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# African agriculture toward 2030: changes in urbanization and agricultural land dynamics and their implications for CGIAR research

A Foresight Study of the Independent Science and Partnership Council

**T.S. Jayne, Gustavo Anriquez, and Erin Collier**

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# ISPC FORESIGHT STUDY:

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## Changes in Urbanization and Agricultural Land Dynamics and

## Their Implications for CGIAR Research

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**African Agriculture Toward 2030:**
**Changes in Urbanization and Agricultural Land Dynamics and Their Implications for CGIAR Research**

## 1. INTRODUCTION

This review identifies how major trends in African urbanization and agricultural land dynamics are shaping the research priorities of the international public research system. The study's specific purpose is to inform the research agenda and priorities of the CGIAR system.

As will be shown below, farm size and urbanization issues in sub-Saharan Africa (hereafter *SSA*) are interrelated. Urban population growth is affected by the rate of rural-urban migration (about 35% of urban population growth is currently due to migration), which is influenced by policies affecting access to land and the returns to farming. Our treatment of urbanization underscores the changes it is bringing in food demand patterns, the sheer volume of increased marketed food supplies necessary to feed Africa's growing cities, the region's growing dependence on world food markets, and the potential contribution that CG system research can make to poverty reduction by focusing on means to reduce food production costs even in the world's main breadbasket areas outside of SSA.

Our treatment of land issues in SSA highlights the apparent paradox of land abundance amidst localized land shortages contributing to urbanization without growth, the trade-offs between future land expansion for cropland on the one hand and increased greenhouse gas emissions and environmental destruction on the other hand, the pressures that such trade-offs create for research systems to maintain future yield growth on existing farmland to feed SSA's (and the world's) growing population, and the potential limits of an inclusive small farm-led agricultural development strategy due to pressures in the political arena for public resources and policies (including land policies) to be skewed in favor of influential local and international stakeholders.

A foundational starting point for this review is to briefly assess the trends in the global food and energy systems, as these will greatly influence trends in farm structure, urbanization, and many other localized dynamics in SSA. We identify four major trends. **First,** according to most projections, the world will experience higher food prices (Rosegrant *et al* 2012; Hertel *et al* 2010). Over the next several decades, cereal, meat products, and other crops relying on fossil fuel-intensive inputs and production modes may rise even further relative to general price levels (Woods et al 2010) especially if peak oil theories materialize sooner rather than later. **Second**, an upward shift in energy prices may favor more labor-intensive production patterns and provide advantages to more localized production patterns that minimize transport costs. Higher energy prices may thus encourage shifts in the location of agricultural production, the techniques of production, and the composition of production from energy-using sectors (e.g., livestock) to energy-saving ones, although localized incomes and demand patterns will differentiate these effects spatially. An offsetting development is the novel drilling technologies created to open up tight gas reserves such as "fracking", which may serendipitously reduce the pressure on global fertilizer prices, and, with an uncertain but apparently low probability, render major aquifers unsuitable for human use. A broader point (which should probably be bolded and put as the subtitle) is that the future is too dynamic to predict with much accuracy! **Third,** most of the world's food production systems are contributing to other major sources of serious environmental change. Conversion of forest and grasslands to new crop land will exacerbate these problems. By 2050, the world's population is likely to be 9.1 billion, the $CO_2$, ozone concentration will have increased significantly, and the climate may be warmer by $2^o$ Celsius (Jaggard et al 2010). Projected changes in ozone concentration will reduce cereal yields by 5 percent or more. Crop productivity growth will be impeded as temperatures rise above critical thresholds, with as much as 10 percent yield loss for +1°C of warming in some locations (Lobell, forthcoming).[1] Warmer weather is also projected to exacerbate problems associated with soil-borne pathogens. Strzepek and Boehlert's (2010) review of water models project an 18 percent reduction in the availability of water for agriculture by 2050. The rate of growth in cereal yields has leveled off and even declined in many of the world's food breadbasket zones (Cassman 2012). This doesn't necessarily imply that food yields won't continue to grow – in fact most projections are that they will[2] – but certainly the various stressors are serious and should be factored into decisions about the resource commitment necessary for the international public agricultural research system to make it possible to feed 9.1 billion people in an environmentally sustainable manner in 2050. And SSA, while being the poorest region of the world, depends greatly on the rest of the world to feed its cities. And **fourth**, the share of agricultural R&D research undertaken by the private sector has increased dramatically over time. Private expenditures now exceed public expenditures in most industrialized countries (Pray *et al* 2007), although overall 64 percent of global agricultural R&D is spent by the public sector (Pardey *et al* 2006). But this share is declining. Six multinationals dominate the agricultural seed, chemical, and biotech industry. Piesse and Thirtle (2010) argue that public research systems are increasingly disadvantaged by the growing thicket of intellectual property rights that used to be considered global public goods, representing a threat to the global commons in agricultural technology.

These global trends and are likely to affect African urbanization and land use patterns in ways that are beyond our disciplinary expertise; clearly multi-disciplinary teams are required to better tease out the precise questions emerging from these global trends. In addition to these overarching global drivers are endogenous local changes occurring in SSA. The implications of these interactions for CG research priorities are discussed in Section 4 and briefly summarized here. The most important implications of urbanization in Africa concern the changes it is bringing in food consumption patterns, the demands it is placing on marketing systems to expand volumes to feed the region's growing cities, the region's growing dependence on world markets for food, the demands for water, coastal areas' vulnerability to increased flooding, and the likelihood that urban areas are likely to be the most severely affected by sudden migration in-flux as a response to sudden weather/environmental disturbances. A considerable portion of SSA's urban populations, primarily men, are involved in circular migration, periodically returning to the village (Potts 2009), which impedes land consolidation and contributes to the feminization of rural areas.

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[1] Both sub-Saharan Africa and South Asia appear particularly prone to productivity losses from global warming, in part because major staples in these regions are often already grown well above their optimum temperature (Lobell forthcoming).

[2] e.g., see Piesse and Thirtle (2010).

Concerning land issues, the most important processes are the apparent paradox of growing constraints on land access amidst apparent land abundance, growing landlessness, the "pushing" of people out of agriculture into poverty-wage off-farm activities rather than their being absorbed into productive off-farm jobs, the trade-offs between future land expansion for cropland and environmental effects/greenhouse gas emissions, the pressures that such trade-offs present on technological advances and yield growth on existing farmland to feed the world's growing population, the very limited potential for expanding the share of land under irrigation in Africa, and the potential limits of an inclusive small-farm led agricultural strategy presented by political economy considerations in future land allocation patterns, which in many cases may favor local elites and capitalized commercial farm interests.

In spite of these developments, the CGIAR's most fundamental research priorities are likely to remain focused on the technological, institutional, and policy challenges of achieving farm productivity growth on existing farmland in the face of declining cheap water availability, doing so in a way that accounts for the distinct possibility of higher long-term energy prices. One clear research priority, relevant for Africa in particular and the world in general, is identifying whether coming up with alternative methods of producing food that require less intensive use of water, energy, minimize additional area expansion, and produce less greenhouse gas emissions are, on the one hand, desirable but not critical, or, on the other hand, fundamental for maintaining living standards on the planet. If anything, the primacy of these research priorities is further reinforced by the major trends of urbanization and increasing land pressures. Other priorities may be to identify strategies for adapting and mitigating the effects of more serious coastal flooding and inundation of the many cities along Africa's coastlines, planning for sudden demographic shocks affecting urban areas in response to environmental/weather disturbances, and working with African governments to achieve, as much as possible, rural and urban development strategies that provide adequate public goods investments for a pro-poor, inclusive pattern of growth. There are certainly other interesting and important issues, but the task of identifying *priority* issues requires that the list be fairly concise. Developing a list of 25 topics would run the risk of defeating the purpose of identifying priorities.

This review does suggest potentially strong implications for advocacy – promoting national and regional fora for African governments to consider strong research evidence showing that societies' interests would be well served to increase their expenditures to public goods such as crop science, adaptive research, extension, and infrastructural investments, and to carefully consider the potential externalities of their decisions on world environmental conditions and livelihoods. Such a role may not be explicitly within the current mandate of the CG system, but to the extent that it could promote such efforts through, e.g., the design of CAADP national investment plans and subsequent national public expenditure plans, this could provide leverage points for achieving tangible payoffs from the research activities undertaken by the CG system in tandem with national partner research groups.

## 2. URBANIZATION

*2.1 How fast is Africa urbanizing?*

Urban population growth is the sum of four components: net fertility (the birth rate minus the death rate); urban expansion or reclassification of areas from rural to urban; rural-urban migration; and international immigration. McGranahan *et al* (2009) have estimated that roughly 2/3 of the 3.1 percent annual rate of growth in SSA's urban population is from natural growth in urban areas (births minus deaths) and 1/3 from rural-urban migration.

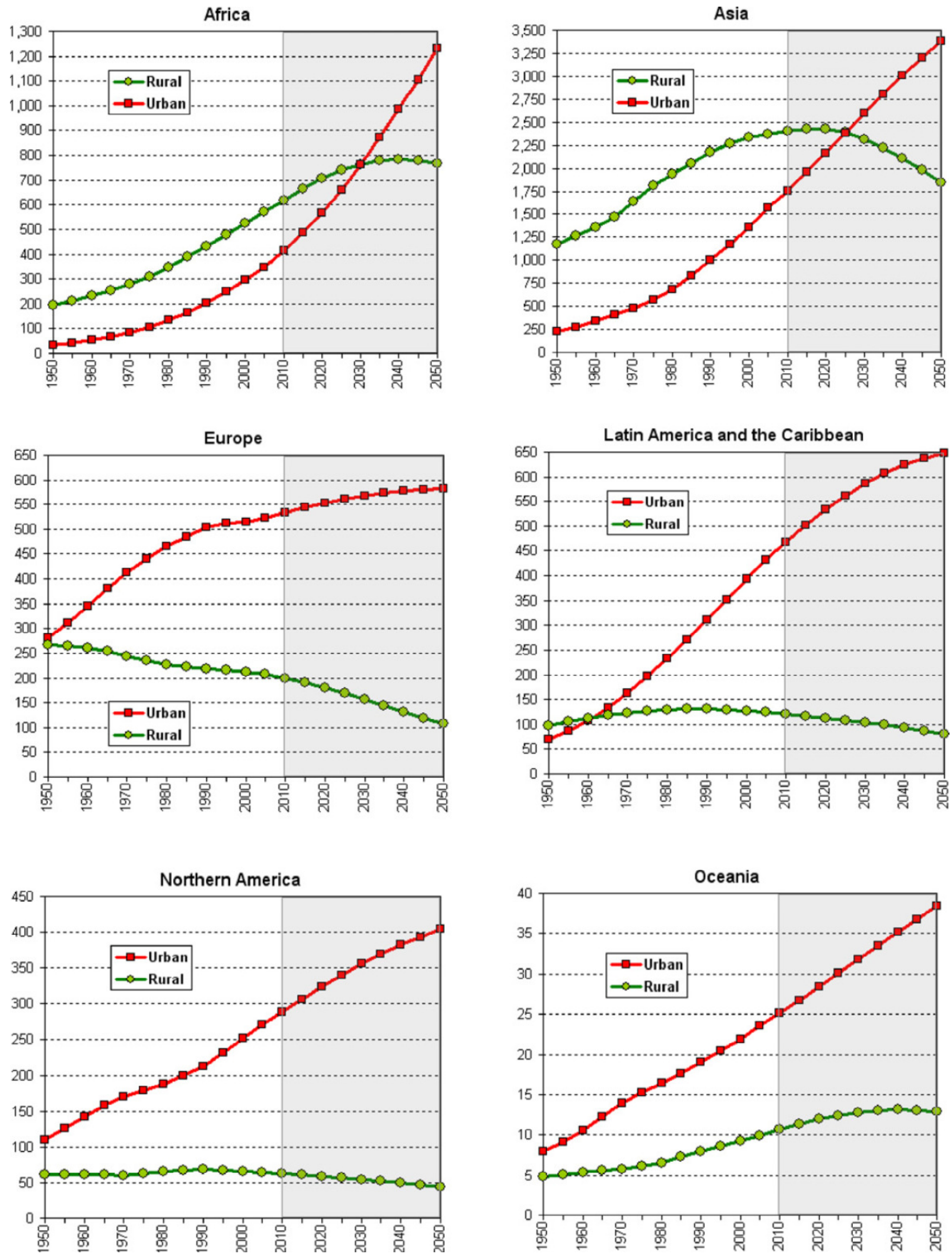
According to the latest United Nations' projections and as shown in Figure 1, virtually all of the world's population growth over the next 30 years will occur in urban areas (Cohen 2006). This is true for Sub-Saharan Africa (SSA) as well, which has the highest urban population growth rate of any region of the world. SSA's urban population will triple in the next 40 years, putting extreme pressure on public resources to respond and keep up (law and order, water, sanitation, housing, electricity, road infrastructure, security, etc.). The Economist reports that 70% of the people in SSA's cities are "slum dwellers" (Economist 2010). Much of the literature on Africa's urbanization speaks of population growth without income growth (e.g., Fox 2012; Potts 2009), but in recent years this appears to be changing. SSA has registered impressive growth in national GDP growth since the mid-2000s. Bottom line: there is substantial heterogeneity across SSA. But in any case, the literature stresses the need to plan for predictable urbanization by ensuring adequate public investments, urban service delivery and land for expansion of new low-income housing, or face serious problems.

de Brauw et al (2013) take a decidedly positive stance toward urbanization. They argue that urbanization occurs as an endogenous process of rising living standards. Migrants to urban areas have significantly higher levels of education than those staying behind (Anriquez 2007). de Brauw et al (2013) note that a large proportion of laborers in some African countries still reside and work in rural areas and that rural-urban migration rates are quite variable and low in some countries, being 1% or less (Figure 2), despite higher available returns to internal migration. "If those economies are to grow rapidly in a sustainable manner, additional rural-urban migration must occur" (p. 2). Support for this conclusion is provided by evidence presented later that a strategy of keeping people on the land will not be feasible in many rural areas where the potential for land expansion is limited, farm sizes are already exceedingly small, and further population growth will lead to even more land fragmentation.

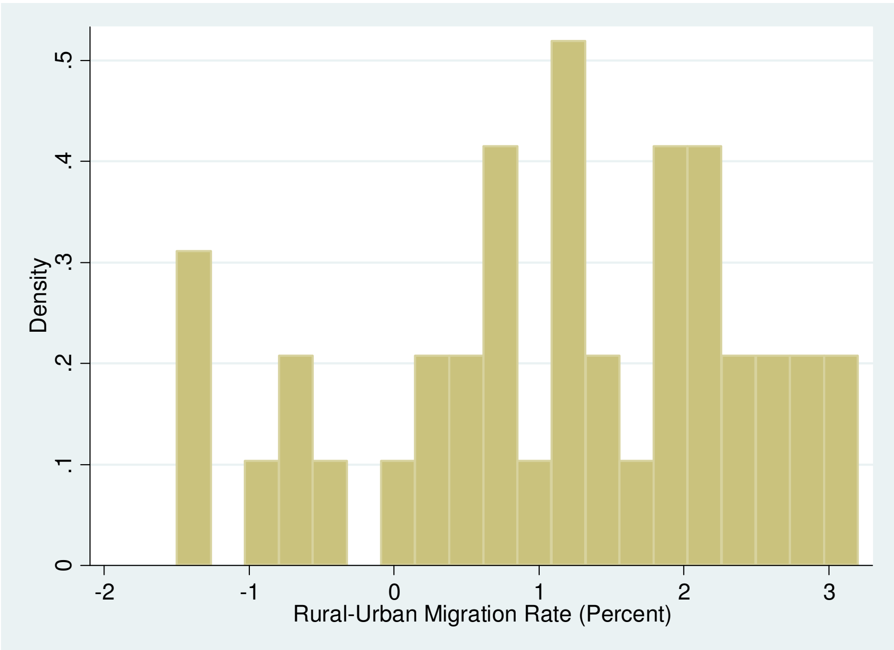
In the medium term, in SSA domestic rural-urban migration will continue to outweigh international migration both in terms of people mass and economic remittances mass. International migration does not affect all countries equally. Most international migrants come from former USSR republics, Eastern Europe, Northern Africa, and Central and North America, that is around the developed countries which are the greatest migration attraction poles. One way to look at the international migration phenomenon is to look at international remittances which are easier to track. The latest estimates of remittances from the World Bank for 2012 indicate that in 41 out of 213 countries surveyed international remittances amounted to more than 5% of GDP. Of these 41 countries, only 6 are from the SSA region, and only two were not from West Africa, Lesotho and Uganda. The latest figures on international migrants, also tell a similar story, relative to domestic populations, international migration is relatively higher (> 50 international migrants per one thousand inhabitants over a decade) in West African countries including islands, and Lesotho and Eritrea. Notwithstanding these figures, even in West African countries, which are better connected to Europe, international migration is outweighed by rural to urban migration. The impact of remittances that follow migration in rural households is harder to track, however Davis et al. (2010) in a household income comparative analysis of 15 countries show that transfers (which includes private, i.e. remittances, and public, i.e. pensions and subsidies, transfers) are not progressively distributed. This means the wealthier households receive more transfers, which is consistent with the hypothesis that it is not the poorest household that migrate, but those that are better-off and can cover the initial investments of a migrant. In the Davis et al. (2010) sample of countries, transfers in rural African households amounted to 6-8% of household income.

Why are urban areas of SSA generally growing rapidly? While there are many reasons, the one that probably provides the most explanatory power is that people migrate to urban areas when the wage they anticipate receiving in urban employment exceeds the returns to their labor in agriculture (Harris and Todaro 1970). Expectations turn out to be wrong for many, however, leading to unemployment and underemployment. The discrepancy between expected wage and actual wage appears consistent with why rural-urban migration occurs even while many remain underemployed in the cities. At the same time, however, rising cognizance of the travails of slum life may have something to do with why rural-urban migration are quite low in some countries (Figure 2) and why circular migration (periodic returns to rural areas) is common in some areas

**Figure 1. Changes in rural and urban population, projections to 2050.**




Source: Parnell and Walawege 2012.



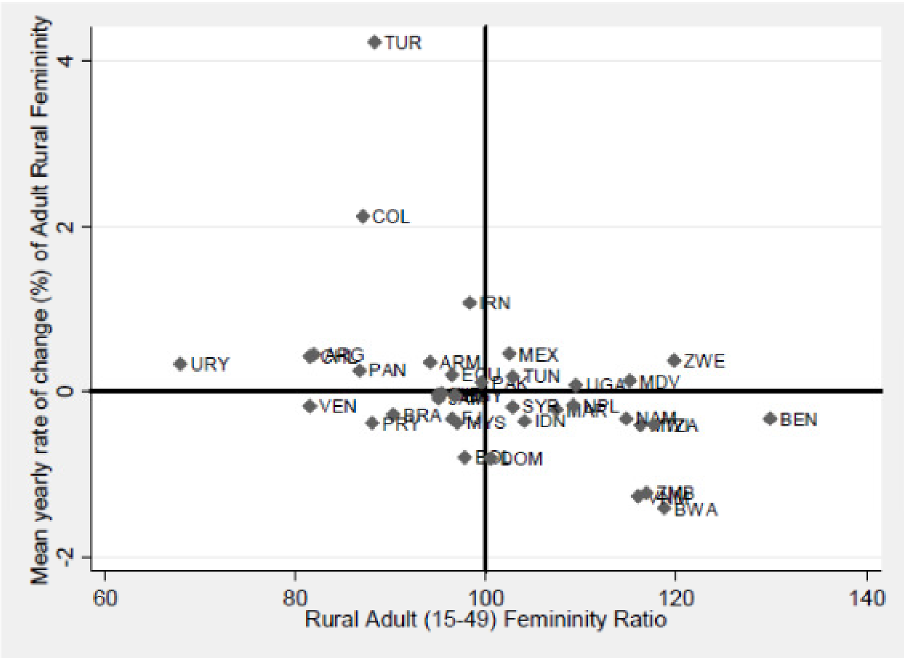

*Source:* CIESEN (2004), lifted from de Brauw et al (forthcoming).

**Figure 2. Number of Countries with Different Rural-Urban Migration Rates, 1990-2000, Sub-Saharan Africa**

(Potts 2009). Migration is predominantly male, which contributes to the fact that female:male ratios are as high as 1.16 to 1 in some areas of SSA (Anriquez 2007). In fact, the prime adult (15 - 49) rural female to male ratios in SSA are higher than in any other developing region.

The fact that rural femininity measured both as female to male ratios, or prevalence of female household headship is higher in the region does not amount to rising femininity in the region. Anriquez (2007) explores this issue carefully with the available data sources, namely household surveys and demographic censuses[3]. For example, out of 23 SSA countries with at least two Demographic and Health Surveys (DHS), rural female headship was increasing in 15 and decreasing in 8. Among the countries with increasing females headship are several muslin countries in the Sahel like Burkina Faso, Mali and Senegal where female household headship is limited. On the other hand, an inspection of the rural female to male ratios, using demographic censuses, shows that these ratios are not generally on the rise in the SSA region. As shown in Figure 3, female-to-male ratios tends to rise where they fall below 1, and decline when they raise above 1.

**Figure 3. Evolution of Rural Prime Adult (15 - 49) Femininity Ratios**



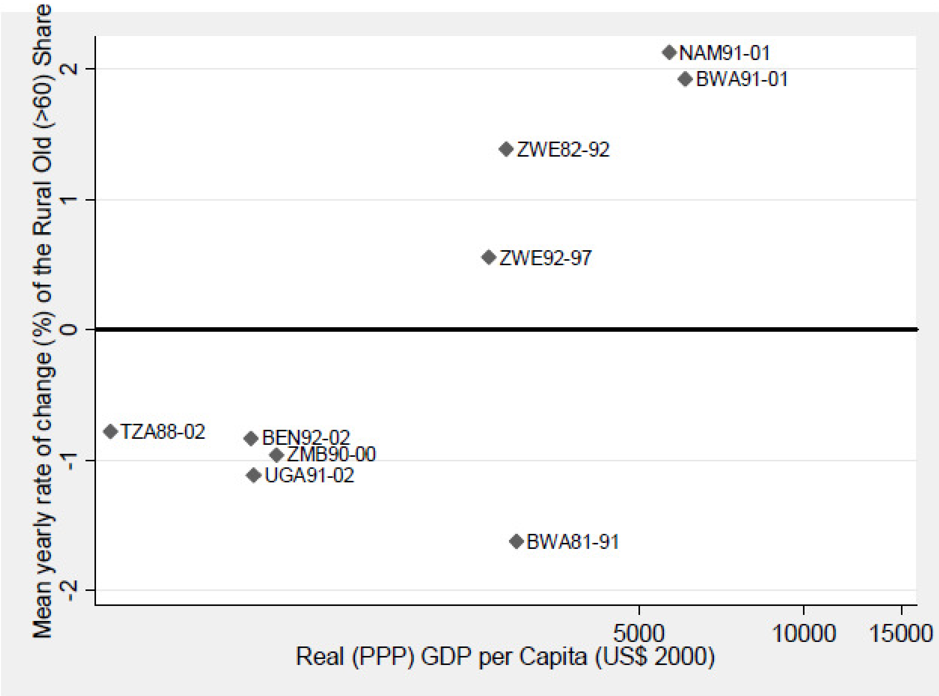

Source: Anriquez (2007).

Given documented cases in some villages/regions where war or the AIDS pandemic has contributed to a temporary ageing of household heads (and also productive heads), there has been growing concern among some experts about the risks of rapid ageing in SSA. The macro demographic evidence, at national, rural and regional level, shows that such concerns are unfounded.  There are two very clear demographic forces, namely the higher mortality rates, and higher fertility rates, that dominate and manifest in rural SSA with a younger population than any other developing regions. The different indicators show this relative youth, for example the average age of household heads in SSA is lower than any other region, also the share of older population (those older than 64) is lower in rural SSA than any other region. Furthermore, given the high fertility rates, and lower life expectancy, the rate at which the population ages in SSA is lower than other regions, as the evidence of both  household surveys and demographic censuses

[3] Agricultural censuses were not used for this task because they are sparsely available and many times do not delve into the farm/household demographics.

show, Anriquez (2007). As countries develop, they move along the demographic transitions and start to age faster as can be seen in figure xx.

**Figure 4. Rural Ageing in Sub Saharan Africa**




Source: Anríquez (2007)

One conclusion that emerges from the fact that SSA is becoming primarily urban is that efficiency gains – if they can be achieved either in domestic production and marketing systems or in global food production and marketing systems – will confer major benefits by putting downward pressure on food prices and raising disposable incomes. Productivity gains in domestic value chains will have greater effects on poverty reduction because of growth linkages between farm and non-farm sectors (Mellor 1976; Binswanger 2012). Therefore, an important research priority for the CG system is to reduce production costs of the crops constituting a large fraction of food expenditure shares in urban consumers' diets in SSA, e.g., especially grains (because of their importance in direct human consumption and indirectly through animal products) as well as fresh fruits and vegetables, oilseed and legume crops, and animal products.

### *2.2 How is urbanization affecting food systems?*

As Africa's population becomes more urbanized and assuming per capita incomes continue to rise, the strain of feeding Africa's cities will grow explosively. Partially because of rapid urbanization over the past 50 years, staple food consumption has outstripped production, leading to steadily increasing dependence on world markets for food in every region of SSA (Figures 3a to 3d). These trends in rising import dependence for staples is also a consequence of missed opportunities to promote agricultural growth (Badiane 2013; World Bank 2007), which at least suggests that the situation can be improved with the adoption of more growth-promoting policies and public investments.

Rising urban populations and import dependence presents a more favorable environment for local production, as prices consistently rise to import parity levels. Sub-Saharan Africa is increasingly dependent on the world market for food. Cereal imports are increasing dramatically (Mason *et al* 2012). There are several reasons for this: rapid urbanization, low agricultural productivity growth, and insufficient public goods investments in support of smallholder agriculture. The growing staple food deficit is largely being filled by wheat and rice (Figures 3 and 4), crops not commonly grown by smallholder African farmers. This trend is reducing the potential growth-producing multiplier effects between the farm and non-farm sectors of the economy. While urban consumer preferences appear to be shifting somewhat away from domestically produced to imported staples, this is not necessarily a deterministic future trend because consumption patterns are importantly a function how actively governments work to improve the competitiveness of domestic agriculture. If governments and donor agencies actively support crop science, adaptive research and extension programs, invest in road and rail infrastructure, support improved processing technologies for domestic crops such as cassava, and make other public goods investments that support private investments in agriculture, then urban food demand may increasingly be met through locally produced food, which would then provide advantages to the development of local marketing systems and confer more important urban-rural growth multipliers within local SSA economies. By contrast, a continued under-provision of public goods investments in support of smallholder agriculture is likely to further erode its competitiveness, exacerbate the region's growing dependence on imported staple foods, and increase the role of international firms in supplying domestic processing and retailing networks.

Urbanization is also causing changes in the composition of food demand. Urbanization is raising the demand for packaged convenience foods and requires substantial investment in food processing technology, which will most likely be provided by private firms. This food will be more processed, better packaged, more ready to eat, and must pass certain hygienic and safety standards. There will be a particular rise in the demand for processed foods. Minde et al (2011)

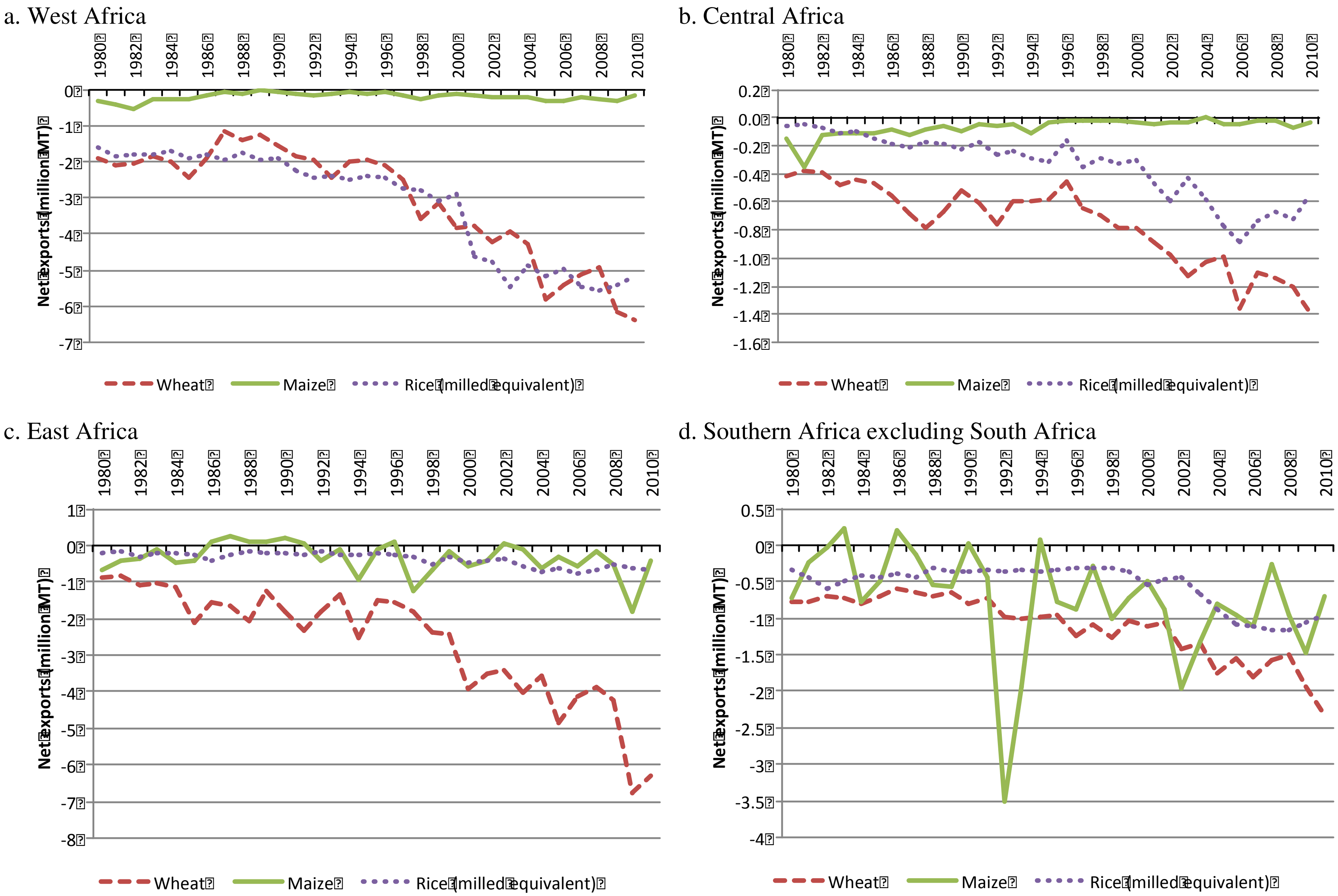



**Fig. 3.** Net exports of wheat, maize, & rice by region, 1980-2010. *Source:* Mason et al (2012) using FAO Stat Trade database

e. South Africa

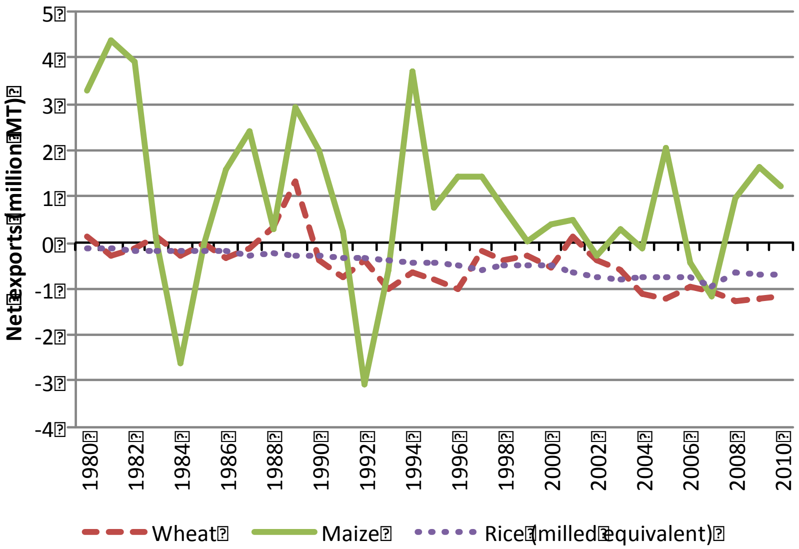



**Fig. 3** (cont'd)

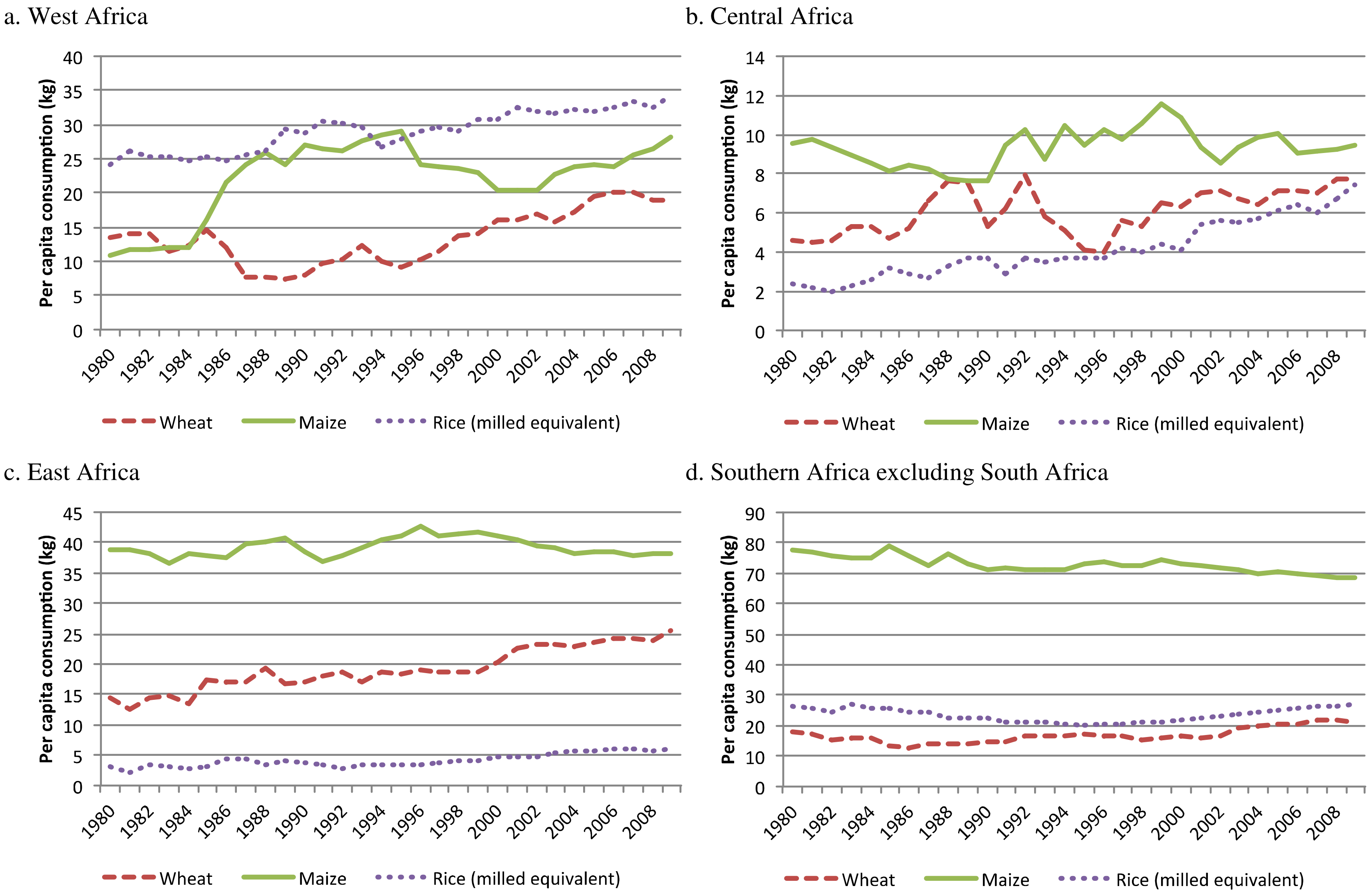



**Fig. 4.** Per capita consumption of wheat, maize, and rice by region. *Source:* Mason et al (2012) using FAOSTAT Commodity Balances and Population Databases.

e. South Africa

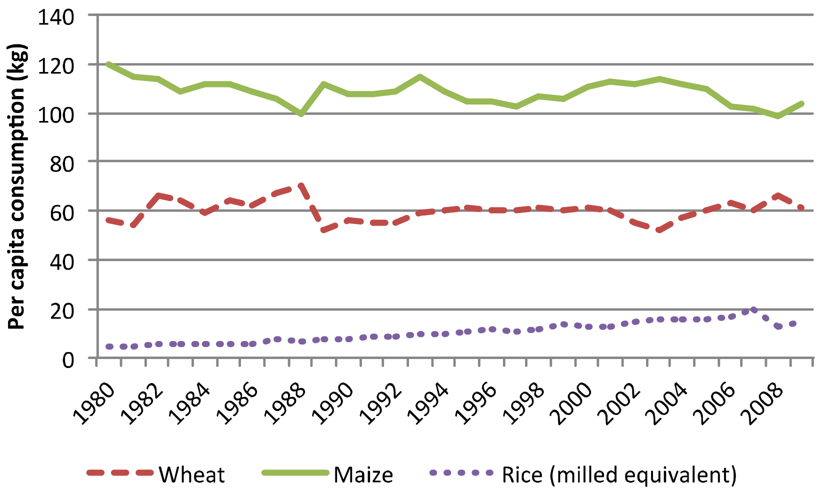



**Fig. 4** (cont'd)

show that formally processed food has substantially larger elasticities than unprocessed and informally processed food, and that the highest level of processing has by far the largest elasticity. These findings indicate that processing is going to take-up a progressively larger share of the food budget among African consumers as time goes on.

Minde *et al* (2011) also identify a shift in the "center of gravity" in the food system, from people working primarily on production issues (plant breeding, agronomy, extension agents) in public-sector institutions to people working on post-farm issues (storage, processing, food chemistry, food safety, transport, regulatory issues) in private firms. This "double pivot" – from public- to private and from farm- to post-farm – has major implications for the types of skills and attitudes that African educational and training institutions need to build over the next 40 years.

Though grains will remain the largest single category of budget shares for the foreseeable future, urban income growth will create substantial increased demand for fresh fruits and vegetables, beverages, and animal products. Quoting Minde et al (2011): "Beverages, both alcoholic and non-alcoholic, will grow at nearly 6% per year. At that rate, together they will attain nearly a 15% share of food expenditures by 2050. In third position, meat, poultry, and dairy products will grow between 3.5% and 5% per year. By 2050, they will account for 15% of food expenditures. Finally, healthy, fresh, high value foods such as fruits, vegetables and fish will grow steadily, though less explosively, at slightly over 3% per year. Overall, the growth of fresh products (meat, dairy, fresh produce) and processed products (beverages) suggests great growth downstream after the farm in activities such as processing and maintenance of cold chains" (p. 3). There is major scope for private investment in local production in these sectors but they are also experiencing widening import gaps because most SSA farmers lack the technical know-how to produce for the upper income urban market. Training and know-how to small-scale farmers to be able to meet the more exacting grade and standards of higher-income African urban consumers is likely to be an important area for CG system research, linked to private and public extension and outreach systems.

The full transition to import parity price surface for most food commodities should create substantial local and regional marketing opportunities for African farmers, but only if certain conditions are met: improved physical infrastructure including roads and rural electrification, transport and post-harvest infrastructure are improved; sufficient land is made available to rural communities for area expansion; regional trade agreements within Africa are forged and trade between African countries is encouraged and not constrained.

Kearney (2010) identifies obesity and cardiovascular disease as being on the rise in urban Africa as its dietary patterns become more "westernized". The nutrition transition traced out by the developed countries and by more urbanized, affluent developing economies in Asia and Latin America suggest that Africa will encounter serious nutritional hazards over the coming decades (Minde et al 2011). More broadly, Pinstrup-Anderson and Watson (2012) report that while one billion people suffer from hunger, another billion are overweight, including 23% of all Chinese, 40% of South African adults and 70% of Mexicans. Resulting problems of obesity, heart disease and diabetes impose heavy costs on human health, worker productivity and public health systems. Future CG research should consider both interrelated food sector and health issues to promote coherent policies that consider the human health implications of food systems development.

### *2.3 Supermarkets and traditional markets: near term projections*

The rapid rise of supermarkets in Africa has received great attention in recent years (Reardon and Timmer 2006). Several recurring themes in this literature concern the difficulties of traditional food distribution channels to compete with supermarket-driven supply chains, and fears over the marginalization of smallholders from participating in them. If supermarkets were able to capture a significant portion of consumers' food expenditures in Sub-Saharan Africa, and develop procurement channels back to the wholesale or farm level requiring exacting crop quality standards, then this would indeed raise major challenges for the viability of smallholder agriculture.[4]

However, the empirical evidence of supermarket penetration in Africa shows, so far, a minor influence. There is now a relative consensus that earlier warnings were premature, although the long-term trend is for supermarkets to become increasingly important. Humphrey (2007) concludes that "the extent of transformation of retailing…as a consequence of (supermarket expansion) is overestimated." In Kenya, where supermarkets had penetrated more than in any SSA country outside South Africa, Tschirley et al. (2006) show that supermarket chains held less than 2% of the national urban fresh produce market in late 2003. Also nearly all fresh produce purchases in these supermarkets were made by consumers in the top 20% of the income distribution. They calculate that, to reach a 10% market share in 10 years, supermarket sales of

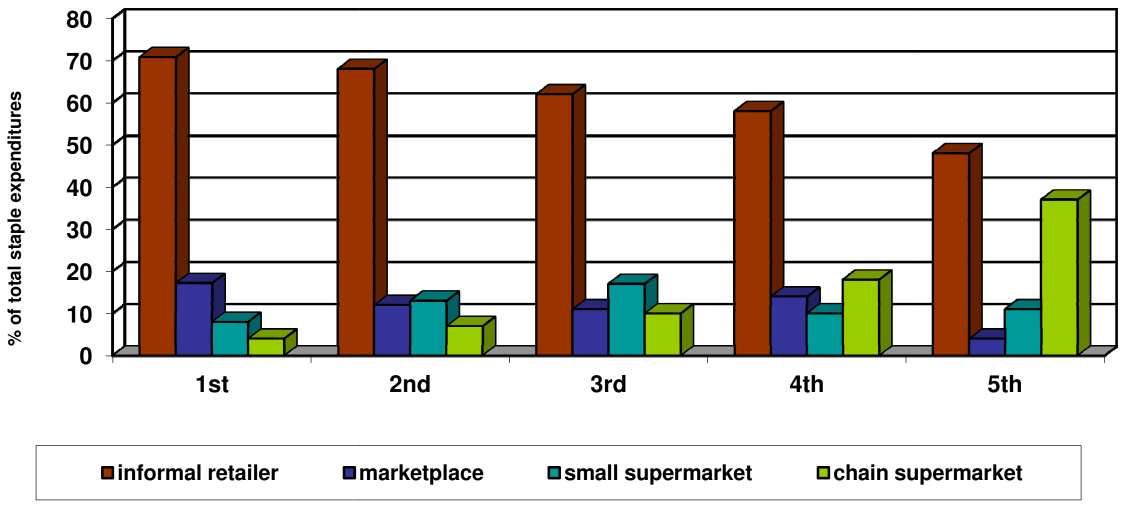
[4] The following quote encapsulates this view: "Our premise is that supermarkets will continue to spread over the (African) region … and thus their requirements will either gradually or rapidly, depending on the country, become those faced by the majority of farmers … Understanding those procurement systems … is thus a way of predicting what will be the challenges and opportunities facing farmers … *in the next 5-10 years"* (Weatherspoon and Reardon 2003; parentheses and emphasis added).

fresh produce would have to grow 22% per year in real terms. In a cross-country econometric analysis, Traill (2006) estimates that Kenyan supermarkets will hold at most a 16% share of total food sales by 2013; this would correspond to a 4%-5% share of fresh produce. Reardon and Timmer (2006) also indicate that there is "considerable uncertainty about the rate at which the supermarket sector will grow". In most of the rest of SSA, they deemed it "unlikely that…we will see supermarket growth for several decades."

A certain fear over export horticultural channels being captured by firms preferring to deal with larger farms (to the exclusion of smallholders) is also put into context by considering the fact that less than 10% of total horticultural production goes into export markets (even in relatively commercialized Kenya). Domestic demand constitutes by far the largest share of horticultural production and sales, and the domestic market accounted for over 90% of the total growth in Kenya's horticultural production between 1995 and 2004 (Tschirley 2007). As shown earlier, fresh fruits and vegetables now account for a larger share of smallholder revenue from crop sales than maize. Most of this growth in horticultural sales is due to expansion of the domestic market, not export demand. Clearly, the horticultural success story in Kenya is driven by rapid growth in local demand and the ability of smallholders to supply this market.

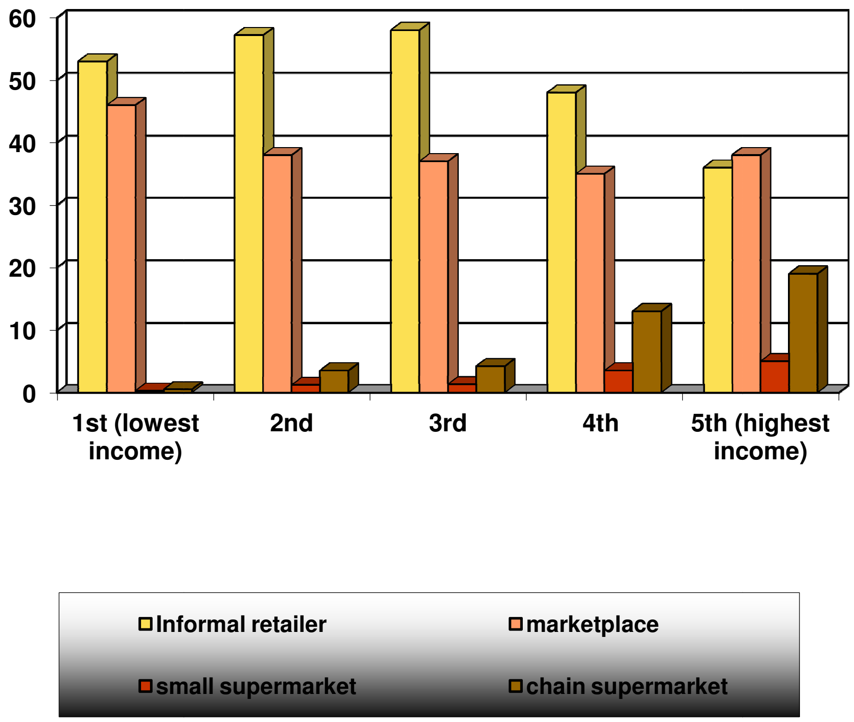
The situation is largely the same regarding the major food staples. Again even in the relatively modernized capital of Kenya, Nairobi, small kiosks, informal shops, and small independent stores accounted for 71% of consumers' expenditures of food staples (Jayne et al. 2010). Local open markets and small millers account for another 13%. The big supermarket chains accounted for 17% (Figure 5). Throughout the country, across all retail consumer food expenditures, the share of supermarkets is estimated to be roughly 3%.

**Figure 5. Shares of Consumers' Expenditures on Staple Food Products by Retailer Type, Nairobi, Kenya, 2003**




Source: Tegemeo Institute Urban Consumer Survey 2003.

**Figure 6. Shares of Consumers' Expenditures on Staple Food Products by Retailer Type, Four Cities of Zambia, 2008**




Source: Jayne et al., 2010.

In four urban centers of Zambia surveyed in 2007 and 2008, supermarkets were found to have only 5-17% market share for staple foods and are frequented mainly by households in the upper consumption quintiles Figure 6). Retail grocers/general dealers and market stands/stalls account for ~60% of total value of staple purchases and are commonly used by households across all consumption quintiles. This shows the staying power of small-scale, more 'traditional' retailers and that urban consumers are heavily dependent on non-supermarket/informal retail outlets, even in the more developed parts of the continent.

There are several important reasons why supermarkets' share of African consumer food expenditures will not grow much for the foreseeable future. Given that almost half of the populations of most African cities are below the poverty line, and another 30% are not far above it, the vast majority of urban African households will, for the foreseeable future, have relatively low disposable incomes (Ravallion et al 2007). Shopping patterns of the poor follow distinct patterns all over the developing world. They buy low value-added goods, in small units, with minimal processing and packaging. They lack easy access to transportation and hence tend to make most of their food expenditures within walking distance of their homes and work. An unrecognized large share of the urban poor's food expenditures is in the form of street food eaten purchased at small kiosks and from street vendors. For these reasons, informal corner stores in high-density neighborhoods, open markets, street kiosks, other traditional retail outlets – and the marketing chains that supply them – will remain the dominant food supply systems in most of Sub-Saharan Africa for the foreseeable future.

In light of this situation, a much greater priority should focus on upgrading the performance of urban wholesale and retail marketing systems and facilities on which the vast majority of smallholder farmers and consumers are likely to depend for the foreseeable future (Tschirley 2007). Currently, traditional wholesale markets are congested, unsanitary, sometimes unsafe, and difficult for trucks to move in and out smoothly. Squalid conditions add transaction costs and reduce consumer demand for products sold in these markets. More sanitary conditions with a modicum of amenities like clean water and toilets would help to solidify their position in the future development of the value chain, and with it, a greater chance that strong multiplier effects would benefit local farmers, traders, and associated local commerce. Public policy and investment to upgrading traditional wholesale markets will be a major determinant of how the sector evolves, and whether it promotes smallholder interests.

For these reasons, the more salient issues of wholesale and retail food modernization revolve around whether growing food demands of an increasingly urbanized continent will be met by local production or by imports, not whether it will be met by supermarkets or traditional channels. If smallholders are made more competitive by public goods investments (R&D, extension, farmer organization, physical infrastructure for regional trade, etc.), then many more smallholders will remain commercially viable in grain staples and other food crops, and will provide growth linkage effects that support overall economic development and poverty reduction. However, if governments continue to under-invest in these productivity-enhancing public goods, then international imports are likely to continue to penetrate local urban markets.

The FAO (2006) determined that of the $3.7 billion of cereals imported annually by African countries over the 1990-2005 period, only 5% of it was produced in other African countries. Regional trade is negligible as a proportion of total food trade. Between 1990/92 and 2002/04, cereal imports by Sub-Saharan Africa have been rising at 3.6% per year. If the region continues to slide increasingly into a structurally food deficit situation, this would affect the kinds of future investment we would expect to see in the staple food value chains. As an increasingly large share of African cities' food requirements is met from international imports, future investment by global firms is increasingly likely to be aimed at the milling and retailing stages – supplying mostly urban markets with internationally sourced grain, processing the grain into meal, flour, or bread, and distributing these staple products through retail channels, including small kiosks, local shops, open markets, and supermarkets. There is already strong evidence that global capital is investing rapidly in integrated milling and retailing of the main staple grain products. We would also expect new foreign direct investment in large-scale farming in the region to have advantages in meeting the requirements of large commercial mills. The unfolding of this scenario would make parts of Africa look increasingly like the Latin American *latafundia* model.[5]

[5] In the past several years, southern and eastern Africa has witnessed substantial foreign direct investment in large-scale food production. Many of the major milling firms in the region have also invested in large-scale farming. In Zambia alone, Olympia Milling, National Milling Corporation, Chimsoro Milling, and Mkushi Milling all have vertically integrated backward into large-scale food production. Large trading companies have also integrated into

*2.3 Harvesting the opportunities of urbanization: Smallholder market integration and urban agriculture.*

The growing demand for higher quality foods and more proteins brought about by rising urbanization in SSA, presents a growth opportunity for local farmers if they are able to enter the more modern value chains and supply the new growing demand. This opportunity may or may not be grasped by domestic farmers. The scenario in which infrastructure bottlenecks and limited savings/capital formation capacity of local farmers keep them away from these new opportunities which are covered by international markets, is also a very feasible outcome. Certainly, the degree of current integration of farmers to agricultural markets can help us predict these outcomes.

**Table 1. Rural Household Market Participation**

| | (%) Rural Households | | | | Share (%) of Crop Output Sold | |
|---|---|---|---|---|---|---|
| | Participate in Agricultural Output Markets | Farm Oriented Households | | | | |
| | | Market | Subsistence | Total | 1st Land Quintile | 5th Land Quintile |
| Malawi 2004 | 70 | 20 | 14 | 34 | 10 | 22 |
| Nepal 1996 | 67 | 17 | 8 | 25 | 10 | 35 |
| Madagascar 1993 | 94 | *na* | *na* | 54 | 51 | 49 |
| Bangladesh 2000 | 66 | 4 | 2 | 6 | 33 | 48 |
| Ghana 1998 | 71 | 13 | 41 | 54 | 26 | 36 |
| Vietnam 1998 | 92 | 38 | 4 | 41 | 32 | 65 |
| Nigeria 2004 | 66 | 11 | 60 | 71 | *na* | *na* |
| Pakistan 2001 | 51 | 29 | 2 | 31 | 63 | 78 |
| Nicaragua 2001 | 80 | 18 | 4 | 21 | 36 | 34 |
| Guatemala 2000 | 57 | 4 | 7 | 11 | 18 | 40 |
| Albania 2005 | 79 | 9 | 10 | 19 | 11 | 26 |
| Ecuador 1995 | 62 | 14 | 11 | 25 | 11 | 43 |
| Bulgaria 2001 | 28 | 4 | 1 | 5 | 2 | 13 |
| Panama 2003 | 49 | 1 | 5 | 6 | 6 | 23 |

Sources: Built from tables in Davis et al. (2007), and Zezza et al. (2011).
Notes: Farm-oriented households are defined as those deriving more than 75 percent of their total household income from farm production. This does not necessarily imply that their farm income is high or even above established poverty lines. Farm/market-oriented households are defined as those for which more than 50 percent of agricultural production is sold on markets. Farm/ subsistence-oriented households: less than or equal to 50 percent of agricultural production sold on markets.

production. Export Trading Corporation, for example, acquired a 51% share in the former Commonwealth Development Corporation farm at Mpongwe, which is capable of producing 30,000 mt of maize per year. These moves reflect a bet that future food demand will outstrip available supplies in the region, and that local investment in large-scale food production can minimize landed costs of maize to the major urban mills compared to imports.

A long term study done at the FAO dissecting the sources of rural household income, presents some troubling evidence. Table 1 shows that, as expected, farm households, i.e. those that derive at least 75% of household income from own agricultural activities are the most prevalent type of household in rural SSA. This is consistent with most of the region being at a relatively early stage of development, before the expected secular decline of agriculture as experienced in other regions of the world. However, Table 1 also shows that most of these households that depend on agriculture are subsistence farms, selling less than 50% of their generally low levels of output. In SSA, the evidence indicates that most farms are subsistence farms, poorly integrated with agricultural markets. This situation is the contrary to what is observed in Asia (i.e. Vietnam, Pakistan), where most farms are integrated to output markets. Table 1 also shows that, perhaps with the exception of Madagascar (a country with favorable agricultural conditions, see below), even the largest farms ($5^{th}$ quintile of the agricultural land distribution) sell only a small portion of their output to the market. Altogether, the evidence indicates, that the new opportunities for agricultural markets conveyed by increasing urbanization in SSA will probably not be enjoyed by the great mass of SSA farms if existing production and marketing barriers are not comprehensively addressed.

Another important segment of the agricultural sector that may benefit from growing urban food demand is the urban agricultural area which, because of its proximity to urban markets, enjoys important relative advantages. It must be first noted that urban agriculture is more prevalent, and economically important than what is usually acknowledged (Table 2). In SSA, 3 to 4 out of ten urban households have some participation in agricultural activities, higher than in most of Asia and Latin America. A large portion of these agricultural activities take place around small urban enclaves in the rural landscape. Furthermore, not only the prevalence of rural agriculture is high, but its relative importance in urban households' income is higher than what is usually thought, as shown in Table 2. Also, urban agriculture plays an important role in urban food security, as shown in Zezza (2010), and Anriquez et al. (2013)

**Table 2. The Size of Urban Agriculture in Developing Countries**

| | % Urban HH Participating in Agricultural Activities | % of Urban HH Income from Agriculture |
|---|---|---|
| ***Africa*** | | |
| Ghana 1998 | 41 | 18 |
| Madagascar 2001 | 33 | 21 |
| Malawi 2004 | 46 | 12 |
| Nigeria 2004 | 32 | 27 |
| ***Asia*** | | |
| Bangladesh 2000 | 30 | 3 |
| Indonesia 2000 | 11 | 3 |
| Nepal 2003 | 57 | 11 |
| Pakistan 2001 | 14 | 3 |
| Vietnam 1998 | 69 | 9 |
| ***Eastern Europe*** | | |
| Albania 2005 | 19 | 3 |
| Bulgaria 2001 | 27 | 2 |
| ***Latin America*** | | |
| Ecuador 1995 | 35 | 2 |
| Guatemala 2000 | 42 | 5 |
| Nicaragua 2001 | 68 | 5 |
| Panama 2003 | 34 | 1 |

Source: Zezza and Tasciotti (2010)

## 3. LAND ISSUES IN AFRICAN AGRICULTURE[6]

The use of SSA's vast unutilized arable land will continue to be determined by the longstanding and ongoing struggles between chiefs and states (Herbst 2000). Land in the hands of traditional authorities is mainly reserved for crop area expansion by smallholder farmers. The most likely scenario is that central governments will progressively wrest control of land and water rights from the traditional authorities, although the pace of this will vary considerably across the continent. Such trends will make inclusive, broad-based agricultural growth more difficult and impede structural transformation processes unless some as yet unforeseen source of dynamism enters the scene to productively absorb rural labor out of agriculture. Current trends in land allocation suggest a bigger future role for large-scale commercial investors and urban-based individuals who are able to gain access to land through the political process, often at heavily discounted prices. While evidence is scantly, case studies show that typically only a small proportion of the land acquired through these state processes is productively utilized and that land speculation and "bonanza farms" are common (Deininger and Byerlee 2011). These processes, if continued, will impede the rate of growth at which new land is put into production until land markets develop to put more land into the hands of those with the skills to farm it productively.

### *3.1 How much land is available for farming in Sub-Saharan Africa?*

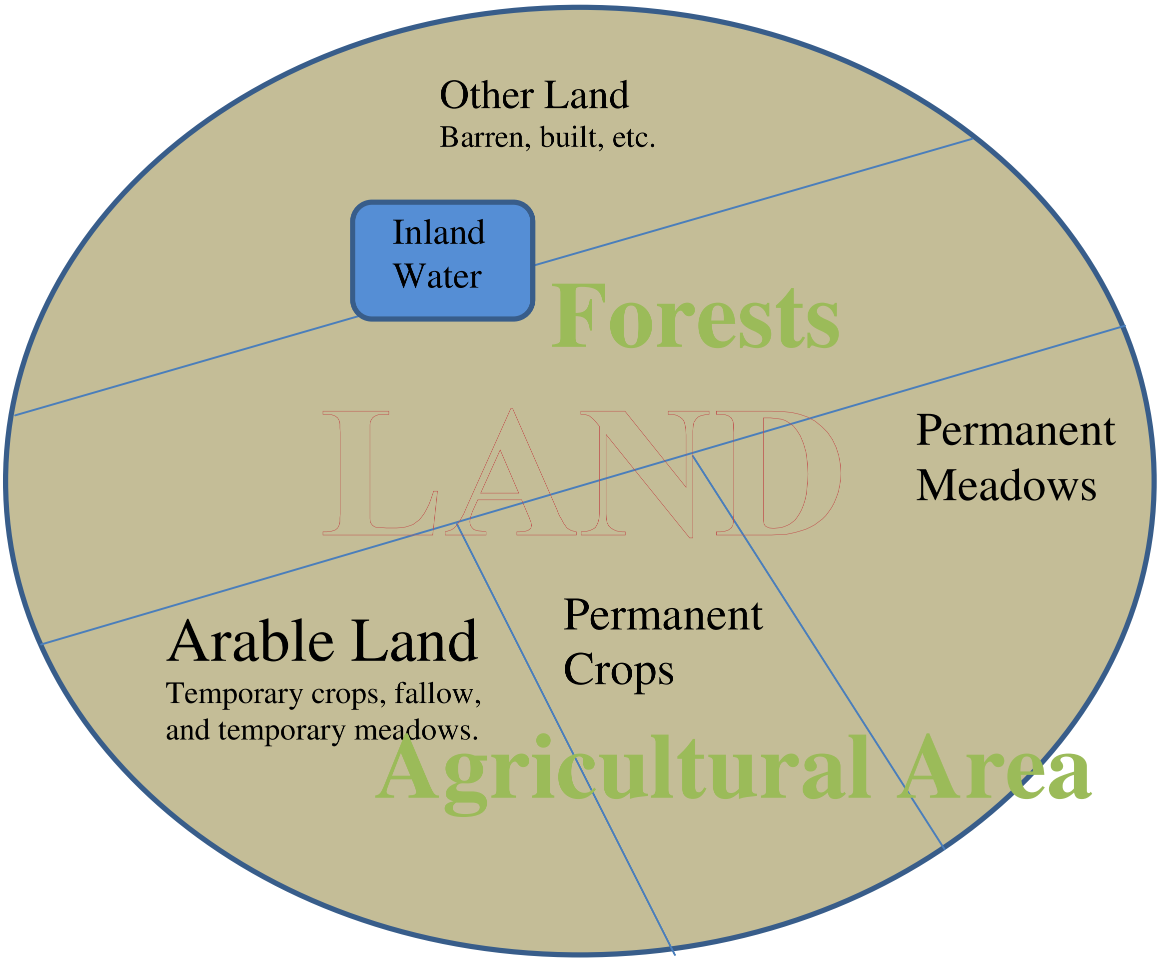
Figure 7 shows how land use is usually measured. "Agricultural land" is not a meaningful indicator of the land that could be put under crop production, because permanent pastures and meadows which are included in agricultural land represents land that is often unproductive or not used economically at all. Neither is "arable land" a good indicator of crop production capacity, because it does not account for potentially cultivable land, includes land not under current production (i.e. land under fallow), and ignores cultivated land that is occupied by permanent crops, some of which are very important for food security like cassava or bananas. "Cultivated land" typically includes both land under permanent and temporary crops and is an indicator of the quantity of land as an agricultural input.[7]

Land use is very fluid and dynamic. For example, a country with a growing agricultural sector will expand its area under cultivation, moving the agricultural frontier into permanent pastures and/or forests. Rural population growth will also increase the land used by agriculture, sometimes in an unsustainable fashion. Similarly, the introduction of a new technology, like drip irrigation, can increase cultivated area using the same amount of water resources, expanding agricultural land use. In general, the opportunity cost of land alternative uses over time determines its use profile. This process is not unidirectional, sometimes the agricultural frontier shrinks, and these swings can be severe; like the case of Kazakhstan, a large agricultural player of the USSR, which after its demise shrunk its cultivated land use by almost 40% between 1992 and 2000.

[6] Some material in this section is drawn from Jayne, Chamberlin, and Muyanga (2012) and Headey, Jayne and Chamberlin (forthcoming).
[7] More explicitly: cultivated land = arable land + land under permanent crops – fallow land – temporary meadows.

In SSA, cultivated land has been growing at an average of 1.1% between 1990 and 2009, with the pace picking up in the last eight years, with a mean growth rate of 1.6% per year. Table 3 presents the broad picture of land use in Africa in the year 2005.[8] The table shows that, for the continent as a whole, only 20% of the agricultural land is cultivated. At the same time, agricultural land is 40% of the total land in the continent. Most of this agricultural land, roughly 80% is permanent pastures, a proportion that is higher than in other regions of the world; at a global level 69% of agricultural land are permanent pastures and meadows. Obviously there is great regional heterogeneity. Southern Africa, the Indian Ocean Islands (mostly Madagascar), and the Gulf of Guinea (West Africa) all have agricultural land that exceeds half of their total land area. On the other hand, Eastern Africa, and the Gulf of Guinea have a larger share of their agricultural land that is under cultivation 34 and 44% respectively.

**Figure 7. Composition of Country Area**




[8] The year 2005 is chosen to ensure comparability with other estimates of land availability and irrigation presented in this section.

**Table 3. Distribution of Agricultural Land in Africa in the year 2000 (1,000 ha)**

| Region[*] | (1) Arable Land | (2) Permanent Crops | Cultivated Land | As % of Agric. Land | (3) Perm. Meadows | (1)+(2)+(3) Agricultural Land | As % of Total Land | Forests as % Total Land |
|---|---|---|---|---|---|---|---|---|
| Central | 18,838 | 2,617 | 21,455 | 19.4 | 88,969 | 110,424 | 21.1 | 58.2 |
| Eastern | 35,733 | 5,316 | 38,267 | 33.9 | 71,822 | 112,871 | 41.7 | 20.7 |
| Gulf of Guinea | 51,506 | 11,690 | 62,525 | 44.4 | 77,530 | 140,726 | 68.2 | 23.4 |
| Indian Oc. Islands | 3,124 | 660 | 3,784 | 9.2 | 37,315 | 41,099 | 70.1 | 22.0 |
| Northern | 22,676 | 5,180 | 21,499 | 21.5 | 72,276 | 100,132 | 17.4 | 1.4 |
| Southern | 30,362 | 1,501 | 31,425 | 12.1 | 228,510 | 260,373 | 55.8 | 30.1 |
| Sudano-Sahelian | 54,162 | 545 | 48,227 | 12.6 | 327,536 | 382,243 | 45.6 | 14.4 |
| **Sub Saharan Africa** | **193,725** | **22,329** | **205,683** | **19.6** | **831,682** | **1,047,736** | **44.3** | **28.9** |
| **Africa** | **216,401** | **27,509** | **227,182** | **19.8** | **903,958** | **1,147,868** | **39.1** | **23.5** |
| **World** | **1,386,132** | **143,198** | **na** | **na** | **3,385,191** | **4,914,521** | **37.8** | **31.2** |

Notes: Data corresponding to the year 2005, available at FAOSTAT.

*The Central region is composed of Angola, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, and Gabon. Burundi, Ethiopia, Kenya, Rwanda, Uganda, and Tanzania make up the Eastern region. The countries of West Africa: Benin, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone, and Togo are included within the Gulf of Guinea region. The islands in the Indian Ocean are Comoros, Madagascar, Mauritius, and Seychelles. The Mediterranean countries of Algeria, Egypt, Libya, Morocco, and Tunisia comprise the Northern region. The Southern region includes: Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe. Finally, the countries included in the Sudano-Sahelian region are Burkina Faso, Cape Verde, Chad, Djibouti, Eritrea, Gambia, Mali, Mauritania, Niger, Senegal, Somalia, and Sudan.

The issue of how much land is still available in SSA for additional cultivation is an essential question to understand future prospects of the sector in the continent. A naïve approach would be to count all currently available agricultural land as cultivable. However, this would be misguided because much of these permanent meadows are located in semi-arid zones that cannot sustain traditional staple crops. How much land is available for cultivation depends on the economic incentives and the technology available. Given high enough prices of agricultural commodities, arid places can turn green, and even high-sloping lands can sustain crops. In spite of these inherent difficulties, there are two important studies attempting to quantify the potentially available land for agriculture. First, FAO (2005) gathered all country-level information regarding assessments to all potentially cultivable lands, and completed the information with FAO experts where there were no local assessments available. Methodologies and assumptions vary by country, including the inclusion of forest, but this work provides a summary of mostly local expert opinion. The other attempt in the literature is the work by Fischer and Shah (2010). They take a Geographic Information Systems (GIS) approach. They first identify agro-ecological zones that are favorable for rainfed cultivation of any of the following staples: wheat, maize, soybean, sugarcane, oil palm. Then they identify within these zones, the areas that are not currently used (agriculture, buildings, etc.) or are protected areas (i.e. national parks). Finally, they identify within these unprotected areas with potential for the growth of staples, the areas with population densities below 25 persons per $km^2$. By using this low population density threshold of roughly 20 ha per households, this methodology is not only identifying available cultivable land, but that which is mostly untapped.

**Table 4. New land that can potentially be brought into cultivation (1000 ha)**

| | FAO (2005) | | Fischer and Shah (2010) | | | |
|---|---|---|---|---|---|---|
| **Region** | Cultivable FAO | As % of Agricultural Land | Suitable for Agriculture | As % of Agricultural Land | Of Which Non-Forest | As % of Agricultural Land |
| Central | 168,927 | 153.0 | 168,620 | 152.7 | 49,207 | 44.6 |
| Eastern | 43,202 | 38.3 | 23,199 | 20.6 | 18,000 | 15.9 |
| Gulf of Guinea | 52,930 | 38.3 | na | na | na | na |
| Indian Oc. Islands | 4,450 | 10.9 | 18,624 | 45.6 | 16,244 | 39.8 |
| Southern | 75,195 | 31.2 | 55,307 | 23.0 | 32,831 | 13.6 |
| Sudano-Sahelian | 160,011 | 41.9 | 74,057 | 19.4 | 68,462 | 17.9 |
| **Sub Saharan Africa** | **504,716** | **49.2** | **364,917*** | **35.6** | **201,540*** | **19.7** |
| **World** | **na** | | **775,211** | | **445,624** | |
| **Countries with most potentially cultivable land in Africa** | | | | | | |
| Congo, Dem. Rep. | 72,550 | 323.2 | 98,258 | 437.7 | 22,498 | 100.2 |
| Mozambique | 31,610 | 64.8 | 24,503 | 50.3 | 16,256 | 33.3 |
| Sudan (former) | 89,612 | 65.9 | 49,906 | 36.7 | 46,025 | 33.8 |
| **Sub Total** | **193,772** | **93.5** | **172,667** | **83.3** | **84,779** | **40.9** |

Notes: * Regions do not sum to total as individual country-level data is incomplete both in Fischer and Shah (2010), and in Deininger and Byerlee (2010).

Table 4 presents both estimates of new land that can be brought into cultivation. Given that the second methodology restricts the potential land to low-density areas, we expect FAO (2005) estimates to be above those of Fischer and Shah (2010), which is generally confirmed in the table. Deininger and Byerlee (2010) center their attention in non-forest available land, however the land that first gets converted is that which is most suitable, both from an economic (proximity to markets) and biophysical perspective (i.e. soil fertility, climatic suitability). Even with the higher costs involved in changing forests into cultivated land, compared to pastures, the most suitable lands may be covered by forests, which is why the preferred availability indicator is total available land suitable for agriculture. Table 4 also shows that in the Fischer and Shah

(2010) study, Africa accounted for roughly 50% of total additionally available land, a very high share that is probably driven by the strict population threshold applied, unlikely to be found in most of Asia, Europe and important sections of Latin America.

Cultivable land availability is not equitably distributed across the continent. The available cultivable land is highly concentrated. Between 64 and 70% of all agricultural land still available for crop production is located in the Central and Sudano-Sahelian regions. Furthermore, as the table shows in the latter rows, these regional weights are carried by DR Congo in the Central region, and Sudan in the Sudano-Sahelian region. Furthermore, even though the outlook with regards to future cultivable land availability looks positive, provided that Africa has a potential to grow from current cultivation usage by 35 to 50% (depending on the source), this availability shown is highly localized, as shown in more detail in section 3.3.

Table 5 shows the distribution of underutilized land across SSA countries. Land available for cropland expansion is highly concentrated in just a few countries. The Democratic Republic of Congo (DRC) alone has almost half of SSA unutilized non-forest land, while the top six countries contain over 80 percent. About 40 countries of SSA have very limited potential for additional expansion of non-forest land.

**Table 5. Land availability in African countries**

| | Non-forest (1000s Ha) | Proportion | Cumulative Proportion |
|---|---|---|---|
| DRC | 84824 | 46.5% | 46.5% |
| Angola | 18889 | 10.4% | 56.9% |
| Congo | 12872 | 7.1% | 63.9% |
| Zambia | 10834 | 5.9% | 69.9% |
| Cameroon | 10447 | 5.7% | 75.6% |
| Mozambique | 8994 | 4.9% | 80.5% |
| CAR | 7049 | 3.9% | 84.4% |
| Gabon | 6534 | 3.6% | 88.0% |
| Sudan | 5803 | 3.2% | 91.2% |
| Tanzania | 4313 | 2.4% | 93.5% |
| Madagascar | 2718 | 1.5% | 95.0% |
| Zimbabwe | 2142 | 1.2% | 96.2% |
| Chad | 1520 | 0.8% | 97.0% |
| South Africa | 1219 | 0.7% | 97.7% |
| Kenya | 807 | 0.4% | 98.2% |
| Mali | 800 | 0.4% | 98.6% |
| Burkina Faso | 655 | 0.4% | 99.0% |
| Ethiopia | 651 | 0.4% | 99.3% |
| *Rest of Africa* | 1259 | 0.7% | 100.0% |

Notes: Estimates of underutilized land extents are drawn from Fischer and Shah (2010). The methods are explained in Chapter 3 of Deininger and Byerlee (2011).

Most of sub-Saharan Africa has witnessed a gradual but steady decline in mean farm size over the past 50 years as rural population growth has outstripped the growth in arable land. Table 6 shows the changes in the ratio of land cultivated to agricultural population over the past five decades for a number of African countries. About half of the countries in Table 6 show a substantial decline in land-to-labor ratios in agriculture. In Kenya's case, for example, cultivated land per person in agriculture has declined from 0.462 hectares in the 1960s to 0.219 hectares in the 2000-08 period. A consistent story emerges from farm survey data; most but not all countries show a gradual decline in median and mean farm size over time.

**Table 6. Hectares of arable land per person in agriculture (10 year average) in selected countries**

| | 1960-69 | 1970-79 | 1980-89 | 1990-99 | 2000-09[1] | 2000-09 land-person ratio as % of 1960-69 |
|---|---|---|---|---|---|---|
| Ethiopia | 0.501 | 0.444 | 0.333 | 0.224 | 0.218 | 43.5% |
| Zambia | 0.643 | 0.607 | 0.398 | 0.342 | 0.297 | 46.2% |
| Kenya | 0.462 | 0.364 | 0.305 | 0.264 | 0.219 | 47.4% |
| Uganda | 0.655 | 0.569 | 0.509 | 0.416 | 0.349 | 53.3% |
| Malawi | 0.480 | 0.466 | 0.357 | 0.304 | 0.307 | 64.0% |
| Zimbabwe | 0.613 | 0.550 | 0.452 | 0.420 | 0.469 | 76.5% |
| Rwanda | 0.212 | 0.213 | 0.195 | 0.186 | 0.174 | 82.1% |
| Mozambique | 0.356 | 0.337 | 0.320 | 0.314 | 0.294 | 82.6% |
| Ghana | 0.646 | 0.559 | 0.508 | 0.492 | 0.565 | 87.5% |
| Nigeria | 0.982 | 0.860 | 0.756 | 0.769 | 0.898 | 91.4% |

Source: FAO STAT (2010).
Notes: Data on land utilization is only available for the period 2000 to 2008. Land-to-person ratio = (arable land and permanent crops)/(agricultural population). For the periods 1960-69 and 1970-79, agricultural population is estimated by multiplying rural population by an adjustment factor (mean agricultural population 1980-84/mean rural population 1980-84). This is because data on agricultural population was only collected from 1980 onward.

There is a widespread view that sub-Saharan Africa is a land abundant region with low rural population density. Tables 7a and 7b present the distribution of rural population density in 10 countries according to the Global Rural-Urban Mapping Project (GRUMP) and AfriPop spatial databases described in the data section. Use of these data allows for much greater localized variation in rural population densities than has been typically reported previously using more aggregated spatial units.

Both data sources indicate great variation in rural population densities. While the bottom 50 percent of the rural population in all countries live in relatively sparsely populated areas, conforming to conventional perceptions, a sizeable proportion of the rural population are in heavily populated areas exceeding 500 persons per $km^2$ of arable land (defined as cultivated and fallow land plus grasslands). According to the GRUMP data in Table 7a, over 25 percent of the rural population lives in areas exceeding 500 persons per $km^2$ of arable land in five of the 10 countries examined in this study. According to AfriPop (Table 7b), at least 25 percent of the rural population lives in areas exceeding 500 persons per $km^2$ in six of these 10 countries.

**Table 7a. Rural population density distribution on land categorized as arable, GRUMP 2010**

| | Percentiles of all pixels with arable land ranked by population density | | | | | | | Mean across |
|---|---|---|---|---|---|---|---|---|
| | 5th | 10th | 25th | 50th | 75th | 90th | 95th | all pixels |
| Ethiopia | 20 | 55 | 121 | 183 | 296 | 563 | 816 | 278 |
| Ghana | 25 | 40 | 87 | 159 | 258 | 501 | 1,294 | 336 |
| Kenya | 18 | 55 | 221 | 575 | 1,202 | 2,186 | 3,126 | 996 |
| Malawi | 96 | 127 | 209 | 365 | 682 | 1,574 | 2,497 | 1,228 |
| Mozambique | 12 | 20 | 42 | 90 | 208 | 1,011 | 2,105 | 520 |
| Nigeria | 47 | 61 | 119 | 236 | 580 | 1,335 | 1,902 | 579 |
| Rwanda | 222 | 354 | 510 | 641 | 828 | 1,239 | 1,834 | 841 |
| Tanzania | 15 | 26 | 52 | 83 | 183 | 379 | 697 | 359 |
| Uganda | 65 | 109 | 232 | 404 | 646 | 1,086 | 1,823 | 825 |
| Zambia | 7 | 9 | 17 | 30 | 50 | 77 | 140 | 60 |

Source: Year 2010 population estimates from GRUMP.

Notes: These estimates are based on all 1 $km^2$ grid cells ("pixels") categorized as rural. Urban and peri-urban areas, as defined by GRUMP, were not included. Pixels with more than 2000 persons were also not included in analysis. Arable land, used in the denominator of population density estimates, was defined as cultivated land + grasslands, as defined by GAEZ 3.0 database.

**Table 7b. Rural population density distribution on land categorized as arable, AfriPop 2010**

| | Percentiles of all pixels with arable land ranked by population density | | | | | | | Mean across |
|---|---|---|---|---|---|---|---|---|
| | 5th | 10th | 25th | 50th | 75th | 90th | 95th | all pixels |
| Ethiopia | 19 | 40 | 104 | 182 | 342 | 762 | 1,112 | 328 |
| Ghana | 22 | 43 | 136 | 520 | 1,650 | 2,799 | 3,366 | 1,788 |
| Kenya | 15 | 43 | 184 | 490 | 1,115 | 2,148 | 2,908 | 936 |
| Malawi | 90 | 112 | 169 | 274 | 440 | 944 | 1,477 | 589 |
| Mozambique | 9 | 16 | 34 | 73 | 145 | 438 | 1,345 | 249 |
| Nigeria | 32 | 45 | 88 | 258 | 988 | 2,139 | 2,825 | 780 |
| Rwanda | 209 | 287 | 442 | 699 | 1,149 | 1,826 | 2,406 | 1,119 |
| Tanzania | 16 | 29 | 75 | 201 | 686 | 1,729 | 2,749 | 1,281 |
| Uganda | 58 | 94 | 187 | 339 | 725 | 1,482 | 2,164 | 1,039 |
| Zambia | 6 | 9 | 16 | 31 | 58 | 167 | 488 | 191 |

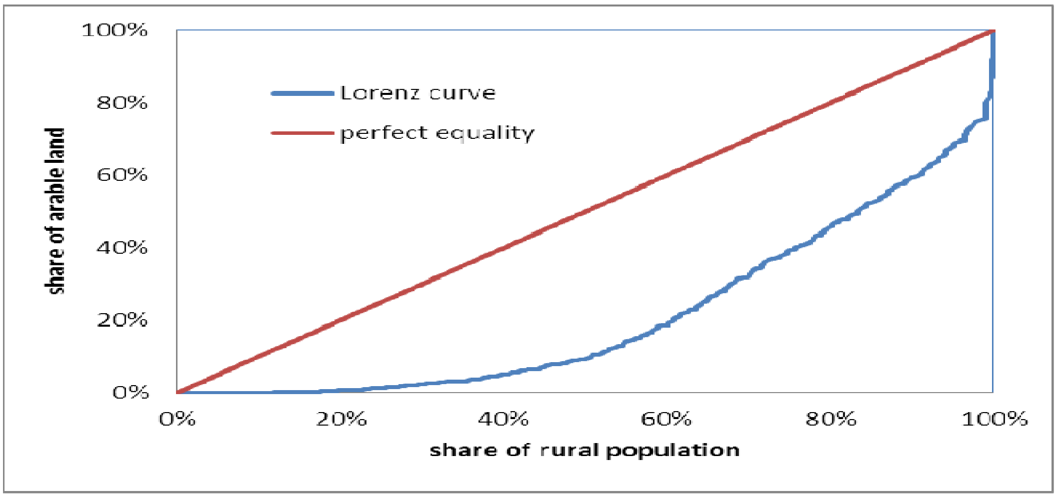
Source: Year 2010 population estimates from AfriPop.
Notes: These estimates are based on all 1 $km^2$ grid cells ("pixels") categorized as rural. Urban and peri-urban areas, as defined by AfriPop, were not included. Pixels with more than 2000 persons were also not included in the analysis. Arable land, used in the denominator of population density estimates, was defined as cultivated land + grasslands, as defined by GAEZ 3.0 database.

Because rural population growth is rising faster than land under cultivation in most countries, these proportions are most likely rising over time. Recall that according to a joint FAO/IFDC report, the maximum carrying capacity of the land for intensive cultivation in most areas is 500 persons per $km^2$ (Henao and Baanante 1999); while this threshold cannot be considered to be precise for all areas, e.g., those with multiple cropping seasons and/or irrigation potential, it does give a first-order approximation of land supporting capacity for the dryland farming conditions on which the vast majority of Africa's rural population is located.[9]

A visual representation of the dispersion in rural population density on arable land is shown for Kenya in Figure 8. Roughly 40 percent of Kenya's rural population resides on five percent of its arable land. On the other end of the continuum, three percent of the population controls 20 percent of the nation's arable land. An alternative visual impression of the dispersion of population density is shown in Figures 9 and 10 for Kenya and Zambia, respectively.

Moreover, the effects of increasingly crowded rural areas are not confined to those living in such areas. At least some part of rapid urbanization and its associated problems of the spread of slums, health and sanitation problems, and congestion are due to inadequate living standards in rural areas giving rise to migration. Jayne and Muyanga (2012) show that the net outflow of adult labor is four times higher from the top 20 percent of villages ranked by population density than from the bottom 20 percent of villages. Therefore, the question of appropriate development strategies for densely populated rural areas would appear to be increasingly relevant to a significant portion of Africa's population.

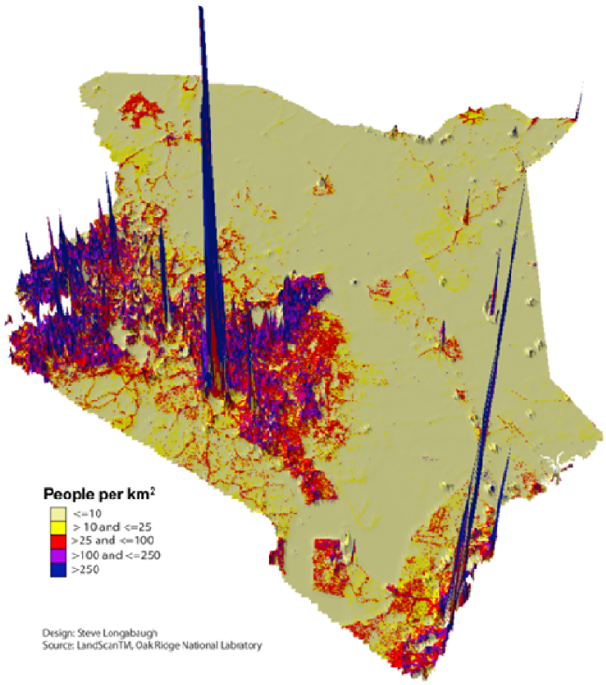
**Figure 8. Lorenz curve showing the percentage of arable land by percentage of rural population in Kenya, 2009**




Source: Population data from 2009 Kenya National Bureau of Statistics Census; arable land from Columbia University Global Rural-Urban Mapping Project (GRUMP).
Notes: Gini coefficient: 0.51. A Lorenz curve shows the degree of inequality that exists in the distributions of two variables, and is often used to illustrate the extent that income or wealth is distributed unequally in a particular society.

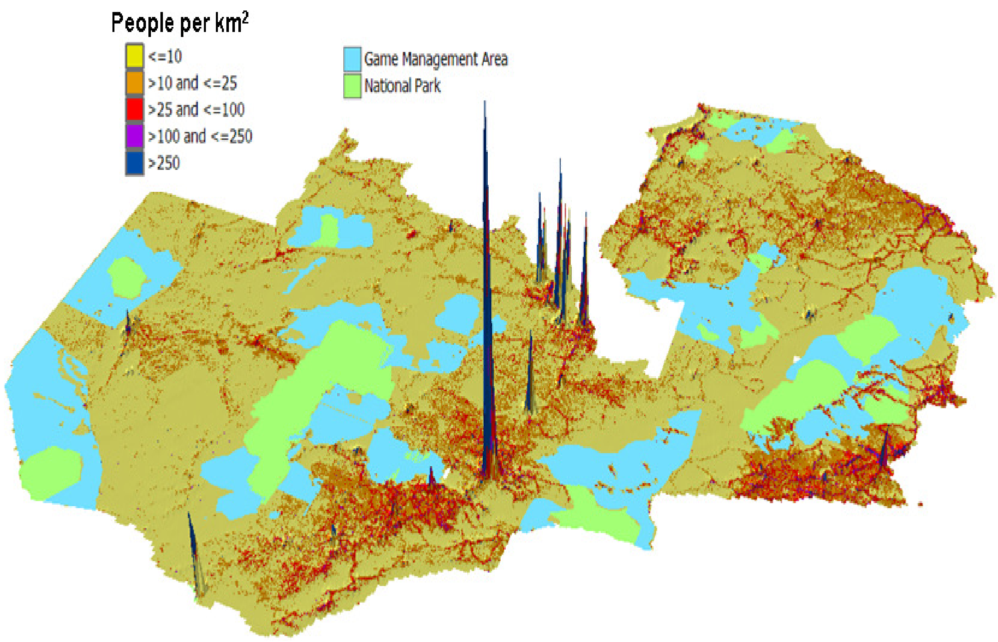
[9] Binswanger and Pingali (1988) show that after accounting for soil and climate conditions as well as potential technological options, it is possible to compute standardized *agroclimatic population densities* for various countries measuring the number of people per million kilocalories of production potential. They report that when countries are ranked conventionally by population per square kilometer of agricultural land, Bangladesh comes first, India comes seventh, Kenya falls somewhere in the middle, and Niger is near the bottom. When ranked by agro-climatic population density, the rankings change dramatically: Niger and Kenya are more densely populated than Bangladesh is today, and India ranks only twenty-ninth on the list.

**Figure 9. Population density in Kenya**




Source: LandScan data for 1999 Census, Kenya.

**Figure 10. Population density in Zambia**




Source: LandScan data based on 2000 National Census.

### *3.2 Population density and farm size evolution*

Many rural areas of sub-Saharan Africa will become substantially more densely populated by 2030. In fact, sub-Saharan Africa will experience the highest rate of rural population growth of all regions of the world. As shown in Table 8, even taking into account the effects of HIV/AIDS, the UN estimates that sub-Saharan Africa's rural population increased by 273 percent between 1950 and 2000. Similar growth rates were observed in South Asia, but China and South-East Asia experienced substantially lower growth rates. However, the greater difference lies in the medium fertility projections from 2000 to 2050. Africa's rural population is expected to almost double between 2000 and 2050 (89%), which may be somewhat conservative given the region's sluggish fertility transition thus far. In contrast, no other region is expected to see substantial growth in its rural population. Rural populations in most of small-farm Asia will actually decline. It is also worth noting that the growth in Africa's working age population will be even larger. Whilst UN age-specific estimates are not disaggregated by age, they show that Africa's total population is projected to increase by 193 percent over 2000-2050, but its population aged 15-59 years will increase 240 percent. Thus, unless the non-farm economy grows rapidly, land will likely be a major and growing constraint on the livelihoods of rural African households in the coming decades (Headey *et al* forthcoming).

**Table 8. Estimated (1950-2000) and projected (2000-2050) rural population growth rates in developing regions**

| | Estimated: 1950-2000 | Projected: 2000-2050 |
|---|---|---|
| Sub-Saharan Africa | 273% | 89% |
| China | 168% | -64% |
| South Asia | 252% | 10% |
| South-East Asia | 221% | -20% |
| Latin America | 130% | -21% |
| North Africa | 235% | 19% |
| Middle East | 184% | 28% |

Source: United Nations (UN 2012).
Notes: Projected populations are based on the medium (fertility) variant of the UN 2010 Population Revision (UN 2010).

To what extent is rural population density or land constraints a determinant of farm sizes and farm size evolution? This question is empirically difficult to answer because rural population density is often a poor proxy for land constraints. A good example of the problem is Madagascar. FAO population and land data suggest that Madagascar has a very low population density of 30 people per square kilometer in 2004, and seemingly abundant tracts of underutilized but somewhat marginal land.[10] However, average farm size in the same year was 0.86 hectares, with nearly all of this area devoted to lowland rice cultivation. The shrinking of farm sizes over time in Madagascar suggests that Malagasy smallholders have been unable or unwilling to utilize

[10] Several years later the government was looking to lease 1.3 million hectares of underutilized and mostly marginal lands to the Daewoo corporation.

abundant but more marginal land outside of the valley floors. Thus while population density is low on average, in some sense these farmers are indeed land constrained.

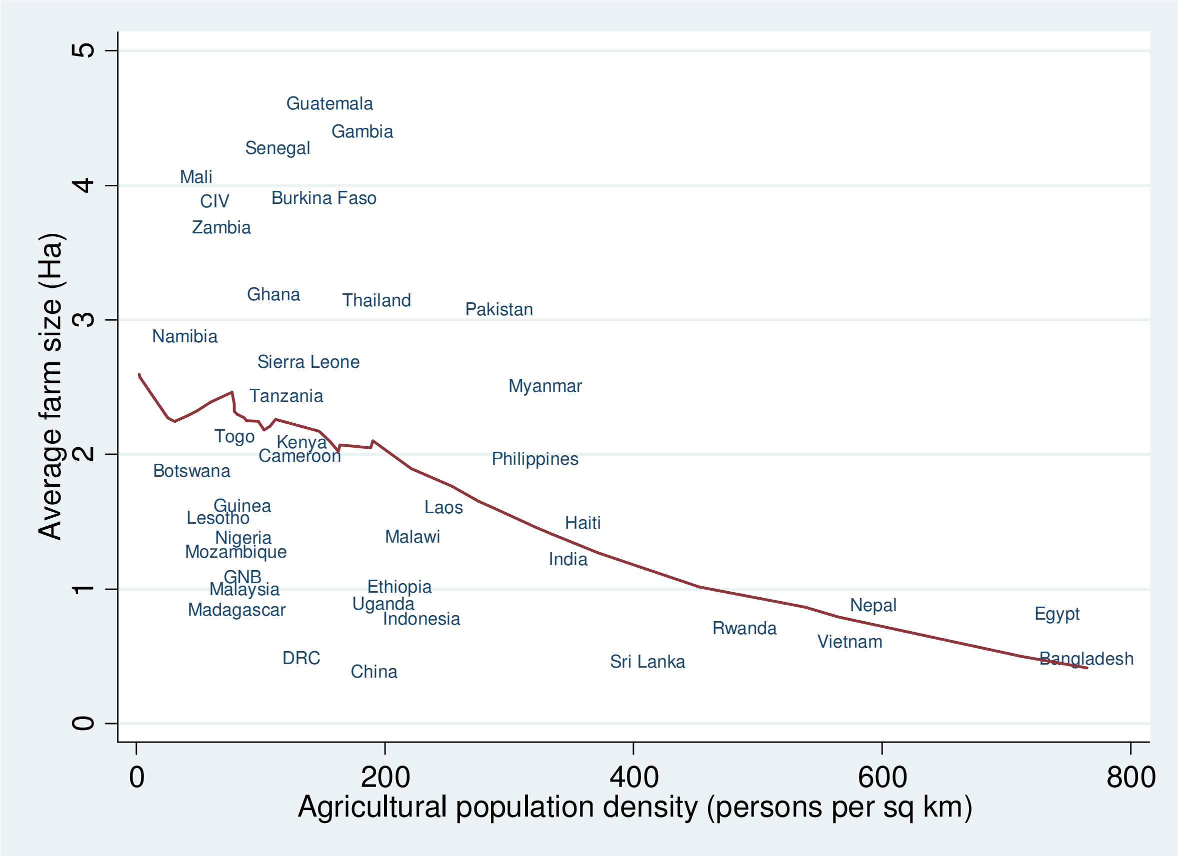
Figure 11 shows that Madagascar's somewhat paradoxical situation is not uncommon in Africa. On the right axis we display agricultural population density against average farm size on the x-axis. [11] We focus only on small-farm countries in which average farm size is under five hectares. As is well known (Eastwood, Lipton, and Newell 2010), virtually all such countries are in Africa and Asia.[12] In fact, every sub-Saharan African country excluding South Africa falls into this category. Yet interestingly, there is a highly heteroskedastic relationship with agricultural population density, despite the significant negative slope. That is, in all very high density countries farm sizes are indeed very small, such that land is unambiguously a very fixed constraint. However, in the lower density countries – nearly all of which are in Africa – there is a surprising variation in farm sizes. Some low density countries like Burkina Faso, Senegal, Mali, Cote d'Ivoire and Zambia have relatively larger average farms (around 4 hectares), but Madagascar, the DRC, and Mozambique have farm sizes of around 1 hectare. In these countries – and perhaps others such as Ethiopia -- it is clear that there is extra land that could be exploited, but that a mix of agronomic, economic or institutional factors prevent smallholder expansion on to this land.

At somewhat higher densities, African countries do indeed have small farms, and it is striking how structurally similar some African countries are to Asian countries in this regard. Ethiopia, Uganda and Indonesia, for example, all have similar average farm sizes and similar agricultural population densities. Malawi and Laos, and Rwanda, Nepal and Vietnam, are other Africa-Asian groupings sharing strong similarities across these two dimensions. It would thus appear that a large fraction of Africa's population is far more land constrained -- at least in the short term -- than is often perceived amidst Africa-wide generalizations.

[11] One would expect agricultural population density to be more closely linked to farm size than rural population density, although in practice the difference is immaterial.

[12] A caveat here is that higher land inequality in Latin America means that some of these countries still have sizeable numbers of small farmers despite relatively large average farm sizes.

**Figure 11. A scatterplot of mean farm size and agricultural population density in small-farm developing countries**




Sources: Farm size data are principally drawn from FAO World Census of Agriculture data from 1996-2005 and augmented with results from various household surveys (mostly for 2005-2010). Agricultural population density is the FAO (2012) estimates of the population primarily dependent on agriculture divided by agricultural land, which is the sum of arable land, permanent crops and permanent meadows and pastures.
Notes: The fitted line is the prediction of a Lowess regression. Note that both indicators are measured with substantial error. Farm size data are problematic because "holdings" may refer to land owned, but in some cases refers to land cultivated, and because some values are census-based results, while some are drawn from household surveys. Agricultural population data are estimates drawn from infrequent surveys, and only refer to primary occupation.

Further evidence on this important hypothesis is provided when examining trends in farm size. This is made more difficult by the absence of multiple observations for some important countries, such as Nigeria, and by the fact that census years vary by country.[13] Bearing these constraints in mind, in Table 9 Headey et al (forthcoming) present a smaller but balanced sample, taking observations from the 1970s (or late 1960s in a few cases) and the 2000s. Note that we again separate African countries into low density and high density groups. This distinction turns out be critical, for not only are farm sizes smaller in high density Africa (1.2 hectares in the 2000s, versus 2.9 hectares in low density Africa), they are also shrinking. In high-density Africa average farm sizes shrank from around 2.3 hectares in the 1970s to 1.2 hectares.

[13] A further complication is that land holding definitions sometimes differ across surveys, particularly between owned area and cultivated area.

This 1.1 hectare reduction is almost identical to average farm size reductions in East and South Asia, suggesting that land is indeed a major constraint in high-density Africa. Note also that while we have no strictly comparable series for Nigeria, the 1993 agricultural census suggested that average farm size was 2.54 hectares, while a very recent national household survey suggests it is 1.39 hectares. One should be cautious in drawing inferences from such different sources, but it would certainly appear that farm sizes in Africa's largest country have also been shrinking. In contrast to high density Africa, farm sizes in low-density Africa have remained roughly constant, with some countries experiencing slight increases (Cote d'Ivoire, Tanzania, Zambia), and some experiencing significant shrinking (Madagascar, Botswana). While these countries are not the principal subject of our analysis, we note that in agroecological terms (that is, relative to the inherent agricultural potential of the land) farm sizes in many of these land abundant countries are actually quite low.

**Table 9. Population density and farm sizes in densely and sparsely populated countries of Africa and other developing regions, 1970s and 2000s**

| Region (# of countries) | Period | Population density | | Mean farm size | Farm inequality* |
|---|---|---|---|---|---|
| | | Rural | Agricultural | (ha) | (Gini 0-1) |
| Africa | 1970s | 32 | N.A. | 3.0 | 0.49 |
| -low density (n=10) | 2000s | 53 | 54 | 2.9 | |
| Africa | 1970s | 115 | N.A. | 2.3 | 0.46 |
| -high density (n=5) | 2000s | 221 | 217 | 1.2 | |
| East Asia (n=6) | 1970s | 257 | N.A. | 2.5 | 0.54 |
| | 2000s | 287 | 228 | 1.3 | |
| South Asia (n=5) | 1970s | 365 | N.A. | 2.2 | 0.50 |
| | 2000s | 640 | 455 | 1.2 | |
| South | 1970s | 22 | N.A. | 115.0 | 0.83 |
| America (n=9) | 2000s | 19 | 16 | 140.9 | |
| Central | 1970s | 133 | N.A. | 13.6 | 0.70 |
| America (n=5) | 2000s | 159 | 122 | 10.2 | |
| Middle East & | 1970s | 144 | N.A. | 8.4 | 0.63 |
| North Africa (n=10) | 2000s | 170 | 103 | 6.4 | |

Sources: Farm size data are principally drawn from FAO World Census of Agriculture data from 1996-2005 and augmented with results from various household surveys (mostly for 2005-2010). Agricultural and rural population density are derived from FAO (2012) population and agricultural land estimates.
Notes: "Africa-low density" includes Botswana, Cote d'Ivoire, Ghana, Madagascar, Mali, Senegal, Sierre Leone, Tanzania, Togo and Zambia. "Africa-high density" includes Ethiopia, Kenya, Malawi, Rwanda and Uganda. *Farm inequality refers to Gini coefficient of land holdings, but since fewer data were available for this indicator it does not refer to any particular period.

More systematic econometric validation of the inverse relationship between rural population density and farm size is presented in Headey *et al* (forthcoming).

The following basic identity synthesizes the basic challenge for farming areas facing rising land pressures in a structured way. Labor productivity in agriculture *(Y/L)* is defined as the product of two terms: net farm income per unit of land *(Y/A)* and the ratio of land to labor *(A/L).*

$$(1) \qquad \frac{Y}{L} = \frac{Y}{A}\frac{A}{L}$$

We focus on labor productivity in agriculture because it is normally considered to be the closest reflection of returns to labor in agriculture. *Y* is defined as net farm income (gross value of output minus all input costs such as seed, fertilizer, hired labor, etc., except own family labor). In most of the countries shown in Table 6, *A/L* appears to be declining over time, as rural population grows at a faster rate than arable land.[14] This implies that in order for labor productivity to rise over time, the net value of output *Y/A* (net value of output per unit land), must rise faster than the ratio *A/L* declines.

Raising the growth rate of *Y/A* puts a major burden on technology and changes in farmer management practices to outpace the decline in *A/L*, which may be especially challenging in the decades to come due to likely changes in weather patterns (Lobell 2012). To reduce the dependence on technology to save the day, some extensification of land might be needed (i.e., *A* may need to rise over time to sustain labor productivity growth in agriculture). Hence, important questions arise over the feasibility of area expansion, *A,* and whether and how arable land can be conserved for current and future generations of rural African farmers as part of a long-term and broad-based structural transformation development strategy. These questions relate front and center to current policy issues about how best to utilize Africa's available arable lands.

### *3.3 Trends in farm size and land concentration in customary lands*[15]

Despite widespread acceptance that "pro-poor" agricultural growth is strongly associated with equitable asset distribution, surprisingly little attention has been devoted to quantifying land distribution patterns within Africa's small-scale farming sector.[16] To examine the degree of concentration of land within African farming sectors, Table 10 presents basic information on farm size and distribution within the smallholder farm sector in six countries for which nationwide survey data were available. As shown in column b, mean farm size in the small farm sector range from 2.76 hectares in Zambia to 0.71 hectares in Rwanda in 2000. The three Rwanda surveys indicate that mean household land access has declined significantly over the past 15 years.[17]

[14] See Appendix Table 1 for data on rural population growth rates in sub-Saharan Africa countries.
[15] Much of the material in this section draws from Jayne et al. (2003).
[16] Some notable exceptions include Haggblade and Hazell (1988) and Holden, Otsuka, and Place (2009).
[17] Andre and Platteau (1998) present an in-depth case study which shows acute competition over land and suggests a connection between land disputes and the civil war in 1994.

**Table 10. Land distribution within the smallholder farm sectors in selected African countries**

| Country (year of survey) | (a) Sample size | (b) Mean farm size (ha) | (c) Farm Size (hectares per capita) Mean | Quartile 1 | 2 | 3 | 4 | (d) Gini Coefficients Land per household | Land per capita | Land per adult |
|---|---|---|---|---|---|---|---|---|---|---|
| Kenya, 1997 | 1146 | 2.28 | 0.41 | 0.08 | 0.17 | 0.31 | 1.10 | 0.55 | 0.56 | 0.54 |
| Kenya, 2010 | 1146 | 1.86 | 0.32 | 0.07 | 0.12 | 0.25 | 1.12 | 0.57 | 0.59 | 0.56 |
| Ethiopia, 1996 | 2658 | 1.17 | 0.24 | 0.03 | 0.12 | 0.22 | 0.58 | 0.55 | 0.55 | 0.55 |
| Rwanda, 1984 | 2018 | 1.20 | 0.28 | 0.07 | 0.15 | 0.26 | 0.62 | -- | -- | -- |
| Rwanda, 1990 | 1181 | 0.94 | 0.17 | 0.05 | 0.10 | 0.16 | 0.39 | 0.43 | 0.43 | 0.41 |
| Rwanda, 2000 | 1584 | 0.71 | 0.16 | 0.02 | 0.06 | 0.13 | 0.43 | 0.52 | 0.54 | 0.54 |
| Malawi, 1998 | 5657 | 0.99 | 0.22 | 0.08 | 0.15 | 0.25 | 0.60 | -- | -- | -- |
| Zambia, 2001 | 6618 | 2.76 | 0.56 | 0.12 | 0.26 | 0.48 | 1.36 | 0.44 | 0.50 | 0.51 |
| Mozambique, 1996 | 3851 | 2.10 | 0.48 | 0.1 | 0.23 | 0.4 | 1.16 | 0.45 | 0.51 | 0.48 |

Source: Kenya: Tegemeo Rural Household Surveys, Tegemeo Institute, Nairobi. Ethiopia: Central Statistical Authority surveys 1995 and 1997, Government of Ethiopia. Rwanda:1990 Ministry of Agriculture Survey. Malawi: Profile of Poverty in Malawi, 1998, National Economic Council, 2000. Zambia: Central Statistical Office Post-Harvest Surveys. Mozambique: 1996 Ministry of Agriculture and Rural Development (MADER) Smallholder Survey.
Note: Numbers for Ethiopia, Rwanda, Mozambique, and Zambia, including Gini coefficients, are weighted to be nationally representative.

On a per capita basis, farm sizes range from 0.56 hectares per person in Zambia to 0.16 hectares per person in Rwanda in 2000 (Table 10, column c). Mean farm size figures mask great variations in land access within the smallholder sector. After ranking all smallholders by household per capita farm size, and dividing them into four equal quartiles, households in the highest per capita farm size quartile controlled between eight to 20 times more land than households in the lowest quartile. In Kenya, mean landholding size for the top and bottom land quartiles were 1.10 and 0.08 hectares per capita, respectively. These figures already include rented land, which is marginal for most countries examined. It was also found across all countries a tendency for the poorest households to control the least amount of land, and to have relatively high labor-to-land ratios within their households. In this respect, Africa's rural poor are similar to those in much of Asia as reported by Sen (1990).

In each country, the bottom 25 percent of small-scale farm households are approaching landlessness, controlling less than 0.12 hectares per capita. In Ethiopia and Rwanda, the bottom land quartile controlled less than 0.03 hectares per capita. It is important to stress that these surveys contain only households engaged in agricultural production; households not engaged in farming are not in the sample.

Nevertheless, it is possible that the bottom land quartile may contain mostly "Sunday farmers" who are engaged primarily in off-farm activities for their livelihoods. To examine this possibility, income shares from crop production, animal and animal-derived production, and off-farm income for each land quartile were computed. As expected, off-farm income shares are highest for the bottom land quartile and decline as landholding size rises. However, in none of the five countries do households in the bottom land quartile earn more than 50 percent of their total income, on average, from off-farm activities, despite having very small farms. In Zambia, Rwanda, Mozambique and Ethiopia, the off-farm income shares for households in the bottom land quartile were 38.5 percent, 34.5 percent, 15.9 percent and 12.7 percent, respectively. By contrast, this figure was 50 percent in Kenya, which can be attributed to that country's relatively developed and diversified economy, and which affords land-constrained rural households greater opportunity to earn a livelihood through the labor market.

Survey evidence also indicates declining landholding sizes over time. A nationally representative survey of Kenya's small-scale farm sector in 1977 carried out by the Central Bureau of Statistics reports mean farm size ranging across provinces from 2.10 to 3.48 hectares (Greer and Thorbecke 1986). By contrast, mean farm size in Egerton University's nationwide surveys from 1997 to 2010 show mean farm size to be 1.97 hectares per farm; these longitudinal surveys show a decline in farm size even within that 13-year period.

Using survey data from Kenya, Jayne and Muyanga (2012) examined how population density is related to the amount of land inherited from the previous generation. Respondents in a nationwide survey in 2007 were asked how much land the father of the household head owned. The previous generation had considerably larger farms (three times larger) than those of the current survey respondents themselves. After ranking respondents' answers according to the population density of the village, the mean size of respondents' parents' farms was found to vary from 7.80 hectares in the low-density quintile of villages to 4.41 hectares in the high-density quintile. Survey respondents were also asked about the amount of land inherited by the household head from his father. This ranged from 1.49 hectares in villages in the low-density quintile to 0.89 hectares in the high-density quintile, where the mean amount of land inherited by survey respondents was roughly one-fifth of the total landholding size of the father. An important policy question is how the current generation of adults in the high population density areas with one hectare of land or less are going to subdivide their land among their children when they reach their old age (the average age of household heads was 48 years in 2010) and whether farming can provide a viable livelihood for those remaining on the land. These findings are consistent with Yamano et al. (2009) who found that roughly a quarter of young men and women in rural Kenya start their families without inheriting any land from their parents, forcing them to either commit themselves to off-farm employment or buy land from an increasingly active land sales market. We speculate that, because farm sizes in the high density areas are already quite tiny and cannot be meaningfully subdivided much further, increasingly fewer people born on farms in Kenya will be able to remain there. This may point to even higher rates of rural-to-urban migration in the future, or at least from agriculture to non-agriculture.

In all countries, the various Gini coefficients displayed in Table 10 column (d) also indicate a high degree of dispersion in farm size. The Ginis for these African countries are -- perhaps surprisingly -- comparable to those estimated for much of Asia during the 1960s and 1970s

(Haggblade and Hazell 1988). If land is allocated according to household size or labor availability, more equal land distribution in household per capita or per adult land holdings than per household land holdings should be found. This would imply that the Gini coefficients of landholding by per capita and per adult measures should be smaller than those of landholding per household. This is not the case in any of the five countries examined in Table 10. The Gini coefficients of per capita and per adult land holdings are virtually unchanged in Kenya, Ethiopia, and Rwanda, and are even higher in Mozambique and Zambia when family size is accounted for in the estimates of land distribution inequality.

What is the evidence on trends in landholding inequality over time within the small-farm sectors? This is difficult to assess because of inevitable differences in sample design and variable definitions across surveys; results must therefore be interpreted cautiously. However, Haggblade and Hazell's (1988) survey of available landholding Gini estimates for Africa, Asia, and Latin America during the 1960s and 1970s provides some grounds for comparison. They report that the basic sampling unit is landholdings, not households, and thus landless households are excluded from these calculations. At least in this way, their estimates are consistent with the data reported in this study. Their sample includes three of the same country/farm sector combinations as in this study: Ethiopia, from 1976/77 survey data; Kenya's small-scale farming sector from 1960; and Mozambique's smallholder sector from 1970.

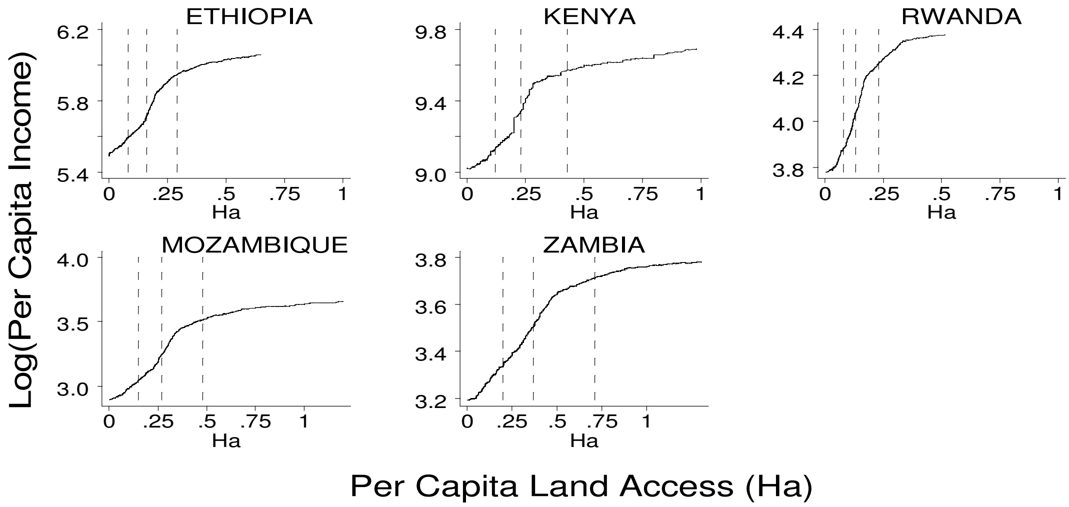
On the basis of these comparisons, it appears that landholding concentration within the small-scale farm sector has increased slightly to moderately over the past 20 to 30 years. The Gini coefficients for landholdings per farm increased from 0.50 to 0.55 between 1960 and 1997 in Kenya; from 0.41 to 0.45 between 1970 and 1997 in Mozambique; and from 0.44 to 0.55 between 1976/77 and 1995/96 in Ethiopia. Ethiopia's case is particularly intriguing because it had undergone a radical land reform program during the 1970s, yet land concentration appears to have increased.

Probably the most robust case for changes in land concentration is in Rwanda, where the Ministry of Agriculture used relatively consistent survey methods across three surveys for 1984, 1990, and 2000. Changes in the distribution of land access in Rwanda are shown in Table 10. Civil disruption undoubtedly has had a critical effect on land distribution over this period. Mean household land access (use rights plus rented land) has declined by 43 percent over this 16-year period, from 0.28 to 0.16 hectares per capita. In absolute terms, the decline in farm size has been borne mostly by the relatively large farms. Mean land access for households in the highest land quartile declined from 0.62 to 0.43 hectares per capita, while it declined from 0.07 to 0.02 hectares per capita for the bottom land quartile. In relative terms, however, the dispersion in land access across the distribution has widened. There was a nine-fold difference in mean land access per capita between the top and bottom land quartiles in 1984, but this has worsened to a 21-fold difference in 2000. While Gini coefficients from 1984 are not available, the Gini coefficients of household access to land between 1990 and 2000 increased from 0.43 to 0.52. These results, though tentative, indicate that land concentration may be worsening over time in many of the region's small-scale farming sectors.

*3.4 Relationships between farm size and household income*

The importance of these findings for rural growth and poverty alleviation strategies depends in part on the degree to which land allocation patterns influence household income and poverty. If non-farm activities are able to compensate for small landholdings and provide land-poor households with adequate alternative income sources, then disparities in land ownership should not necessarily be a policy problem. To examine these issues, the bivariate graphs in Figure 4 relate household per capita landholding size to household per capita income, including non-farm income and crop income from rented land. The three dashed vertical lines show the 25th, 50th, and 75th percentiles of sampled households along the x-axis. For example, 25 percent of the sample households in Kenya have between zero and approximately 0.10 hectares per capita, while the top quartile owns on average 1.1 hectares per capita.

**Figure 12. Log of per capita landholding size and per capita household incomes**




Note: The vertical lines are drawn at 25th, 50th, and 75th percentiles of per capita land owned for each country. The top five percent of observations are excluded from the graphs because lines are sensitive to a few extreme cases.

In each country, a positive association is found between household per capita land holdings and per capita income (the sum of crop, livestock, and off-farm income). The association between household income and land is especially steep among households whose land size is below the median level in each country (the middle dotted line in each country graph in Figure 12). Because the vertical axis showing per capita income is in log form, differences in numbers can be read as percent changes. For instance, the line for Kenya starts at the log of per capita income at 9.2 and has a kink at 9.6. The difference between these two points is 0.4, which indicates a 40 percent increase in per capita income when household per capita land size increases from zero to 0.25 hectares. The same increase in land holdings (from zero to 0.25 hectares) increases per capita income by more than 40 percent in Rwanda, just less than 40 percent in Mozambique, and about 30 percent in Ethiopia. In all four countries, the association between land and income becomes weaker somewhere within the third land size quartile, and nearly disappears in the fourth quartile.

What do such land-income relationships mean for feasible smallholder-led development pathways? Improving access to land among the most land-constrained smallholder households would be a seemingly effective way to reduce poverty. For small farms, a very small incremental addition to land access is associated with a large relative rise in income.

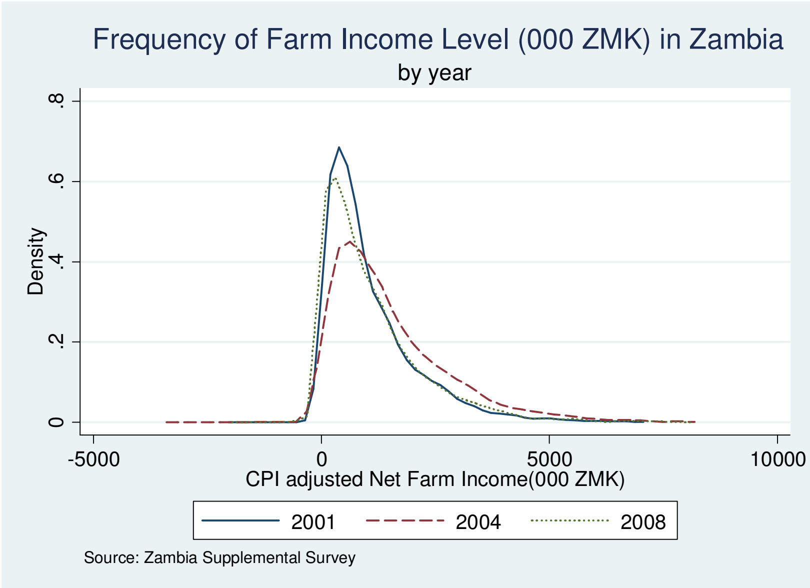
Another recent study from Kenya analyzed the impact of endogenous population density[18] on the evolutions of farming systems and farm productivity (Jayne and Muyanga 2012). Household farm size, cropped area, and asset wealth were strongly inversely related to local population density, other factors held constant. Input intensity and farm productivity per unit land and labor all rise with population density to roughly 600-650 persons per $km^2$; beyond this population density threshold input intensification and farm productivity decline. What would explain these threshold effects? Market participation studies consistently show that farm sales are related to farm size (Barrett 2008). If farm sizes decline beyond a given point due to sub-division and land fragmentation caused by population pressures, households are less likely to generate cash from crop sales that would allow them to purchase modern productivity-enhancing inputs. Less intensive input use then reinforces small farms' difficulties in producing a surplus. Furthermore, access to farm credit also tends to be restricted for farmers with limited land and other assets that could otherwise act as collateral. For these reasons, population density threshold effects may be very plausible and may explain why in Kenya a number of important farm productivity indicators tend to decline beyond a certain level of population density. In 2009, according to Tables 7a and 7b, roughly 35 percent of Kenya's rural population resides in areas exceeding 650 persons per $km^2$ of arable land.

The structural transformation processes in Asia, as documented by Johnston and Kilby (1975) and Mellor (1976), show that a smallholder-led agricultural strategy was necessary to rapidly reduce rural poverty and induce demographic changes associated with structural transformation. An inclusive smallholder-led strategy is likely to provide the greatest potential to achieve agricultural growth with broad-based reductions in rural poverty in most of sub-Saharan Africa as well. However, it is not at all clear how such a smallholder-led agricultural strategy must be adapted to address the limitations of very small and declining farm sizes in densely populated areas that are dependent on rain-fed production systems with only one growing season per year.

Figures 13a 13b and 13c present the changes over time in the distribution of farm income in Zambia, Kenya, and Malawi. Zambia and Kenya show little change over time in the distribution of farm incomes (in Kenya's case over the 13 year period). The distribution of farm income in Malawi, by contrast, shows a significant shift in the distribution toward the right (higher farm income). Both Malawi and Zambia have implemented large-scale input subsidy programs in recent years coupled with a resurgence of marketing board operations to support maize prices. In Malawi's case at least, these programs, coupled with good weather in the most recent survey years, has tangibly raised the distribution of farm income.

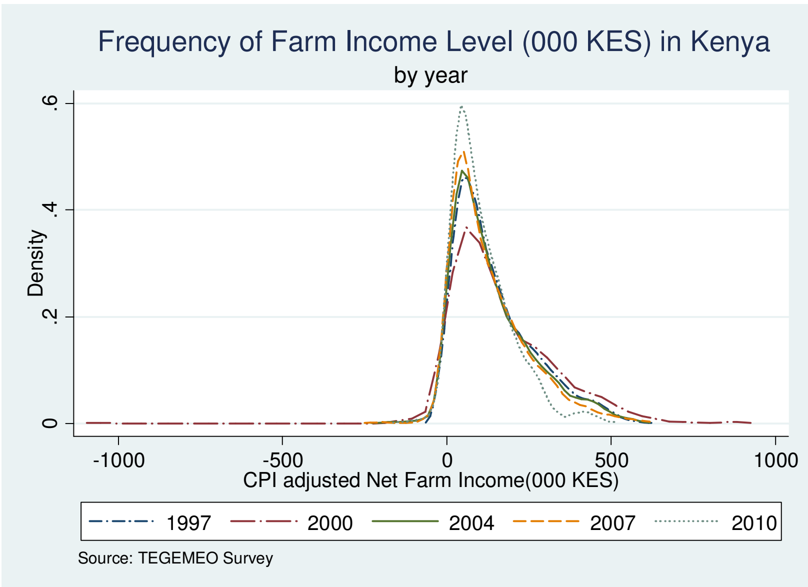
[18] The major determinants of district-level population density in 2009 were found to be distances to infrastructural facilities, the population and stock of arable land of the district at independence, and village-level rainfall, rainfall variability, soil quality, and agro-ecological potential.

**Figure 13a. Changes over time in the frequency of farm income levels (2008=100), Zambia**



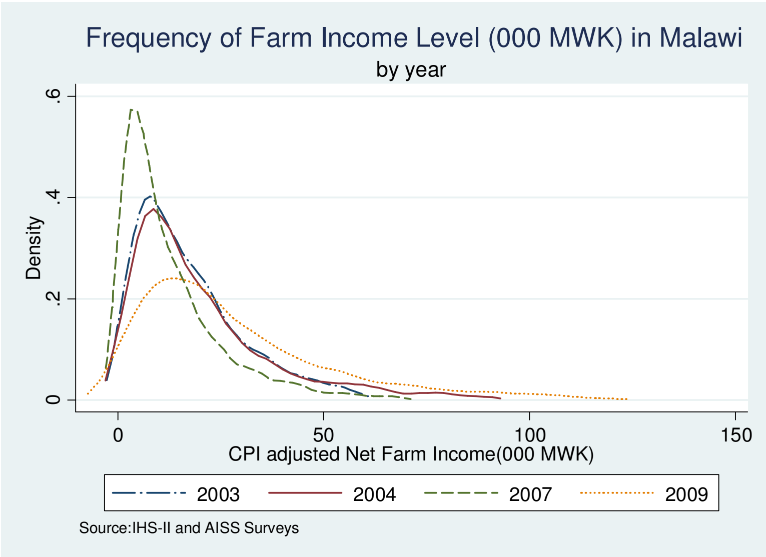

Source: nationally representative Supplemental Surveys to the CSO Post Harvest Surveys, 2001, 2004 and 2008.
Note: ZMK 3,950=US$1; ZMK 1,000,000=US$253.

**Figure 13b. Changes over time in the frequency of farm income levels (2010=100), Kenya**




Source: Tegemeo Rural Farm Household Surveys, 1997-2010. 2010 Ksh 82=1 USD. Ksh100,000-US$1219.

**Figure 13c. Changes over time in the frequency of farm income levels (2008=100), Malawi.**




Source: Integrated Rural Household Survey II (National Statistical Office) for 2003/04; 2007 and 2009 data from the Agricultural Inputs Support Survey, SOAS/Wadonda/MSU. MWK10,000=US$64.

*3.5 A paradox of land pressures amid land abundance?*

Several conclusions emerge from the evidence presented so far. First, while many parts of sub-Saharan Africa are very sparsely populated, often leading to relatively low population densities when computed over all rural area; a growing proportion of its population reside in fairly densely populated areas of 500 persons per $km^2$ or greater. These data may resolve the apparent paradox of land constraints amid the appearance of land abundance and massively under-utilized land.

Many of the "state vs. traditional chiefs" conflicts that have featured prominently in post-independence Africa (Herbst 2000) have centered on attempts by the state to wrest control of customary lands. Politicians' arguments for converting customary land to state land normally focus on the need to allocate land to commercial entrepreneurs and capitalized "emergent" farmers with the ability to use it productively; although as shown earlier there is very little evidence to suggest that large-scale farms are more efficient than small-scale farms (Binswanger et al. 1995). In areas where traditional authorities have succeeded in retaining control over customary land, there are still numerous reports of land being allocated to local elites having no legitimate claim to land in that area under traditional norms (Deininger and Byerlee 2011).[19]

[19] For example, in a recent study of "emergent" farmers (10-100 hectares) in Zambia, Sitko and Jayne (forthcoming) found that most of the 186 farmers interviewed purchased or obtained a 99-year lease from local authorities in customary lands. Of these, the majority entered into farming later in life after earning enough money from urban (often civil service) employment to purchase land. These farmers are cultivating an average of 27 percent of the land obtained, while over 90 percent of the surrounding small-scale farmers in the area own less than 5 hectares.

Regardless of whether land is retained under customary or state control, several scholars argue that African farmland is facing an "enclosure" process in the absence of efforts to reverse it (Woodhouse 2003; Stambuli 2002). Woodhouse argues that much of Africa is facing increased commodification and individualization of land driven by population growth and increased pressure on remaining arable land regardless of land tenure regime. This process is being intensified by the post-independence continuation of converting unutilized customary land into titled property or state land. While one might be tempted to regard this as evidence of emerging land markets in Africa, in most cases the processes of allocation are opaque; little public information about land transaction prices have emerged in any country that could serve as a basis for price discovery more broadly. Meanwhile, many customary (i.e., smallholder) farming areas are facing intensifying land constraints borne of steady rural population growth since independence, which is only made more acute by transfers of land from customary to state control (Colin and Woodhouse 2010). An important literature in Kenya has documented the rapacious disempowerment of local communities from their traditional lands, first by colonialists and later by successive post-colonial governments (Juma 1996; Kanyinga 1998; Okoth-Ogendo 1976). Post-independence Kenyan governments have largely retained the same institutions despite recognizing the importance of land rights and even elevating it to a crucial post-independence challenge (Republic of Kenya 1965). While the modes of land access were primarily through inheritance and the market, access to state land (and land converted from customary to state land) has been a major instrument of patronage favoring the political elite.[20] For these reasons, it is perhaps not surprising that median farm sizes are quite small and declining for a large proportion of the smallholder population, while large tracts of land in other parts of the country continue to be allocated by the state to local elites and foreign investors.

### *3.6 Irrigation potential in African agriculture*

The yields of currently cultivated land and that which will be brought into cultivation will be strongly determined by irrigation availability. In fact, one of the main reasons why yields in Africa lag so strongly behind other regions of the planet is the very limited availability of irrigation infrastructure. To put things in perspective, in Sub Saharan Africa only 2.7% of the arable land and permanent crops area is equipped for irrigation (including surface and groundwater infrastructure), while at the global level this coverage runs at 20%, and in regions like Asia is as high as 40%. Given how far behind the African continent is in terms of irrigation availability, the question of irrigation potential has been carefully studied in the literature.
The first large study that investigated this question is FAO (1997). This study constructed at a basin by basin level considers the biophysical limitations for irrigation availability using GIS. For each hydrologic basin, this study considers first the soil characteristics, and the water availability given climatic patterns and runoff. Then, the different crop suitability for different agro-ecological zones is considered to develop water requirements information. Given the estimated availability of water and the crop requirements, FAO (1997) estimates the potential area that can be equipped for irrigation. This study received some minor updates in FAO (2005), which figures we reproduce below. Another different estimation of irrigation potential for the

[20] Namwaya (2004) reports that over 600,000 hectares of land, or roughly one-sixth of Kenya's total land area, are held by the families of the country's three former presidents, and that most of this land is in relatively high-potential areas.

continent was prepared by You et al. (2010). These authors consider what can be irrigated like in the previous study, given the biophysical constraints, but also estimate the costs of building this irrigation infrastructure in terms of conveying water and building large irrigation projects (dams). These costs are compared to the maximum revenues that these potentially irrigable areas have (given alternative land use/crops), which together is used to calculate the internal rate of return IRR of different irrigation projects. Finally, the authors consider potentially irrigable areas those that fall under projects with positive IRR. Hence, in addition to different (GIS) data sources, both studies differ in that the second considers economic limitations in addition to the biophysical restrictions. Given these conceptual differences, by definition the FAO (2005) study should estimate more irrigation potential than the You et al. (2010) study, which is confirmed in general and in every sub-region except the Gulf of Guinea region, see Table 11. Furthermore, both approaches are valid, because although the IRR indicates the projects that will likely get implemented earlier, even those with currently negative IRR, may become economically viable in the medium term, 10-15 years from now.

The picture emerging from Table 11 is that SSA's potential to expand the percentage of its crop land under irrigation is fairly limited. The IFPRI study indicates that SSA can achieve irrigation on 10% to 15% of its current cultivated land. In other words, if all the irrigation potential of the continent were to be exploited, only 14 to 19% of the currently cultivated land would be irrigated, a coverage that lies below today's global averages. Emerging water supply problems and environmental change may reduce this potential further. The available science today suggests that rainfed agriculture is not only essential for the continent today, but will likely remain in the foreseeable future. This provides a clear direction for CG system research priorities in SSA: focus on rainfed, dryland systems which will continue to characterize the conditions of the vast majority of farmers on the continent.

Table 11 also reveals important differences in the estimations between the FAO and IFPRI studies. The most glaring difference is in the central region. FAO estimates high potential for Congo DR (and also Angola), while the You et al. (2010) does not. The Congo basin has the most water resources of the continent, it is the third river in the world by discharge. The differences between studies are that You et al. (2010) finds that most projects in this basin would not be economically viable. For the rest, although estimates vary, there is broad consensus at the basin level. The areas with the most potential are in the Niger basin (Gulf of Guinea), and most of it in Nigeria. The other basin with untapped irrigation potential is the Nile (which includes

**Table 11. Irrigation Potential in Africa.**

| *Region* | Land Area | Agricultural Area | As % of Land Area | Cultivated Area | As % of Ag. Area | Area Currently Equipped for Irrig. | As % of Cult. Area | FAO (2005) Irrigation Potential | As % of Cult. Area | As % of Irr. Pot. | IFPRI (2009) Irrigation Potential | As % of Cult. Area | As % of Irr. Pot |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 000 ha's | | | | | | | |
| Central | 520,861 | 110,100 | 21.1 | 21,235 | 19.3 | 127 | 0.6 | 13,670 | 64.4 | 29.5 | 1,625 | 7.7 | 6.9 |
| Eastern | 268,043 | 110,991 | 41.4 | 36,835 | 33.2 | 609 | 1.6 | 5,490 | 14.4 | 11.8 | 3,450 | 9.0 | 14.6 |
| Gulf of Guinea | 206,310 | 140,726 | 68.2 | 62,525 | 44.4 | 571 | 0.9 | 7,416 | 11.9 | 16.0 | 9,980 | 16.0 | 42.3 |
| Madagascar | 58,154 | 40,843 | 70.2 | 3,550 | 8.7 | 1,086 | 30.6 | 1,517 | 42.7 | 3.3 | 204 | 5.7 | 0.9 |
| Northern | 573,839 | 100,132 | 17.4 | 21,499 | 21.5 | 6,415 | 29.8 | 7,194 | 33.5 | 15.5 | 1,769 | 8.2 | 7.5 |
| Southern | 466,295 | 260,373 | 55.8 | 31,425 | 12.1 | 2,065 | 6.6 | 5,789 | 18.4 | 12.5 | 3,657 | 11.6 | 15.5 |
| Sudano-Sahelian | 838,044 | 382,166 | 45.6 | 48,175 | 12.6 | 2,619 | 5.4 | 5,289 | 10.9 | 11.4 | 2,885 | 5.9 | 12.2 |
| **Sub-Saharan Africa** | **2,357,707** | **1,045,199** | **44.3** | **205,502** | **19.5** | **7,077** | **3.4** | **39,170** | **19.1** | **84.5** | **21,801** | **10.6** | **92.5** |
| **Africa** | **2,931,546** | **1,145,331** | **39.1** | **227,001** | **19.7** | **13,492** | **5.9** | **46,365** | **20.4** | **100** | **23,571** | **10.4** | **100** |
| **World** | **13,005,835** | **4,914,522** | **37.8** | **Na** | **na** | **304,629** | **na** | | | | | | |

Eastern, Sudano-Sahelian, and Northern regions), led by areas in Sudan (former) and/or Egypt and Ethiopia (depending on the source). The third basin with the highest potential is the Zambezi basin with high irrigation potential in Mozambique and Zambia. In terms of country level estimates, there is very little correlation between estimates, as shown in Table 12; actually the correlation coefficient is only 0.2.

The irrigation potential outside these three basins is very low. Also the fact the three basins conform international waters creates political challenges to the development of some of the best irrigation projects in the continent.

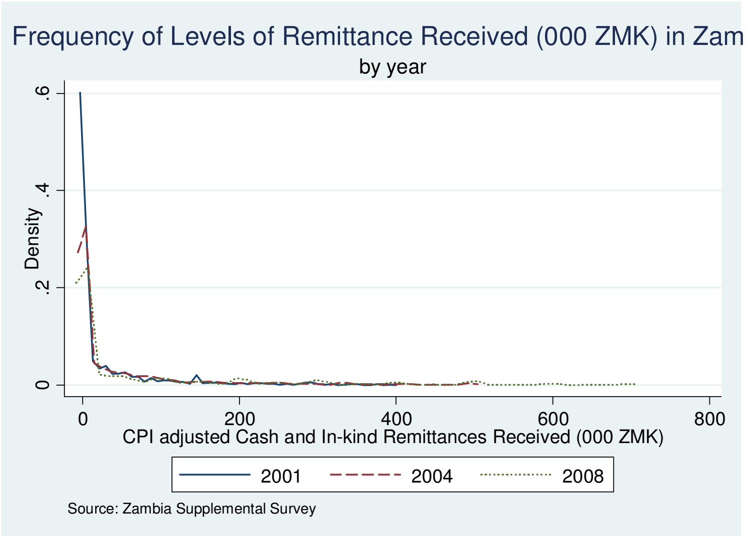
**Table 12. Countries with most irrigation potential**

| | FAO (1995) | | IFPRI (2009) | |
|---|---|---|---|---|
| **Country** | **Irrigation Potential** | **Rank** | **Irrigation Potential** | **Rank** |
| Congo, Dem. Rep. | 7,000 | 1 | 579 | 16 |
| Egypt | 4,420 | 2 | 0.3 | 45 |
| Angola | 3,700 | 3 | 227 | 26 |
| Mozambique | 3,072 | 4 | 1,223 | 4 |
| Sudan (former) | 2,784 | 5 | 628 | 13 |
| Nigeria | 2,331 | 7 | 5,674 | 1 |
| Benin | 322 | 28 | 1,697 | 2 |
| Guinea | 520 | 19 | 1,324 | 3 |
| Uganda | 90 | 41 | 1,151 | 5 |

*3.7 Remittance income of Farm households*

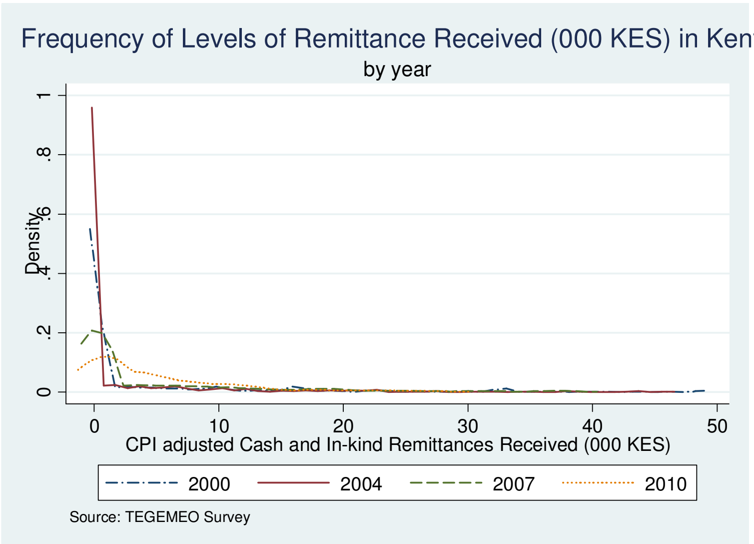
Available large-scale survey data from Zambia and Kenya show that remittance income is, for almost all rural farm household, extremely low (Figures 14a, 14b and 14c). For 95 percent of such households in both countries, remittance income is less than 5 percent of total household income. Remittance income includes both cash and in-kind goods (mainly grain) sent back to the farm from non-resident household members.

**Figure 14a. Frequency distribution of remittance income (2008=100) received by rural farm households in Zambia**




Source: Nationally representative supplemental surveys to the CSO Post Harvest Surveys, 2001, 2004, and 2008.

**Figure 14b. Frequency of remittance income (2010=100) received by rural farm households in Kenya**




Source: Tegemeo Rural Farm Household Surveys, 2000, 2004, 2007, 2010.

## 4. PRIORITY RESEARCH TOPICS FOR THE CG SYSTEM

*Priority topic 1:* Is the structural transformation model of inclusive agricultural development still appropriate for Sub-Saharan Africa, or should African agricultural policy be geared toward larger commercialized agriculture? Which approach would better achieve the goals of poverty reduction, agricultural productivity growth on available farmland, conserving as much forest and grassland as possible, and contribute the least to local and global environmental damage? Does the inverse farm size-productivity relationship still hold for Africa? Is a smallholder-led strategy politically feasible? What would be required of national governments in terms of public investments and agricultural, land and water policies in order to make a smallholder-led development strategy feasible? There is increasing need to align land and water policies to be consistent with agricultural/rural development strategies. How would the CG system most effectively mount a research programme to inform and guide these issues?

*Priority topic 2:* Related to the above, what are feasible and productive development strategies for densely populated rural areas of sub-Saharan Africa, especially if arguments by analysts such as Collier and Dercon (2009) are found to be compelling? What is the right strategy to deal with the 80 percent of Africa's farms that are currently less than 2 hectares in size?

*Priority topic 3:* Given the limited potential for expansion of irrigated land, what is the feasible scope for rural income growth under semi-arid dryland conditions that characterize much of the region? How feasible would it be to put in place performance contracts with international R&D firms to work with national and regional agricultural organizations to develop improved agricultural technologies relevant for the semi-arid areas?

*Priority topic 4:* What are the likely implications of global climate change for sustainable agricultural development strategies for the varied regions of sub-Saharan Africa? What kinds of resilience strategies would best achieve the goals of national and regional food security, agricultural productivity growth on available farmland, rural poverty reduction, and other important policy goals?

*Priority topic 5:* How can Africa's farmers be cost-effectively supported to respond to the changing demands and technical skills being imposed on them in order to enter into high-value crops and meet the evolving preferences of urban consumers and food retailing systems?

*Priority topic 6:* How to support technological, institutional and policy innovations to reduce costs within the food value chains? Marketing/processing costs account for the lion's share -- 55% to 65% -- of the cost that consumers pay for staple maize and wheat flour (Jayne et al 2010). This implies that new marketing technologies or institutional innovation within the marketing system that would reduce marketing costs by 10%, for example, would benefit consumers more than a 10% reduction in farm production costs brought on by new farm technology. Efforts to improve farm-level productivity are absolutely critical to achieve broad-based rural income growth and food security. Yet the potential for future farm-level income and productivity growth in the region will also be intimately tied to future cost-reduction in the marketing systems. Therefore, a major research priority for the CG system is to identify ways to improve efficiencies/reduce costs within the value chains of the major food commodities – this will be facilitated by identifying barriers to entry and expansion at various stages of the food system (which may often be related to government regulations and operations), and by encouraging competition and a level playing field in the marketing system.

*Priority topic 7*: How should African governments respond to rising urban population growth in Africa's megacities and smaller cities? What are the implications for urban planning, e.g., securing low-income housing, sanitation, water, etc.? And how can rural development policy contribute to sustainable development in Africa's cities?

*Priority topic 8:* What are the likely implications of global climate change for urban development and livelihoods, especially in the coastal areas where a large proportion of Africa's population resides and where vulnerability to climate change is especially acute? Initial research in this area (e.g., Parnell and Walawege 2012) is projecting that urban areas will be the primary locus of impact of global environmental change. Many of the largest cities in low-income nations are particularly at risk and at present lack the capacity to adapt. Much greater research attention is needed to incorporate effective resilience and mitigation strategies into coherent urban development plans.

*Priority topic 9:* how should African governments and international donors respond to the rising incidence of "westernized diseases" such as obesity, cardiovascular diseases, and cancer associated with the changes in urban diets?

*Priority topic 10:* What are the implications of much of Africa's rural areas being composed on women? With the adult female:male ratio approaching 1.2:1.0 in some areas, will this affect in any unforeseen ways the CG's approach to the topics mentioned above?

### *5.2 Several additional ad hoc issues*

1. *Seeking ways of achieving greater public sector "buy-in" to the research process:* Most if not all of the aforementioned issues requires solid public sector support and ownership to translate research findings into implementation. Perhaps as important as identifying the most salient issues to guide future research is the challenge of identifying ways of doing research that ensure greater public sector ownership in the findings. Perhaps more creative modes of collaboration need to be explored. If public sector policy choices do not reduce the currently high levels of risk and uncertainty in African agricultural markets, and if governments use their scarce resources in ways that do not provide greater investment incentives for the private sector, then there will be limited scope for addressing most of the policy challenges identified in this review. On the other hand, if governments were able to be pulled into the process of jointly determining research priorities and becoming more invested in the outcomes of research, the payoffs from CG system research would clearly be higher.

2. *To what degree will technological innovations be needed to raise agricultural productivity, or are the primary constraints institutional?*

   There is little doubt that technological innovation and yield growth will reduce pressures on the world's remaining land and water resources. Agricultural R&D is normally ranked as the Number 1 or 2 types of public investment in terms of their cost-effectiveness in promoting agricultural growth *and* poverty reduction (Economist Intelligence Unit 2008; Fan *et al* 2009). The research record on the payoffs to investment in crop science is overwhelming (Masters. At the same time, there is something of an assembly line. New technology, even if otherwise viable, can fail to be widely adopted if institutions and markets are not organized to reflect consumers' or farmers' interests. The rules of the game are normally the outcome of the relative power of the interest groups involved. Institutions can therefore articular certain groups' interests very well and other groups' interests very poorly. There are many examples of viable technologies that lost out to "inferior" technologies as a result of mismatched political and economic power of the parties involved (e.g., see David's famous 1985 description of how the QWERTY typewriter rose to dominance in spite of other typewriter layouts that provided greater efficiency in typing). Addressing institutional and policy constraints are often crucial to extending important new technical innovations into broad diffusion, and hence the CG's research priorities should obviously incorporate both technological and institutional dimensions.

3. *Can CGIAR research better achieve its current system-level objectives (SLOs) by emphasizing increases in the quantities of food produced in the developing world or by focusing on income generation for farmers (not necessarily involving staple food production), or by doing both?*

   As Africa and other developing regions become increasingly urbanized, an important way for CG research to improve livelihoods would be to focus on efficiency gains in farm production and marketing/value chains. By 2020, the majority of Africa's populations will benefit from lower food prices, especially if it can be achieved locally due to the multiplier effects between farm and non-farm sectors. Research on technological and institutional innovations that can reduce the cost of food delivered to consumers' tables. This will reduce urban poverty as well as benefit the substantial fraction of rural households that are buyers or net buyers of food.

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## Appendix Table 1.

| | Period | Ethiopia | Ghana | Kenya | Malawi | Mozambique | Nigeria | Rwanda | Tanzania | Uganda | Zambia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rural population | 1960-69 | 2.2 | 1.8 | 2.9 | 2.3 | 1.9 | 1.4 | 2.5 | 2.7 | 3.1 | 1.5 |
| growth rate (%/year) | 1970-79 | 1.9 | 2.0 | 3.1 | 2.8 | 1.7 | 1.9 | 3.0 | 2.5 | 2.8 | 1.8 |
| [A] | 1980-89 | 2.7 | 2.3 | 3.4 | 3.8 | 0.3 | 1.7 | 3.5 | 2.5 | 3.0 | 3.1 |
| | 1990-99 | 2.8 | 1.5 | 2.8 | 1.9 | 1.6 | 1.3 | -0.4 | 2.6 | 3.1 | 3.5 |
| | 2000-09 | 2.3 | 0.8 | 2.3 | 2.3 | 1.3 | 1.1 | 2.2 | 2.2 | 3.1 | 2.3 |
| Urban population | 1960-69 | 5.4 | 4.7 | 6.6 | 5.7 | 6.7 | 5.6 | 5.5 | 7.0 | 7.4 | 8.2 |
| growth rate (%/year) | 1970-79 | 3.9 | 3.1 | 7.9 | 7.2 | 10.7 | 5.1 | 7.1 | 9.3 | 4.2 | 6.0 |
| [B] | 1980-89 | 5.0 | 4.6 | 5.1 | 6.6 | 5.9 | 4.8 | 4.6 | 5.7 | 7.2 | 3.0 |
| | 1990-99 | 4.7 | 4.5 | 3.7 | 5.0 | 6.7 | 4.4 | 10.4 | 4.6 | 4.1 | 1.6 |
| | 2000-09 | 3.7 | 3.8 | 3.8 | 5.5 | 4.7 | 4.0 | 5.7 | 4.5 | 4.2 | 2.6 |
| Percentage of population | 1960-69 | 7.4 | 25.8 | 8.6 | 5.0 | 4.6 | 19.5 | 2.8 | 6.1 | 5.4 | 23.2 |
| residing in urban areas (%) | 1970-79 | 9.4 | 30.0 | 12.7 | 7.5 | 8.7 | 25.3 | 3.9 | 10.8 | 7.0 | 34.5 |
| [C] | 1980-89 | 11.4 | 33.1 | 16.9 | 10.2 | 16.5 | 31.5 | 5.0 | 16.6 | 9.1 | 39.7 |
| | 1990-99 | 13.7 | 39.8 | 18.9 | 13.2 | 25.6 | 38.5 | 8.5 | 20.4 | 11.6 | 37.3 |
| | 2000-09 | 16.0 | 47.4 | 20.7 | 17.2 | 34.1 | 45.8 | 16.7 | 24.1 | 12.5 | 35.1 |
| data sources: | | | | | | | | | | | |
| [A] http://data.worldbank.org/indicator/SP.POP.GROW | | | | | | | | | | | |
| [B] http://data.worldbank.org/indicator/SP.RUR.TOTL.ZG?page=5 | | | | | | | | | | | |
| [C] http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS/countries | | | | | | | | | | | |

Sources:
[A] World Bank, http://data.worldbank.org/indicator/sp.pop.grow
[B] World Bank, http://data.worldbank.org/indicator/sp.rur.totl.zg?page=5
[C] World Bank, http://data.worldbank.org/indicator/sp.rur.totl.zs/countries

## Appendix 2: A Review of Two Studies on Returns to Public Agricultural Investments

Many parts of Asia have achieved impressive gains in agricultural productivity and poverty reduction over the past half-century. By contrast, sustained agricultural development remains elusive in most of Africa. Policy makers are struggling to find the answers but there is no consensus about what the right mix of policies and public investments are. Can African policy makers learn from Asia's green revolution? Conditions differ in many respects between Africa and Asia, as well as across countries within Africa, and the impacts of various investments and policies in Asia may not necessarily produce the same impacts in Africa. However, it is instructive to understand the mix of public investments and policies that helped many Asian countries achieve their smallholder-led green revolutions and to consider the potential lessons for Africa.

Two studies are especially insightful to provide guidance. The first study, carried out by the Economist Intelligence Unit (EIU 2008), estimated the contribution of various types of public investments and strategies to agricultural growth and poverty reduction in six Asian countries: China, India, Indonesia, South Korea, Taiwan, and Vietnam. The second study, carried out by IFPRI (Fan et al 2007) provides an in-depth analysis of India to identify the returns to various types of public expenditures over a 40-year period.

**Main Findings:** The EIU study highlights the primacy of policy and enabling environment in driving both agricultural growth and poverty reduction in most of Asia (Table 14). As stated by the report:

"In places such as Korea and Taiwan, land-to-the tiller reforms created a broad-based agrarian population with ownership over land and strong incentives to increase output. In China and Vietnam, increasing individual farmers' rights over their land and output, combined with agricultural market liberalization, substantially improved farmers' incentives and stimulated rapid growth in output and private investment. Indeed, policy and institutional reforms have been central to (arguably, the main sources of) agricultural growth in China and Vietnam because those countries had to overcome complete state control of the entire economy. But getting institutions and policies right also mattered a great deal in the other four Asian economies as well" (p. 7-8).

"Appropriate policy reforms not only bring about one-off efficiency gains…more importantly they improve incentives for private investment in resource conservation, technology adoption, innovation, and increased modern inputs application, all of which lead to higher steady-state rates of output growth" (p. 8).

"Policy and institutional improvements can also improve equity since administrative power over farmer behavior tended to favor the wealthiest and those with the best political connections, rarely poorer individuals or communities" (p. 8).

The EIU (2008) study contends that policy and institutional reform in Africa may not produce the same magnitude of benefits as in Asia because of its view that African nations have already undertaken most of the major sectoral reforms enacted in Asia. However, food and input markets in Africa continue to be hampered by unpredictable state operations, trade barriers, and sudden entry and retreat from markets. If anything, state intervention in food and input markets appears to be on the rise. The high degree of policy uncertainty creates major market risks and impedes private investment from flowing into the agricultural sector to support smallholder farmers. In these ways, there is still a great deal to be gained from sectoral reform in Africa, not necessarily to liberalize private trade *per se* but to reduce the risks and costs imposed on private trade arising from unpredictable government actions. The policy environment will clearly influence the impact of public investments on agricultural growth and poverty reduction.

As shown in Table 14, other investments found by the EIU study to have high payoffs were: crop science R&D and investments in rural roads, electricity, health and education. These investments helped smallholders produce more food while also improving their access to markets and services. Resources invested in input subsidies and direct distribution of fertilizers and other agri-chemicals showed modest returns on average. Input subsidies played a greater role in irrigated areas where the combination of water control, improved seed varieties and fertilizer raised yields dramatically. Returns to subsidies were lower under rainfed conditions, especially in semi-arid areas.

The IFPRI study of India estimates the return to various types of government expenditures in terms of agricultural growth and poverty reduction. Moreover, this study estimates impacts at different periods in India's development path from the 1960s to 2000. As shown in Table 15, most public expenditures to agriculture in the 1960s generated very high returns to both agricultural growth and poverty reduction. During this period, India's green revolution was just starting to take hold, which might make this period particularly relevant for many African countries. Particularly high returns were generated from public investments in roads and education, which had estimated benefit-cost ratios of 6 to 9. Agricultural research investments and credit subsidies yielded benefits that were 3 to 4 times the amount spent. This was the period when improved seed varieties, fertilizer, and credit were being promoted as a high payoff technology package. Irrigation and power subsidies yielded the lowest returns in this period, though returns to these subsidies were more than double spending. In the 1970s and 1980s, the returns to most of the subsidy programs declined though they began to account for a growing share of national budgets. Meanwhile, investments in agricultural R&D, roads and education provided the greatest payoffs in terms of agricultural growth. By the 1990s only agricultural R&D and road investments continued to yield estimated returns of more than 300 percent. Estimated net returns to irrigation investments and education were low but still positive, whereas credit, power, and fertilizer subsidies had negative net returns, i.e., a Rupee invested generated less than one Rupee of benefits (Fan et al., 2007). These findings are similar to those of Rashid et al (2006) who concluded that state subsidies in input and output markets played an important role in supporting the initial uptake of improved farm technologies in Asia, but that their return fell over time and that the subsidies have now become a major drain on the treasury while crowding out other public investments that could produce higher payoffs.

The ranking of public investments in terms of poverty reduction follow the same broad pattern as that for agricultural GDP growth. Spending on roads, agricultural R&D, and education provided the greatest poverty reduction impacts. These findings are consistent with evidence from Africa showing returns to investment in agricultural R&D over 20% per year (Oehmke and Crawford

1996; Masters, Bedingar, and Oehmke 1998). The economic assessment evidence strongly indicates that if the resources that were spent on crop science had been spent on something else, African economies would now be poorer, government finances would be in worse shape, food import bills would be higher, and more Africans would suffer from food insecurity.

Fertilizer subsidies are estimated to have been effective at reducing poverty in the 1960s and 1970s, but subsequently appear to have been highly ineffective (Table 15). Credit subsidies were effective in the 1960s and 1980s. As stated by Fan et al, "These results have significant policy implications: most importantly, they show that spending government money on investments is surely better than spending on input subsidies. And within different types of investments, spending on agricultural R&D and roads is much more effective at reducing poverty than putting money in, say, irrigation" (p. 18-19).

**Table 14. Summary of Analysis of Six Asian Economies' Agricultural Growth Boom Periods**

| | Agricultural growth effects | | | Poverty-reduction effects | | |
|---|---|---|---|---|---|---|
| | Median share of agricultural growth attributable to: | Median rank by total effect | Median rank by benefit/cost ratio | Median share of poverty reduction attributable to: | Median rank by total effect | Median rank by benefit/cost ratio |
| *Policy / institutional reform* | 40% | 1 | 1 | 30% | 1 | 1 |
| *Infrastructure* | | | | | | |
| Rural roads | 10% | 3.5 | 3 | 15% | 3 | 3 |
| Irrigation | 9% | 4.5 | 4 | 8% | 5 | 4 |
| Electricity/health/ education | 9% | 4 | 7 | 18% | 2 | 4 |
| *Agricultural inputs delivery* | | | | | | |
| Fertilizer/seed/chemicals | 10% | 5 | 6 | 7% | 6 (tied) | 6 |
| Agricultural credit/ insurance | 2% | 6 (tied) | 8 | 5% | 6 (tied) | 2.5 |
| *Agricultural/ natural resource managmt research/extension* | | | | | | |
| Ag./NRM research | 15% | 2 | 2 | 10% | 4 | 2 |
| Ag/NRM extension | 2% | 6 (tied) | 4 | 5% | 6 (tied) | 2.5 |

Source: The Economist Intelligence Unit (2008).

The findings of these two studies from Asia provide potentially important implications for promoting agricultural growth and poverty reduction in Africa. Although the regions differ in important respects, there are strong reasons to believe that the policy reforms and investments in R&D and infrastructure that generated high payoffs in Asia are likely to be crucial drivers of growth in most of Africa as well. The payoffs to most types of public investments will be greater in a policy environment conducive to private investment. As concluded by EIU (2008):

**Table 15: Returns in Agricultural Growth and Poverty Reduction to Investments and Subsidies, India, 1960-2000.**

| | 1960s returns | rank | 1970s Returns | rank | 1980s returns | rank | 1990s returns | rank |
|---|---|---|---|---|---|---|---|---|
| *Returns in Agricultural GDP (Rs produced per Rs spent)* | | | | | | | | |
| Road investment | 8.79 | 1 | 3.80 | 3 | 3.03 | 5 | 3.17 | 2 |
| Educational investment | 5.97 | 2 | 7.88 | 1 | 3.88 | 3 | 1.53 | 3 |
| Irrigation investment | 2.65 | 5 | 2.10 | 5 | 3.61 | 4 | 1.41 | 4 |
| Irrigation subsidies | 2.24 | 7 | 1.22 | 7 | 2.28 | 6 | na | 8 |
| Fertilizer subsidies | 2.41 | 6 | 3.03 | 4 | 0.88 | 8 | 0.53 | 7 |
| Power subsidies | 1.18 | 8 | 0.95 | 8 | 1.66 | 7 | 0.58 | 6 |
| Credit subsidies | 3.86 | 3 | 1.68 | 6 | 5.20 | 2 | 0.89 | 5 |
| Agricultural R&D | 3.12 | 4 | 5.90 | 2 | 6.95 | 1 | 6.93 | 1 |
| *Returns in Rural Poverty Reduction (decrease in number of poor per million Rs spent)* | | | | | | | | |
| Road investment | 1272 | 1 | 1346 | 1 | 295 | 3 | 335 | 1 |
| Educational investment | 411 | 2 | 469 | 2 | 447 | 1 | 109 | 3 |
| Irrigation investment | 182 | 5 | 125 | 5 | 197 | 5 | 67 | 4 |
| Irrigation subsidies | 149 | 7 | 68 | 7 | 113 | 6 | na | 8 |
| Fertilizer subsidies | 166 | 6 | 181 | 4 | 48 | 8 | 24 | 7 |
| Power subsidies | 79 | 8 | 52 | 8 | 83 | 7 | 27 | 6 |
| Credit subsidies | 257 | 3 | 93 | 6 | 259 | 4 | 42 | 5 |
| Agricultural R&D | 207 | 4 | 326 | 3 | 345 | 2 | 323 | 2 |

Source: Fan et al., 2007

"Our assessment is that the interventions that proved most effective in Asia – policy and institutional reforms, an agricultural research revolution, major expansion of rural roads and irrigation, and improved rural financial services delivery – must likewise be the primary targets for new investments…..The specifics of the strategies will vary among countries and even among agro-ecologies within countries, and must be developed internally, albeit with external financial and technical assistance. But the broader patterns are clear" (p. 18).

The main caveat to these studies is that they are based on the period 1960-2000. Much has changed since then. Global climate change, constraints and costs associated with bringing new land into production, higher energy prices, the evolving structure of the global food system, the concentration of agricultural R&D research and increasing intellectual property right protection barriers to public R&D, Africa's increasingly urban complexion, and the possible slow-down of crop productivity growth in the world's breadbasket zones are several of the most important developments that would need to be carefully considered which might alter, perhaps fundamentally, the way relative payoffs to public sector investments in the future and the nature of the CG research priorities.