The Rise of Large-Scale Farms in Land-Abundant Developing Countries: Does it have a future?

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1. Introduction

A recurring debate in the development literature is the relative emphasis to place on the roles of small-scale farms versus large-scale farms in fostering agricultural growth and economic development more generally. In the 1960s, T.W. Schultz's landmark study, *Transforming Traditional Agriculture* convincingly argued the case for the efficiency of small-scale family operated farms and their responsiveness to new markets and technologies. Together with the success of Asia's Green Revolution when hundreds of millions of small-scale farmers rapidly adopted new technologies, this placed small-scale farm productivity at the center of the development agenda. Work by Mellor (1976) and many others also showed that broad-based gains in productivity of small-scale farmers favored better development outcomes in terms of overall economic growth, employment generation, and poverty reduction. The much greater success of Asian countries in building on the Green Revolution to transform their economies and reduce poverty relative to Latin America with its highly unequal agrarian structure, further re-enforced this development model. Recent reviews (Lipton 2009, World Bank 2007) have re-affirmed the relevance of smallholder agriculture and its broader political economy effects. For example, recent analysis of rural country data in the USA in the late 19th century finds that high inequality in land ownership reduced investments in public goods such as schools, due to effects on local tax schedules (Vollrath 2010).

At the same time, disillusion with limited success of smallholder-based efforts to improve productivity in sub-Saharan Africa (Collier and Dercon 2009) and the apparent success of Brazil in establishing a vibrant agricultural sector based on much larger farms have led many countries to view the development of large-scale mechanized farming as the path to modernization of the sector. This has been most common in relatively land-abundant regions in Latin America and Africa where a focus on labor-saving versus land-saving technologies appears to have some economic logic. This trend has been reinforced by a number of new trends, in particular the establishment of very large 'megafarms' by operators in Latin America or Eastern Europe; an apparent rapid and large influx of investments into agriculture in what the popular press labeled a 'land grab' (UNCTAD 2009, World Bank 2010b); and a rediscovery of the agricultural sector by institutional investors of various stripes. The latter include importing countries or sovereign wealth funds and state enterprises acting on their behalf who, in the wake of the 2008 global food crisis and export bans, have decided that a more activist role will be essential for them to satisfy the food security concerns of their populace.

These recent developments raise questions about the extent to which innovations in the technology or management areas, pecuniary economies of scale through market power and volume could help stimulate new business models that could imply a role for larger farms in helping countries fully exploit the land and human resources at their potential (Byerlee *et al.* 2009). The issues raised center around the likely development impact of large farms, in particular whether they can help generate employment and provide access to markets and services for small and medium producers and the extent that public policy can and should regulate these trends in the interests of wider development impacts.

Against this backdrop, this paper has three objectives. First, we review the evidence on establishment and evolution of large farms across different regions. Doing so illustrates that, in many cases, large farms emerged in response to specific policies or market failures related to availability of infrastructure, technology, and property rights institutions. In virtually all cases, the environmental, social, and productivity impact of large farms was strongly affected by these constraints, highlighting the importance of well-defined property rights and a clear, transparent, and enforceable regulatory framework, provision

of public goods, and undistorted factor prices. In the presence of these factors, establishment of large farms capitalized on advantages, such as bargaining in markets for inputs or outputs, led to positive impacts. If, on the other hand, these conditions were absent, the social and environmental risks of large farms strategies were evident, in particular the danger of them exercising power at the local level in ways that were not conducive to longer-term development.

Second, a discussion of key factors determining the organization of agricultural production highlights that, while large operations have historically played a significant role in plantation crops, agricultural production, in contrast to marketing or processing, is not characterized by significant economies of scale. While larger units have long had advantages in accessing credit or lumpy inputs, the ability to overcome these through collective action, together with owner-operators' superior incentives for providing work effort implied that, in contrast to most other industries, farming is still dominated by family-owned businesses. A key reason for operational farm sizes to increase over time was higher wages in the non-agricultural economy and the desire to equalize returns to labor across sectors. Three types of developments may affect this, namely (i) new technology that makes it easier to standardize and/or monitor farm operations; (ii) increased consumer demand for integrated supply chains, e.g. because of certification requirements; and (iii) a desire to expand cultivation into previously uncultivated areas with scarce labor and limited in-migration.

To assess how these factors may affect the potential for emergence of large farms, they need to be related to country -level endowments, in particular (i) growth of non-agricultural employment and the sector's ability to productively absorb labor; (ii) availability of land that is potentially suitable for agricultural production in areas with very low population density that is currently not cultivated; and (iii) the extent to which gaps in provision of public goods or market imperfections may limit the potential of the agricultural sector to achieve its potential as indicated by the 'yield gap'. We use this typology as well as experience with actual land acquisitions and case studies to analyze the potential efficiency and equity outcomes of investments in large farms. Finally we briefly provide policy priorities for regulating investments in large-scale farming and minimizing efficiency-equity tradeoffs.

2. Evidence on changing farm size and organization in relatively land abundant regions

While there is little evidence of significant recent changes in agrarian structure in land scarce countries (Lipton 2009), many land-abundant countries are characterized by rising investment in large-scale farming based on a nonfamily corporate model, a trend that can but need not be accompanied by growing concentration of production and land ownership. Table 1 provides characteristics of a sample of large-scale farming operations in land abundant countries or regions within countries.[1] The largest operations, most of them in developing or transition countries, share three characteristics. With operational units that often exceed 10,000 ha, they are bigger than the largest farms in comparable land abundant regions in developed countries. Such large operational units are often horizontally integrated into corporations controlling hundreds of thousands of hectares with the largest now approaching a million ha of good crop land and sales of over $1 billion annually. Often, they are vertically integrated with processing and marketing activities and export logistics. Associated business models depart substantially from that of family farming characteristic of developed countries and often separate ownership, management and labor. At the same time, there are contrasted by big inter-regional differences in commodity orientation and characteristics related to institutional and policy context. To illustrate the diversity of conditions, we review the evidence on establishment and evolution of large farms across different regions.

2.1 Latin America

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

[1] Land abundance is defined in terms of area suitable for cultivation that is not currently under cultivation as discussed in Section 4.0. We find little evidence of a shift toward large-scale farming in land scarce countries. However, some countries such as Indonesia are characterized by land scarcity (Java) and land abundance (outer islands).

increase their position in world markets for several major products such as soybean, sugar, and meat. This has been associated with three main processes of land expansion. The best known is forest clearing for extensive livestock ranching and establishing land rights in the Amazon basin where, in less than two decades (1990 – 2006), the cattle population more than doubled and pasture expanded by 24 million ha (Pacheco and Poccard Chapuis 2009). Unclear boundaries of public land, weak enforcement of environmental regulations, and legislation that required land clearing in order to establish property rights contributed to a rapid expansion of cultivated area by both small and large-scale farms. Even where small farmers were the first to expand the frontier, farm sizes concentrated rapidly thereafter. The impact was often negative as most of the deforested land, often of very poor quality, was not put to productive use.

A second process was the expansion of soybeans and other crops in the *cerrado* (savannah) region of Brazil by using varieties and methods of conservation tillage developed through long-standing public investment in research and development (R&D) that allowed cultivation of acid soils that were previously considered unsuitable for agriculture. This was a major technological success that dramatically increased production and exports. Impacts on rural poverty, however, were below potential as capital subsidies encouraged highly mechanized cultivation rather than more labor intensive production with possibly higher employment and poverty-impacts (Rezende 2005, World Bank 2009a). Currently, the median farm size in the Cerrado is more than 1,000 ha and many companies operate more than 100,000 ha of crop land in this region. Few studies have analyzed the economic efficiency of these very large farms over 10,000 ha but one study finds a U-shaped curve with decreasing efficiency up to about 500 ha and then increasing efficiency up to 10,000-20,000 ha, especially for renters (Helfand and Levine 2004). This is attributed to preferential access to services such as credit and extension. Inequities associated with foreign ownership of farm land, which is reported to be as high as 20% in Mato Grosso, is also developing into a political issue and measures to limit land acquisition by foreigners are under discussion.

Finally, in the south of Brazil, production of sugarcane, often for ethanol, is expanding rapidly, under a more mixed regime. About half of production is from medium farmers with an average of about 50 ha while the rest is produced in vertically integrated operations with mills on land they manage and operate. While average operated size per mills is some 13,000 ha, some very large operators such as Cosan now farm over 300,000 hectares. Farm size is likely to increase with large new investments such as a recent $12 billion investment by Shell in Cosan.

Argentina presents a somewhat different picture. There, farm management companies, *pools de siembra*, have emerged that own neither land nor machinery but rent in land and contract machine operators (Regunaga 2010). This business model emerged 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, operate across several countries. Access to a 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 any efficiency savings of Argentine's large operators are passed on to landowners, who generally receive lease payments above what they may have been able to earn by self-cultivation. Although land ownership did not change significantly, agricultural production has become more concentrated -the 30 largest companies control a total of 2.4 million ha (Manciana 2009).

Finally, positive experiences with investment in large-scale farming have been recorded in Peru's Pacific region, in contrast to frontier expansion in the Amazon. There auctions of some 235,500 ha of public land in a very transparent process brought in almost $50 million in investment over the past 15 years, generating large numbers of jobs, underpinning the country's emergence as a major high-value agro-exporter (Hernandez 2010).

2.2 Eastern Europe and Central Asia

Eastern Europe has undergone far-reaching transition 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. 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 fromer managers could easily identify land owners and consolidate land parcels and shares. Services, institutions, and logistics were geared to large-scale production. In countries with large amounts of land, capital-intensive, corporate farming is now dominant. On the other hand, countries where land was split into smallholder farms performed fairly well. The diversity is illustrated by the share of area under corporate farms 10 years after the transition, ranging from 90 percent in Slovakia, 60 percent in Kazakhstan, 45 percent in Russia, and less than 10 percent in Albania, Latvia, and Slovenia (Swinnen 2009).

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 and high levels of concentration, especially in Russia, Ukraine, and Kazakhstan. For example, in Russia, the 30 largest holdings farm 6.7 million ha, and in Ukraine, the largest 40 control 4.5 million ha (Lissitsa 2010). Investments in very large farms contrast with an overall contraction of agricultural land use and de-population of the countryside. In Russia, Ukraine, and Kazakhstan, area sown to grains has declined by 30 million ha since the end of the Soviet era even as exports, at least in years of normal rainfall, have increased dramatically. Most of these agricultural companies are home grown, though often with significant investment and technology transfer from abroad. 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. Large farms were also better able to deal with financing, infrastructure, and technology constraints of the transition than smaller operators. They have increased grain production in Russia, Ukraine, and Kazakhstan, the region's three most land abundant countries but large scope to improve technology and yields remains (Agri Benchmark 2008).

In Russia land is commonly leased but sometimes owned, and in Ukraine, where private land sales are not allowed, all land is leased, usually for 5 years although some operators try to lock in lease contracts at favorable terms for much longer. All over the region, land rents relative to land of comparable quality in other parts of Europe are very low. Competitive markets for land rents have yet to emerge, and in many situations imperfections in financial and output markets make own-cultivation difficult. Land owners' weak bargaining power pushes down rental rates and implies that few of the potential benefits from large-scale cultivation are transmitted to them.

2.3 Southeast Asia

The perennial crop sector in Southeast Asia illustrates the plantation model of large-scale farming. Malaysia and Indonesia produce nearly 90 percent of the world's palm oil, production of which has expanded rapidly in response to growing global demand for edible oils and strong government support. In Indonesia, planted area more than doubled from about 2.9 million ha in 1997 to 6.3 million ha in 2007. Unlike annual crops, the level of mechanization in oil palm is low so that labor intensity is high and the industry is estimated to have created an estimated 1.7 to 3 million jobs with significant smallholder participation usually in direct association with plantations.

Given the processing requirements, large-scale production close to the processing unit, often complemented by outgrower schemes, is the norm, with the sourcing area for a typical palm oil mill averaging around 10,000 ha. In many cases, companies have integrated operational units horizontally into some very large firms. Eight of the world's 25 largest agricultural production–based companies identified in the 2009 *World Investment Report* have major interests in oil palm (UNCTAD 2009). There has also been a strong trend toward consolidation in the industry through mergers and by vertical integration with

refining oil and manufacturing palm oil and palm kernel oil products. Several large oil palm companies now control plantations of 200,000–600,000 ha of oil palm.

The fact that more than half of the expansion was at the expense of natural forests has been a source of major global controversy (Koh and Wilcove 2008). Policies aiming to foster development of the industry by providing land and trees at well below opportunity cost led to deforestation of large areas. Concerns abound about oil palm expansion as a major contributor to loss of biodiversity, greenhouse gas emissions, and social conflict due to a failure to recognize local land rights and enforce concession obligations (World Bank 2009b). Social conflict associated with oil palm expansion also derives from opaque and poorly understood contractual agreements, and limited benefit-sharing with local communities (World Bank 2009b). Poor definition of land rights of customary users, and weak land governance institutions, have been major issues in the transfer of land to large-scale producers, and often to smallholders as well.

The rubber sector provides an interesting contrast. Large rubber plantations often opened areas through the establishment of processing facilities, markets and roads accompanied by schemes for local people and migrants to acquire land as outgrowers via settlement programs. Outgrowers who provided initial labor for plantation establishment have often moved on to become smallholder producers in their own right. In some cases, as in the FELDA program in Malaysia and the Indonesian transmigration program, these processes have been state sponsored. In fact, in the rubber sector, production has shifted largely from large plantations to smallholders with farms of 2–3 ha now making up 80 percent of world rubber production (Hayami 2010). Rubber's high labor intensity, the emergence of production systems adapted to smallholders' capital constraints, and processing requirements that are more flexible than those for oil palm all helped to facilitate this shift.

2.4 Sub-Saharan Africa

In Africa after independence, many countries attempted to 'modernize' their agricultural sector through large-scale farming, providing subsidized credit, machinery, and land. These efforts almost universally failed (Eicher and Baker 1992). Policy distortions against (export) agriculture and low public investment in rural areas reduced investment incentives and precluded realization of Africa's agricultural potential. Elimination of many of these interventions over the past two decades allowed agricultural growth to accelerate and paved the way for renewed investor interest in the continent. Still, attempts to jumpstart agricultural growth via large-scale farming face many challenges and awareness of the lessons from past investments are important for future development strategies.

One of the largest and most well-documented cases of large scale farming in Africa has been mechanized sorghum and sesame production in Sudan. Given its large land resources, financing from the Gulf aimed, after the 1970s oil price spikes, to transform the country into a regional breadbasket through favorable access to land and subsidized credit for machinery. Schemes attracted civil servants and businessmen who mostly hired managers for farms 1,000 ha or larger, with some companies operating 100,000 ha or more. While some 5.5 million ha were 'officially' converted to arable land according to official statistics, up to 11 million ha were informally encroached upon (Government of Sudan 2009). Partly due to the tenure insecurity this created, investment was low and most of Sudan's mechanized farms rely on low-level technology. 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). Land rights by traditional users, both small-scale farmers and pastoralists, have been violated, and encroachment by mechanized farms has contributed to serious conflict (Johnson 2003). These problems were not unique to Sudan. Efforts to introduce mechanized rainfed wheat in Tanzania on some 40,000 ha, of land that had previously been prime grazing grounds for pastoralists illustrate the challenges. After a $45 million investment, wheat production was deemed unprofitable, and production is declining (Lane and Pretty 1991, Rogers 2004). Nigeria's large-scale mechanized irrigated wheat schemes of the 1970s and 1980s have now largely been abandoned (Andrae and Beckman 1985).

Structural issues arising from long-standing neglect of technology, infrastructure, and institutions were a key contributor to disappointing performance of commercial cultivation of bulk commodities, where Africa should have a comparative advantage. Past success with commercial agriculture was thus limited to higher-value crops such as cotton, cocoa, and coffee produced by smallholders, and more recently horticultural exports where medium and large farms are important (World Bank 2009a). Plantation crops such as sugarcane in Southern Africa (often aided by preferential access to developed country markets), and oil palm for domestic markets in West Africa have also had some success. Policy distortions and gaps in technology, infrastructure, and institutional arrangements that made bulk commodity production difficult also affect smallholder performance. After policy reforms of the 1990s agricultural growth in sub-Saharan Africa has recently accelerated. With few exceptions, almost all the expansion has been through smallholders. However, there have been intermittent efforts to revive large-scale farming, especially in recent years, particularly for crops related to biofuels. These industries are not yet globally competitive but aim at import substitution or exports into markets where African countries have preferential access.

3. Factors affecting the organization of agricultural production

With the exception of plantation crops, agricultural production, in contrast to marketing or processing, is not characterized by significant economies of scale. While larger units have long had advantages in accessing credit or lumpy inputs, the ability to overcome these through collective action, together with the superior incentives for work effort implied that, in contrast to most other industries, farming is still carried out largely by owner-operators. Historically, a key reason for operational farm sizes to have increased over time was thus higher wages in the non-agricultural economy and the desire to equalize returns to labor across sectors and economies of scale in processing were not transmitted to the farm. Three types of developments may affect this, namely (i) new technology makes it easier to standardize and/or monitor farm operations; (ii) increased consumer demand for integrated supply chains, e.g. because of certification requirements; and (iii) a desire to expand cultivation into previously uncultivated areas where labor is scarce and in-migration may be limited.

3.1 Why agricultural production is dominated by owner-operated farms

In most countries, both rich and poor, average farm size is relatively small, implying that the industry is dominated by owner-operated family units that combine ownership of the main means of production with management (table 3). Indeed, at a global scale, agriculture is one of few industries based overwhelming based on a family firm model; that is, farms are owner operated and rely largely on family labor (Lipton, 2009). A key reason is that agricultural production has few technical (dis) economies of scale, implying that a range of production forms can coexist. A look at the 300 or so publicly listed companies in table 4 illustrates this point. Even though farming accounts for 22 percent of the global agricultural value chain, it makes up a mere 0.2 percent of market capitalization. As of October 2009, there were only seven publicly listed farming companies worldwide, three in Brazil and Argentina and four in Ukraine and Russia.

There are three reasons for the endurance of the family farm model even in rich countries (Allen and Lueck 1998, Binswanger and Deininger 1997, Lipton 2009). First, as residual claimants to profit, family workers will be more likely to work hard than wage workers who require costly supervision. This is important as agriculture requires adaptation to micro-climate and a spatially dispersed environment. Owner operators also have an intimate knowledge of local soil and climate, often accumulated over generations, that gives them an advantage in tailoring management to local conditions and the flexibility to quickly adjust management decisions to site, seasonal and market conditions. Moreover, family farms have considerable flexibility to adjust labor supply to the seasonality and annual variability of production since family labor can more easily be reallocated to other tasks on and off the farm.

A well-known and 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 of production and processing can make plantations more efficient. The need for

quick processing of some harvest products to avoid deterioration, often within 24-48 hours, requires tight adherence to delivery and harvesting schedules and transmits economies of scale in processing to the production stage (Binswanger and Rosenzweig 1986). Sugar factories and palm oil mills usually run their own plantations to ensure at least a base load for processing. This is not a new phenomenon, but the scale may have increased. New sugarcane-ethanol mills in Brazil for example, may capture produce from up to 70,000 ha versus 20,000 ha that was standard up to a decade ago.

Spatial concentration of production can also improve efficiency by lowering transport costs from the field to the processing point. This is especially important if the cost of transport is high relative to the value of the raw product and where the unit value of the raw product is low relative to the value of the processed product. A simple model of sugarcane based on actual data for Brazil and Kenya indicates that spatial concentration of production in large estates owned by mills in Brazil may reduce total costs by some 20% by lowering transport costs to the mill, relative to a dispersed smallholder model as practiced in Kenya.

Finally, plantations that specialize in perennial crops have developed highly structured 'industrial type' production processes that facilitate labor supervision and management efficiency. A focus on a single crop with relatively low seasonality of operations provides year round employment and allows both managers and workers to develop specialized skills. The modern tropical plantation is akin to the highly specialized stall-fed livestock operations in industrial countries that for the same reasons have moved away from family farm to nonfamily corporate farming in industrial countries (Allen and Lueck, 1998, Gardner 2002).[2]

The above implies that, with the exception of plantation crops, as long as policies create a level playing field, family farms combine efficiency with high levels of employment generation and a desirable poverty impact (Lipton, 2009). Agricultural processing, agricultural input industries and sometimes output markets are characterized by significant economies of scale largely related to fixed costs (e.g., R&D for inputs, large processing mills). This has often given rise to consolidation and often high levels of industry concentration in input and processing industries (World Bank, 2007).

In most industrialized countries, a key factor contributing to growing farm sizes has been rising wages in the nonagricultural sector that led farm operators to seek ways to attain incomes comparable to what they can obtain in other sectors of the economy (Eastwood *et al.* 2010). Normally this implies substitution of capital for labor and an increase of farm size over time in line with wage rates. As figure 2 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 in the US are mostly owner-operated rather than company-owned.

Further, the capital requirements of farm operations typically increase with economic development, with higher levels of technology, and investment in land and other improvements, as well as investment in labor-saving machines. Although small agricultural operations have advantages in acquiring labor and local knowledge, they in many cases 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). 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).

3.2 Factors favoring recent establishment of large farms

[2] In developing countries, a modern day equivalent to the plantation crop is fresh horticulture for export. Not only is the produce highly perishable, but the harvest must be closely coordinated with shipping schedules (usually air). In addition, export markets have very stringent quality requirements and demand backward traceability of output to the farm level. However, due to market limitations, these enterprises may be large-scale in terms of capital and labor but *not usually in land*. The huge horticultural enterprises in Chile and more recently in Peru that supply a large part of the winter fruits and vegetables to the North American market are an exception in terms of land size.

In addition to secular shifts of labor out of the agricultural sector, three main factors contributing to increased farm size recently are (i) new technology that makes it easier to supervise labor; (ii) the limited availability of labor in frontier areas, which may be exacerbated by high capital requirements of land clearing and establishing infrastructure; and (iii) greater emphasis on integrated supply chains. Although not directly relevant to operational size, the effect of these factors will be reinforced by advantages from horizontal or vertical integration further up in the supply chain.

Recent innovations in crop breeding, tillage, and information technology may make labor supervision easier and reduce diseconomies of scale of large operations. Pest-resistant and herbicide-tolerant varieties have facilitated the widespread adoption of zero tillage and reduced the number of steps in the production process and the labor intensity of cultivation thereby making the management of larger areas possible. The ability to have machinery operations guided by GPS technology rather than driver's skills makes close supervision of labor less relevant. The scope for substituting crop models, information technology at the field level or even remotely sensed information on field conditions for personal observation also reduces the advantage of local knowledge and experience in tactical farm decisions. Interviews with private companies in Argentina and Ukraine suggest that, with modern technology, a good manager can now effectively supervise units of 10,000 to 15,000 ha for grain and oilseeds, operational sizes common for key large farm operators in these countries as well as in Brazil and Russia.

With changes in technology and markets, the ability to acquire and process information also gives advantages to managers with high levels of formal schooling and technical education -the 'value of the ability to deal with disequilibria" (Schultz 1975). This advantage is particularly important for new crops and land frontier areas in which managers skilled in modern methods may enjoy an advantage (Collier and Dercon 2009). Unit costs of acquiring and processing information decline with farm size (Feder and Slade 1985). This implies that large farms that employ highly trained managers may enjoy an efficiency advantage under conditions of rapidly changing markets and technologies, and in opening new areas to agriculture.

Expansion of standards and certification into relatively low value 'bulk commodities', parallel to earlier experience in high value commodities is a further recent development that can provide advantages to integrated operations. These are being introduced as buyers in high income countries demand certification of social and environmental sustainability. Industry-led organizations, such as the Roundtable on Sustainable Palm Oil or Responsible Soy, the Better Sugar Initiative, and EU biofuels standards, have all been put in place in the past decade to develop certification standards and procedures. The high fixed costs of gaining certification and the need to preserve product identity provide distinct advantages to large operating units and to integrated supply chains. While smallholders have at times achieved certification in high value products, doing the same for bulk commodities is more challenging, and indeed certifying smallholder producers in industries such as oil palm is difficult. Some standards favor large operations in other ways as well. In sugarcane, environmental standards that require no burning prior to harvest in order to reduce carbon emissions, essentially rule out hand harvesting. Not only are smallholders disadvantaged, but the employment impacts of investments are reduced by about half.

In addition to these factors, advantages in marketing and processing associated with large companies' ability to horizontally or vertically integrate many operational units can provide additional advantages in a number of respects.

First, vertical integration increases company size but not directly farm size. However, tightly integrated supply chains transmit economies of scale upstream or downstream to production. Where markets are not working well large firms can improve coordination with processors or shippers, and reduce transactions costs and risks through vertical integration. For example, the close integration of with livestock production with grain and oilseed production in Russia and Ukraine reflects efforts by large livestock operations to assure feed supplies (Serova 2010). Similarly, some of the largest companies in Argentina are vertically integrated with processors or input suppliers. Where there are major gaps in public services,

companies can fill these gaps through vertical integration. 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. This is consistent with studies in Russia that fail to find any inherent economies of size in farm production but a clear advantage by large farms who face lower transactions costs in markets and receive higher product prices (Svetlov and Hoekmann 2009), suggesting that the ability to overcome market imperfections is a key driver toward large farms in Russia (Koester 2007).

In addition to advantages arising from the ability to spread the fixed cost of providing credit over a larger amount to be borrowed, the ability of vertically or horizontally integrated firms to access foreign capital markets, possibly by issuing equity, can provide large agricultural firms with additional advantages. These will be particularly relevant if domestic financial markets are distorted, as in the case of Argentina, where the cost of raising capital in global markets may be significantly below domestic interest rates. In some cases, Argentinean companies that obtain loans abroad pay only half of the rate demanded from farmers by local banks, if they are able to obtain funds at all. Such advantages, which are particularly relevant in cases of high start up costs such as land improvements through investments in soil amendments, irrigation, and establishment of perennial crops that do not return a positive cash flow for several years, can well affect industry structure in the long term. This advantage is often compounded by policies; for example in Brazil and Indonesia, the state-owned development banks advance credit lines for export oriented and 'strategic' industries at rates often well below the commercial bank lending rate.

Horizontally integrated large operators will also be better able to compensate for shortcomings in the provision of public goods such as infrastructure or technology. For example, in industries dominated by large companies such as sugarcane (Brazil), oil palm (Malaysia), or plantation forestry, a large part of R&D is now carried out by private firms. Much of this research is proprietary and not available to others, including smallholders. Horizontal integration allows companies to reap the large economies of size inherent in modern crop research (Traxler and Byerlee 2001). In other cases (e.g., for soy in Brazil), this role is performed by the public sector so that technologies are equally available regardless of farm size. However, public R&D has weakened in many countries to the detriment of smallholders in particular.

Large firms even if they are not vertically integrated can also leverage their better bargaining power' as markets for agricultural inputs and outputs are often highly concentrated. In Argentina, large companies with more bargaining power are reported to be able to reduce cost on either side of the market by 10–20 percent (Manciana 2009). Likewise, it is also well known that spatial covariance of risk implies that markets for agricultural insurance are often incomplete even in developed countries. Diversification of operations across space can allow large companies to self-insure, thereby overcoming these difficulties. Some companies explicitly identify spatial dispersion of production to manage risks as part of their growth strategy, in addition to diversification across commodities to smooth market risks. This could allow large companies to expand strategically by acquiring assets at relatively low prices in periods of climatic or other distress.

4. Land supply and farm size

To assess how the above factors may affect the potential for emergence of large farms, they need to be related to endowments at the country level, in particular (i) growth of non-agricultural employment and the sector's ability to productively absorb labor; (ii) availability of land that is potentially suitable for agricultural production in areas with very low population density that is currently not cultivated; and (iii) the extent to which gaps in provision of public goods or market imperfections may limit the ability of the agricultural sector to achieve its potential. If little land is available for expansion, the only way in which large farms can be established is by obtaining land from existing operators, suggesting that market transactions should be determine farm size providing markets are working well. On the other hand, if large areas of currently uncultivated land could be brought under agricultural cultivation, large farms may help better utilize existing resources and, if agreements are fair and a regulatory framework is in place to

prevent negative externalities, provide benefits to land owners and local producers. We use the typology as well as experience with actual land acquisitions to illustrate typical cases.

4.1 Assessing land availability and the yield gap

With stronger global markets for agricultural commodities, concerns about food security, and improved transportation, pressure on previously uncultivated lands that could be suited for crop cultivation is increasing. Typically, these are areas of low population density with important traditional uses for hunting and gathering, pastoralism, or low intensity agriculture (e.g., swidden farming systems in forest areas). In many of them, intensification of existing operations is not an option. Labor supply through migration from other regions is likely to be inelastic in the short to medium term so that intensification of land use would require some mechanization and larger farm sizes. Trends towards larger operational units may be reinforced by high capital outlays to clear land or establish necessary infrastructure and a need for new crops which can place a premium on skills and entrepreneurship that may not be available locally.[3]

To gauge how widespread such situations may be, one needs to have an idea of the potential supply of land for rainfed cultivation. We use the global agro-ecological zoning (GAEZ) methodology developed by IIASA (Fischer *et al.* 2002) to assess potential rainfed yields that can be achieved on a given plot in light of prevailing agro-ecological conditions to do so. This predicts potential yield for rainfed cultivation of five key crops (maize, wheat, soybean, sugarcane, oil palm) based on simulated plant growth at each stage of the vegetative cycle based on factors including soil, temperature, precipitation, elevation, and slope, allowing for different climate change scenarios as well.[4] Applying a price vector then allows the determination of the crop that produces the highest revenue. Figures 4 and 5 depict results for Africa and Latin America. As market access will affect transport cost, we classify potential crop areas based on whether they are within 6 hours of an urban center with a population of at least 50,000. Full details of the model and data sources are provided in World Bank (2010).

Depending on current land use, this technique provides two parameters of interest. For cultivated areas, the difference between possible output and what is currently attained taking crop choice as given provides an estimate of the 'yield gap' which can indicate the extent to which gaps in technology, institutions, or other public goods (e.g. infrastructure) prevent existing cultivators from realizing there potential and thus might provide an advantage to large farms. Uncultivated areas with high potential could be possible candidates for area expansion if they are not designated as a protected area, not forested, have low population density so that whatever existing interests are displaced can be compensated, and are located reasonably close to infrastructure access.

There are two key results. First, yield gaps vary widely across regions and can be large especially for Africa. Table 6 illustrates that Oceania is close to realizing its full potential, followed by North America (0.89), Europe (0.81), and South America (0.65). By contrast, Sub-Saharan Africa overall realizes only 20 percent of potential production, offering large potential for increasing yields. If Africa were to attain 80 percent of potential yield, a level usually considered economical, it could quadruple its maize output. At

[3] Historically these areas have been cultivated through settlements from more densely populated areas of the country or from abroad (e.g., North America and Australia). Settlement may be state supported schemes or spontaneous in response to land pressures in the origin area. Large state-supported schemes such as the transmigration program in Indonesia and several schemes in Africa have been extensively reviewed (Kinsey and Binswanger 1993, Lipton 2009) and found to be high cost and less productive than expected as inexperienced farmers deal with new crops in a new environment (or non-farmers attempt to learn farming). Conflicts, some of them ethnically based, with local land users have been common in these schemes. After Ethiopia's disastrous resettlement program from the high density highlands to the 'virgin' lowlands in the 1980s under the communist regime, the current government of Ethiopia revamped resettlement of 600,000 people from 2004-06 under strict guidelines for rectifying mistakes of the past. A review of the experience by Pankhurst et al (2008) found that respect for rights of local people was still a major issue resulting in serious conflicts.

[4] To keep things tractable, we use a 5' x 5' resolution that divides the world into 2.2 million grid cells. Computation of output in each grid cell is based on more disaggregated data and the extent of (meaningful) disaggregation possible in the model is limited only by the quality of the underlying data. Cropped area yields are for 2008. Suitable area is not currently used for crop production, could attain at least 60 percent of the potential yield for this crop, is located in an area with population density less than 10 persons/km^2, and at 2005 prices will not yield higher gross revenues with any other of the five crops considered here (maize, soybean, sugarcane, oil palm, wheat). Close to infrastructure means a travel distance of less than six hours to the next market based on available transportation.

current yields, this would be equivalent to an area expansion of 90 million ha, more than the area suitable for maize expansion close to infrastructure globally. Such intensification could provide significant benefits to local populations and often involve lower risks or cost than area expansion.

Second, the non-forested non-cultivated area suitable for rainfed cultivation of at least one of the crops considered here amounts to 446, 306, or 198 million ha for population density cut-offs of 25, 10, and 5 persons per km^2 (table 5). In all scenarios, non-cultivated area suitable for rainfed cultivation is highest in Africa (202, 128, and 68 million ha corresponding to 45, 42, and 34 percent of the total, respectively), followed by Latin America. Within Africa and Latin America, available land is concentrated in a few countries and not always close to infrastructure. Using the 25 persons/km^2 cutoff, the seven countries with the largest amount of suitable but uncultivated land (Sudan, Brazil, Australia, Russia, Argentina, Mozambique, and Democratic Republic of the Congo, in that order) account for 224 million ha, or more than half of global availability. Thirty two countries each with more than 3 million ha of land available account for more than 90 percent of available land. Of these, 16 are in Africa, 8 in Latin America, 3 in Eastern Europe and Central Asia, and 5 in the rest of the world. More strikingly, many of the counties with ample amounts of suitable but uncultivated land have limited amounts of land under cultivation.

4.2 Towards a country typology

To put these two elements together and identify implications for countries' broader development, we classify countries by (relative) availability of land for rainfed cultivation and the 'yield gap', i.e. the share of potential output achieved on areas currently cultivated. Figure 3 illustrates this by plotting relative land availability compared to currently cultivated area (in logs) against the potential for increasing yields and defining four types of countries depending on whether they are above or below the sample mean/median for these two variables (indicated as a dashed line). It clearly illustrates that most countries have little spare land available.

One group (type 1) includes Asian countries with high population density, such as China, Vietnam, Malaysia, Korea, and Japan, Western European countries, and some countries in the Middle East where agricultural growth has been, and will continue to be, led by highly productive smallholders and yield gaps are relatively low. To meet expanding demand for horticultural and livestock products, private investors increasingly provide capital, technology, and access to markets through by contracting smallholders. As some of these countries reach declining agricultural population due to rural-urban migration, land consolidation, largely by entrepreneurial farmers leasing or buying plots from neighbors, will gradually increase farm sizes. Well-functioning land markets to facilitate such processes will be of increasing importance.

A second group (type 2) includes the majority of developing countries as well as densely populated areas in highland Ethiopia, Kenya, Malawi, the Philippines, Cambodia, some Eastern European countries (figure 7), and Central American countries (such as El Salvador) with limited land availability but with large numbers of smallholders locked into poverty. Productivity on land currently cultivated far below the yield potential. Strategic options depend on the reasons underlying this yield gap as well as the size and likely evolution of the nonagricultural sector. If yield gaps are large and non-agricultural development is limited, increased smallholder productivity will be the only viable mechanism for rapid poverty reduction. This will require public investment in technology, infrastructure, and institutions and market development to raise smallholder productivity, following the example of the green revolution in Asia. If, on the other hand, incomes and employment in the nonagricultural sector grow rapidly, land markets work reasonably well, and population growth is low, as in parts of Eastern Europe, land consolidation and the associated move to larger operational units can possibly provide benefits. The distribution of these will depend on the bargaining power of the parties involved which in turn is dependent on their access to information, the means to enforce contracts.

Two other groups of countries with relative land abundance are especially relevant. The first consists of countries in the right upper quadrant where land with reasonably well-defined property rights and where

infrastructure access is fairly good and technology advanced as demonstrated by a relatively low yield gap that is often the result of past investment in technology, infrastructure, institutions, and human capital. Figure 4 illustrates that many of these are located in Latin America, including Argentina, Uruguay, and central Brazil and some countries in Oceania including Australia. It is here where investors, some of them passive, have exploited opportunities for cropland expansion mainly through large-scale farming. If property rights are secure, markets function well, and areas with high social or environmental value are protected effectively the public sector's role is mainly to regulate externalities. Good institutions and land governance will thus be critical to ensure that the technical potential is realized sustainably.

The second group, in the right bottom quadrant, consists of countries with available land and a high yield gap. It includes sparsely populated countries in Sub Saharan Africa (figure 5) such as the Democratic Republic of the Congo, Mozambique, Sudan, Tanzania, and Zambia with large tracts of land in areas with sufficient precipitation and limited run-off suitable for rainfed cultivation as well as a number of countries from Eastern Europe and Central Asia region like Russia and Ukraine. Many of the African countries have an agricultural sector dominated by smallholders who achieve a fraction of potential productivity. Labor supply often constrains expansion by smallholders, implying that much potentially suitable land is used for crop production. If migration from other regions is inelastic in the medium term, intensification will require larger farm sizes, and labor-saving mechanization may be the most attractive short-term option. In some cases, the investment needed for this transition can be generated locally. Especially if it requires the introduction of new crops and farming systems, large investments in processing, or links to export markets, outside investors may have an important role. This could result in institutional arrangements, technology, and infrastructure for mutually beneficial and agreed on land transfers.

It is this context that defines most of the recent upsurge in investor interest and where there appears considerable scope for the private sector to contribute technology, capital, and skills to increase productivity and output in the short to medium term. How to accomplish this most effectively will depend on local conditions. Capital-intensive activities with low labor absorption, such as annual crops using fully mechanized production, will be appropriate only if population density is low, the likelihood of in-migration is limited, and a vibrant nonagricultural sector can absorb growth of the labor force. However, the examples discussed earlier illustrate that, in many historical contexts, provision of land either free of charge or well below its opportunity cost has seriously distorted investors' choices, encouraging land expansion rather than intensification, and often leaving local communities with few if any benefits. Ill-advised provision of subsidized credit often exacerbated these effects.

If property rights are well defined, markets work well, and nonfarm sectors lead economic growth and employment generation, investment in large-scale farming may lead to positive social outcomes. If land and labor markets function competitively and information is broadly accessible, land prices will reflect productive potential and market transactions will benefit land owners and investors. Entrepreneurs can earn rents by bringing capital and technology to improve productivity on land that is currently used less intensively (and thus available at fairly low prices) whereas holders of land rights can negotiate for their share of these rents. Land market imperfections are especially pronounced in Sub-Saharan Africa and investors often acquire land through government intermediaries, ostensibly acting on behalf of local communities. Limited access to markets or lack of access to technology that affect potential returns from landowners' self-cultivation 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 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. Clarifying and securing the rights of existing land users is thus an essential precondition for fully realizing and equitably sharing the potential benefits from operation of large farms.

In areas of higher population density, existing producers can benefit from investors providing access to technology, finance, or markets. 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 can be limited. A variety of institutional arrangements, including contract farming, nucleus-outgrower schemes, or joint venture companies can help combine investors' assets (capital, technology, markets) with land, labor, and local knowledge by communities and smallholders (Vermeulen and Cotula 2010). If population density is low or required investment are larger, as for horticulture and perennials or high upfront investment in improvement or infrastructure, land ownership will be more important and most of the benefits would come through wage payments and land rental fees rather than self-cultivation. Providing the institutional environment for parties to be well informed and able to voluntarily enter into mutually advantageous and enforceable contractual relationships is an important public sector role. This role can be complemented by collective action through farmer organizations or cooperatives (Bernard et al., 2010). As transaction costs and implementation capacity are key, the most appropriate arrangement will depends on local context -population density, the type of production system, and the nature of local institutions and markets.

4.3 Recent investment in large farms in Africa: Will it live up to its potential?

The recent wave of land acquisitions in Africa, which has attracted large amounts of media attention, can be interpreted as indicating the improved policy environment. Inventory data from six countries where reliable information could be gathered -often at regional rather than national level- highlight that, even if not all intended purchases result in actual transfers or all transferred land is actually utilized, the amounts of land transferred recently is several times larger than the size of land expansion in the past. Total transfers in 2004-09 amounted to 4.0 million ha in Sudan, 2.7 million in Mozambique, 1.2 million in Ethiopia (table 2) and 1.6 million in Liberia where it involved mainly renegotiation of existing agreements. Virtually everywhere, local investors, rather than foreign ones, were dominant players. In most cases, expected job creation and net investment were either not recorded or consistently low. Often, land was not fully used, as in Mozambique where a 2009 land audit found that some 50 percent of transferred land was entirely unused (34%) or not used in accordance with investment plans (15%). The amount of land transferred also depended on policy; for example in Tanzania, where land rights are firmly vested with villages, less than 50,000 ha were transferred to investors in the same time period.

Case studies of projects in 7 countries suggest that widespread concern about large-scale farming being associated with potentially large risks is justified. Key risks include (i) weak land governance and an associated failure to recognize, protect, or -if voluntary transfer can be agreed upon- properly compensate local communities' land rights (Alden-Wily 2010); (ii) lack of capacity to process and manage large scale investments, including inclusive and participatory consultations that result in clear and enforceable agreements; (iii) investor proposals that were non-viable technically, or inconsistent with local visions and national plans for development, in some cases leading investors to encroach on local lands to make ends meet economically; and (iv) resource conflict with negative distributional and gender effects (Tamrat 2010, World Bank 2010a). Often, progress with implementation was well behind schedule. As a result, local people had often suffered asset losses but received few or none of the promised benefits.

At the same time, field visits also confirmed that investments can provide benefits. These accrue through four main channels, namely (i) social infrastructure, often supported by community development funds using land compensation; (ii) generating employment and jobs; (iii) providing access to markets and technology for local producers; and (iv) higher local or national tax revenue. In all cases, economic viability of investment is a necessary condition for positive social outcomes to materialize. Even then distributional issues may be of relevance and should be addressed upfront to inform negotiation and contract design. For example, entrepreneurial and skilled people could gain from jobs creation through an investment while vulnerable groups or women lost access to livelihoods without being compensated.

Both unilateral and bilateral regressions suggest that, in contrast to general foreign direct investment, a country's probability to be targeted by large scale farmland investment is positively associated with weak land governance and failure to protection traditional land rights. This suggests that, if the recent trend of growing interest in large scale corporate agriculture in Africa is to be sustained and bring about positive

development outcomes, improvements in land governance and transparency are essential. Efforts by some African countries to better protect customary land rights, increase transparency and incentives for land-related investment, and improve access to information to improve negotiations and subsequent contract enforcement go in the right direction. In most cases, however, significant additional effort and investment will be needed for these to translate into ground reality.

Lack of institutional capacity and non-transparent processes that did not involve local consultation led to overlapping land claims, conflict, and negative outcomes for local communities. Weak land governance creates challenges to reigning in opportunistic behavior by elites, e.g. by ensuring proper consultation with local and indigenous populations and makes it difficult to appreciate the true value of a piece of land. In many cases this appears to have resulted in land being transferred at implicit values that were well below its opportunity cost. Many initial investment projects were thus poorly conceived in terms of technical and financial viability, leading to sub-standard performance and in some cases abandonment. In countries that heavily promoted large scale investment, making productive use of the underlying assets, often through liquidation, requires a different set of policy actions that remains to be articulated and debated.

5. Conclusions and policy implications

Review of regions and country endowments demonstrates that the social impacts of large-scale farming are very context specific.

First, the number and size of large farms is rising especially in Latin America and Eastern Europe, for perennial crops in Southeast Asia, and very recently in sub-Saharan Africa. This phenomenon is not new and in some cases represents long understood factors that favor a plantation organizational mode for some perennial crops. Nor is it yet a dominant mode of production outside of a few countries in the former Soviet Union. It is also important to note that many different business models that involve large farms in terms of land and capital are evolving, and many do not depend on changes in land ownership.

Recent changes in technology and rapidly evolving markets have characteristics that may favor larger sized farms or at least help them overcome traditional diseconomies of size. Our review points to greater flexibility in operational farm sizes than generally believed and suggests that that very large farms may well be competitive in a global market setting. However, there is still too little study of the competitiveness of these farms to be able to ascertain whether this is a new trend but it needs to be monitored and should be studied more closely. If institutional investors' appetite for agricultural assets remains, these trends could have important implications for future agrarian structures. This applies as well to farming in developed countries where there is circumstantial evidence of similar trends, e.g., in Australia.

Second, there are "traditional reasons" relating to policy distortions and market imperfections on why large farms are emerging. Although agricultural policies in developing countries have generally reformed especially the elimination of macroeconomic distortions, many more subtle policy measures remain that favor large farms. These relate particularly to cheap credit to large farms, usually through state-owned banks, and cheap land provided through government allocations. At the same time, market imperfections such as lack of well well-defined property rights, under provision of public goods such as investment in R&D or infrastructure, monopsonistic industry structures for inputs and processing, and continuing failures in credit and risk markets, all favor larger farms and often very large farms. Without leveling the playing field for farms of all sizes and improving the functions of markets, social and environmental outcomes of private investments in the sector are likely to be suboptimal.

Third, notwithstanding the broad generalizations above, the efficiency and equity impacts of investments in large farms are likely to be highly context specific, depending on factor endowments, institutions and history, and the strength of the nonfarm economy. The very heterogeneity of experiences of countries in the socialist block of countries in evolving new agrarian structures is evidence of these differences. In this

paper, we have also highlighted the role of land endowments as a factor driving investments in large farms. For agriculture-based countries in the early stages of development, a significant concentration of land can have far reaching, and often negative, implications for equitable growth. Large farms for annual crops are generally much less labor intensive than small farms, reducing the opportunities for investments to generate employment and stimulate local economies.[5] At the same time, in low population density areas, some form of mechanized farming will be needed to utilize a relatively abundant resource but protection of existing rights holders is critical for positive social outcomes.

These factors have come together in Sub-Saharan African countries that have recently attracted investor interest. If technology, infrastructure, and institutions can be improved, higher global demand for agricultural commodities can bring large benefits to existing producers and countries. To date, these investments have often failed to live up to expectations. Much depends on better land governance and property rights as well as availability of information and ability to negotiate. In the absence of these, resources will not be appropriately valued and project choices will be biased away from socially optimal choices (i.e. land will be given away for free) or be associated with large scale rent seeking. Public policy has a key role in building capacity of smallholders and their organizations through provision of advisory and business development services. Information about potential crops and their markets is especially important to strengthen the bargaining power of local communities. It is also important to level the playing field in terms of access to technology and infrastructure, possibly through more demand-driven mechanisms. With public sector capacity increasingly limited, large farms can have an important function to allow small farmers access to finance, markets, and technology, especially in situations where yield gaps are high. Finding incentive-compatible arrangements will be important. The challenge, especially in African countries with large land endowments, is to more explicitly consider options for large farms and partnerships with smallholders in its strategy, provide the necessary institutional and regulatory environment as well as complementary investments and, in partnership with the private sector, identify ways to tap these opportunities in a way that provides local benefits.

[5] At the same time, large operations for perennial crops where mechanization options are limited may be more labor intensive than small farms.

Table 1: Examples of very large corporate farms in developing and transition countries

Company	Main country (s) of operation	Commodities	Crop area	Comment
Sime Darby	Malaysia, Indonesia	Oil palm	600,000 ha	Planned investment of $1+ billion in 220,000 ha plantation in Liberia
Cosan	Brazil	Sugarcane-ethanol	300,000 ha own & 300,000 contract growers	Shell Oil joint venture to double production with $12 b investment
El Tejar	Argentina, Brazil and Paraguay	Grains, oilseeds	660,000 ha +	Expanding to Colombia
Involga	Russia and Kazakhstan	Grains, oilseeds	1,000,000 ha +	
Fibria	Brazil	Fast growth Eucalyptus	500,000 ha	Merger of Aracruz and JVC

Source: Review of company websites

Table 2: Extent of large land acquisitions in selected countries, 2004–09

Country	Projects	Area (1,000 ha)	Median size (ha)	Domestic share area
Cambodia	61	958	8,985	70
Ethiopia	406	1,190	700	49
Liberia	17	1,602	59,374	7
Mozambique	405	2,670	2,225	53
Nigeria	115	793	1,500	97
Sudan	132	3,965	7,980	78

Source: World Bank (2010).

Table 3: Mean farm sizes and operational holding sizes worldwide

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

Source: Based on Eastwood et al.

Table 4: Publicly listed companies in agribusiness value chains

Item	Global agric. 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	4.0
Total	**100**	**300**	**100**

Note: Global market capitalization is in US$ millions as of October 2009.
Source: Own computation based on Brookfield 2010

Table 5: Potential land availability by country (all areas are in thousands of ha)

	Total Area	Forest Area	Cultivated Area	Suitable non-cropped, non-protected			
				Forest	Non-forest with pop. density of		
				<25/km^2	<25/km^2	<10/km^2	<5/km^2
Sub-Saharan Africa	**2,408,224**	**509,386**	**210,149**	**163,377**	**201,540**	**127,927**	**68,118**
Angola	124,294	57,941	2,930	11,502	9,684	6,625	4,561
Burkina Faso	27,342	2,072	4,817	452	3,713	1,040	256
Cameroon	46,468	23,581	6,832	8,973	4,655	3,205	1,166
Cent. Afr. Rep.	62,021	23,496	1,879	4,358	7,940	6,890	5,573
Chad	127,057	2,280	7,707	680	14,816	10,531	7,061
Congo	34,068	23,132	512	12,351	3,476	3,185	2,661
D.R. Congo	232,810	147,864	14,739	75,760	22,498	14,757	8,412
Ethiopia	112,829	8,039	13,906	534	4,726	1,385	376
Gabon	26,269	21,563	438	6,469	954	927	839
Kenya	58,511	3,284	4,658	655	4,615	2,041	935
Madagascar	58,749	12,657	3,511	2,380	16,244	11,265	6,572
Mali	125,254	3,312	8,338	582	3,908	776	28
Mozambique	78,373	24,447	5,714	8,247	16,256	9,160	4,428
South Africa	121,204	8,840	15,178	918	3,555	1,754	649
Sudan	249,872	9,909	16,311	3,881	46,025	36,400	18,547
Tanzania	93,786	29,388	9,244	4,010	8,659	4,600	1,234
Zambia	75,143	30,708	4,598	13,311	13,020	8,367	3,083
Latin America & Caribbean	**2,032,437**	**933,990**	**162,289**	**290,631**	**123,342**	**91,576**	**64,320**
Argentina	277,400	33,626	28,154	16,228	29,500	23,835	16,856
Bolivia	108,532	54,325	2,850	21,051	8,317	7,761	6,985
Brazil	847,097	485,406	62,293	130,848	45,472	27,654	15,247
Colombia	113,112	64,543	7,339	31,313	4,971	3,776	2,838
Ecuador	25,152	11,631	3,384	3,663	638	415	313
French Guiana	8,034	7,809	6	3,554	27	27	27
Guyana	20,845	17,737	464	8,501	210	189	156
Mexico	194,218	64,447	25,845	7,206	4,360	2,857	1,719
Paraguay	39,904	19,112	5,419	10,269	7,269	6,035	5,133
Peru	128,972	68,312	3,799	39,951	496	476	438
Suriname	14,460	13,847	86	5,318	6	5	5
Uruguay	17,772	1,323	2,030	731	9,269	8,681	7,340
Venezuela	90,531	48,345	3,912	6,167	8,966	7,725	5,891
Eastern Europe and Central Asia	**2,469,520**	**885,527**	**251,811**	**140,026**	**52,387**	**29,965**	**18,210**
Belarus	20,784	7,784	6,019	4,853	3,691	868	204
Russian Fed.	1,684,767	807,895	119,985	128,966	38,434	24,923	15,358
Ukraine	59,608	9,265	32,988	2,594	3,442	394	74
East and South Asia	**1,932,941**	**493,762**	**445,048**	**46,250**	**14,341**	**9,496**	**5,933**
China	935,611	167,202	136,945	10,514	2,176	1,383	843
Indonesia	183,897	95,700	32,920	24,778	10,486	7,291	4,666
Malaysia	32,243	21,171	7,184	4,597	186	119	50
Middle East and North Africa	**1,166,118**	**18,339**	**74,189**	**209**	**3,043**	**843**	**236**
Rest of World	**3,318,962**	**863,221**	**358,876**	**134,700**	**50,971**	**45,687**	**41,102**
Australia	765,074	88,086	45,688	17,045	26,167	25,894	25,593
Canada	969,331	308,065	50,272	30,100	8,684	8,289	7,598
Papua N.G.	44,926	29,387	636	9,746	3,771	3,193	1,917
United States	930,303	298,723	174,515	74,350	8,756	6,818	5,058
World Total	**13,333,053**	**3,706,457**	**1,503,354**	**775,211**	**445,858**	**305,711**	**198,064**

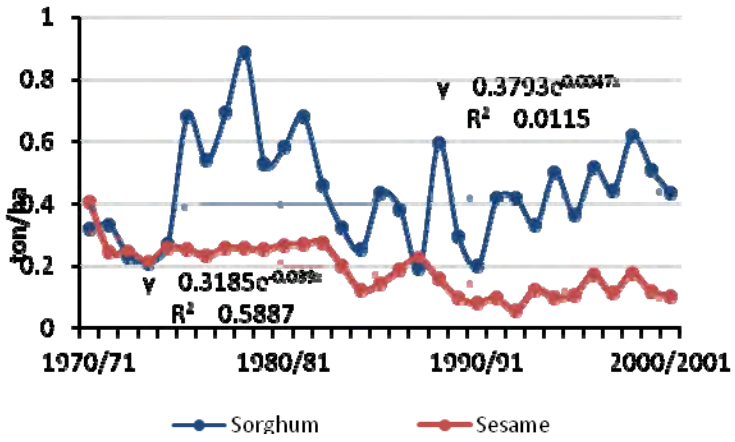
Note: 'Suitable' means that at least 60 percent of possible yield can be attained for any of the 5 rainfed crops considered here (wheat, oil palm, sugarcane, soybean, maize). Countries are included if they have a total of at least 3 Mn ha of forested or non-forested suitable area for areas with population density <25/km^2. Suitable ha per cultivated ha area based on non-protected, non-forest suitable area where the population density of the grid cell is <25/km^2, <10/km^2, or <5/km^2.
Source: World Bank 2010

Table 6: Current yield relative to estimated potential yield

Country/ region	Maize	Oil palm	Soybean	Sugarcane
Asia (excluding West Asia)	0.62	0.74	0.47	0.68
Europe	0.81	n.a.	0.84	n.a.
North Africa and West Asia	0.62	n.a.	0.91	0.95
North America	0.89	n.a.	0.77	0.72
Oceania	1.02	0.6	1.05	0.91
South America	0.65	0.87	0.67	0.93
Sub-Saharan Africa	0.20	0.32	0.32	0.54

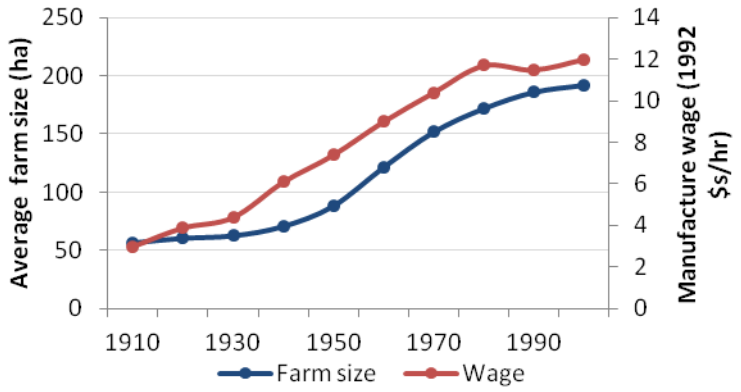
Source: World Bank 2010

Figure 1: Yields on semi-mechanized farms, Sudan, 1970–2007 (t/ha)



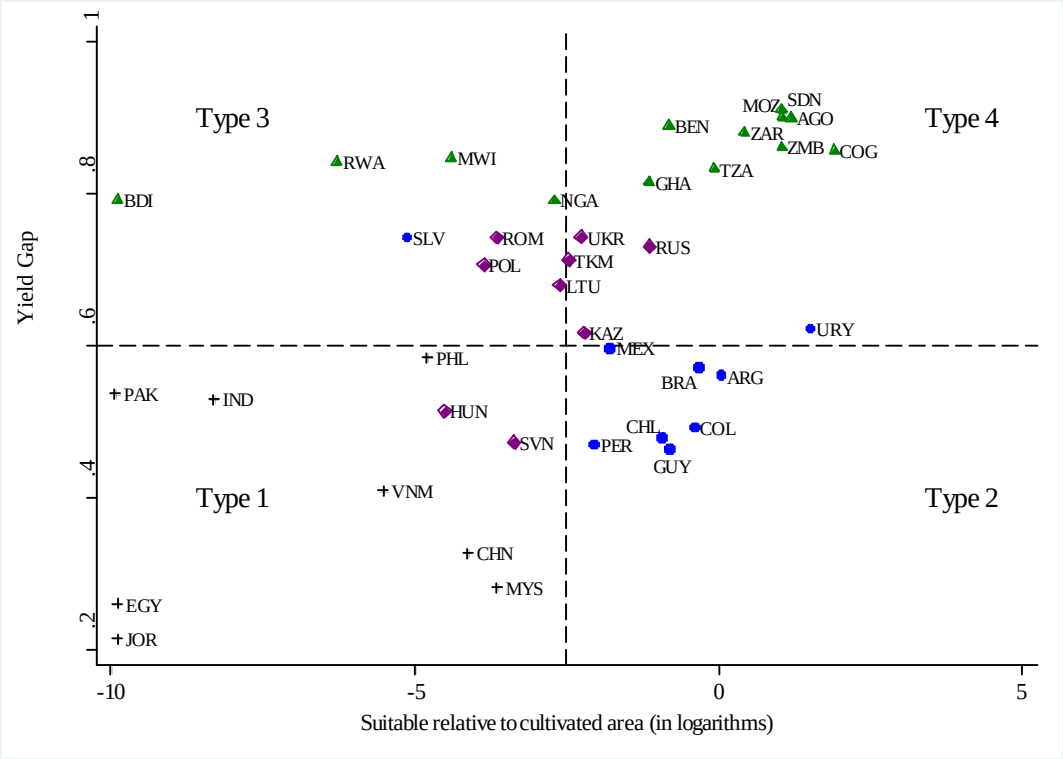
Note: Yields are for rainfed production.
Source: Authors based on Government of Sudan 2009 and official statistics.

Figure 2: Evolution of United States farm size and nonfarm manufacturing wage



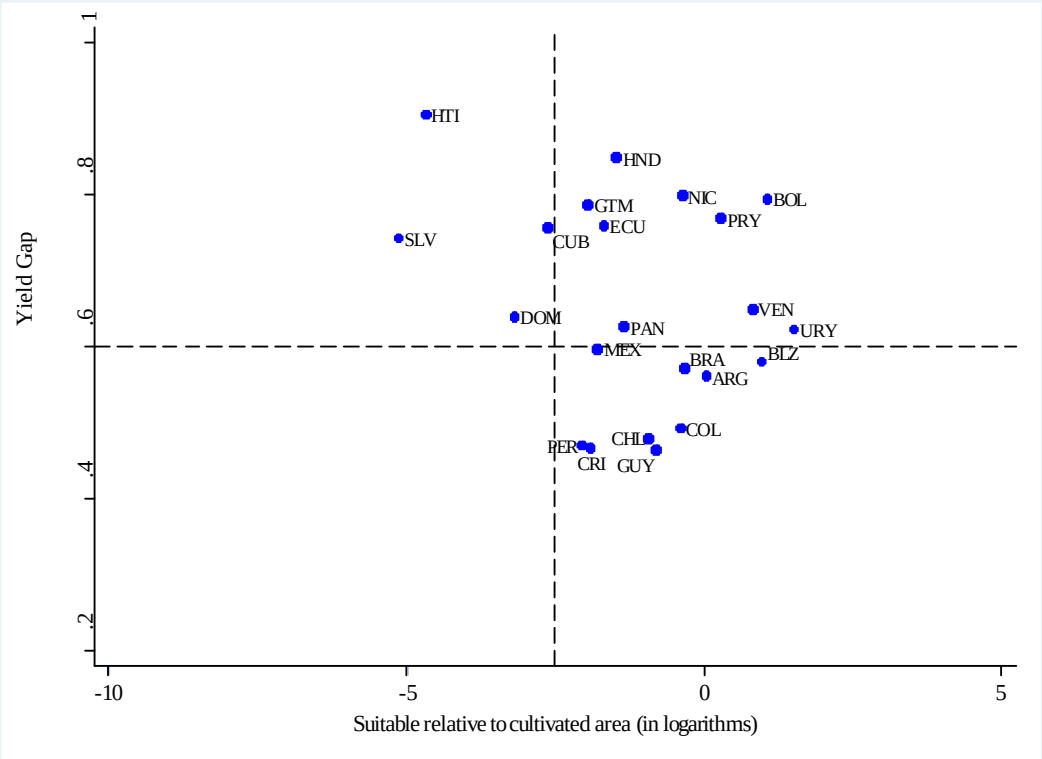
Source: Based on Gardner 2002.

Figure 3: Potential land availability vs. potential for increasing yields



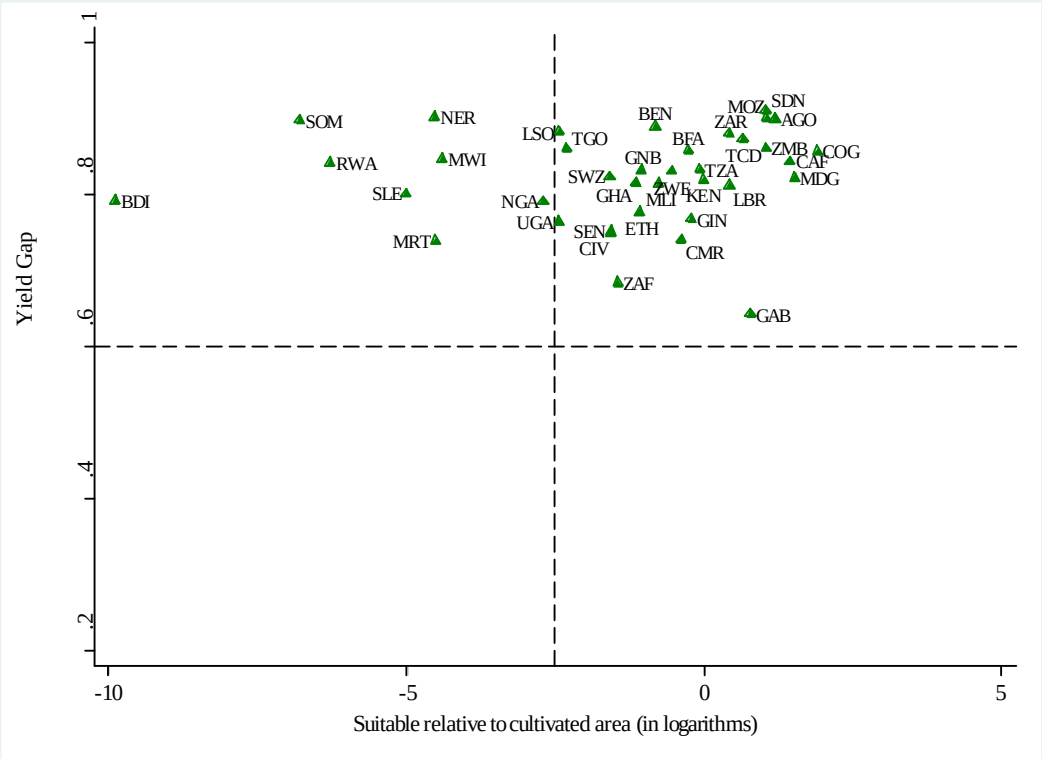
Note: Dashed lines indicate average yield gap and 50th percentile for relative suitability.
Source: World Bank 2010

Figure 4: Yield gaps and relative land availability for Latin America and the Caribbean



Source: World Bank 2010

Figure 5: Yield gaps and relative land availability for Africa



Source: World Bank 2010

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Overview

- Context
- Different regional phenomena
- Underlying factors
- Land availability & a country typology
- Policy conclusions

Owner-operated agrarian structures

Region	Mean size	% < 2 ha	Gini
Central America	10.7	63	0.75
South America	111.7	36	0.91
East Asia	1	79	0.50
South Asia	1.4	78	0.54
Southeast Asia	1.8	57	0.62
West Asia/North Africa	4.9	65	0.70
Sub-Saharan Africa	2.4	69	0.49
Europe	32.3	30	0.60

Contrast to other parts of value chain

Item	Ag VC (%)	# Firms	MCap (%)
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/dist.	25.6	88	36.8
Integrated	n.a.	16	4.0
Total	**100**	**300**	**100**

.. But is this changing?

Company	Country	Crops	Area in 1000 ha
Sime Darby	Malaysia, Indonesia	Oil palm	600
Cosan	Brazil	Sugarcane	300 own; 300 outgr.
El Tejar	Arg., Brazil Par	Grains, oilseeds	660 +
Ivolga	Russia Kazakh	Grains, oilseeds	1,000 +

Latin America

- Pasture expansion into forest
  - Largely through policy-induced deforestation (land title; conflict)
  - Only about ⅓ utilized productively, concentration ex post
  - Recent efforts (beef boycott, RTRS, reserve monitoring) to regulate
- Technology driven frontier expansion (soybean *cerrado)*
  - Long R&D investment to cultivate previously unsuitable land
  - Cost advantages : Zero tillage & herbicide resistant crops
  - Social/poverty impact below potential due to capital subsidies
  - Optimum at some 10,000 ha
- Highly intensive sugarcane cultivation in Brazil:
  - Plantation model with outgrowers (50/50)
- Pools de siembra expanding from Argentina
  - Specialize in management without owning any land or machinery
  - Competitive contracts, often with returns above own cultivation
  - Operation of 10-15,000 ha units, hierarchical structure, spatial div.

ECA

- Very different responses to decollectivization
  - Corporate < 10% in Alb.; > 90%, 60, 45 in Slov. Kaz, Rus.
  - Inflows of capital & management from West
  - 30 big holdings in Russia 6.7 Mha; 40 in Ukraine 4.5 Mha
  - Re-emergence as major grain exporters (in normal years)
  - Despite large areas taken out of production
- Deal better with market imperfections
  - Access to capital & technology not locally available
  - Response to gaps in infrastructure & marketing (own ports)
  - Compensate for deficient provision of public goods

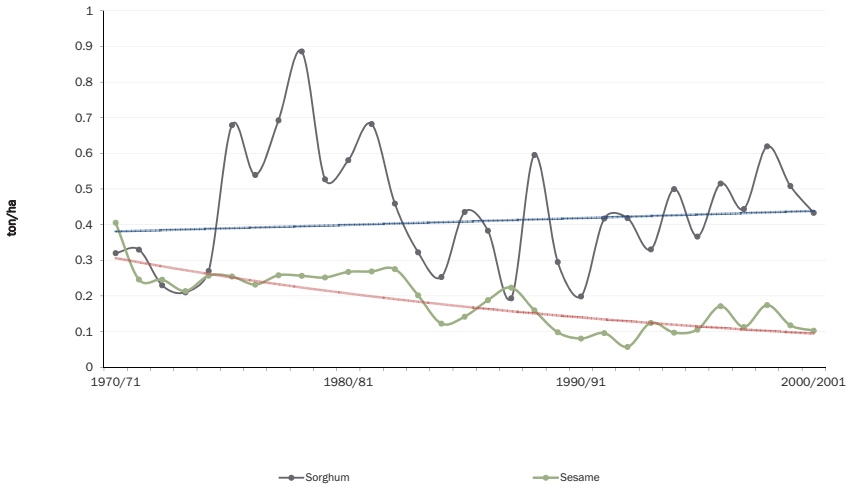
Asia

- Plantation economies
  - Oilpalm production in very large units (85% in Indonesia & Malaysia)
  - Subsidy-driven growth (2.9 to 6.3 million ha) in Indonesia
  - Land & trees subsidy (18 Mn cut); monopsony
  - Processing scale economies spill over (200-300,000 ha operations)
- Rubber is an interesting contrast
  - Originally grown on large plantations with outgrowers
  - Now almost entirely (80%) on 2-3 ha smallholder farms
  - Production systems suited to smallholders & processing
- India
  - Negative FS-Py relationship attenuated for some time
  - Availability of
  - Adjustment limited by leasing restrictions, undisclosed conflict & interest, duplicate records (political economy issue)

Africa

- Little large-scale investment due to policy bias
  - Macro policies; taxation, especially of exportables
  - Low public investment in R&D & infrastructure
  - Weak institutions (property rights)
- Existing investment a disappointment (e.g. Sudan)
  - 70s: Rapid expansion; 5.5 Mha official 11 Mha encroached
  - Neglect of existing land rights leads to conflict
  - Lack of investment & poor technology lead to soil mining
- Legacy of poor investment limits scope
  - High value crops compensate for transport cost disadvantage
  - Bulk commodities limited to regional markets ($50 Bn/a)
  - Policies critical for longer-term evolution

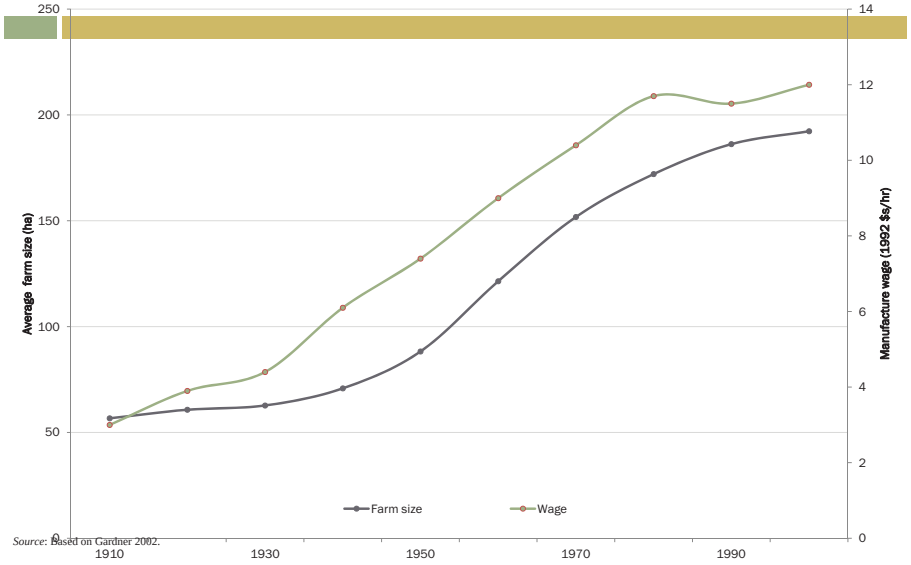
Sudan: Yields of sorghum & sesame



What are the underlying factors?

- Plantation model
  - Need for rapid processing
  - Physical proximity; Year-round schedule
  - Outgrowers possible, though monopsony issues
- Advantages of owner-operators
  - Supervision & adjustment to variation, seasonality
  - Knowledge of local conditions
  - Issue of indivisible inputs (capital, mach, mgmt)
  - Desire to attain comparable income increases size

Evolution of US farm size

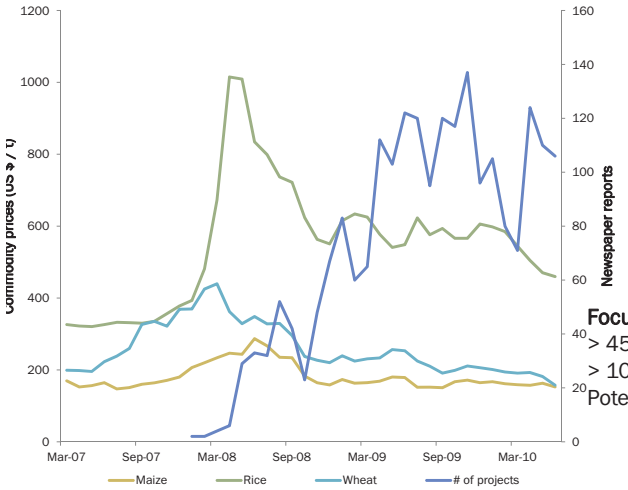


Source: Based on Gardner 2002.

More recent development that favor large farms

- Technology erodes supervision cost advantage
  - Less need (zero tillage), standardization, GPS tractors, reports
  - Info access & processing: Moisture monitoring & IPM; variability
  - One operator can supervise 10,000-15,000 ha of grain/oilseeds
- Ways to benefit from integration
  - Economies of scale in research with retreat of public sector
  - Countering market power in output and input markets
  - Financing constraints (Argentina); ability to tap global markets
  - Spatial dispersion to self-insure (choose covariate locations)
- Expansion into uncultivated 'virgin' lands
  - Thinly populated, so intensification not an option
  - High capital requirements for startup & infrastructure construction
  - Potentially long gestation periods

Explosion in 'virgin' land demand



Focus on Africa

> 45 m ha deals in 11 months

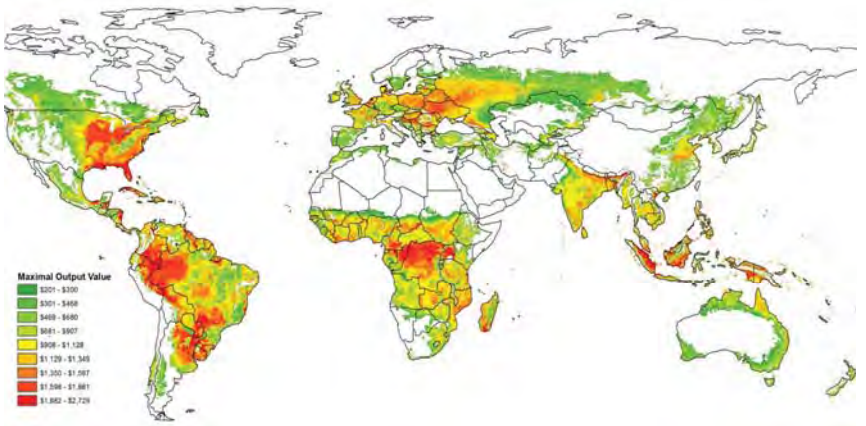
> 10 years of expansion

Potentially far-reaching impact

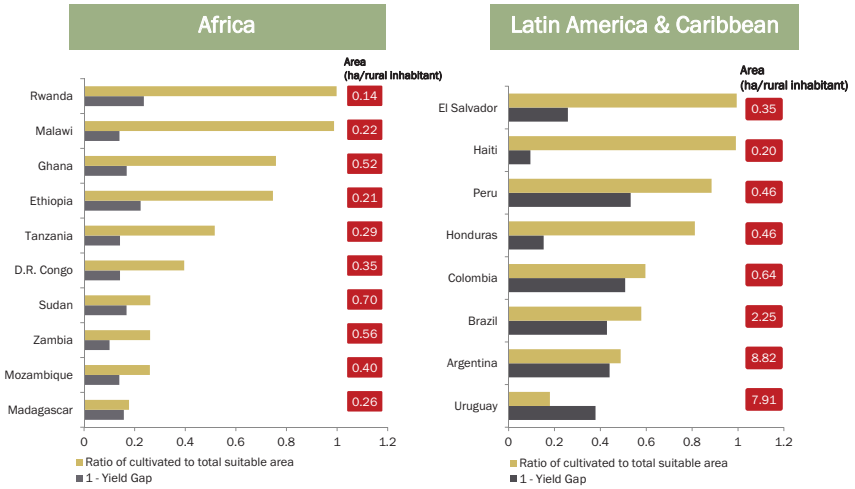
Is there land available?

- Use Agro-ecological model to determine maximum yield
  - Suitability for rainfed high cultivation (engineering relation)
  - Here: 5 crops (wheat, maize, soybean, sugarcane, oil palm)
  - Identify 'optimum' crop for every pixel using 2005 prices
- Determine 'yield gap' & potential area for expansion
  - Yield gap: % of potential actually produced
  - Expansion area: Non-forested, protected, rights compensated
  - Variations possible (crop, infrastr., etc.)
- Extensions
  - Link to a transport cost to establish land rental surface
  - Decompose yield gap (technoloy, infrastr. Institutions)
  - Check robustness by running for changed climate

Potential output value from rainfed 5-crops



Yield gap, share of land used, area/rural person



Yield gap estimates

Region	Maize	Oil palm	Soybean	S. cane
S Asia	0.62	0.74	0.47	0.68
Europe	0.81	n.a.	0.84	n.a.
N&W Africa Asia	0.62	n.a.	0.91	0.95
N America	0.89	n.a.	0.77	0.72
Oceania	1.02	0.6	1.05	0.91
S America	0.65	0.87	0.67	0.93
SS Africa	0.20	0.32	0.32	0.54

Country level availability of uncult. land

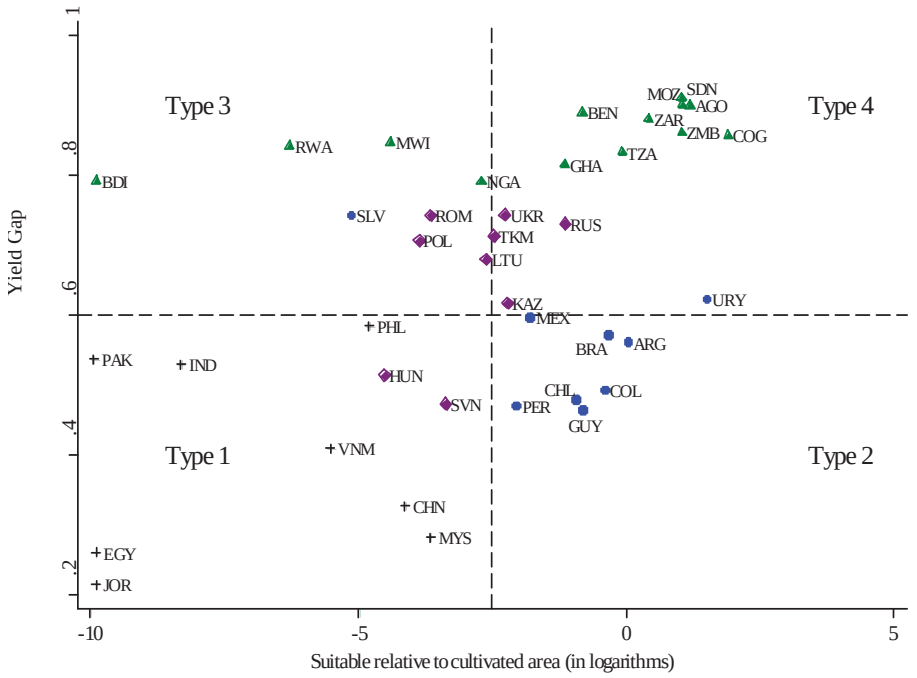
Concentrated
- > 90% in 32 ctries
- 16 in Africa

Large relative to cult. area
- > double in 11 ctrs
- > triple in 6
- Social disruption
- Other constraints

445 Mn ha (< 25/km^2)
306 Mn ha (< 10/km^2)
198 Mn ha (< 5/km^2)

Non-cultivated, -forested, -protected land (1000 ha and relative)

Sudan	46,025	2.82	Tanzania	8,659	0.94
Brazil	45,472	0.73	Bolivia	8,317	2.92
Russian Fed.	38,434	0.32	Cent. Afr. Rep.	7,940	4.23
Argentina	29,500	1.05	Paraguay	7,269	1.34
Australia	26,167	0.57	Colombia	4,971	0.68
D.R. Congo	22,498	1.53	Ethiopia	4,726	0.34
Mozambique	16,256	2.85	Cameroon	4,655	0.68
Madagascar	16,244	4.63	Kenya	4,615	0.99
Chad	14,816	1.92	Mexico	4,360	0.17
Zambia	13,020	2.83	Mali	3,908	0.47
Indonesia	10,486	0.32	Papua N.G.	3,771	5.93
Angola	9,684	3.31	Burkina Faso	3,713	0.77
Uruguay	9,269	4.56	Belarus	3,691	0.61
Venezuela	8,966	2.29	South Africa	3,555	0.23
United States	8,756	0.05	Congo	3,476	6.79
Canada	8,684	0.17	Ukraine	3,442	0.10
World Total	**445,858**				



Typology and implications for farm growth

- Type 1
  - Smallholder path; mech. adjust to declining ag. pop.
  - Larger operational areas through market transactions
- Type 3
  - Public/private provision of technology & infrastructure (contract farming); regulatory issues
  - Land as important safety net & asset; not push out if no alternative available
- Type 2
  - Economically sustainable large farm expansion (funds)
  - Land markets can take care of it if distributional, environmental & social issues are regulated
- Type 4
  - Increasing output requires mechanization & larger farms
  - How will have long-term impacts (dualism vs. broad-based growth)
  - Challenges considerable; property rights & land markets not defined

Is it relevant?

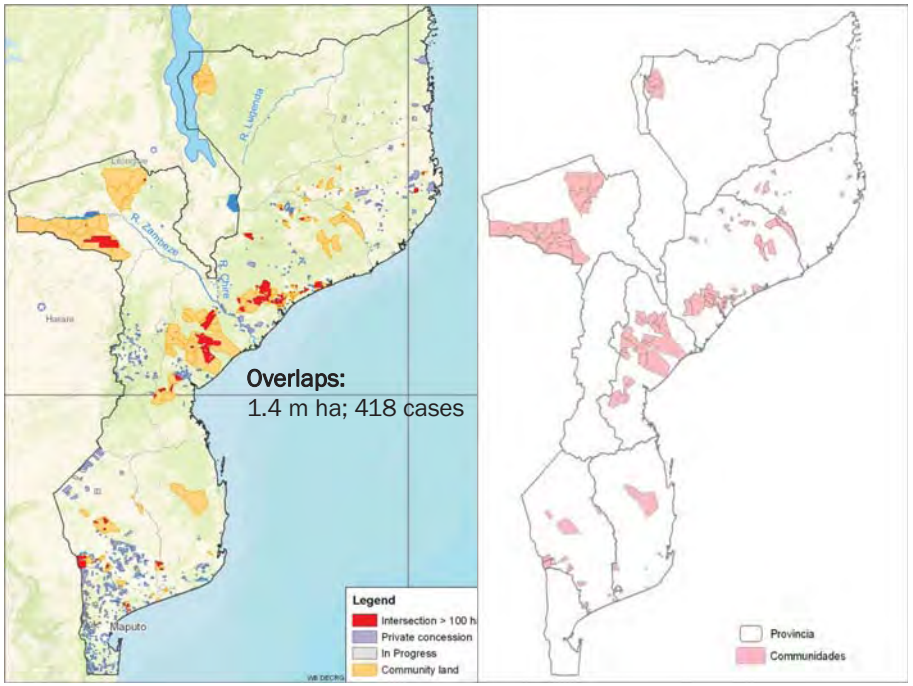
Country	All projects			Domestic			Foreign		
	Projects (#)	Total area (1000 ha)	Median (ha)	Projects (#)	Area (Tha)	Median (ha)	Projects (#)	Total area (1000 ha)	Median (ha)
Ethiopia	406	1,190	700	383	582	616	23	607	4,000
Liberia	17	1,602	59,374	2	117	58,323	15	1,485	98,179
Mozambique	405	2,670	2,225	274	1,402	2,000	131	1,268	3,800
Sudan	132	3,965	7,980	90	3,086	6,930	42	879	8,400

Probability of being target of LS inv.

Dependent variable	**Interest**		**Impl.**
	1	2	3
Suitable land nonf.	0.3049**	0.2987**	0.3916***
Suitable land forest	0.0503	0.0396	0.0770
Yield gap	-0.3635	-0.2774	-1.7457**
Land tenure recognition	-0.512***	-0.691***	-0.3416*
Investment protection		+0.0058*	0.0033
Pseudo R-squared	0.311	0.339	0.268

Inventory/policy framework

- Gaps in process of investment processing/approval
  - Expropriation/extinction of existing rights often required
  - Unclear/duplicative institutional responsibility
  - Low land payments; rarely collected (non-viable projects)
  - Neglect of economic/technical viability
  - Limited capacity to do/monitor ESIAs
  - Rudimentary boundary description/data management
  - Asset & employment generation limited
- Across countries policy a key determinant
  - Tanzania vs. Mozambique – 50% not utilized
  - Peru: Public auction, technical review, down-payment



Case Study evidence

- Near universal lack of consultation/neglect of property rights
  - Even if consultations, agreements are not written/monitored
  - Ill-informed decisions due to lack of information on rights/project
  - Vulnerable people often left out – implicit subsidy through land price
- Limited consideration of economic viability
  - Non-viable projects may subsequently encroach on local rights
  - Negative effects often shifted to locals (damage but no benefits)
  - Conflict due to neglect of rights causes
  - Requirements for liquidating investments made rarely considered
- Different channels for benefits to materialize
  - Local public goods: Often compensation for land (comm dev funds)
  - Employment: Crop specific, does not benefit all (skill-dependence)
  - Technology & market spillovers: Not for the most destitute
  - Need to tailor to local characteristics–this is rarely done

Conclusion & implications

- A number of new factors emerged
  - Technical change reducing supervision needs
  - Mechanized cultivation of previously fallow areas
  - Not only large vs small but also owner- vs. wage operated farms
- Implications for agrarian structure can be enormous
  - But have so far been largely negative because of
    - Ad hoc rather than strategic approach by public sector
    - Absence of property rights, ill-functioning markets (subsidy)
    - Lack of institutional capacity to regulate identify & capitalize on benefits
    - Limited provision of public goods (infrastructure) to attract investment
- Could provide an opportunity to explore new partnerships
  - Identify ‘clusters’ & areas with highest potential
  - Decompose & narrow yield gaps
  - Eliminate obstacles (info, rights) for market functioning
  - Evaluate contractual arrangements in specific contexts