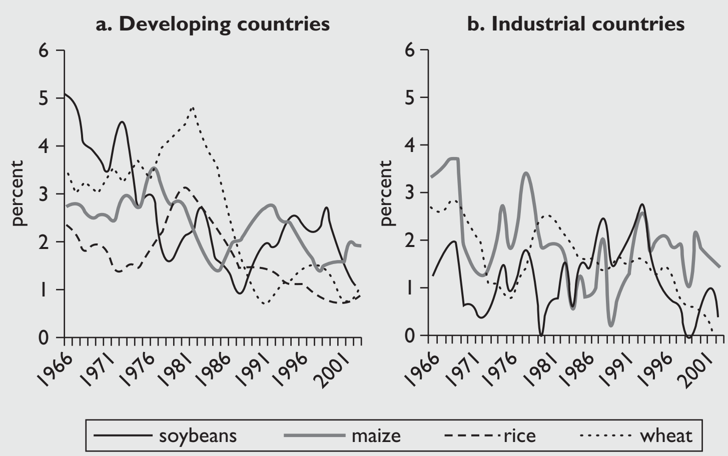
Experts agree that population growth, rising incomes, and urbanization will continue to drive demand growth for some food, especially vegetable oils and livestock, with higher derived demand for feed and for industrial products. To cope with a 40 percent increase in world population, production would need to rise by 70 percent, and raising food consumption to 3,130 kcal/person/day by 2050 would require agricultural production to nearly double in developing countries (Bruinsma 2009). With slower advances in technology and greater resource constraints, especially for water, even conservative estimates suggest that past rates of land conversion will be maintained or exceeded until 2030 (box 1.1). So, the "land rush" is unlikely to slow.

Assumptions about yield growth are critical to assess how demand for commodities relates to land demand. Among the major crops, especially rice and wheat, yield growth has slowed sharply since the 1980s, a result of exhausted

Box 1.1 Are Crop Yields Stagnating?

Much of the concern about producing enough food for the future relates to slower yield growth in the major cereals over the past three decades (World Bank 2009a). The 10-year moving average annual growth rates for wheat and rice yields in developing countries declined from 3 percent to 5 percent in the mid-1980s to 1 percent to 2 percent in this decade (box figure 1.1). The trends for maize and soybean are much less pronounced.

Box Figure 1.1 Yield Growth Rates for Selected Crops in Developing and Industrial Countries, 1996–2001



Source: Authors, based on data from FAOSTAT.
Note: Figures show 10-year moving averages of annual growth rates, estimated by log linear trend regression.

green revolution technology, lower grain prices until 2000, slower growth in research and development (R&D) spending in most countries, and land degradation. With few breakthrough technologies on the horizon, the scope for yield gains over 2005–30 seems lower than in the past.

Irrigation has contributed to past growth in crop yields, but water scarcity is slowing the expansion of irrigation in many regions where water is now a major constraint to production. Large areas of China, South Asia, and the Middle East and North Africa maintain irrigated food production through unsustainable extraction of water from rivers or aquifers. The availability of water in these regions will be further reduced by competition from growing urban populations and industrial sectors. In contrast, Sub-Saharan Africa and Latin America and the Caribbean have large untapped water resources for agriculture. With greater efficiency in water use, global irrigated area could expand by 23 million ha and harvested area by 41 million ha by 2030 (Bruinsma 2009).

Climate change will have profound impacts on agricultural production in several ways. While higher temperatures may allow crop cultivation to expand into areas that have traditionally been too cold for crop cultivation, it is likely to reduce yields in hotter climates. Experts also agree that with climate change extreme weather events are likely to create higher variability of output. Even if, as in many parts of Africa, rainfall remains plentiful, it may be concentrated in shorter time periods, creating a need for infrastructure to minimize runoff and the associated soil erosion and to allow storage of water to extend growing seasons. While likely impacts need to be considered on a country-by-country basis, aggregate impacts could be significant. One study estimates that climate change will reduce irrigated wheat yields in developing countries by as much as 34 percent by 2050 (Nelson and others 2009). The Food and Agriculture Organization of the United Nations (FAO) thus estimates annual yield gains of 0.9 percent for cereals, a decline from 1.5 percent over 1980–2005.

Demand for biofuel feedstocks is a major factor for world agriculture with land conversion for biofuels by 2030 estimated to range between 18 and 44 million ha (Fischer and others 2008). If mandates imposed in many countries are maintained, such demand will be inelastic to oil prices in the medium term until, in a decade or so, second-generation biofuels derived from cellulosic material such as leaves, stalks, and straw become viable.[3] Potential impacts on land use could be large (Searchinger and others 2008). Over 2008–18, biofuel feedstocks may account for 52 percent of the increased demand for maize and wheat, and 32 percent of that for oilseeds (OECD and FAO 2010). Biofuel mandates also drive expansion of sugarcane for ethanol. Brazil processes half its cane into ethanol, and the cane area is expected to double by 2017 (BNDES 2008).

Plantation forestry has been one of the land use categories that has expanded fast over the past decades and is expected to continue doing so in the future. But no study of demand for land includes such plantations. Including projected growth of this land use category of 42–84 million ha (the higher figure based on a continuation of past trends) adds significantly to the total demand for land (Carle and Holmgren 2008).

Without accounting for biofuels and forest plantations, or trade and price effects, FAO projections suggest that for 2010–30, after adjusting for increases in cropping intensity, 47 million ha of land will be brought into production globally—a decrease of 27 million in developed countries and transition economies and an increase of 74 million in developing countries. This translates to an annual increase of 1.8 million ha for food and feed only.

Computable general equilibrium (CGE) models allow for adjustments to prices and trade that induce land supply in regions where land is fairly abundant (Keeney and Hertel 2009). Such adjustments increase the estimates, with projected annual land use changes ranging from 4.5 million ha (Fischer and others 2008) to 10 million ha (Al-Riffai and others 2010) or even 12 million ha (Eickhout and others 2009), highlighting the conservative nature of FAO estimates. Plantation forestry could add some 1.5 million ha/year, although part of the required land does not compete with crop uses.

In sum, a conservative estimate is that 6 million ha/year of additional land will be brought into production through 2030, implying a total land expansion of 120 million ha. Projections that allow for trade and price changes can be much larger, with total area increases of up to 240 million ha over the period. The fact that land use is in decline in developed and transition economies implies that more area expansion will shift to developing countries. As land that may be used for expansion is not equally distributed, some two-thirds of land expansion in developing countries is likely to be in Latin America and the Caribbean and in Sub-Saharan Africa.

LESSONS FROM PAST PROCESSES OF LAND EXPANSION: REGIONAL PERSPECTIVES

In each of the world's major regions, area expansion happened in a variety of historical contexts, driven by different actors and with social and environmental impacts profoundly affected by public policies. A review of key factors and differences across regions and commodities helps identify issues deserving attention. It can be useful to help countries where such demand is only now materializing to be aware of some of the pitfalls and ideally take measures to avoid them.

Latin America: Missed Opportunities for Poverty Reduction and Environmental Challenges

Following the liberalization of markets and trade in the 1980s, relatively land-abundant countries in Latin America—including Argentina, Brazil, Paraguay, and Uruguay—capitalized on growing global demand to increase their position in world markets. Higher prices, improved technology, and lower transport costs pushed out the land frontier. Soybean production increased from 33 million tons (t) to 116 million t from 1990 to 2008, making Latin America the world's largest soybean exporter. Beef, sugarcane, and plantation forestry also occupy an important position.

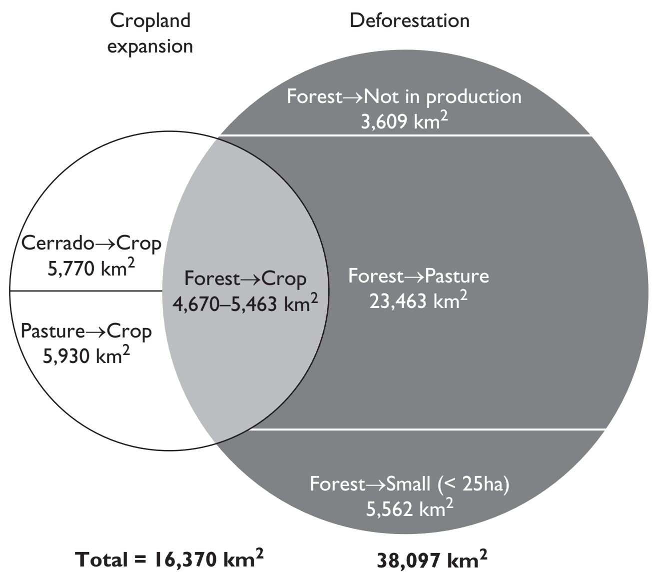
Over the past two decades, Brazil's *cerrado* experienced the world's fastest expansion of the agricultural frontier (World Bank 2009a).[4] Largely uncultivated until the 1970s, it now accounts for more than half of Brazil's soybean area, making it the world's second-largest soybean exporter after the United States. A key factor was technology, particularly the development of varieties suited to the cerrado's low latitudes and acid soils and wide adoption of conservation tillage, which sharply reduced costs. Significant expansion has also taken place in the Argentine *Pampas* as zero tillage and herbicide-tolerant and pest-resistant varieties increased the profitability of soybeans, which then substituted for other crops and pasture. Though concerns have been expressed about the contribution of soybean cultivation to the clearing of the dry topical forests of the cerrado, there is little evidence that such cultivation directly pushed into areas of the Amazon biome on a significant scale.

But rapid agricultural growth has also not always translated into positive social impacts. Land policy failures and large-scale programs of subsidized credit for large farmers at negative interest rates led to mechanized rather than labor-intensive production (Rezende 2005). Employment generation and poverty impacts thus remained far below potential (World Bank 2009a). The exit of small farms contributes to a continued concentration of farm operations with average farm sizes of more than 1,000 ha. A main reason small farmers lost their land is that land records were poor and the protection of land rights limited, leading many to argue that development of the cerrado region, although successful commercially, missed opportunities for social development. To address this problem, Brazil initiated efforts to regularize land tenure and better protect natural areas.

Brazil is the world's largest meat exporter with exports, mostly for beef or chicken, increasing from US$600 million to US$11 billion between 1990 and 2007. The expansion has been fastest in the Amazon, where the cattle population more than doubled from 1990 to 2006 and the pasture area expanded by 24 million ha (Pacheco 2009). But this expansion has come at the expense of tropical forests, with negative social and environmental impacts. Pasture expansion is the most important cause of deforestation, accounting for about two-thirds of the Amazon's forest loss (Pacheco 2009). Based on satellite imagery, Figure 1.2 summarizes key changes in forest and cerrado areas in the state of Mato Grosso between 2001 and 2004 (Morton and others 2006):

- About 2.7 million ha (27,000 km^2) of forest was converted to pasture or abandoned, pointing to low efficiency in the use of forest resources.
- About 1.0 million ha (10,000 km^2) of forest was converted to cropland, with mechanized large farms and small farms each accounting for about half of observed forest loss.

Figure 1.2 Cropland Expansion, Deforestation in Mato Grosso, Brazil 2001–04



Source: Morton and others 2006.

- About 1.1 million ha (11,000 km^2) was brought under crop production from cerrado or degraded pasture that had previously been converted.

A key factor for expanding cattle ranching was policies requiring "productive use" of land to claim ownership. Together with weak institutions and gaps in governance of forest resources and the protection of indigenous peoples' rights, these policies contributed significantly to deforestation (Fearnside 2001). Due to its low fertility, most land was quickly converted into low-grade pastures for cattle ranching or even abandoned, implying that long-term impacts on output or welfare remained limited.

Building on more than 30 years of research and a proactive policy to promote sugarcane, Brazil also developed an advanced sugarcane industry to produce sugar and ethanol, producing 20 percent of the world's sugar and 34 percent of its ethanol in 2005 and accounting for 38 percent of world trade in sugar and 74 percent of world trade in ethanol. In addition to low production cost for sugarcane, the high concentration of sucrose in Brazilian varieties (14 percent) contributes to its competitiveness and has made it one of the lowest-cost global producers.

The expansion of sugarcane suggests that increased productivity can mitigate the environmental effects of agricultural expansion. About two-thirds of the area into which sugarcane expanded has been from converting pastureland, 32 percent from substituting other crops, and only 2 percent from converting natural vegetation. Rapid gains in productivity in both sugarcane and pastures reduced the indirect effects on land expansion, although the resulting higher price of land has probably put pressure on pasture expansion further north to the cerrado and the Amazon biome.

Investments to establish fast-growing plantation forestry on vast expanses of land led to major shifts in land use in some countries. In Brazil, private R&D investment that tripled the productivity of eucalyptus over the past 30 years was a key to developing a competitive industry (Bacha 2008; Doughty 2000). Benefiting from substantial technology transfers from Brazil and international companies, Uruguay started to develop an export-oriented pulp industry in 1990. Targeted subsidies to convert poor quality pasturelands expanded the area under plantation forest from 97,000 ha to 751,000 ha between 1990 and 2005 (Morales Olmos 2007).

Public and private sector players in the region now recognize that agricultural investment and expansion pose serious environmental challenges. They have taken action to reduce detrimental impacts, including better delineating protected areas, using satellite-based technology to monitor deforestation in real time, and prosecuting violators (de Souza and others 2010). The Brazilian government is increasingly using financial incentives, such as the barring of individuals who do not comply with legal requirements (in maintaining minimum levels of forested areas on their property, for example) from access to state-supported credit. It has also initiated a zoning exercise to limit negative environmental impacts of sugarcane and other crops by limiting areas into which these crops can expand. Other initiatives, such as the Roundtable on Responsible Soy and an industry-led boycott on beef from recently deforested pasture, also point toward increased awareness by the private sector of the reputational risks in contributing to unsustainable outcomes. While their impact remains to be seen, they could hold lessons for other regions.

Southeast Asia: Tropical Deforestation with Diverse Social Impacts

Oil palm is regarded as one of the most profitable land uses in the humid tropics (Butler and Laurance 2009). It is highly labor intensive, providing scope for employment generation and positive social impact although this potential was not always achieved and environmental impacts were often negative. The crop expanded rapidly in Indonesia and Malaysia in response to growing global demand for edible oils and strong government support.[5] Malaysia pioneered the commercial oil palm industry (Martin 2003; Rasiah

2006). With rising land and labor costs, the industry moved to neighboring Indonesia, which at 16.9 million tons (Mt) in 2008 is now the world's largest producer, slightly ahead of Malaysia (15.8 Mt), with Malaysia and Indonesia now accounting for 85 percent of global palm oil production. Planted area in Indonesia more than doubled between 1997 and 2007, from about 2.9 million ha to 6.3 million ha. Given the processing requirements and the rapid deterioration of harvested fruit, large-scale production close to the processing unit, often complemented by outgrower schemes, is the norm (see chapter 3). There has also been a strong trend toward vertical integration with refining oil and manufacturing palm oil and palm kernel oil products.

While large units dominate, Indonesia's smallholders account for about a third of production. Average income from oil palm cultivation is much higher than from subsistence farming or competing cash crops (Rist and others 2010). Given the high labor requirements, oil palm expansion in Indonesia helped to significantly reduce poverty with estimates of employment in the oil palm sector ranging from 1.7 million to 3.0 million. Poor planting material, limited access to finance and a noncompetitive market for fresh fruit gives mills considerable market power. This limits smallholder's ability to be successful on their own and implies that most are in formal partnerships with oil palm companies through nucleus estate schemes.

A major social issue in oil palm development is the frequent failure to recognize local land rights. Improving the clarity of rights would allow local people more say in negotiating the terms for making their land available for oil palm—and reduce the costs for companies. Social conflict surrounding oil palm expansion also derives from opaque or poorly understood contractual agreements, lack of consultation, and limited benefit-sharing with local communities (World Bank 2009b). Contracts are often unclear on the terms for transferring land, remunerating outgrowers, and employing local people (Colchester and others 2006). Smallholder associations, greater clarity, and avenues for conflict resolution, could help address these problems.

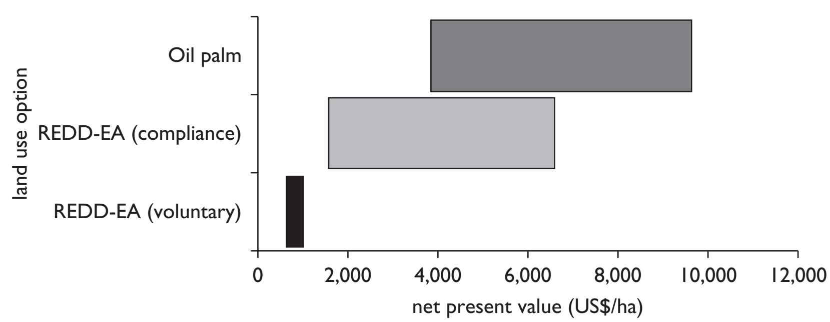
The oil palm sector has also been criticized for being a major contributor to deforestation and greenhouse gas emissions. Oil palm plantations harbor less biodiversity than natural forests, fail to provide the same environmental services (carbon storage, forest products, soil fertility), and may force smallholders to give up subsistence production and rely on food from the market. Some 70 percent of Indonesia's oil palm plantations (4.2 million ha) are on land previously part of the forest estate; and 56 percent of expansion between 1990 and 2005 was at the expense of natural forests (Koh and Wilcove 2008). To help expand production, the government provided land, in many cases still forested, almost for free, within a legal framework that did not recognize local land rights (Barr and others 2010). Timber sales were expected to finance planting and oil palm establishment. But many companies allegedly use fictitious palm oil schemes to obtain logging licenses without ever establishing oil palm estates. By some estimates up to

12 million ha have been allocated to oil palm and deforested but not planted (Fargione and others 2008).

Approximately 25 percent of oil palm is estimated to have been established on peat. Developing oil palm on peat land causes irreversible damage to vulnerable ecosystems and high levels of carbon emissions; it also requires high levels of management skill to be sustainable. Land use change and deforestation are the largest single contributors to Indonesia's greenhouse gas emissions of 1.7 million Gt in 2007. Studies of the value of carbon stocks in Indonesian forests suggest that payments through programs under the REDD (Reducing Emissions from Deforestation and Forest Degradation) umbrella will be well below the US$22/t at which they could compete with returns from oil palm (figure 1.3). Environmental costs can, however, be reduced, by developing oil palm on *Imperata* grasslands (*alang-alang*) usually portrayed as unproductive wasteland.

At more than 20 million ha, the amount of such land available is well above the 10–20 million ha expected to be needed to meet oil palm demand for the next decade and beyond. Costs of establishing oil palm on these lands are much lower than on secondary forests, and yields are indistinguishable from those on forest land (Fairhurst and McLaughlin 2009). However, as local people and communities may already use degraded lands, bringing these into production will require recognizing such rights and negotiating and sharing benefits with local people. Nongovernmental organizations (NGOs) are implementing demonstration activities that can provide important lessons. For example, the World Resources Institute is conducting community mapping to identify degraded land of interest for oil palm development that could be swapped for planned expansion in forest areas.

Figure 1.3 Range of Returns to Oil Palm and Potential REDD Payments for Forest Conservation in Indonesia



Source: Authors based on Butler and Laurance 2009.
Note: "Compliance" is based on mandated carbon emission reduction in Europe. "Voluntary" is based on voluntary participation in carbon markets, such as the Chicago Board of Trade.

Given the controversies surrounding oil palm, especially the threat to tropical forests, the industry initiated the Roundtable on Sustainable Palm Oil in 2004 to develop and implement palm oil certification. In principle, certification criteria require recognition of local land rights, especially those of local communities, and (since November 2005) ban plantings that "replace primary forest or any area containing one or more High Conservation Values." But applying these criteria to actual operations has been difficult and controversial. Moreover, only 1.6 Mt (4 percent of global production) was certified by April 2009, and demand for certified oil has been slow to develop.

Rubber, although originally grown on large plantations in humid forest areas of Southeast Asia that also suffered from deforestation and neglect of local rights, provides an interesting contrast. Improved clones, techniques suited to smallholder production and processing, and rising labor and land costs led to the rapid expansion of smallholder production. Farms of 2–3 ha make up 80 percent of world rubber production (Hayami 2009). Smallholders in Indonesia produce rubber in diverse natural or improved agro-forestry systems that maintain carbon stocks and species richness. While returns from such systems are lower than those from monocultures, reduced risk and lower initial capital costs more than compensate, and efforts are under way to certify rubber from these systems to obtain a price premium.

Rice, with some additional 10 million ha of cultivated area since 1990, accounted for by far the largest expansion of cultivated area in Southeast Asia and is grown almost entirely by small farmers, in many cases with strong impacts on poverty reduction. For example in Thailand, institutional support through research, extension, credit, and producer organizations was critical in engaging smallholders. In response to land conflicts in the 1970s, a land titling program was initiated to provide tenure security and allow land markets to develop. Until 2004, this program issued 12 million out of a total of 26 million titles countrywide. Thailand also became a major exporter of other commodities (sugar, cassava, maize) in similar smallholder expansions driven by the following:

- Availability of previously uncultivated land, combined with land policies that allowed farmers to expand cultivated area rapidly in response to market opportunities
- Improved agricultural technologies, such as short-duration cassava varieties and improved soil management practices
- Government investment in rail and road infrastructure to reduce the cost of market access
- An undistorted policy environment and supportive investment climate for a rapid supply response by the private sector to market signals (World Bank 2008).

Sub-Saharan Africa: Policy Distortions and Disappointing Performance of Large-Scale Farming

Until the late 1980s, almost all Sub-Saharan African countries had policies that strongly discriminated against agriculture. Overvalued exchange rates lowered real agricultural prices while producer prices of agricultural commodities were suppressed through controlled procurement prices and high export taxes. In the 1980s, net taxation of the sector averaged 29 percent but stood at 46 percent for exportables (World Bank 2009a). At the same time, public expenditure in agriculture fell below 4 percent of national budgets, affecting in particular spending on infrastructure and research. These policies discouraged investment by local farmers and outsiders alike.

After 1990, most Sub-Saharan African countries moved to market-determined exchange rates and open trade regimes. Net taxation of agriculture decreased (though it still exists for export crops), and lower inflation and real interest rates now create a more favorable environment for agricultural investment, especially to the extent that institutional reforms to secure property rights, reduce red tape, and combat corruption were implemented. Several countries have reformed their land laws to protect customary rights, increase incentives for land-related investment, and make land transfers easier. While growth in the sector responded positively, gaps in infrastructure and markets as well as the time required to strengthen property rights and other institutions continue to constrain investment and market development. Most production growth is thus still based largely on land expansion (Fuglie 2008).

Policy bias greatly reduced Sub-Saharan Africa's attractiveness for investment so that, despite relative land abundance, expansion was mainly driven by population growth to provide food to subsistence producers and growing urban populations. Coarse grains, oilseeds, and pulses account for some 90 percent of land expansion since 1990, reflecting slow adoption of improved technology so that increasing food production still depends on area expansion rather than increasing yields. With few exceptions, almost all the expansion has been through smallholders. Little commercial agriculture has taken hold, though experts generally agree that there is large untapped potential.

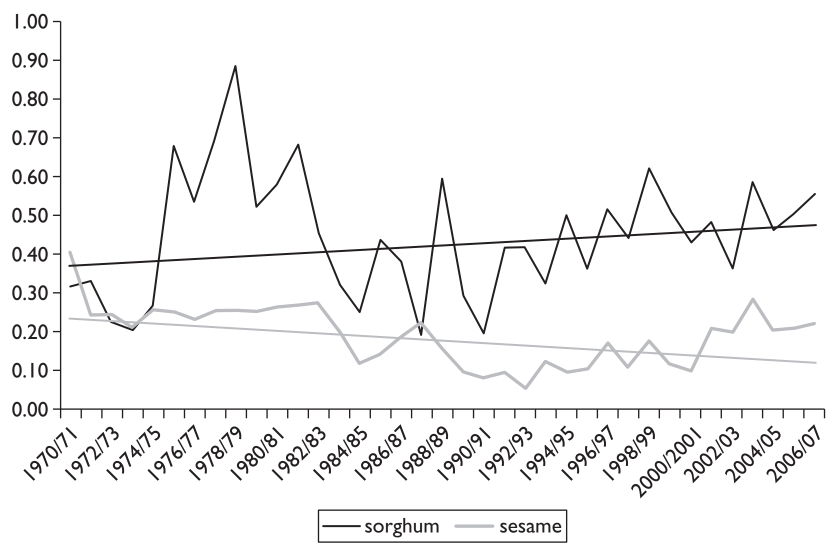
Where large-scale land acquisition has taken place, experience has not been encouraging: Semi-mechanized sorghum and sesame production in Sudan, which captured investor attention some decades ago, illustrates the risks of large-scale farming and holds lessons for current investors. The scheme expanded rapidly in the 1970s when financing from the Gulf aimed to transform Sudan into a regional breadbasket through favorable access to land and subsidized credit for machinery. It attracted civil servants and businessmen who mostly hired managers for farms 1,000 ha or larger. Existing land rights were neglected on a large scale: while official statistics indicate that some 5.5 million ha were "officially" converted to arable land under the scheme, up to 11 million ha were informally encroached upon (Government of Sudan 2009; UNEP 2007).

Partly because of the resulting tenure insecurity, most of Sudan's semi-mechanized farms rely on low-level technology. Limited use of fertilizer, rotations, or livestock to maintain fertility points to soil mining in a system neither ecologically sustainable nor economically competitive. In an agro-ecological environment comparable to Australia, where yields are 4 t/ha, sorghum yields are only 0.5 t/ha and have been stagnant or declining (figure 1.4). Land rights of traditional users, both small-scale farmers and pastoralists, have been neglected, and encroachment by mechanized farms has contributed to serious conflict (Johnson 2003). Natural vegetation has been destroyed, land degraded, and farms have been abandoned. Land access is a key contributor to broader conflict (Pantuliano 2007).[6]

As there are many parallels to recent expansion of large-scale mechanized farming in Sudan and neighboring countries such as Ethiopia, the lessons from semi-mechanized farming in Sudan could be of wider relevance. With improved technology and farming systems, production could be competitive internationally. But unlocking the agro-ecological potential would require investment in adaptive research and extension, combined with institutional reforms, to provide incentives for sustainably managing land, resolving-conflict, and protecting traditional land users' rights (Government of Sudan 2009).

Large-scale production of low-value bulk commodities in other parts of Sub-Saharan Africa has often been unsuccessful. Efforts to introduce mechanized

Figure 1.4 Yields on Semi-Mechanized Farms, Sudan, 1970–2007 (t/ha)



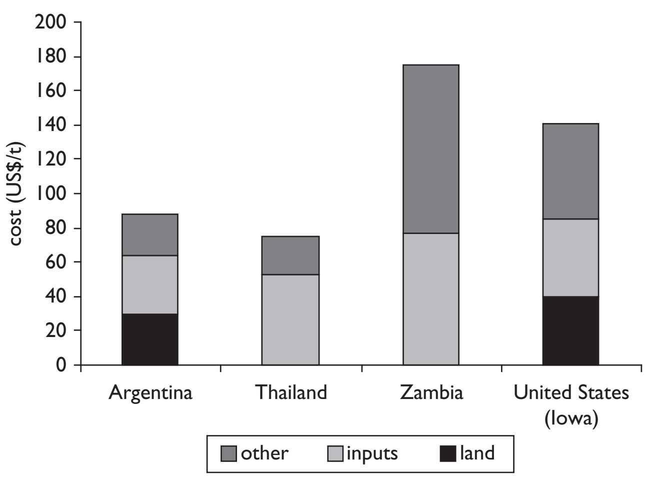
Source: Authors based on Government of Sudan 2009 and official statistics.
Note: Yields are for rainfed production. Dashed lines indicate trends.

rainfed wheat in Tanzania on some 40,000 ha of land that were previously prime grazing grounds for pastoralists illustrate the challenges. Pastoralists tried to use litigation to force a benefit-sharing agreement with wheat farmers, with limited success. After a US$45 million investment, production became only marginally profitable financially, without accounting for the social cost associated with the loss of livelihoods and increased land conflicts. Wheat cultivation was ultimately deemed unprofitable, and production has been declining (Lane and Pretty 1991; Rogers 2004). Similarly, Nigeria's large-scale mechanized irrigated wheat schemes of the 1970s and 1980s have largely been abandoned (Andrae and Beckman 1985).

Maize is Sub-Saharan Africa's most important food crop, and although largely produced by smallholders, large-scale production was attempted throughout the colonial period. Yields on large-scale Sub-Saharan African farms are comparable to or higher than those in Brazil and Thailand. But despite negligible or zero payments for land, production costs in Sub-Saharan Africa are as much as twice those in Brazil and Thailand (figure 1.5). Although maize is competitive with imports in Cameroon, Ghana, and Zambia, it is not competitive as an export because of high transport costs (including unofficial fees). In Zambia, large farms produce at a cost twice the world market price and only the protection provided by high transport costs allows them to turn a modest profit. For rice in Ghana, semi-mechanized, large-scale production could be competitive with imports only if milling rates improve (Winter-Nelson and Aggrey-Finn 2008).

Recently, a surge in demand for sugar and biofuels sparked great interest in sugarcane, either to supply protected and subsidized European markets, as in

Figure 1.5 Maize Production Costs by Country



Source: Figures are from Agri Benchmark and World Bank 2009a.

Malawi, South Africa, Swaziland, Zambia, and Zimbabwe, or to benefit from domestic subsidies, as in Sudan. Given the distorted environment the industry's competitiveness is doubtful, especially in view of low processing efficiency and high transport costs (Mitchell 2010). Jatropha, a shrub whose fruits can be used to produce oil for biofuels, has also attracted large-scale investments in Sub-Saharan Africa, partly due to European Union trade preferences. Initial experience failed to meet expectations and lower crude oil prices forced many newly established enterprises to exit the industry. Lack of research on appropriate varieties, management practices, and technologies for oil extraction leaves economic viability and production parameters uncertain (Global Exchange for Social Investment 2008). Jatropha can be a viable fuel substitute in countries or regions with low wage rates and high fuel costs (say, because they are landlocked) (Mitchell 2010). Still, it remains a risky investment.

Production of high-value export crops has resulted in some marked successes. Factors conducive to this were an ideal agro-ecological setting, low if any compensation for land, and cheap labor (Poulton and others 2008). These natural advantages offset a lack of technology, weak institutions, high transport costs, and ill-functioning markets for outputs, inputs, and capital. Indeed, poor infrastructure and the difficulty of assembling sufficient volumes continue to limit the potential for bulk commodity exports from many Sub-Saharan African countries. However, these successes were limited almost exclusively to export crops where values above US$500/t allowed to compensate for high transport and marketing costs.

Experts agree that Sub-Saharan Africa's fairly plentiful endowment of water and land imply that a better policy environment and business climate would create considerable scope to profitably produce bulk commodities. Infrastructure constraints imply that, initially, supply would be limited to domestic and regional markets, worth some US$50 billion a year, which could then provide a springboard for global exports. Investors will need to work with local communities to engage smallholders. And if farming is large-scale, attention needs to be given to the rights of local land users. While still at an early stage, experiences with productive partnerships and between large operations and local smallholders that have been initiated by a number of investors recently could provide valuable lessons and help identify good practice.

Eastern Europe and Central Asia: The Rise of Superfarms

Eastern European countries have undergone major transitions from the former Soviet system of collective and state farms to new agrarian structures. These transitions have unfolded in many ways, depending on countries' factor endowment, the share of agriculture in the overall labor force, infrastructure, and the way the reforms were implemented (Swinnen 2009). In areas of low population density, where collectives were divided into small plots allocated to members, the plots were quickly rented back by companies with access to finance and machinery. These companies were often created from former collective farms whose managers could more easily consolidate land parcels and shares. Services, institutions, and logistics were geared to large-scale production, so smallholder grain production was never a viable option. Where farms were land- and capital-intensive, corporate farming was the dominant organizational structure. On the other hand, many countries where land was split up into smallholder farms also performed well. The diversity is illustrated by the share of area under corporate farms 10 years after the transition, ranging from 90 percent in the Slovak Republic, 60 percent in Kazakhstan, 45 percent in the Russian Federation, to less than 10 percent in Albania, Latvia, and Slovenia (Swinnen 2009).

In Kazakhstan, Russia, and Ukraine, the transition was associated with a 30 million ha decline in area sown, with most of that area returning to pastures or fallow. Large farms were better able to deal with the prevailing financing, infrastructure, and technology constraints. Aided by the phasing out of an inefficient meat industry and the associated demand for grain as feed, the region turned from a grain deficit of 34 Mt in the late 1980s to exports of more than 50 Mt of grain and 7 Mt of oilseeds and derivatives (Liefert and others 2009). In light of the scope for transfer of available technology, Kazakhstan, Russia, and Ukraine, the region's three land-abundant countries, have an opportunity to establish themselves as major players in global grain markets, especially if ways to effectively deal with volatility are found.

Given the slow development of markets, mergers to integrate vertically to help acquire inputs and market outputs led to the emergence of some very large companies. For example, in Russia, the 30 largest holdings farm 6.7 million ha, and in Ukraine, the largest 40 control 4 million to 4.5 million ha (Agri Benchmark 2008; Lissitsa 2010). Many of the agricultural companies are home grown, though often with significant investment from abroad. Several have issued initial public offerings (IPOs). Some Western European companies have also invested directly in large-scale farming in the region. For example, Black Earth, a Swedish company, farms more than 300,000 ha in Russia.

With greater demand and better logistics, there remains substantial potential for intensification and, in some cases, for area expansion. Cereal yields increased 38 percent from 1998–2000 to 2006–08 but are still far below potential. For example, Ukraine's cereal yields are 2.7 t/ha, some 40 percent of the Western European average. The potential to transfer technology and relatively cheap land has been one of the major motivations for foreign direct investment in the region.

In Russia, land is either leased or owned, and in Ukraine (where private land sales are not allowed), all land is leased, usually for 5 years to 25 years. But throughout the region, land rents are still very low relative to land of comparable quality in other parts of Europe. Competitive markets for land shares have yet to emerge, and in many situations imperfections in financial and output markets preclude owner-cultivation as a viable option. So the bargaining power of land owners is often weak, suggesting that rental rates are low and that owners receive few of the benefits from large-scale cultivation.

FACTORS AFFECTING THE ORGANIZATION OF AGRICULTURAL PRODUCTION

To understand factors that may promote or constrain the expansion of area under cultivation and the potential impact of such expansion, it will be useful to discuss how such production is organized and how it has evolved over time.

Why Agricultural Production Is Dominated by Family-Owned and Operated Farms

In most countries, both rich and poor, the average farm size is quite small. The industry is dominated by owner-operated family units that combine ownership of the main means of production with management (table 1.3). The main reason is that, unlike marketing, agricultural production has few technical (dis) economies of scale, implying that a range of production forms can coexist. In contrast, processing and distribution are characterized by significant economies of scale that have given rise to consolidation and often high levels of industry concentration.

Agricultural production, in contrast, is generally in owner-operated farms that are small by comparison. The main reason is the spatial dispersion of production, which requires flexibility and an ability to quickly adjust to microvariations in climate or soil conditions. As residual claimants to profit, family workers will be more likely to adjust and work hard than wage workers, who have an incentive to shirk and require costly supervision. Unless they

Table 1.3 Mean Farm Sizes and Operational Holding Sizes Worldwide

Region	Mean size (ha)	% < 2 ha	Gini coefficient
Central America	10.7	63	0.75
East Asia	1	79	0.5
Europe	32.3	30	0.6
South America	111.7	36	0.9
South Asia	1.4	78	0.54
Southeast Asia	1.8	57	0.6
Sub-Saharan Africa	2.4	69	0.49
United States	178.4	4	0.78
West Asia and North Africa	4.9	65	0.7

Source: Based on Eastwood and others 2010.

are disadvantaged by policy distortions in favor of large farms (Binswanger, Deininger, and Feder 1995), they will produce more efficiently than wage labor–based operations, which need to spend resources supervising workers (Allen and Lueck 1998; Binswanger and Deininger 1997; Lipton 2009).

A look at the 300 or so publicly listed companies in table 1.4 illustrates this point: Even though farming accounts for 22 percent of the global agricultural value chain, it makes up less than 1 percent of market capitalization. The main reason is the industry's dispersion: with average farm sizes of less than 1,000 ha in the United States and Europe, gaining the scale for a public listing is difficult. As of October 2009, there were only seven publicly listed farming companies worldwide, three in Brazil and Argentina and four in Ukraine and Russia.

Three factors are critical determinants of the evolution of the structure of agricultural production over time: access to credit and insurance; lumpy inputs, such as machinery and skills; and the nonagricultural wage rate. Although small agricultural operations have advantages in accessing labor and local knowledge, in many cases they have difficulty acquiring capital. The high transaction costs of providing formal credit in rural markets mean that the unit costs of borrowing and lending decline with loan size and bias lending against small farmers. Raising interest rates on small loans does not overcome this problem, as it will lead to adverse selection (Stiglitz and Weiss 1981). Moreover, as formally titled land is ideal collateral, the cost of borrowing in the formal credit market will be a declining function of the amount of formally owned land, conferring an additional advantage on borrowers who formally own larger amounts of land. Unless ways are found to provide small farmers with access to finance (through, for example, credit cooperatives), their inability to obtain financing may outweigh any supervision cost advantages they have, thus linking size and efficiency (Chavas 2001).

Table 1.4 Publicly Listed Companies in Agribusiness Value Chains

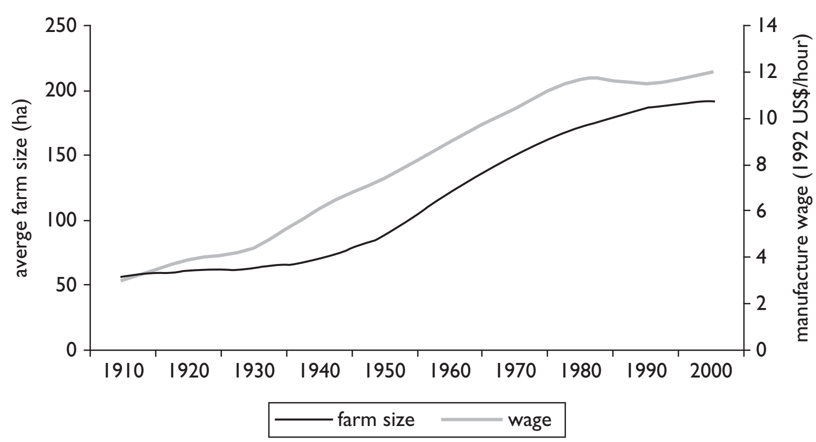
Item	Global age. value chain (%)	Number of companies	Market cap (%)
Suppliers	22.7	103	39.6
Farming	22.2	7	0.2
Processing	14.8	60	9.7
Logistics	14.7	26	9.7
Packing and distribution	25.6	88	36.8
Integrated	n.a.	16	4
Total	**100**	**300**	**100**

Source: Own computation based on Brookfield 2010.
Note: Global market capitalization is in US$ millions as of October 2009. n.a. = not applicable.

Machinery such as threshers, tractors, and combine harvesters may reach their lowest cost of operation per unit area at a scale larger than the average size of operational holdings. If farms were to rely only on their own machinery, this could produce economies of scale and increase the optimum operational farm size. But machine rental can help small farms use large machinery, circumventing this constraint for all but the most time-bound operations.[7] A second indivisible factor is operators' ability to acquire and process information. This factor, which assumes greater importance with more advanced technology, gives managers with formal schooling and technical education a competitive edge and increases the size of the holdings they manage. It is particularly important for new crops, in which managers skilled in modern methods may enjoy a large advantage (Collier and Dercon 2009; Feder and Slade 1985). Over time, part of this advantage may dissipate, especially if technology is scale-neutral and, aided by public provision of extension services or farmer associations, spreads to small farmers.

Rising wages in the nonagricultural sector will lead farm operators to seek ways to attain incomes comparable to what they can obtain in other sectors of the economy (Eastwood and others 2010). Normally this implies substitution of capital for labor and an increase of farm sizes over time in line with wage rates. As figure 1.6 illustrates, both variables moved together closely in the United States for most of the 20th century, suggesting that the desire to obtain a comparable nonagricultural income was the main factor driving changes in the average size of operational holdings (Gardner 2002). Of course, even large farms are mostly owner-operated rather than company-owned.

Figure 1.6 Evolution of United States' Farm Size and Nonfarm Manufacturing Wage



Source: Based on Gardner 2002.

Why Do Large Farms Emerge?

An important exception to the superior performance of owner-operated units of production over those relying on wage labor is in plantation crops, where economies of scale in processing and the need for close coordination with processing make plantations more efficient. The need for quick processing of produce to avoid deterioration, often within 24 hours to 48 hours, requires tight adherence to delivery and harvesting schedules (Binswanger and Rosenzweig 1986). The perishable nature of these crops and the sensitivity of the timing between harvesting and processing transmit economies of scale in processing to the production stage. The potential loss of quality in unprocessed sugarcane due to fermentation, together with high sensitivity of total cost to the cost of transport, requires that production be not only tightly coordinated but also spatially concentrated close to a processing plant. This need usually prompts sugar factories to run their own plantations to ensure at least a base load for processing. In densely populated areas in India and Thailand, for example, mills contract with outgrowers to deliver their cane to the mill and determine which farmers receive technical advice and inputs from the firm.

The advantage of large production of plantation crops is consistent with the fact that firms in the sugar and oil palm sectors, many of them based in developing countries, manage production on enormous areas. For example, Cosan, one of the largest sugar-ethanol producers in Brazil, manages more than 600,000 ha, about half of it on land it owns (the rest is produced by outgrowers). Operational size in the oil palm sector, which includes 8 of the 25 largest agricultural production companies in the world, is also very high. Several large oil palm companies manage plantations of 200,000 ha or more. Although large firms' ability to raise large amounts of capital provides them with significant advantages in establishing plantations in areas of low population density, in-migration, together with family labor's higher incentives, has, in situations with high population growth, led to the gradual replacement of plantations with smallholder production (Hayami 2010), contrary to what is generally observed in annual crops.

A general trend toward larger operational units in developed countries is underpinned by recent innovations in breeding, zero tillage, and information technology that make supervision easier. By facilitating standardization, they allow supervision of operations over large spaces, reducing owner-operator advantages. Pest-resistant and herbicide-tolerant varieties reduce the number of steps in the production process and the labor intensity of cultivation. The scope for substituting information technology and remotely sensed information on field conditions for personal observation to make decisions increases managers' span of control. Also, importing countries' increasingly stringent requirements on product quality and food safety throughout the supply chain increase the advantages of large-scale production and an integrated supply chain. Establishing such a supply chain can be more difficult under smallholder production models, as illustrated by the challenges encountered by the Roundtable on Sustainable Palm Oil in certifying smallholders.

The superior ability of large companies to overcome market imperfections further up in the supply chain can also provide them with a competitive advantage in production, especially if other markets do not function well. This can happen through several channels:

- First, large firms may be able to access global financial markets where funds can often be obtained at much lower cost than in domestic ones. This was important in Argentina during the period of financial repression and continues to be relevant in settings requiring high investments, either to establish new plantations or to make degraded land productive. In addition, as markets for agricultural inputs and outputs often are highly concentrated, large operators are reported to be able to reduce cost on either side of the market by 10–20 percent, giving them an edge in highly competitive global markets (Manciana, Trucco, and Pineiro 2009).
- Second, diversification across space can allow large companies to self-insure, thereby generating opportunities to overcome the difficulties for establishing crop insurance created by covariance of risks. This ability could allow large companies to expand strategically by acquiring assets at relatively low prices in periods of climatic or other distress.
- Third, large firms can substitute for gaps in public services (in transport and logistics or in applied R&D, for example). In Brazil and Ukraine, a number of large companies have constructed their own port terminals for export, shielding them from the limitations imposed by public facilities. Poor integration of agricultural markets across Africa is reported to provide business opportunities for large vertically integrated producers that can operate across many countries. High fixed costs of R&D and significantly reduced public funding for it have stimulated research by private firms, for example, in plantation forestry or oil palm.

Even in production of annual crops, a combination of technical change favoring mechanization and more stringent phytosanitary standards by importing countries, together with large farms and a superior ability to overcome market imperfections, can favor large operations in some contexts. In Ukraine, 85 agriholdings together operate more than 6 million ha of land (Lissitsa 2010). In Argentina, the 30 largest companies control a total of 2.4 million ha (box 1.2). Some large firms, such as the Russian firm Ivolga in grains and El Tejar, which cultivates soybeans and maize in Brazil and Argentina, operate more than 600,000 ha, albeit in operational units rarely larger than 10,000 ha.

On the other side of the spectrum, rice production shows that agricultural produce can be grown competitively on a wide range of sizes depending on local factor endowments and labor costs. With a total export volume of 4.6 million t, Vietnam is a major global exporter and low-cost producer of rice, with an average farm size of 0.5 ha and labor intensive technology (table 1.5). A large effort to secure property rights after decollectivization

Box 1.2 Competitive Land Markets in Latin America

Led by Argentina, farm management companies have emerged that own neither land nor machinery but rent land and contract with machine operators. This business model evolved during Argentina's financial crisis, when having access to outside capital provided a significant advantage. With clear property rights allowing easy contracting, several companies farm more than 100,000 ha, most of it rented, with operational units in the 10,000–15,000 ha range. The largest companies, many of them traded publicly, are vertically integrated into input supply and output markets and operate across several countries. Access to a large pool of highly qualified agronomists who undergo continued training and are organized hierarchically allows adoption of near-industrial methods of quality control and production at low cost.

Competitive land lease markets, with contracts renewed annually, imply that at least part of the savings is passed on to landowners, who generally receive lease payments above what they would have been able to earn by self-cultivation (Manciana, Trucco, and Pineiro 2009). A number of options are used to share risk, including fixed-rent contracts with up-front payment in dollars (all risks to the company), fixed payment in grain equivalents (only the production risks are borne by the company), and sharing production (production and price risk are shared). This model and other innovative ways to harness private investment for agricultural production are expanding into neighboring Uruguay, Paraguay, and lowland Bolivia and Colombia (Regunaga 2010).

Source: Authors.

Table 1.5 Yields and Cost Structure for Major Rice Exporters

	Vietnam	Northeast Thailand	South Thailand	Uruguay
Farm size (ha)	0.5	4	3.4	340
Irrigation	Yes	No	No	Yes
Yield (t/ha)	4.32	2.2	2.62	8.3
Farm price (US$/t)	166	161	199	230
Cost (US$/ha)	372	252	420	1,238
Cost (US$/t)	86	127	160	150
% costs as inputs	47.9	26	27.3	26
% costs as labor	34.6	62	27.2	12
% cost of machinery	12.9	2	34.2	35
% costs as land and water	2.1	3	6.9	26

Source: Authors based on Insituto Nacional de Investigación Agropecuaria Uruguay (INIA); personal communication; Ekasingh and others 2007; IRRI.

expanded labor-intensive rice production as a basis for rapid poverty reduction and subsequent diversification of the rural economy into high-value exports and nonagricultural employment (Do and Iyer 2008; Piongali and Xuan 1992). Uruguay, with different factor endowments, developed a rice industry based on large-scale rice production, with exports of some 1 million t in 2009. Rice farms there average 340 ha of fully mechanized and irrigated production and attain average yields of more than 8 t/ha.

CAN LARGE-SCALE INVESTMENT CREATE BENEFITS FOR LOCAL POPULATIONS?

Small Farmers and Large Investors Can Form Mutually Advantageous Partnerships

Large-scale investment does not necessarily have to result in the conversion of small-scale agriculture to large-scale agriculture. To the contrary, a variety of institutional arrangements can be used to combine the assets of investors (capital, technology, markets) with those of local communities and smallholders (land, labor, and local knowledge). Such arrangements include land rental, contract farming, and intermediate options, such as nucleus-outgrower schemes. Large-scale farming is only one option for farming the land and, as box 1.3 illustrates, small farmers may find it more profitable to retain their activity rather than accept a wage job. In these circumstances it may be advantageous for both smallholders and large-scale investors to enter into partnerships rather than an agreement involving the transfer of land.

As long as property rights to land and, where necessary water, are well-defined and a proper regulatory framework to prevent externalities is in place, productivity- and welfare-enhancing transactions can occur without the need for active intervention by the state. The desirability and the outcomes of partnerships or contracting depend on the institutional context. Parties will be more likely to voluntarily enter (mutually advantageous) contractual relationships if the transaction costs of doing so, particularly those of enforcing agreements, are low. The chosen arrangement will depend on commodity and market characteristics. Contract farming, with investors providing capital and technology, would be expected for crops such as oilseeds or sugarcane because processing makes it easy to enforce contracts, as side-selling is limited. It can also provide opportunities for landless people and women by increasing labor demand, as for example in Senegal (Maertens and Swinnen 2009). When the share of investment is larger—for example, for horticulture, perennials, and oil palm or in cases with high up-front investment in irrigation—land ownership will be more important. This may lead to situations where wage payments and land

Box 1.3 Can Smallholders and Large Farms Coexist?

To explore whether, when smallholders already own and cultivate land, there may be a case to replace them by large cultivation, we use representative farm budgets from areas where smallholders and large farms for the same crop exist side by side (see appendix 2, table A2.5).[a] Three factors are of interest.

First, although yields on smallholder farms are lower than or equal to those on large farms, often by a large margin, lower yields do not necessarily translate into lower efficiency. On the contrary, smallholder farms' costs are lower than or roughly equal (ratio less than 1.1) to those of large farms in two-thirds of the comparisons, suggesting that there is no strong case to replace smallholder with large-scale cultivation on efficiency grounds.

Second, and more important, the data clearly indicate that, even though efficiency is comparable, smallholder cultivation has advantages on equity grounds. Smallholders' income is 2 times to 10 times what they could obtain from wage employment only. This does not imply that there may not be opportunities for productive partnerships between investors and smallholders (in gaining access to technology, for example, as illustrated by the poor performance of some smallholders without such access). Such opportunities would not require the transfer of land but would be based on more traditional contracting and outgrower schemes (Cotula 2010; Vermeulen and Goad 2006).

Third, if payments for land are made or if advantageous opportunities exist for nonagricultural employment, small farmers, especially those with limited management skills or access to capital, may increase their welfare by renting their land to an investor. A land rental payment can be computed that, for a given (exogenous) wage rate, would leave a small landowner indifferent between self-cultivation and renting out the land and working for wages on a large farm. In many cases, the land rents to be paid would be large, implying that investors may prefer to engage in contract farming rather than acquire land.

rental fees leave local communities better off than would self-cultivation. The most appropriate arrangement will depend on local contexts (see box 1.4 for an example).

If rights are well defined, if land markets function competitively, and if information is accessible to all, land prices should ensure that a mutually satisfying outcome is achieved. In this context, entrepreneurs can earn rents by bringing technology to improve productivity on land that is currently used less intensively (and thus available at fairly low prices). Land rights holders can in theory capture some of this rent through well-informed negotiations. The situations in which this can occur and land can be transferred at an adequate price are described in more detail in box 1.5.

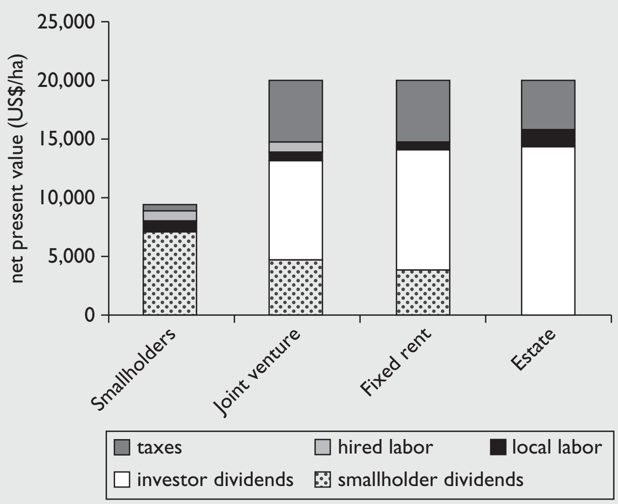
Box 1.4 Options for Engaging Small Farmers

Although compensation for land is only one way for local populations to benefit from large-scale investment (in addition to employment and access to markets or technology), it will be critical in many situations. Case studies illustrate that there are a number of options in the way in which land compensation can be provided. For example, in Sarawak, Malaysia, four options have been analyzed.

- A smallholder model tied to a nuclear estate
- A joint venture model in which local people with customary rights to the land receive an equity share in a plantation run as a single operation by a company
- A fixed land-lease model based on an annual rental payment
- A purely private company operation, with government providing the land through a concession without compensation to communities.

As it helps to overcome smallholders' limited access to technology and capital, the joint venture model almost doubles total benefits per hectare compared to lower-yielding smallholder-managed fields (box figure 1.4). Still, unless ways are found to share the benefits, it would be rational for smallholders to self-cultivate.

Box Figure 1.4 Distribution of Benefits from Oil Palm in Sarawak, Malaysia



Source: Authors based on Cramb and Ferraro 2010.

Box 1.5 What Is the Right Price for Land?

Conceptually, the sale value of a land plot should be the discounted value of all net future income streams associated with the plot of land. The lease price should be the net return to land after all other factors (labor, capital, and management) have been properly remunerated.

The reasoning is simple: if prices were lower, demand for land plots would increase because potential buyers would gain from buying the land and putting it to better use. If prices were higher, land supply would increase because sellers would be better off selling the land rather than farming it themselves. These responses in supply and demand ensure equality between the net present value of income streams and the price of land that prevails on the land market.

If buyers and sellers have different characteristics (for instance, if a potential investor has a technological advantage or better access to capital or product markets), a mutually advantageous transaction can in theory make both agents better off and increase economic efficiency. For such a transaction to occur, the agreed price needs to be set between the net present value of income streams under present ownership and under the planned investment.

In practice, future income streams depend on the characteristics of the land, particularly its agro-ecological potential, which thus needs to be assessed by both parties. If the party selling the land rights is not well informed of the potential use of the land, it can enter transactions that will appear ex post to have squandered land assets.

Another important characteristic associated with location is transportation costs, which if low can increase the profitability of any investment and result in higher land values. If major infrastructure investments are expected in the future, investors will factor the investments into negotiations. The potential for irrigation will also increase the value of a land parcel. However, not all parameters that contribute to the value of the land are known with certainty. On the contrary, there can be much uncertainty (and asymmetric information) about future input and output prices, the future development of the land, and the best timing for a land use change.

To estimate the "right price" for a lease or land sale, three cases can be distinguished. Where land markets are active and transactions are open, observed prices for land transactions should reflect the economic fundamentals. Many governments and real estate agents publish prices of land transactions to provide better information to potential market participants. In areas with no established land markets, where land is made available to investors directly by the government or a government body, practices such as auctioning the land through a competitive bidding process can ensure that the host country is able to at least partially extract some of the surplus created by the project. Where no such auction mechanism exists, or where it is necessary to determine a starting value for an auction, it will be useful to

(*continued*)

Box 1.5 (Continued)

consider the value of profits from (planned or actual) production. As a rule of thumb, data from the United States indicate that leases are a relatively constant portion of crop value (35 percent to 40 percent of gross crop value from corn and 45 percent to 50 percent of gross crop value from soybeans).

Source: Authors.

With decentralized contracting, market imperfections due, for example, to limited access to markets or lack of access to technology, that affect potential returns from landowners' self-cultivation will weaken the bargaining position of small producers and the returns they can obtain from their land. The potential impact of such imperfections is illustrated in Ukraine, where high transaction costs in input and output markets and lack of competition in land markets reduce land rents to only a fraction of what is obtained in Argentina, even though the productive capacity of the land is very similar. This implies that there is an important role for the public sector to ensure access to information and a level playing field for all. The public sector needs to be involved only to ensure that no negative external effects on others or the environment are imposed so that land users can make informed and independent decisions.

There Can Be Considerable Potential for Employment Generation

How much local populations can benefit will be determined to a large extent by the employment intensity of potential investments. Employment generation is often a key avenue for local people to benefit from outside investment because for bulk commodities, it is at the production, rather than the processing stage that employment is generated. In many developing economies, the ability of the agricultural sector to absorb labor and provide gainful employment provides a key safety net. Labor requirements for production vary greatly among crops and production systems so that crop choice and organization of production will have far-reaching impacts on the scope for agricultural growth to reduce poverty.[8]

The crops of interest to large investors differ widely in their labor requirements. Oil palm and (manual) sugarcane generate between 10 and 30 times more jobs per hectare than does large-scale mechanized grain farming (table 1.6), generating large amounts of employment. The reason is that, for tree crops and perennials, the scope to substitute capital for labor is more limited than in grains and annuals. In the former, key operations, especially harvesting, are thus usually manual regardless of farm size and labor intensity varies little between production systems. In fact, large oil palm

Table 1.6 Key Factor Ratios in Case Studies of Large-Scale Investments

Commodity	Jobs per 1,000 ha	Investment US$/ha	Investment US$/job
Grains	10	450	45,000
Jatropha	420	1,000	2,400
Oil palm	350	4,000	11,400
Forestry	20	7,000	360,000
Rubber	420	1,500	3,600
Sorghum	53	900	17,000
Soybean	18	3,600	200,000
Sugarcane-ethanol[a]	153	5,150	33,600
Sugarcane-ethanol[b]	150	15,500	105,000
Sugarcane-ethanol[c]	700	14,000	20,000
Wheat-soybean	16	6,000	375,000

Source: Authors based on business plans for investments covered in case studies undertaken for this report.
a. Rainfed, one-third mechanized harvest (Brazil).
b. Irrigated, mechanized harvest (Mozambique).
c. Irrigated, manual harvest (Tanzania).

plantations may employ more labor per hectare than smallholder-operated ones. By contrast, the ease of mechanizing grain production leads to vast differences between small and large operations. For example, a smallholder using animal power and manual labor in Cameroon is estimated to require 40 days to produce a hectare of maize; a large, fully mechanized farm will use 2 days of labor but higher amounts of capital to achieve the same result (World Bank 2009a).

If land is plentiful and neither in-migration nor need for employment is envisaged, mechanized large-scale farming of grains can be appropriate. If it is not, crops with higher labor intensity could provide greater benefits and may need to be actively promoted.

Proper Valuation Is Critical to Determine Compensation for Land

How land values are determined may also largely determine the benefits that local people may derive from investments. The price paid for land is clearly a central parameter. It is thus useful to consider ways to determine it in a "fair" way that can then serve as a point of reference in negotiations. Legitimate users and occupants of the land should be offered compensation by investors that reflects the value of the land, either through profit shares or through direct compensation for the transfer of land rights. Compensation may occur in several ways, either through the provision of equivalent land, the creation of a community fund to provide public services, or monetary transfers (including the payment of a land rent). But to determine the fair level of these compensations, it is necessary to be able to assess the value of the land used by the investor.

Assessing land values this way appears to be what is happening in Argentina, where companies determine residual returns to land based on expected yields, prices, and input levels and then use these returns as a basis for negotiating land rentals. The process is highly competitive, as landowners have the option of leasing their land to a different operator if they are not satisfied with the price on offer (Manciana, Trucco, and Pineiro 2009). Mutually beneficial outcomes are possible because, despite higher expenses for management, costs on farms operated by large operators are some 10 percent below those on smaller farms. With competitive land markets and land rents of US$250–US$300, a landowner of 50 ha would net more than US$10,000/year from renting.

In many of the countries where land is relatively plentiful, land markets are either absent or do not function well. In the absence of markets, an upper bound for land values can be provided by the imputed residual return to land after all other factors have been remunerated. Inspection of the land expectation value (LEV), which captures the residual return to land based on actual ventures (table 1.7), suggests that returns to land close to infrastructure can be very high.[9] For irrigated sugarcane, the up-front investment may be US$6,000/ha. As short-term rental is not a viable option in this case, the LEV provides a better measure of land values (Zinkhan and Cubbage 2003). Although adjustments for risk and a proper return to entrepreneurial initiative would significantly reduce the amounts that could be obtained in a market setting, LEVs for perennial crops suggest scope for raising significant revenue by selling or leasing currently unused land to investors, especially if such land has fairly good access to infrastructure and water (Cubbage and others forthcoming). For example, based on an existing (optimistic) business plan, the sugarcane-ethanol investment in Mozambique yields a LEV of US$9,800 per hectare, significantly more than the net present value of the annual US$0.60 rental fee investors are charged for cropland.

Profits from agricultural cultivation and implicit values of land can be high in areas with good infrastructure access and for crops with readily available technology and markets but in practice the compensation received by original rights holders is often limited. The scope for land payments—which can provide an avenue for all rights holders to benefit—may thus not always be fully utilized. Although investors are of course justified in requiring a return for the risks they assume, at the same time, comparisons of these returns to land with the levels of official payment required in some countries—which may not be collected or fully accrue to local people—suggest scope to negotiate deals that provide higher benefits for local communities. For such scope to be feasible, local communities need to have their customary land rights recognized and be able to transfer these rights in a credible way based on a consensus that will not be challenged in the future.[10]

Table 1.7 Land Expectation Values for Perennial Crops	
Commodity and country	**Land expectation value (US$/ha)**
Oil palm	
Indonesia	4,800
Plantation forestry	
Argentina	3,125
Brazil	5,250–8,300
Colombia	5,400
South Africa	2,900
Uruguay	750–1,400
Sugar	
Brazil	3,750
Kenya	8,000
Mozambique	9,750
Tanzania	11,000
Zambia	18,500

Source: Authors based on Marques 2009 and World Bank 2009a for Brazil; World Bank 2009a for Zambia; Mitchell 2010 for Kenya; Locke 2009 for Mozambique; Mitchell 2010 for Tanzania; Fairhurst and McLaughlin 2009 (adjusted) for Indonesia; and Cubbage and others forthcoming for plantation forestry everywhere.

Note: Values for all countries except Brazil are imputed. For Mozambique, sugarcane-ethanol is irrigated and (optimistic) yields are from the business plan. For Tanzania, sugar is irrigated. For Indonesia, the figure is based on palm oil price of US$600/t. For Uruguay, production is targeted at marginal lands. For Brazil, market rental rate is paid in kind converted at 8 percent. For Kenya, sugar is rainfed; high prices due to import protection. For Zambia, sugar is irrigated, high prices due to European Union access.

CONCLUSION

A broad review of experience with expansion of cultivated area illustrates not only that land expansion has happened in the past, but also that buoyant demand for agricultural produce provides opportunities that relatively land-abundant countries can use to foster social and economic development. Experience suggests that the ability of investors large or small to capitalize on these opportunities will be affected by availability of public goods. It highlights how technology and infrastructure can be instrumental in facilitating a strong supply response, a nondistortive policy environment can help to create a supportive investment climate, and well-defined property rights can allow the emergence of factor markets.

How property rights were assigned or could be acquired had a critical impact in several ways. While requiring self-cultivation or productive use may make sense, requiring forest clearance as a precondition for gaining property rights, as in Brazil, can lead to potentially wasteful processes of area expansion with high social and environmental costs and only limited benefits. Brazil also suggests that identification of protected areas will be critical to prevent encroachment on these areas and avoid negative social and environmental impacts. In Indonesia, limited ability to uphold local rights, together with free provision of land to large investors, led to processes of area expansion that caused immense social disruption and environmental damage. Such land price subsidies have encouraged speculative landholding and displacement of traditional land users.

The nature and profitability of any investment will be affected by the availability of infrastructure and technology. Public investment in R&D underpinned most successful smallholder expansions as well as the expansion of production in the Brazilian cerrado. For perennials, the private sector may invest in R&D, for example, for oil palm, sugarcane-ethanol, and eucalyptus. Investment in infrastructure was also critical as the basis for the supply response in Thailand. Where such investment is not available, private operators can to some extent substitute by establishing networks of their own. But proper regulation will be needed to prevent monopolistic abuse.

Price distortions and subsidies affected land investment and area expansion processes in specific countries. On one hand, policies discriminating against (export) agriculture have long stymied private investment in Africa. In Brazil's cerrado, on the other hand, capital subsidies led to the emergence of a highly capital-intensive mode of production with very limited poverty impacts. A history of subsidies helped to entrench very large units of production in Eastern Europe, providing them with a head start in an environment characterized by significant market imperfections. The export growth witnessed in countries such as Vietnam, Thailand, and Peru following a clarification of the property rights system illustrates the importance of secure property rights. It also suggests that, in a favorable policy environment, providing investment incentives to existing smallholders can be highly effective in fostering commercialization. This then implies that large-scale investment is not the only option and that it should complement and support local dwellers rather than trying to substitute for their efforts. The definition of property rights also affects how factor markets work and thus how factors can transmit signals about economic opportunities to the private sector and allow producers to insure against risks.

With the exception of plantations, owner-operated farms were the main model of production to respond to increased demand, with increases in farm sizes mirroring the emergence of the nonagricultural sector. While a number of technological and economic developments may have weakened the advantage of owner-operated farms, they did not undermine it. In fact, very large operations as observed in a number of countries appear to have emerged mainly to overcome imperfections in other markets (such as those for output, finance, and insurance). This means that there is no reason to abandon the model of smallholder agriculture as the main pillar of poverty-reducing agricultural growth. At the same time, the gaps in public good provision characteristic of many of the more land-abundant countries considered here may well provide a competitive edge to large operations. Policies to promote smallholder involvement and sharing of benefits with local populations can help to fully unleash this potential.

NOTES

1. Both the magnitude and the type of land conversion have large impacts on greenhouse gas emissions. Estimates based on satellite data suggest that 59 percent of agricultural land expansion in the tropics has been at the expense of forests, and 25 percent, disturbed forests, with the highest share in Latin America. Forests, particularly tropical ones, also provide other environmental services such as increasing biodiversity and protecting watersheds.
2. Hertel, Tyner, and Birur (2010) estimate that U.S. and European Union mandates indirectly increase cropland by 11.3 percent in Canada (4.4 percent from pastureland, 6.0 percent from forests, and 0.9 percent other) and 14.2 percent in Brazil (11.0 percent from pastures, 1.7 from forests, and 1.5 percent other).
3. These feedstocks present major advantages over first-generation feedstocks in environmental impacts because using the entire plant for energy production allows much greater efficiency than conventional starch and oilseed feedstocks (FAO 2008). The availability of such technology will not ease the pressure on land, but will shift it toward more marginal areas, where competition with conventional crops is less intense (Melillo and others 2009).
4. Brazil's cerrado is an extensive area of about 200 million ha, of which about 125 million ha can be made suitable for agriculture with significant investment in soil improvement. It is largely made up of savanna, shrubs, and dry forests with low timber value but high biodiversity.
5. Eight of the 25 largest agricultural production-based global companies identified in the 2009 *World Investment Report* have major interests in oil palm (UNCTAD 2009). Some very large global companies control 200,000–600,000 ha of oil palm.
6. According to Salih (1987, p. 112) "It is estimated that 80 percent of the 350,000 pastoralists and agropastoralists of Southern Kordofan province are seriously affected by the expansion of large-scale mechanized schemes. This is mainly because the owners of the schemes do not abide by the agricultural practices devised by the Mechanized Farming Corporation. They have in many cases cultivated even the animal tracks specified by the Corporation. [There is] continuous conflict between the owners of the large-scale mechanized schemes and the pastoralists . . . pastoral nomads are driven out of the best areas of their traditional pasture to places which are not favorable to their herd growth, and agropastoralists are being subjected to various socioeconomic pressures to abandon one of the two activities and change over to agricultural laborers with lower standards of living." In some states, combatants reported that the expansion of mechanized agricultural schemes onto their land had precipitated the fighting, which had then escalated and coalesced with the north-south political conflict (Saeed 2008).
7. Under constant technical returns to scale and with perfect markets for land, capital, and labor, the ownership distribution of land would be irrelevant for production

and affect only the distribution of income. Landowners would either rent the necessary factors of production (labor and capital) and make zero profits operating their own holding or, if there were transaction costs in the labor market, rent in or rent out land to equalize the size of their operational holdings.

8. Processing and other upstream activities are highly capital-intensive for all crops.
9. The land equivalent value is the maximum an investor could pay for land for use, given a risk-free return from the investment in perpetuity.
10. In practice, customary rights are often not recognized and land under customary tenure is often considered to be "owned" by the government, which may be prone to divest it without compensating the users as documented in chapter 4. The divestiture of public land has traditionally been considered one of the most common forms of land grabbing. It has involved many high-profile cases of bad governance; outright corruption (bribing government officials to obtain public land at a fraction of market value); and squandering public assets that deprived original land users or the broader public of resources and created tenure insecurity for a large number of subsequent land transactions.

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