

**CHALLENGES AND OPPORTUNITIES FOR
AFRICAN AGRICULTURE AND FOOD SECURITY:
HIGH FOOD PRICES, CLIMATE CHANGE, POPULATION GROWTH, AND HIV AND AIDS**

Hans P. Binswanger-Mkhize¹

ABSTRACT

Over the past decade, economic and agricultural growth in sub-Saharan Africa (SSA) has resumed. The secular downward trend in agricultural prices ended in the early 1990s; growing incomes in Asia and Africa, combined with continued rapid population growth, are fueling food demand, which is expected to lead to a gradual upward trend in international real agricultural prices. For Africa the major agricultural growth opportunities will be in regional and domestic markets for food staples. Economic and agricultural growth have resumed despite continued high population, the AIDS crisis, and the onset of measurable climate change. Climate change will provide both challenges and opportunities, and countries need to strengthen their general capacities to deal with stresses and weather shocks in line with general agricultural development priorities. Population growth adds to the challenge of increasing per capita income and feeding Africa. It will also drive further agricultural intensification and in many places has led to improvements, rather than deterioration in the natural resource base. The fight against HIV and AIDS in rural areas is lagging badly and will need to be intensified via participatory approaches to prevention, expansion of HIV and AIDS treatment to rural areas, and massive improvements in rural safety nets. To seize the agricultural growth opportunities that derive from recent policy and price trends, SSA will have to support economic growth via continued sound macroeconomic policies, further improvements in the investment climate, and investments in infrastructure and institutions. More specifically in the agricultural sector, SSA will have to (i) further reduce agricultural dis-protection in countries and commodities that still practice it; (ii) reduce barriers to intra-regional trade in food and other agricultural commodities and properly finance the regional institutions that support regional trade, quality and phyto-sanitary controls, and other regional agricultural public goods; (iii) sharply increase domestic and regional funding of agricultural science, science education, and research; and thereby regain the technology agenda from the donors; and (iv) assist in the deepening of domestic markets and foster sharp improvements in smallholder services.

¹ Hans P. Binswanger-Mkhize is Professor Extraordinaire at the Institute for Economic Research on Innovation at the Tshwane University of Technology, Pretoria, South Africa. I am grateful to Alex McCalla for his collaboration on the research that is partly reflected in this paper, and to the International Fund for Agricultural Development and the African Development Bank who supported us. And I am indebted to Ira Matuschke for great editorial support.

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EXECUTIVE SUMMARY

After decades of decline of per capita food production, we are now in a period of new optimism about the prospects for Africa and for African agriculture. For Africa as a whole, economic growth was well above 5% until 2008, whereas for sub-Saharan Africa (SSA) it was above 5.5% (IMF, 2009). Agricultural growth in SSA has been above 3.5%, well above the population growth rate of about 2%. Armed conflicts are down to 5 from 15 in 2003. Although there are setbacks, such as the recent Kenya and Zimbabwe crises, democracy has advanced significantly. Sub-Saharan Africa (SSA) now has faster progress in its business environment than the Middle East and North Africa and Latin America (World Bank and IFC 2006). Africa is in the process of strengthening its regional and sub-regional institutions.

This paper documents the empirical evidence for the causes of the low economy-wide and agricultural growth rates, and for their subsequent recovery. It then goes on to review the evidence of the impacts which climate change, population growth and HIV and AIDS have had and are likely to have in the future on the agricultural and food sectors, as well as the challenges and selected opportunities they present. It then compares these challenges to other challenges faced by agriculture and food security and reviews the needed actions to overcome them. The executive summary provides the conclusions, but not the evidence, which is in the body of the paper.

The failure to grow as rapidly as the rest of the developing World has left a terrible legacy of poverty and hunger (Collier 2007; Ndulu et al. 2007; Binswanger-Mkhize and McCalla forthcoming). As a consequence SSA is the only continent in which poverty has increased in absolute and relative terms. Poverty and hunger are deepest in East, Southern and Central Africa, where AIDS prevalence rates are also much higher than in West Africa. It has made Africa more dependent on food imports, making it much more vulnerable than other regions to the recent food price shock. The failure to grow has retarded the demographic transition that has significantly lowered population growth rates elsewhere. As a consequence, Africa has not yet started to benefit from a population dividend associated with lower dependency rates. Low growth has aggravated the debt crisis and reduced domestic resources for infrastructure, agricultural development, health, education, and nutrition. It has aggravated the HIV and AIDS crisis. And finally it has made Africa less able to adapt to climate change. It is for this reason that this paper will first and foremost focus on growth in general, and agricultural growth in particular. The paper will analyze one by one the factors that caused the decline in growth, those that then led to the recovery, and the remaining challenges for the acceleration of growth.

The decline in growth rates were triggered by the oil and food crisis of the early 1970 and persisted well into the 1990s. The decline was primarily caused by poor macroeconomic management, overvalued exchange rates, high import tariffs that penalized the export sectors, and agricultural policies that penalized the sector. The highly adverse agricultural policy environment was aggravated by a steep decline in international agricultural prices from the early 1970s to the late 1980s, which combined with high agricultural protection and subsidies in OECD countries further reduced the profitability of agriculture. An overemphasis on state economic management via loss-making parastatal enterprises added to the fiscal crises and reduced the space for private sector involvement. By the early to mid 1990s, many of these adverse policies had been replaced by fiscal prudence, macroeconomic stability, a more open trade regime, and a more favorable private sector environment. Economies in general and agriculture in particular resumed their growth, starting with the most rapidly reforming countries. Debt relief in this decade provided further fiscal space.

The long term decline in real food prices ended in the 1990s, with the precise date depending on the commodity group and on the price deflator used. Since 2005 real food prices have exploded by more than 60 percent over their 1998-2000 level, only to lose about two thirds of that increase in the months until since July 2009. While nobody expects food prices to stay at such high levels, all models and experts agree that they will settle at significantly higher prices than in the last decade (FAO 2008). As a consequence, African agriculture is likely to become more profitable. Agriculture has returned as a priority on the International Development Agenda, of the African Union and NEPAD. The latter have developed the CAADP process that provides both a vision for agriculture and a process to develop national and regional agricultural development programs.

It is striking that the resumption of growth and agricultural growth was not caused by significant investments in infrastructure, the closing of the agricultural technology gap, or the provision of better services to smallholders. Aid volumes provided by OECD countries have not significantly increased, and even sharply

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declined for agriculture. Nor has the quality of aid provided improved. Business climates in Africa still rank low in international comparisons, despite the higher rates of improvement. Transport costs are still among the highest in the World. Electricity supplies are unreliable and costly. Financial sectors are underdeveloped, reaching only few clients, and savings rates remain much too low. Private input and output markets did not develop as fast as expected and farmers continue to be severely penalized by inadequate competition in these markets, and by higher input prices and lower farm gate prices than in other regions of the World. While some countries benefited from special trade preferences in US and European markets, these gains were limited because the developed countries continue to protect “sensitive” commodities, some of which would provide the greatest opportunities. Global trade talks have floundered again on questions of agricultural trade and little relief is in sight from reduced protection in OECD countries.

Growth also resumed despite continued high population, the AIDS crisis, and the onset of measurable climate change. In particular, earlier fears of HIV and AIDS induced food crises in countries such as Malawi have not materialized. Instead better rains and supportive fertilizer subsidies have led to an agricultural recovery in that country. That does of course not mean that high population growth, AIDS and climate change are negative factors for growth, only that their impact has not been severe enough to prevent the resumption of growth. And finally, while extremely high oil and mineral prices have helped net exporters of these commodities, growth has accelerated nearly as much in the net importing countries.

Higher world prices, combined with rapid demand growth associated with population growth, urbanization and income growth open the greatest opportunities for African farmers in domestic and regional markets: In these markets farmers compete at import parity prices rather than at the lower export parity prices, and they face lower phyto-sanitary and quality challenges than in overseas markets. Via import substitution they therefore have a major opportunity to re-conquer markets lost to imports in the previous 45 years. Undoubtedly farmers will also be benefiting from enhanced overseas market opportunities, especially in the longer run after developing their domestic and regional markets.

While the outlook for African growth and agricultural growth in general is positive, a number of countries such as Zimbabwe, Kenya and the Ivory Coast suffer from still unresolved political crises, and conflicts in the Sudan, Somalia and Northern Uganda continue. Other countries continue to progress in governance and policy reforms, and Zimbabwe continues to pursue all of the failed policies of the 1980s.

*Because so much policy change has already been done, further improvements in macro, trade and agricultural policies are unlikely to provide a major boost in growth rates. New sources of growth are urgently needed. Based on the analysis in their report, Ndulu et al. (2007) propose a medium-term strategy that hinges on taking action in four areas (characterized as the four “I’s”): improving the **investment climate**; a big push toward closing the **infrastructure** gap with other regions of the world; a greater focus on **innovation** as the primary motor for productivity growth and enhanced competitiveness; and **institutional and human capacity**. And Collier (2007) suggests that much more needs to be done for the lagging bottom billion countries, on which aid should increasingly be concentrated. But aid will not be enough to assist these countries. It has to be combined with measures to reduce and recover from conflict, including prolonged military interventions, and support to the rapid rebuilding of essential state capacity.*

What are the challenges for rural areas, for reducing rural poverty and hunger? The task of this paper was to specifically address the challenges of climate change, population growth, and HIV and AIDS, so they are discussed first.

Climate change

Very few people today doubt that man-made climate change is now occurring. SSA contributes the least to greenhouse gas emissions, yet is expected to be among the most negatively affected by climate change. Depending on whether carbon fertilization benefits materialize, the aggregate impact of climate change on African agriculture until the 2080-2100 period is estimated to be between 15 and 30 percent. To put these into quantitative perspective, an increase in the rate of total factor productivity of less than one-third a percentage point would be able to offset even the higher of these loss estimates.

For African farmers the adaptation challenges are obvious: They increase agronomic complexity and increase risks of shocks at the farm and community levels and imply additional changes in crops, cropping

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patterns, timing, agronomic practices, and seed needs. But the analysis of these papers shows that for particular African regions neither the specific nature nor the severity of the climate change impacts can yet be predicted with any degree of certainty. Therefore, despite several initiatives to do so country by country, it is not possible to plan specific measures of mitigation, such as the length of growing seasons of crops. Instead, in terms of adaptation in Africa, what is required is *strengthening of capacities of African agriculture and food systems to adapt to climate change*, via improved technology generation and adoption systems, more and better irrigation and drainage, better markets, and greater ability to import foods in bad years or on a year round basis, greater preparedness for extreme weather events, and better safety nets. *However, all these improvements are also most urgently needed even if there were no climate change. Climate change, therefore, does not generate a separate agenda for agricultural and rural development, only reinforcements of existing agendas. Adaptation to climate change needs to be mainstreamed into this general agenda.*

In terms of mitigation, public expenditures on mitigation should be subject to serious cost-benefit analysis, comparing the benefits of spending a lot of money on small reductions on CO₂, or the same or less money on more pressing current issues. This is a real trade off, and no-where is this more true than in SSA and its agriculture: SSA is the continent contributing the least to global warming. It has the most urgent economic and social problems that press on the current generation, and that will be less for future, more wealthy generations. Except for land use changes discussed below, the case for putting less emphasis on mitigation in SSA, and more on dealing with the pressing current needs, and with capacity building for future adaptation, is stronger here than anywhere else.

African agriculture, on the other hand, can take advantage of opportunities that climate change may present. Carbon trading, in exchange for offsetting mitigation measures, can increase income in rural areas. Achieving significant carbon mitigation in Africa can be achieved through land use change. The total potential saving still substantial and is achievable at a competitive cost. However, of the over 60 billion US dollars of carbon trades that have already been concluded globally, Africa has only benefited from about 3 percent. Few of these have involved agriculture, and half of the African carbon trades have been in South Africa. The institutional frameworks for carbon trading in land use change are poorly developed globally and in Africa. It is clear that to take advantage of these opportunities will require the building of appropriate policies and institutions at national, sub-regional and regional levels.

Population growth

The analysis in the paper shows clearly that a balanced view of the population challenge for African agriculture and food security stresses both opportunities and challenges:

Past population growth and high fertility rates lock in a considerable momentum of population growth that will lead to higher rural populations, extremely rapid urbanization, and high dependency rates, which in hard hit countries are accentuated by high adult mortality from HIV and AIDS. However, AIDS is not expected to lead to population declines in any country in Africa.

The rapid population growth is not only a drag on growth, but also generates huge unemployment problems among youth; agricultural development should be seen as an opportunity to generate much more employment for rural youth and thereby help stem urbanization. While the demographic transition has barely begun in SSA, faster economic growth, higher female education, and a resumption of family programs could significantly accelerate it, and thereby create a population dividend for future economic and agricultural growth.

Out of the total land area in Africa, only a fraction is used for arable land. A FAO study has estimated the potential land area for rainfed crops with a total potential for the whole of Africa in 300 million hectares. To harness the enormous land reserves of the continent will require more labor and migration of populations from higher population density areas and areas with little or declining agricultural potential to the lower population density areas, where better quality agricultural land is available. Such migration would be greatly facilitated by regional integration that would allow for international labor movements. However, the land reserves cannot simply be harnessed by migration, but require enormous investments in infrastructure and technology. The expected higher agricultural price environment provides a major opportunity for such

investments.

Rather than fueling land degradation, longitudinal studies have convincingly shown that population growth, market access and higher incomes can contribute to more sustainable use of agricultural land and other resources. It induces intensification, higher land investments, crop livestock integration, and more trees. If combined with better output and input markets, population growth leads to higher applications of organic matter and fertilizer, and these in turn can stem the nutrient mining.

The rhetoric of massive land degradation and desertification in Africa is poorly backed up by more than isolated studies and maps of erosion risks. Quantitative evidence is lacking. Where it occurs it is not caused by population growth, but rather associated with low payoffs to land and fertilizer investments, poor tenure security, and open access to pastures and forest areas. Local and national institutions to improve security of tenure and control open access are therefore important to prevent resource degradation.

The TerrAfrica program and the Alliance for and Green Revolution in African (AGRA) have put soil degradation at the center of their activities. Application of known soil conservation and improvement techniques is not as much a matter of more agricultural extension, as a change in underlying conditions of agricultural profitability, tenure security, and institutions to prevent open access.

Climate change, desertification and bio-diversity losses really come together in the local government arena, communities and on the farms, requiring management and adjustment capacities. Conventions in all three areas provide financing opportunities, including the Global Mechanism hosted by the International Fund for Agricultural Development (IFAD), a financing instrument for the Convention of Desertification.

HIV and AIDS

The major impact of HIV and AIDS are the loss of human life and the enormous suffering of the patients and the families who experience AIDS deaths. As mentioned before, even in high prevalence countries of Eastern and Southern Africa, these deaths will not lead to a population decline. Impact estimates on economy-wide growth range from the benign to the alarming. In addition, the AIDS crisis has severely increased tuberculosis and malaria infections, making these diseases much more prevalent and dangerous. The diseases are aggravated by the growing crisis of multi-drug resistant tuberculosis, and increased resistance of malaria to common, inexpensive drugs.

Whatever these impacts of HIV and AIDS may be, they have, however, not prevented the resumption of growth even in the high income countries. Impacts on agricultural output growth are still poorly understood, but as mentioned before, the fears of HIV and AIDS famines have probably been exaggerated.

At the household level, HIV and AIDS morbidity and death can lead to distress sales of assets and therefore reduce capital stocks available to survivors. Both aggregate agricultural labor supply and labor demand are reduced, leading to little aggregate labor scarcity of wage rises. Impacts on the availability of labor of an AIDS death are often mitigated by the absorption of new adult household members, although this is not the case in numerous cases, where grandmothers or older children become household heads. Many households recover quickly in terms of agricultural output, but others suffer a persistent impact of low availability of land, labor, capital, and farming skills. It is for these households that agricultural interventions are the most necessary and useful to help their recovery.

Major counterintuitive findings are as follows: Better food intake and nutrition does little to reduce the risk of infection with the HIV and AIDS virus, nor does it significantly prolong life of untreated individuals beyond the modal number of 8.9 years after infection. Only anti-retroviral therapy can prolong life, by many years across the World and in Africa. In addition, not all orphans are experiencing lower food intake, nutrition, education and health than non-orphans. This is because African families place the orphans with those relatives better able to care for them. On the other hand, the above welfare indicators are worse for households that take care of more than one orphan, apparently because the burden is just too much. Since there are a rapidly growing number of such families in Africa, the social protection acquires even more urgency.

HIV and AIDS prevention, treatment and care and support are less well developed in rural areas than in

urban areas, and even in urban areas there is far from universal access to these measures. The main challenge that HIV and AIDS pose for agriculture and rural development is therefore to ensure that these three components of the fight against HIV and AIDS achieve universal coverage. This is more difficult in rural than in urban areas, but not impossible. For example the WHO guidelines for HIV and AIDS treatment are specifically designed to make it possible to provide treatment even in areas that only have access to a health post managed by a nurse.

Each of the three major components of the fight against HIV and AIDS consists of several individual interventions. In many of them deep involvement of communities is necessary: Attitudes toward condoms and HIV stigma cannot be changed without community involvement. Adherence to AIDS treatment is difficult and requires family and community support. And care and support in rural areas have to be almost entirely managed by communities. Approaches to community involvement in the fight against HIV and AIDS in rural areas are well developed, but used insufficiently. A consequence is that community-driven agricultural and rural development programs must mainstream all three components of the fight against HIV and AIDS. It makes little sense, for example, to implement a land reform program only to see many of the beneficiaries succumb to AIDS or the associated tuberculosis and malaria.

Key Challenges to Agricultural Growth, Rural Poverty and Hunger

Neither population growth nor climate change will present insurmountable challenges to agricultural development in Africa, if Africa seizes the opportunities it now has. And both provide opportunities. Reducing the death and suffering from HIV and AIDS requires generalization of prevention, treatment and care and support in rural areas, taking advantage of agriculture in the care and support area.

But there are other serious threats to the agricultural growth rate, and the reduction of poverty and hunger. This paper focuses on the most serious ones: the widening technology divide, slow development of input and output markets and the associated smallholder services, slow progress in regional integration, and inadequate safety nets to deal with extreme poverty, risks and fluctuations.

Agricultural growth in SSA is primarily a result of area expansion, rather than productivity growth in crops and livestock. The challenges of productivity growth are higher in SSA than in other Regions of the world: There are more different environments to deal with, more crop varieties, and more crop and livestock pests and diseases than elsewhere. There are no dominant farming systems that extend over very large areas such as irrigated rice and wheat in Asia. Irrigation infrastructure is poorly developed. And climate change will significantly add to the technology challenge. As a consequence of these factors, Africa is less able to borrow technology from other tropical countries, and technology transfers between regions in Africa are also constrained.

The growing Technology Divide

Rates of return to agricultural research have been almost as high as in other regions, however. And well above 25 percent of the cropped area now benefits from improved varieties and hybrid seeds. However, yield gains associated with high yielding varieties are much less than in other regions, owing to the heterogeneity of agriculture, the inadequate input and output markets, poor smallholder services, and poor infrastructure. As a consequence the use of irrigation, fertilizers and pesticides is much less than in other Regions, sharply limiting the yield gains.

Despite the much higher need for agricultural research, Africa invests significantly less than other regions. Its large public research system contains over 400 institutions, but they are small. The 3000 agricultural scientists in Africa are less well trained than those in other regions, and they have much fewer resources to work with. The agricultural science education system is similarly fragmented into 200 institutions, and poorly funded. It is therefore not clear where and expanded agricultural science force will come from. Ten of the CGIAR institutions are active in Africa and four are located in Africa. Their funding is, however, only one-tenth of the overall funding for agricultural research in Africa, and has been stagnating at that low level.

The limited research resources also seem to have been increasingly misallocated. Given the heterogeneity, the poor borrowing opportunities, and the enormous challenges from pest, diseases and water stress, basic innovations at the science level are urgently needed to in a wide variety of crops and livestock diseases. Yet the proportion of research going to basic sciences has been declining in national and international research

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systems alike. Instead the resources have gone to agronomic and farming systems and environmental research that has little record of high rates of return. The African Challenge program continues the same unfortunate trend. Scarce scientific resources have also been diverted to implementation of programs, rather than research. While Africa has created not less than four regional centers for biotechnology, these remain severely underfunded. The blame for these factors may lie primarily with donors impatient for immediate results, or distracted by donor fashions. Despite their commitments to the CAADP agricultural priorities, national governments have also not significantly increased their funding for agricultural research in general or biotechnology in particular. They also have invested little in biotechnology capacity, probably for political reasons. In the meantime India, China and Brazil are sharply increasing their investments in biotech research.

There is some relief in sight. AGRA intends to fund the training of 1000 plant breeders. However, unless they can be posted in better funded institutions, the best of them will be lost to emigration. Private sector technology research has grown considerably, albeit less than in Asia and Latin America. However, unless the science base improves, the gains from conventional breeding in the public and private sectors may be insufficient to close the growing technology divide. The Bill and Melinda Gates Foundation, a founding member of AGRA, has also invested in basic research in a number of crops, but given the enormous needs, the funding remains inadequate. There is therefore little hope that the crisis of the growing technology divide will see any rapid solution, unless African governments muster the political will to sharply increase the necessary funding.

Smallholder services and input and output markets

Improvements in technology will continue to lead to lower productivity gains, if services, input and output markets are not significantly improved. Rural finance is also insufficiently developed. Farmers' organizations have made a lot of progress, but are still not able to provide much of the needed capacity. If the smallholder services, rural finance, and markets were improved, however, a number of problems will be closer to a solution: Farm profit and investments will increase, nutrition depletion will be reduced, and food insecurity associated with poor markets will be reduced. The re-conquest of domestic and regional markets will then also be closer at hand. Again, relying on donor finance for these improvements will not be sufficient to solve these problems. Political will on the part of African governments is needed to provide the necessary finance.

Safety nets

While emergency relief is relatively well developed in SSA, safety nets for the very poor are not. This is again in sharp contrast to India and China. For example, less than 1 in 100 orphans receives any kind of assistance in SSA (other than South Africa). While South Africa has a number of conditional grants programs for the aged, children, and the disabled, few other SSA countries are experimenting with them. Support to traditional safety net mechanisms in rural communities is conspicuous by its absence. And few employment generation programs have more than spotty coverage.

But the need for safety nets will not be reduced by growth or agricultural growth. Such growth tends to bypass the very poor and destitute. The population of old people without family support will go up with population growth and improving incomes and health. Climate change, HIV and AIDS, malaria and tuberculosis, and the growing orphan crisis require better safety nets. Growth is increasing the fiscal space of African governments, and they need to take advantage of it to improve the safety nets.

The imperative of Regional Cooperation in agriculture

Throughout this paper many critical issues were encountered that can best be, or only, solved by regional action, and more are yet to come; let's recall a sampling:

- Small countries dominate the African scene often lacking financial capacity for public goods investments;
- Small land locked countries generally do worse and depend on regional integration to be able to do better
- Expanded regional trade in agriculture and food products is good for growth, farmer's income and regional food security; the short run management challenges of the current food price spike and the long run opportunities arising from prices that are expected to settle at higher than past levels only

add to this imperative

- Expanded regional trade and food security will be helped by the harmonization of standards and sanitary measures, and sub-regional and regional capacities to implement them;
- Freer borders and internal infrastructure should encourage private sectors traders;
- For small countries, regional infrastructure – roads, communications, ports – is critical for access to each others and external markets;
- Reversing land degradation and desertification and preserving biodiversity require trans- boundary collective action;
- Managing crucial, but under threat, forestry and fisheries resources must be approached on a transnational basis;
- Defense against plant and animal disease epidemics require collective responses at sub-regional and regional levels;
- Success in agriculture crucially depends on indigenous scientific capacity to generate new technology. Given the capacities of small and poor countries, this is far better done on a regional or sub regional basis: FARA and the SRO's are on the right track, but the effort needs to be greatly expanded;
- Biotechnology research is expensive. It also requires a large critical mass of researchers. Therefore two or three regional institutes is far superior to 48 or 24 underfunded, under resourced national institutions;
- Indigenous scientific capacity requires trained people, again better done by regional institutions which have critical mass and necessary financial support;
- Regional approaches to rural financial architecture may increase potential deposits and loanable funds and spread risk;

These examples hopefully are enough to illustrate that the potential for regional approaches and an overall regional strategy for rural Africa are significant. In most of these areas institutional development programs have been created. Yet they remain massively underfunded. The main reason for this is that the regional efforts produce regional and sub-regional public goods, and therefore their financing is subject to the familiar free rider problem of financing public goods. Except the largest countries which have an incentive to supply themselves with these regional public goods, countries will seek to benefit from the investment of others. Better coordination of funding by African countries, as well as external co-finance, could help overcome the underfunding. But *donor finance remains both insufficient and unreliable for the task. The African Union, via the CAADP, the Economic Commission for Africa, and African Development Bank need to coordinate these efforts.*

Conclusions

African agriculture today faces a context of general economic growth in Africa, and in the medium term a brighter market outlook in international, regional and domestic markets than anytime in the last 40 to 50 years. Both macro-economic and sector policies are more favorable. In most countries the institutional environment has also given local governments, communities and the private sector much more opportunities than in the past. And business climates are improving, albeit from a very low level. The smallholder-dominated agricultural sectors of Africa have already responded in terms of a significantly higher growth rate.

Improved market opportunities will arise in traditional as well as non-traditional agricultural exports and they need to be seized. At the same time domestic and regional markets will present the most promising area for medium to long term agricultural growth. That means that small farmers, despite the supermarket revolution and rising international quality standards, will be well placed to seize them.

While climate change is likely to affect most regions in Africa negatively, it will also open new opportunities in some regions where rainfall and other climate parameters will improve. Other opportunities arise from the possibility of carbon trade once the instruments for trading via land use commitments and changes are better developed. In the aggregate, the impact on African agriculture will undoubtedly be negative, but climate models are not yet sufficiently well developed for Africa to predict what will happen with sufficient certainty to engage in detailed planning. As a consequence, climate change should be mainstreamed into the general agricultural and risk mitigation agendas. In particular much better capacities for agricultural technology

development are needed.

Population growth is not yet slowing sufficiently fast to provide for a population dividend. At the same time the evidence for a generalized negative impact of population growth on agriculture is lacking, and instead in many areas population growth, combined with good market access has led to beneficial agricultural intensification.

HIV and AIDS has led to an enormous human tragedy and a reduction in growth prospects in hard hit countries. Agriculture and food interventions can help in mitigate the impact in rural areas. But neither prevention nor treatment programs have yet been scaled up adequately in rural areas, despite the fact that how to do that is well known, and scaling up of these interventions remains the most pressing issue.

The most neglected aspect of the agricultural agenda in Africa has been agricultural technology, and as a consequence the continent faces a growing technology divide. The continent has a large number of agricultural scientists, research institutions, and agricultural education and science education establishment. But these are mostly too small, donor dependent and underfunded. As a consequence Africa is not only lagging badly in traditional approaches to plant breeding and animal disease control, but is at great risk of missing the boat in the biotechnology revolution. Unless Africa, like China, India and Brazil, starts investing more of its own resources into agricultural science, science education and research, the huge existing technology divide will only deepen.

The agenda for action arising from the analysis of this paper is not new. The four most important among them are as follows:

1. Avoid backsliding on economy-wide and agricultural policies and further reduce agricultural disprotection in countries and commodities that still practice it.
2. Reduce barriers to intra-regional trade in food and other agricultural commodities and properly finance the regional institutions that support regional trade, quality and phytosanitary controls, and other regional agricultural public goods and services.
3. Sharply increase domestic and regional funding of agricultural science, science education, and research, and the associated centers of excellence; and thereby regain the technology agenda from the donors and pull them along in increasing their funding of priority areas.
4. Assist in the deepening of domestic markets and foster sharp improvements in smallholder services

INTRODUCTION

Most of the World's 2.1 billion people who live on less than 2 dollars a day live in rural areas and depend on agriculture for their livelihood. The number of rural poor has increased in Africa and South Asia, and reduced in East Asia and the Pacific. The World Development Report (WDR) of 2008 summarizes an extremely large literature which demonstrates the enormous power of agricultural growth for poverty reduction. Over the past 10 years global poverty with a 2 dollar a day poverty line declined by 8.7 percent in absolute numbers. This decline was caused *entirely by rural poverty reduction, with agriculture as the main source of growth*. At the same time *urban* poverty has increased. *Migration is not the main instrument for rural (and global) poverty reduction. Improved rural conditions are the main cause.*

The secular decline of food prices came to an end in the 1990s, with the précised date depending on the commodity group and on the price deflator used. Since the middle of this decade real food prices started to rise and spiked in early 2008 at about a 60 percent higher average level than in the early years of this century. By July 2009 they had lost at least two thirds of the price gain and have settled at a somewhat higher level than in the early 1990s. Most models and experts agree that food prices will remain at higher real levels than in the last decade (FAO 2008) and may even rise over the next few decades. For this and other reasons, agriculture has returned as a priority on the International Development Agenda.

As Johnston and Mellor (1961) showed nearly 50 years ago, agricultural growth reduces rural poverty:

1. By raising agricultural profits and labor income
2. By raising rural non-farm profits, employment and labor income via linkage effects
3. By causing lower prices of (non-tradable) foods, especially beneficial for the poor
4. Lower food prices reduce urban real wages and accelerate urban growth
5. Tightening urban and rural labor markets raise unskilled wages economy-wide.

The WDR divides developing countries into *urbanizing countries* mostly in Latin America, (but also South Africa) with 255 million people, *transforming countries* mainly in East Asia and the Middle East and North Africa (MENA) with about 2.2 billion rural people, and *agricultural countries*, mostly in sub-Saharan Africa (SSA), with 417 million rural people. It is in the agricultural countries, most of which are now in SSA, in which agriculture can contribute most to poverty reduction; but it is also in these countries in which it has lagged the most and confronts the biggest barriers to growth.

In Africa the impact of growth on poverty reduction is well illustrated by eight SSA countries that have seen per capita growth rates of 2.9 percent on average in the 1990s and have reduced poverty at an annual rate of 1.5 percent during the period (Ndulu et al. 2007). On the other hand, poverty in stagnating countries has increased. Agricultural growth has a much more direct impact on hunger than general economic growth: Pingali et al. 2007 have shown that by and large the countries with faster agricultural growth have made more progress against hunger. Hunger has therefore significantly declined in West Africa, and it has increased significantly in the conflict or coup countries. Countries like Liberia, Sierra Leone, Comoros, Burundi, Guinea Bissau, and most dramatically the Democratic Republic of the Congo (DRC) have neither seen economy-wide or agricultural growth.

FAO has analyzed in great detail the reasons and impacts for the higher international food prices that have shocked the World since 2005, and especially in the past two years (FAO 2008). In the short run these have very negative impacts on the balance of payments, especially in East and Southern Africa, and significantly increase the number of people in poverty and the depth of poverty of those already in it. These impacts provide many policy challenges for African countries, especially for those who are not petroleum or mineral exporters. On the other hand, they provide enormous opportunities for Africa which, along with Latin America, has the greatest reserves of arable land. The rising international prices provide especially good opportunities in domestic and regional markets where Africa can substitute more easily for the now more costly imports. Therefore this paper will pay great attention to these rising market and agricultural growth opportunities.

The outline and some major messages of this paper therefore are as follows: Section 1 will look at past economy-wide and agricultural growth and analyze the factors that slowed it down, and then contributed to

the striking recent turnaround. It will also look at the remaining policy and broad program agendas for further accelerating these growth rates. Section 2 will quickly review the short term challenges arising from the recent price explosion in food prices, as well as the emerging market opportunities for African agriculture. Section three on climate change will briefly summarize what we know, and what we still do not know about climate change and its future impact on agriculture in Africa. It will show that for many regions, science still provides little basis for planning specific adaptations to climate change. The section will therefore propose to integrate it into broad agricultural development and risk mitigation strategies. The section will emphasize that improvements in Africa's science and technology capacities and irrigation infrastructure that are needed for the growth agenda are also critical for dealing with climate change. If these were in place, the challenges of climate change would not be as daunting as it now appears.

Section 4 will deal with population growth in Africa. If economic growth rates can be maintained or further accelerated, the high population growth rate of SSA will come down as it has in other parts of the world. This will lead to a population dividend in terms of lower dependency and higher labor force participation rates that will be helpful for growth. The section also discusses the evidence that population growth is only a threat to natural resources if it is associated with open access; and it will show with African examples that agricultural intensification is usually associated with improved natural resources management as well as increased agricultural productivity. It will then discuss the agenda for natural resources management that arises from these insights. Section 5 deals with the economic and agricultural impact of HIV and AIDS. Agricultural and food interventions are helpful in dealing with the consequences of AIDS on affected households, but provide little leverage for reducing infection rates or prolonging the life of those infected. As a consequence the fight against rural HIV and AIDS has to use classic prevention and treatment approaches which are still lagging much behind. The section then suggests how to better design rural prevention and treatment programs. Section 6 deals with the Key challenges of Agricultural Growth, including subsection 6.1 on the growing technology divide that is probably the biggest threat to African agricultural growth and food security in the coming decades and that most urgently needs to be reversed. Other subsections deal with smallholder services, safety nets, and the imperative of Regional cooperation. Section 8 pulls together the conclusions.

ECONOMY-WIDE AND AGRICULTURAL GROWTH IN AFRICA

Fostering Economy-wide Growth

This section summarizes key findings from a large review of growth research in Africa carried out by Ndulu et al. (2007) and from Collier's (2007) book on the "Bottom Billion". The factors analyzed are by and large the same factors that held back agricultural growth, but we will discuss agriculture specific factors below. Per capita GDP growth in 41 sub-Saharan African countries for which data for the full 45-year period are available amounted to only 0.5 per cent, compared to 3 per cent in 57 countries in the rest of the developing regions, including North Africa. Growth performance has been quite diverse: 6 of 47 sub-Saharan African countries have more than tripled their per capita incomes between 1960 and 2005, 9 countries' per capita incomes are at the same level as when they started or below, and the remaining 32 have seen modest growth in per capita income, but not enough to make a significant dent in poverty levels.

The prolonged period of economic decline between 1975 and 1994 started with shocks on energy and tropical commodity markets and ended with a wave of democratic reforms between 1989 and 1994. In 1994-2004, there was more rapid per capita income growth, with 20 countries expanding more quickly than the average rate for the rest of the developing world. Entry into this high-growth club was associated either with natural-resource exploitation (Angola, Chad, Equatorial Guinea and the Sudan), or with strong reform movements (Benin, Ethiopia, Ghana, Malawi, Mali, Mozambique, Senegal and the United Republic of Tanzania). Economic growth further accelerated in all of Africa between 2004 and 2006, thanks to strong global economic growth and higher raw material and energy prices (ECA, 2007). In 2007, economic growth in sub-Saharan Africa reached 6.1 per cent.

How will the current economic crisis affect growth prospects for Africa? In 2007, world real GDP grew 5.2%, which translates into a 4.2% growth in per capita economic output. World output growth then declined to 3.2% in 2008 and is projected to decline at a -1.9% rate in 2009. The IMF then projects a rebound to 1.9%

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and 4.3%, respectively, in 2010 and 2011. This means that global per capita output is projected to decline about 2.9% for the first time in decades, suggesting perhaps a negative change in global food demand in 2009. However, the decline in output is concentrated in the advanced economies, where income elasticity of food demand is very low. For the emergent and developing economies, where income elasticity of demand is higher on account of their lower income, the growth rate for 2009, 2010, and 2011 is projected at 1.6%, 4.0%, and 6.1%, respectively. They expected to be less hard hit by the global economic crisis, and their rising income may offset declines in food demand elsewhere in 2009 and add a positive trend to global food demand thereafter.

For Africa as a whole as well as for sub-Saharan Africa, the projected growth trends in output are similar to those for emerging and developing economies. It is particularly noteworthy that the output growth in sub-Saharan Africa in 2009, 2010, and 2011 is expected to be about 1.7%, 3.9%, and 4.5%, respectively. Since population growth is about 2% in SSA, the per capita income is only expected to decline marginally in 2009, suggesting that even in SSA, food demand may resume its growth fairly soon.

What explains the slow growth of Africa since 1960? Over the long haul, slightly less than one half of the lower growth in Africa relative to the rest of the developing World is associated with lower growth of physical capital, and slightly more than half with lower productivity growth. The share of investment in GDP has been only about half as high as elsewhere, and for a given investment, Africa has only achieved about two-thirds of the productivity growth.

The over 90 percent of SSA that lie between the Tropics suffer from much higher incidences of diseases that impact negatively on life expectancy, human capital and labor force participation. SSA has 48 small economies with a median income of only 3 billion US dollars. Forty percent of the population lives in landlocked countries, as against only 7.5 percent in other developing countries. Resource-rich landlocked countries did better than their resource-poor land-locked counterparts, especially in the 1970s and since 2000. Coastal resource-poor and coastal resource-rich countries did about the same over the long haul. Oil revenues are still poorly invested, and the recent rate of growth of the African countries benefiting from the oil bonanza has not been higher than that of the other African countries that suffer from the higher oil import costs.

The transport costs of landlocked countries depend less on distance, but on how much their neighbors had spent on transport infrastructure. To increase their chances, these countries need to focus on their own and their neighbor's transport infrastructure, including transport to the sea; on regional integration, and on reducing external trade barriers of their entire region. They must be interested in good economic policies of their neighbors. And, based on the analysis in this paper, growing urban, sub-regional and international markets can provide many opportunities for their agriculture (Box 1).

Conflicts have had huge costs: The proportion of Africa's population in conflict reached a peak near 60 percent in 1984 and another near close to 50 percent in the early 1990s. Conflict therefore was a more important determinant of the collapse of growth in the 1980s than usually recognized. (Ndulu et al. 2007). Collier (2007) shows that civil war is more likely where income is low, stagnates, or declines; in countries dependent on oil, diamonds, and other primary exports; but interestingly not where inequality is high. Civil wars last ten times as long as international wars (which last an average of six months). Once they are over, they are alarmingly likely to restart. Civil wars reduce economic growth on average by 2.3 percent. They sharply increase disease incidence. The end of civil war ushers in a boom in homicides. As a consequence of these factors, nearly half of all costs arise after the war is over. These costs spill over to neighboring countries and the rest of the world. Overall cost per civil war is estimated at 64 billion US dollars. Fortunately since 2000 conflicts ended in Angola, Sierra Leone, Liberia, and Southern Sudan. Conflicts in which a warring party was the government declined from 15 in 2003 to 5 today.

Box 1: Are poor agroclimatic conditions and landlockedness un-surmountable hurdles to agricultural growth?

Some of the past successes in commercialization in sub-Saharan Africa depended on agro-ecological conditions that were “ideal” for cocoa, tea, coffee, sugar and some other commodities. In some of these (e.g. tea and coffee), the market pays high quality differentials and the desired quality attributes can only be obtained where particular growing requirements are fulfilled. Therefore the global players (either traders or processors) have to access supplies from certain African countries in order to be able to satisfy their customers. Success in these commodities therefore has taken place despite the fact that many of the best regions were landlocked and remote. On the other hand, ideal agricultural conditions are not sufficient for success, as the example of the slow growing Zambian sugar sector shows, which enjoys some of the best growing conditions in the World. While there is a major sugar factory in Zambia, it has been unable to export sugar except into the protected European market. Other success stories in Africa, such as cotton and cassava in West Africa, occurred under favorable, but not ideal, climatic and soil conditions. They depend on highly labor intensive production processes that are difficult to mechanize and therefore benefited from low labor cost in Africa (Poulton, et al. 2006).

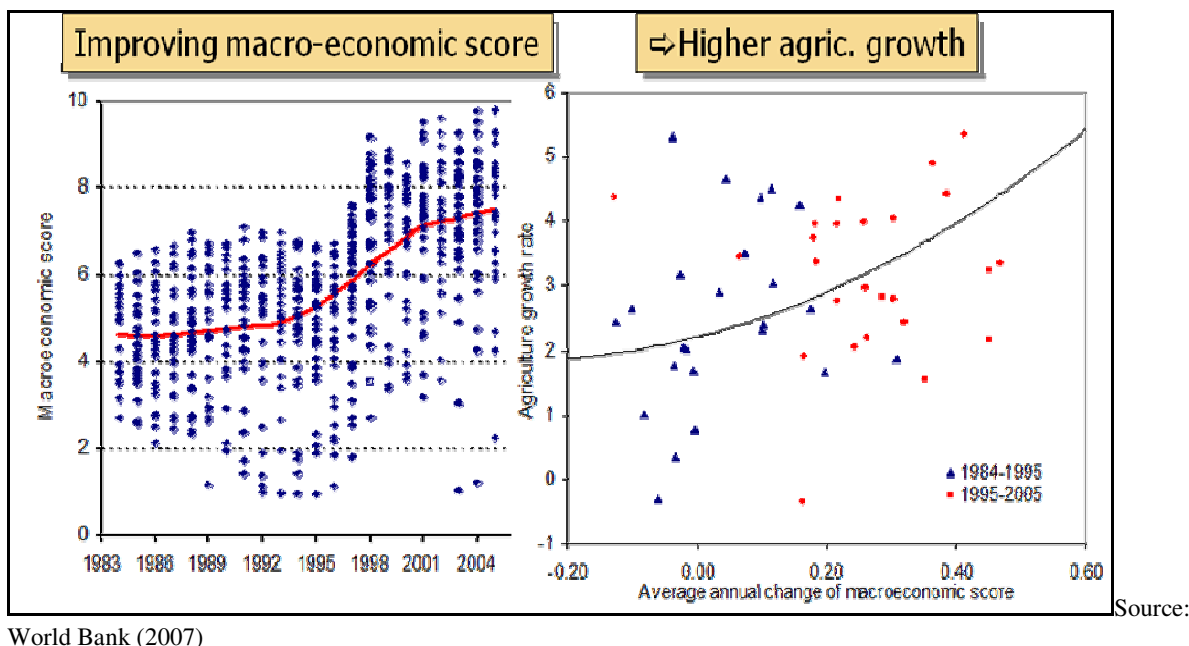
Beyond Africa, agricultural success was achieved in a spectacular manner in landlocked areas of at best moderate agro climatic potential and little irrigation in the Cerrado of Brazil and in North East Thailand. Since the 1960s, when African Agriculture declined or stagnated, these Regions became World class competitors in soybeans, cotton, maize, rice and beef (Cerrado) and cassava products, rice and sugar (Thailand). An in depth analysis of their success with comparisons to African countries can be found on World Bank (2008). Clearly, neither agroclimate nor geographic locations are complete determinants of destiny.

Natural resources contribute to the risk of civil war. Paradoxically, even at peace natural resource exports reduce growth. The “resource curse” arises from “Dutch Disease,” the fact that resource exports lead to an appreciation of the exchange rate that makes domestic products uncompetitive in international markets as exports or as import substitutes. Sharp price fluctuations of the natural resources also lead to a boom and bust cycle. But resources also mess up politics by making it easy to finance patronage politics and reducing the restraints on political power that are so important for a functioning democracy: an independent central bank, judiciary and press, financial transparency, competitive bidding and the likes.

Collier (2007) shows that three quarters of the bottom billion countries have suffered from prolonged periods of poor governance and poor policies. These countries are not able to provide essential services required for growth. Resources get eaten up in corruption. Poor governance and poor policies create a trap because powerful vested interest benefit from them and oppose reforms. Failing states have stayed in their trap for a very long time over which huge costs accumulate: The cumulative cost of a failing state to itself and to its neighbors is about 100 billion US dollars. The benefits of helping turn around a failing state are therefore enormous (Collier 2007).

Controlling for differences in opportunities, differences in policy contribute between 25 and 50 percent of the difference in growth performance between SSA and the rest of the developing world (Ndulu et al. 2007). Greater integration in the world economy consistently is associated with higher growth performance. Fortunately policies have significantly improved over the last decade: unweighted consumer price inflation sharply fell within a decade, from 27 percent in 1995, to about 6 percent by 2004. “In a median SSA country, government spending as a proportion of GDP also fell sharply in the past decade, as it has in other developing countries in the world, and the average fiscal deficit was halved to 2 percent of GDP by 2000. Except in a few countries, black market exchange rate premiums now average just 4 percent. Through unilateral trade reforms, SSA countries have also compressed tariff rates; the average rate is currently 15 percent. As a consequence of the major policy reforms initiated in the continent since 1990, growth has resumed, and the impact of poor policies on growth may have waned” (Ndulu et al. 2007).

The improvements in general economic policies have not only contributed to economy-wide growth but have also accelerated agricultural growth, as Figure 1 shows.

Figure 1: Macro-economic conditions and growth

Other factors that have contributed to low growth are the following:

- In addition to low road densities, transport costs in SSA can reach as high as 77 percent of the value of exports (ECA 2004).
- A serious problem in Africa is the extractions and bribes imposed by the police and others at border posts and road blocks. “Along the West African road corridors linking the ports of Abidjan, Accra, Cotonu, Dakar and Lomé to Burkina Faso, Mali, and Niger, truckers paid 322 million US dollars in undue costs at police customs and gendarmerie checkpoints in 1997.” (ECA 2005).
- Energy costs are higher and power outages are more frequent than in any other region of the World, and in particular compared to China.
- While Africa has made significant improvements in basic education, progress in skills development has been distressingly slow. Basic health care is very poor.
- SSA financial sectors are the least developed in the world. The median spread of interest rates is 13 percent in SSA as against between 5 and 10 percent for the other developing regions. Access by small firms is poor and collateral requirements are very high (Ndulu et al. 2007).
- South and East Asia have savings rates of around 20 percent compared to a mere 9 percent in SSA. Micro-finance institutions have only managed to mobilize a small pool of savings, have limited coverage and narrow areas of operations.

Based on the analysis in the report, Ndulu et al. (2007) propose a medium-term strategy that hinges on taking action in four areas (characterized as the four “I’s”): improving the **investment climate**; a big push toward closing the **infrastructure** gap with other regions of the world; a greater focus on **innovation** as the primary motor for productivity growth and enhanced competitiveness; and **institutional** and human capacity. And Collier (2007) suggests that aid should increasingly be concentrated on bottom billion countries. But aid will not be enough to assist these countries. It has to be combined with measures to reduce and recover from conflict, including prolonged military interventions, and support to the rapid rebuilding of essential state capacity.

Improving Agricultural Policies

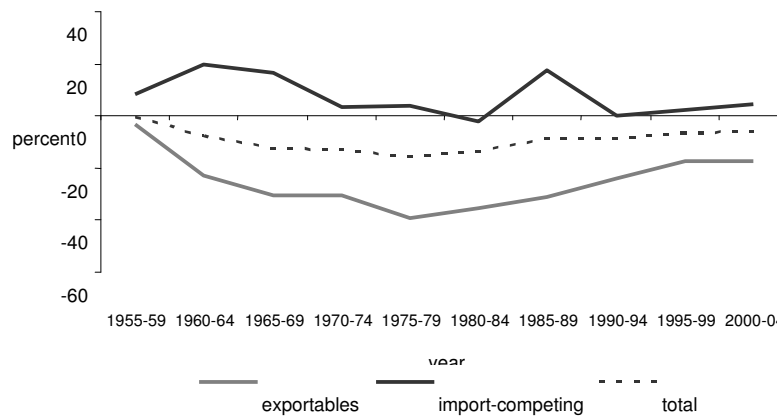
Adverse policies of developed countries have been widely discussed and documented, and unfortunately have not much improved over the past two decades (World Bank 2007). They are therefore not further discussed here except to stress again that African agriculture stands to gain the most from multilateral trade reform rather than bilateral agreements (Anderson and Martin 2006). Moreover, in the absence of a breakthrough in the Doha round of trade negotiations, China and India could follow the developed world,

Korea and Taiwan in protecting their agriculture to close the rising urban-rural income gap. This would close the major future export opportunity for African agriculture. African countries therefore have become active participants in the trade negotiations.

After the end of colonization, African countries started to discriminate sharply against agriculture via overvalued exchange rates, industrial protection, and direct agricultural taxation. A major study now has measured the combined effects of these three interventions on the net rate of agricultural assistance and compares them across the developing and developed world (Anderson and Masters, 2009). A negative rate of protection is in fact the rate of taxation. This is sometimes called *dis-protection*. As shown in Figure 2, for Africa as a whole, the net protection rates have improved from about -20% in 1975-1979 to less than -10% in the first half of the present decade.

However, the dis-protection of agriculture in Africa has to be compared to the trends in protection in the rest of the World. These shows that Africa still lags far behind other developing regions in improving its agricultural incentives regimes: Asia changed from being a net dis-protector of agriculture until around 1960 to a net protector of agriculture at rather high levels of between 20% and 25% since the second half of the 1980s. The same protection levels are also now applied in Eastern Europe and Central Asia. Similarly, Latin America, since the mid-1980s, is protecting its agriculture at a rate of about 5%. The average of the developed world, protection rates remain at close to 40%.

Figure 2: Nominal rates of assistance to exportable, import-competing, and all agricultural products, African region, 1955-2004.²



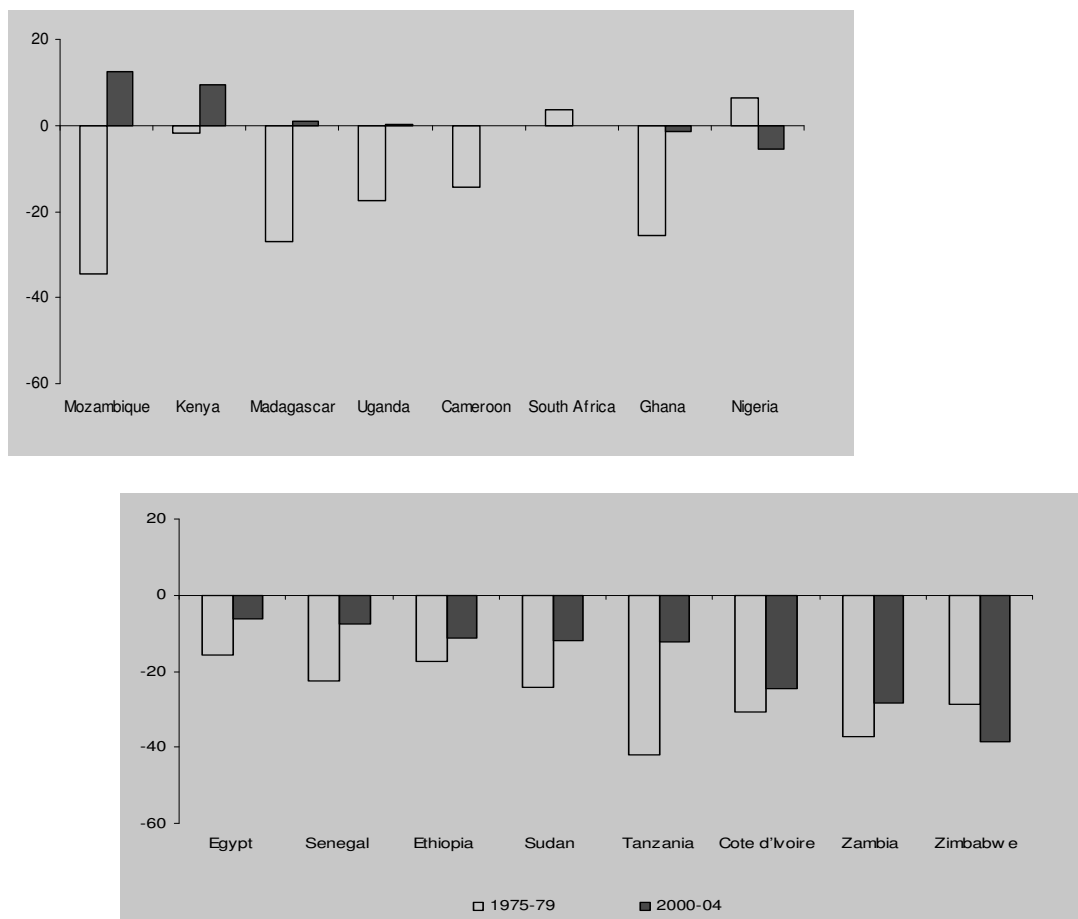
Source: Anderson and Masters (2009).

As Figure 2 shows, the antitrade bias against agriculture was concentrated on exportable commodities, which in the late 1970s were taxed at around 40%, whereas importables were almost always slightly protected. Although dis-protection overall is now less than 10% in Africa, it remains at almost 20% for the exportables.

Within SSA, agricultural taxation remains the most severe in Zimbabwe, the Ivory Coast, Zambia, and Tanzania (Figure 3). The greatest improvements since the first half of the 1980s were made in Mozambique, Kenya, Madagascar, Uganda, and Cameroon, where nominal rates of assistance are now positive or zero. In Egypt, the only North African country for which data are available, the NRA also remains close to -10%.

² Unweighted average across 16 countries.

Figure 3: Nominal rates of assistance to agriculture in Africa by country (%), 1975–1979 and 2000–2004.³

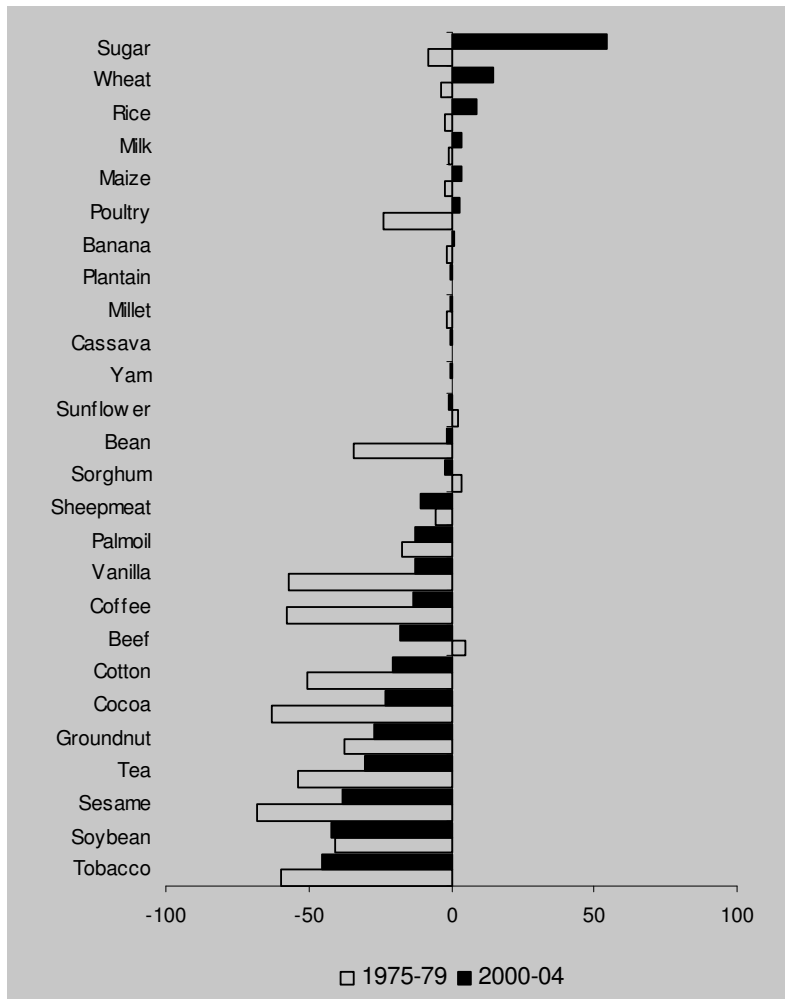


Sources: Anderson and Masters (2009).

Among agricultural commodities in Africa (except for South Africa), the nominal rates of assistance (NRA) across Africa for tobacco, soybeans, groundnuts, cocoa, cotton beans, beef, tea and coffee remained at between -45 % (for tobacco) and -15% for coffee (Figure 4). Clearly, across commodities and across countries there remain important opportunities for improvement in the incentive regime of SSA agriculture.

³ Ethiopia data for the first period refer to 1981–1984; 1975–1979 data are unavailable.

Figure 4: Nominal rates of assistance across commodities (%), 1975–2004.⁴



Source: Anderson and Masters (2009).

In terms of Africa’s own agricultural trade policies, five conclusions stand out:

- On balance, protection rates (or more precisely, nominal rates of assistance to agriculture) are no longer negative; they remain below –10% in Ethiopia, Sudan, Tanzania, Zambia, Côte d’Ivoire, and Zimbabwe.
- Taxation is still concentrated on exportable commodities. However, from taxing them at extremely high rates in the 1970s and 1980s, Africa has steadily improved its incentives regime. On average it is now less than 10%. However, taxation levels of a number of individual exportable commodities remain alarmingly high.
- Despite the improvements in incentives, African farmers still face the worst agricultural incentives in the world. This is first because only Europe has reduced its nominal rates of assistance to agriculture, whereas both the United States and, especially, Japan have increased them. Second, the other developing regions have moved from disprotecting agriculture to protecting their agriculture, in the case of Asia at a level that is now getting closer to the average of the developed world.
- Progress is being made in terms of regional integration across all subregions of SSA, but agricultural incentives also still suffer from barriers to interregional trade and poor phytosanitary capacities.
- Though improving, the business climates in most countries still remain far worse than in other developing countries, holding back private sector activities upstream and downstream from the farm. There has been

⁴ Unweighted average across 21 countries.

significant progress in incentives' regimes, but if countries in SSA want to compete better in domestic, regional, and international markets and benefit from the likely rising trend in international agricultural prices, they must move aggressively to eliminate export taxation of agriculture and remaining barriers to regional trade.

Improving the Institutional Environment for Agriculture and Rural Development (ARD)

In 1980, in a typical country in Africa, a young rural women (or man) who wanted to help develop her community, found herself almost completely disempowered. Three of the five pillars of the institutional environment, which are discussed below, were poorly developed: The first pillar, the private sector, was largely confined to small scale farming and the informal sector. Much of the marketing, input supply and agro-processing was in the hands of parastatal enterprises. The second pillar, independent civil society, community organizations, and traditional authorities were highly constrained or suppressed. In the wake of decolonization, central governments had suppressed the third pillar, local government, or starved it of fiscal authority and resources. Since none of these three pillars were providing much opportunity for the young woman or man, s/he had to join the central government if s/he wanted to contribute her community. But the central institutions failed the rural sector miserably.

Well structured institutions can tackle all the components of rural development, from health and education to infrastructure, agricultural services, social protection, resource management, and more. Not only does the institutional environment determine who can contribute to development and how successful it will be, it also is the most important determinant of the distribution of the benefits. More specifically, where institutions are dis-empowering, they can be used by strong individuals and groups to direct the benefits of development to themselves, via elite capture (Binswanger 2008).

No single institution by itself can carry the burden of local and rural development. Instead the new paradigm that has emerged gives equal weight to the private sector, communities and civil society, local government, and the sector institutions such as health, education and agriculture (World Bank 2004b). A broad consensus has been reached that local development (and therefore rural development) has to be viewed as a co-production by all these four groups of actors. They need to take account of their comparative advantage, delegate functions to the other partners in co-production, and reform themselves to be able to function under this new paradigm. How such an integrated approach would be fostered in a particular country should depend on past history, what currently exists and can be built on, the prevailing traditions and cultures, and a diagnosis of the existing capacities and dis-functionalities.

The following changes have taken place since 1980 and have contributed to growth and development

Private Sector: Private sector opportunities have improved in general as part of improvements in macro-economic and sector policies. The World Bank's agricultural adjustment programs identified the suppression of the private sector, the underperformance of parastatal enterprises, and the fiscal black holes they created as the root cause of the underperformance of agriculture (Binswanger 2008). While this view was partially correct, it was a too narrow. As discussed before, the withdrawal of the parastatals did not lead to spontaneous and rapid growth of private replacements. Too many other problems existed in the "business environment", including corruption, over-regulation, and poor infrastructure and services. The sluggish entry of the private sector into input supply, marketing, rural finance, and technology development and dissemination in Africa has been particularly harmful to the development of the small farm sector, and how to provide these services remains a major challenge of ARD in SSA. Governments will have to play a role in financing a number of these services, without necessarily returning to the failed approaches of government provision. They will also have to create conditions suitable for public-private partnerships, not only with central government institutions, but also with lower level tiers of government.

Civil Society Organizations: In the 1980s a broad range of NGOs started to sharply criticize donor financed projects, policies and structural adjustment programs (Mallaby 2004). The focus on communities came from two additional sources: Sector specialists in water supply and natural resource management had started in the 1980s to involve communities systematically, and found this to enhance project performance significantly (Binswanger-Mkhize et al. forthcoming). The other source was social funds, which quickly discovered the power of communities to assist in project design and implementation. From letting communities participate in the design, finance, and maintenance of micro-projects, Community-Driven Development (CDD)

programs have moved on to truly empower them to choose, design, and execute a large range of micro-projects, by transferring both the responsibility and the co-financing resources for these projects to them.

A recent review of the Africa portfolio of CDD projects of the World Bank is Serrano-Berthet et al. (2008). Between 1989 and 2007 the World Bank has lent or granted 3.5 billion US dollars for 102 operations in about 40 countries of SSA. Unlike integrated rural development, these projects have a high rate of satisfactory project completion, even though their sustainability ratings are more problematic. From being enclave projects they have become more integrated into the decentralization architecture of countries and become an important instrument for fostering decentralization along with community empowerment. Such funds have also been very useful in assisting communities to recover in post-conflict and other emergency settings (ibid). How to adapt them to such settings is discussed in Cliffe et al. (2003).

While NGOs have become a player in ARD all over Africa their capacity as service providers in Africa has been more limited than in South Asia. In the low population density countries they tend to concentrate around major cities and find it hard to operate in remote rural areas. Using NGOs as implementers and intermediaries in CDD programs proved to be costly and has increasingly been abandoned in favor of direct empowerment of communities with knowledge and resources. NGOs of course remain important facilitators, sources of knowledge, innovators, and advocates for change in ARD-relevant sectors.

For agricultural development, a particularly important development is the formation and progressive development of independent farmers' organizations, and micro-finance institutions (World Bank, 1994). A recent review compared the development of producer associations in Mozambique, Nigeria and Zambia to that in Brazil and Thailand. The review found that "Effective producer associations thrive in a democratic environment that provides a favorable climate for civil society organizations in general. A really active role in defending smallholder rights, including those to land and favorable contracts, has emerged in Brazil and Thailand, but in Africa it is still poorly developed. Although a significant start has been made, few African associations have been able to develop themselves and their commercial linkages sufficiently to take on a major role in service delivery. And many continue to be heavily dependent on donor support. While in the African case study countries farmers' organizations have become significant stakeholders in discussions of agricultural policies, they have not yet been able to generate the strong political will in favor of agriculture which has propelled development of the Cerrado and of North East Thailand" (Binswanger-Mkhize 2007).

Local government: During the late 1980s and 1990s, democratization in Latin America and Africa, and the inability of central states to deliver services in widely heterogeneous environments, led to decentralization initiatives in many countries. Unsuccessful decentralization programs are almost always characterized by inadequate allocation of fiscal resources and responsibilities to the local level (Manor 1999; Shah 1994). Local governments can of course become an instrument for elite capture and corruption. To prevent that, they must be democratic institutions, but that in itself is not enough. Without strong communities and civil society, and a strong private sector, local governments will not be subject to the scrutiny and the bargaining processes that are needed to make local development inclusive and efficient.

In the early 1990s, the World Bank first discovered the power of local governments in its CDD programs in Mexico (Binswanger-Mkhize et al. forthcoming), and later in North East Brazil. The innovation spread to the rest of the world. Social funds started to build the capacity of local governments, and entrust them with coordination and some implementation functions. A research program on Decentralization, Fiscal Systems and Rural Development in the mid 1990s (McLean et al. 1998; Piriou-Sall 2007) analyzed the level of decentralization of rural service delivery in 19 countries (or provinces thereof) across the World. Four African countries had the lowest decentralization scores, while Jianxi province in China had the highest one. Latin American countries scored in the upper half, while Karnataka state of India ranked ninth and Punjab, Pakistan 13th. The recent Governance Report of the Economic Commission for Africa (2005) shows that not much progress has been made - in the past decade and a half: Decentralization, along with corruption, still receive some of the lowest scores of a whole series of governance indicators studied in 28 countries of Africa.

In most OECD countries and in the high performing China, local governments perform functions in education, health, social protection, environment, agriculture, land, local and community infrastructure, and promotion of private sector development. They are a multi-sector coordination tool, even though their

coordination capacity is always imperfect. There are powerful reasons for using the lowest level of local government for coordination and execution of rural development. At the local level people have direct knowledge of the local conditions. Transparency is relatively easy to achieve, since people can often verify the result of expenditures with their own eyes. Empowered and properly resourced local governments can mobilize latent capacities in communities and at the local level. And finally, local governments exist in remote areas where neither NGOs nor the organized private sector usually operate.

Sector institutions: Because of their shortcomings in rural development, there has been a growing realization that the sector institutions should delegate implementation to the private sector, to communities, civil society organization, and to local governments, using the principles of subsidiarity⁵ and comparative advantage. They should formulate policies, set standards, and enhance and control quality (World Bank 2004a). Far from withdrawing from ARD, such a change would strengthen the capacity of the overall system to provide the public and quasi-public goods needed by small farmers.

The sector institutions specifically associated with agriculture and natural resources have often performed particularly badly. Agricultural credit institutions not only achieved little for small farmers, they also were fiscal black holes benefiting primarily the better off farmers. Ministries of Lands have lacked an effective constituency to ensure proper budgets for them, are often highly centralized, and corrupt. Ministries of Agriculture are usually weak and politicized, and poor providers of small farmer services. They have great trouble in performing important public good functions, such as collecting the necessary data, monitoring sector developments, analyzing sector policy issues, and designing and implementing appropriate agricultural policy regimes and programs. Efforts to reform individual sectors one by one have had little success. It is now well understood that transformation and de-concentration of the sector institutions is better done via cross-sector governance and public sector reforms.

Central government: The central government still has the ultimate design, oversight, and coordination role of national development programs, including those for rural development. It also usually finances much of education, health, and ARD services. The central government has a particularly important role to play in bringing about the changes needed for successful co-production among the four institutional pillars discussed above, including public-private partnerships. It has to drive forward the process of community empowerment and decentralization of functions, resources and accountability mechanisms to local governments and to the end users, and to ensure that the sector institutions transform themselves. It has to ensure that the business climate for the private sector improves, and that communities and civil society are free to take on their co-production functions.

Today the young lady about whom we spoke at the beginning of the section can operate much more freely in the private sector in a steadily improving business environment. In most countries and commodities she can join a producer association. She can also help her community by engaging in a wide variety of community-driven initiatives for which funding is becoming available more systematically. She can work for one of many NGOs and either use her technical skills in NGO-facilitated development programs or her advocacy skills in advocacy NGOs. In countries such as Senegal or Uganda a number of former functions of ministries of agriculture are either being privatized, or performed by producer associations, often partially financed by the state, and the young lady may operate in one of these services. Finally, most countries have pursued decentralization initiatives, and the young lady may work for her locality either as a staff member of a local government, or as an elected counselor. Unfortunately, however, progress in decentralization has been slow in most countries other than Uganda, South Africa, Burkina Faso and a few more. Fiscal decentralization has been lagging badly, leaving most local governments with little resources to execute their mandated functions, let alone taking a leadership role in local development.

Capacity development of agricultural and rural institutions would flourish best in the context of a broader, national capacity development strategy and program. It cannot be done as a top down provision of capacity development services. Instead it involves learning by doing, and mandatory training, in particular in diagnosis and planning, financial management and reporting, procurement, and monitoring and evaluation.

⁵ The principle of subsidiarity states that functions should be allocated to the lowest level capable of effectively performing them while at the same time minimizing adverse spillover effects to neighboring units at the same or higher levels

Other training should be provided largely on a demand-driven basis. Capacity development must build on the considerable latent capacities that are found in rural areas all over the World. To do so, rules and regulations for program execution must become much more participatory and empowering, and eliminate complex features that destroy latent capacity or hinder its mobilization. (Binswanger et al. 2009, chapter 5). Finally, the broader sector institutions involved in ARD need to become much more accountable to their clients.

RISING FOOD PRICES: SHORT RUN CHALLENGES AND LONG RUN OPPORTUNITIES

OECD and FAO have produced an exhaustive analysis of the recent food price spike and the associated consequences (OECD-FAO 2008). The key facts are as follows: After peaking during the food and energy crisis of the early 1970s, real aggregate food prices, deflated by manufactured import prices from the developed world, declined by 1987 to less than half their peak value. They then stayed flat for nearly 20 years. Between 2005 and early 2008, real aggregate food have risen by more than sixty percent, because of increasing demand from population and income growth, urbanization, declining stocks, and bio-fuel subsidies. The price spikes were aggravated by weather and petroleum price shocks. Prices of individual commodity groups rose much more sharply, with nominal price indices for dairy, oils and fats and cereals spiking at between 150 percent to 200 percent higher than in the 1998-2000 period. Sugar and meat prices rose by roughly 50 percent. The spike was short lived, and by July 2009 real food prices have leveled out at real prices that are somewhat higher than in the early years of this century.

It should be noted that the spike in aggregate food prices even at their peak did not bring them back to their real levels of the 1960s and early 1970s. The price rises were also a small fraction of the rise in energy prices which started much earlier. Along with the spike, fertilizer prices also exploded. But in October 2008, prices of ammonia and nitrogen fertilizers collapsed, in the case of urea, almost to its level in January 2007. By the end of October 2008, the prices of phosphate fertilizers remained very high, however. These spikes in input prices undermined profitability of agriculture during the food price spike, especially where input use was high.

The recent drop of output and input prices are associated with the global economic crisis which deepened sharply since October of 2008. It is not yet clear how long the economic crisis will last. Energy prices have already fallen to less than half their peak levels. Food and fertilizer prices could fall further in the coming year as well. How low they will go depends primarily on what happens to growth in emerging countries, including Africa. As discussed above, the IMF projects higher growth to resume in all emerging regions in 2009 and 2010. It also projects a resumption of per capita income growth even in Africa. Food prices may therefore not drop to the level of the turn of the century. Because of biofuel production, the oil price will also continue to influence cereal and oilseed prices, and probably put a floor under them.

While the short run outlook for prices is very uncertain, the medium and long term outlook is more relevant for the topics pursued in this paper. Once the world recovers from the current economic crisis, the demand forces that have driven the rising food prices will reassert themselves. OECD-FAO, the International Food Policy Research Institute (IFPRI), and other analysts, all agree that in the medium to long term the prices will settle at a significantly higher level than those around the year 2000, and that the underlying trends in demand will lead to gradually increasing prices for decades to come. The period of globally falling real prices of food, therefore, appears to have come to an end.

The Short Run Challenges

The food price spike seriously affected the balance of trade of net food importing countries. Many of these are in Africa, and especially so in Eastern, Southern and Central Africa. Most of these hard hit countries were already reeling under the impact of the higher petroleum import costs. Almost half of 77 countries surveyed by FAO in early 2008 had reduced import taxes on food. However, for food importing countries the price reduction achievable were sharply limited, and could not exceed the tax collected prior to their reduction. Therefore 55 percent of countries resorted to food subsidies or price controls. Only about 25 percent of countries have been able to dip into existing food reserves. An even lower percentage of countries, only about 17 percent, responded via measures to increase the food supply. Most net food exporters surveyed by FAO resorted to export bans or increases in export taxes. As a consequence of these policy measures, the pass-through of higher rice prices to domestic prices ranged from 6, 9 and 11 percent of the international

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price rise respectively in the Philippines, India and Vietnam, all of them net food exporters. The price rises were 43, 53, and 64 percent respectively in Bangladesh, Indonesia and China who import some and export other foods.

A recent debate in the Economist between Homi Kharras and Joachim von Braun (Economist, 2008), discussed the question whether the high food prices, on balance, would be good for the World's poor or not. The upshot of the debate is that (1) higher food prices are needed to bring forth the increased supplies of food that are needed, although the policy interventions just discussed slow down the supply response; (2) many poor producers, who are net sellers of food, will gain from the higher food prices, as the example of Vietnam discussed below suggests; (3) the price explosion will be particularly bad for the urban poor and for farmers who are net buyers of food, as most poor farmers in SSA are; and (4) a more gradual and modest rise in food prices would have created less of a negative impact on the poor and allowed wages to adjust better to the higher prices, and also would have enabled farmers to respond to the rising prices and thereby either reduce their losses or increase their gains.

Ivanic and Martin (2008) took high quality household data from 10 countries to simulate the short run impact of the rise in commodity prices from 2005 to 2007 on poverty incidence and depth. Longer run impacts that arise from rural linkage effects (via forward, backward and consumer demand linkages) that come about as a consequence of higher farm profits associated with higher output prices are not included in the analysis. Their analysis assumes a full pass through of higher international prices to the domestic economy and no countervailing food subsidies. Nevertheless, their analysis sharply illustrates the disparities in short term poverty impacts of identical food price rises around the globe: For urban populations in Nicaragua, who spend a large share of their income on the foods, the impact is a more than 10 percent rise in the poverty rate. Rural populations of Zambia, who are mostly net buyers of maize, are the second worst affected and see their poverty rate increase by around 7 percent. In Malawi and Madagascar, poverty rates increase between 3 and 4 percent. On the other hand, the rural poverty rate in Vietnam declines by 3.1 percent, because the asset distribution in rural areas is very equal and most of them are net sellers of rice, maize and poultry. The changes in depth of poverty paint a similar picture to the changes in the poverty rates.

These back of the envelope calculations ignore all the positive impacts that higher food prices could have in the medium to long term via forward, backward and consumer demand or via wage improvements. They therefore measure the poverty impact of what is most likely to be a transitory spike in food prices. Nevertheless, these estimates are a good indicator of what policy makers were up to if they want to mitigate the adverse poverty effect of the food price spike in the short run. Clearly this is a monumental task: It is not only the additional poor people who need help most of those among the 2.1 billion who were poor before the food price spike. Small increases in safety net programs that rarely have significant coverage in the first place were not up to the task at all. No wonder therefore that policy makers have preferred the aggregate measures such as reducing taxation of food, general food subsidies or price controls, releases from stocks and export controls. Of course some of these measures have poor fiscal sustainability and prevent necessary adjustments in consumption and production of food. But if these measures were indeed used only to mitigate the short run impacts of a spike and then quickly phased out, they may well have been justified.

In the longer run, modestly higher and gradually rising food prices are good for rural populations, because they lead to greater investments, outputs, profits and rural wage rates. Farm-nonfarm linkages will spur an expansion in the rural non-farm sector and enhance these positive effects. For economies dominated by agricultural sectors, there may also be important positive linkage effects on urban economies, as well as higher unskilled urban wages. The higher food prices projected for the future are therefore likely to provide important long run benefits for many African economies, and especially for rural populations.

The Market Opportunities

Even before the recent price spike, a number of analysts, including FAO, have evaluated the market opportunities they would bring to African farmers: The bright international medium to long term market outlook for food does not necessarily mean that the best opportunities are in global markets (Poulton et al. 2006; World Bank forthcoming). Since Africa has become a major food importer, African producers compete in these markets at the import parity price rather than the lower export parity price. In addition, quality standards are not as high and phyto-sanitary barriers lower than in international markets. The combined value of domestic and regional markets for food staples within SSA is considerably in excess of its

total international agricultural exports (Diao et al. 2006). Africa's demand for food staples is projected to about double by 2020. Moreover, an increasing share of output will become commercialized as the continent becomes more urbanized. Bottlenecks in road and export infrastructure in SSA are likely to be removed only gradually, reinforcing the opportunities in domestic and regional markets. Nevertheless, as a recent analysis of IFPRI of prospects in East and Central Africa shows "among agricultural sub-sectors for which there is large and growing domestic and regional demand, staples loom large as a group. Production and sale of these "poor man" crops can be pathways out of poverty for millions of citizens of ECA." (Omamo et al. 2006).

The fact that domestic and sub-regional markets for food crops present the best opportunities does not mean that there are no opportunities in international markets. Unfortunately SSA has yet to record any significant global export success in low value commodities (e.g. cereals, cassava, soybeans) that can be grown in a wide range of locations, including by mechanization (Poulten et al. 2006). With appropriate policies and investments, including in transport infrastructure and technology, the past need not to repeat itself.

This discussion does of course not imply that Africa should not seize opportunities in export commodities in general, or in horticultural products, fair trade and organic agriculture. While not as large as the opportunities in domestic and regional food markets, they are significant and have considerable direct and indirect employment impacts. They are being seized by an increasing number of countries in addition to Kenya. There are numerous examples of benefits arising for African producers from fair trade initiatives, as for example in coffee. And African producers use no or limited inputs that should give them many niche opportunities in organic agricultural products.

Sub-regional trade could be a relatively efficient way of smoothing out the impacts of droughts on production and prices at country and sub-regional levels. There are many physical and institutional impediments to cross-border trade within Africa, including differences in food safety requirements, rules of origin and quality and product standards. More importantly, trade in food staples was for long discouraged by national food policies that placed a high priority on self sufficiency, and vestiges of these policies still prevail in many countries. One of the biggest impediments to large-scale private investment in cross-border trading capability – particularly in Southern and Eastern Africa – is the unpredictable behavior of governments in imposing export bans whenever they fear food shortages in their own markets.

That domestic and regional markets are the most promising area for medium to long term agricultural growth means that small farmers, despite the supermarket revolution and rising international quality standards, will be well placed to seize them. At the same time these conclusions mean that countries and their development partners need to focus more on improving access and trade in regional and sub-regional food markets. Reducing the barriers to regional food trade appears to be a major imperative.

CLIMATE CHANGE

Africa has experienced enormous climate changes since it gave rise to mankind about 150,000 years ago. Ever since the onset of agriculture about 8000 years ago, climates have changed periodically. The most important evidence to this is found in the records of two periods of pastoralism that have covered much of the Sahara desert, only to retreat again since about 4500 years ago (Reader 1998, p. 171ff). The adaptive capacity of African agriculture to these enormous climate changes in the past is well documented. It also has suffered repeated long term droughts with devastating impacts on population size and welfare, such as the decade long drought that afflicted West and Central Africa between 1774-1785, and that, inter alia, contributed to the peak in the transatlantic slave trade (ibid, p. 429 ff).

What does the IPCC say about Future Climate Change in Africa?

Except for a few diehards, there is now agreement that global warming is caused by human activity. The current data and projections from modeling efforts of global climate change have been summarized in the latest Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). The IPCC coordinates the numerous modeling efforts across the World. It emphasizes that projections are associated with uncertainties, which varies widely across the different types of impacts of climate change. It therefore assigns confidence levels on a scale of 1 to 10 to those where quantitative expert judgment is used, and statistical likelihood for those where expert judgment is combined with statistical analysis, ranging from

extremely likely (> 95 percent) to very unlikely (< 10 percent). In the following, selected findings from the IPCC report are presented.

Observed temperatures have increased across wide areas of the World. They are higher in the higher northern latitudes than elsewhere. Land regions have warmed faster than the oceans, but oceans have been taking up over 80 percent of the heat added to the climate system. Consistent with these trends, arctic sea ice has shrunk by 2.7 percent per decade, while mountain glaciers and snow cover have declined in both hemispheres. Between 1900 and 2005, precipitation increased significantly in the eastern parts of North and South America, northern Europe, and Northern and Central Asia, whereas they have declined in the Sahel, the Mediterranean, southern Africa and parts of South Asia. Areas affected by drought across the world are *likely to have increased*. It is *very likely* that hot days and hot nights have become more frequent; it is *likely* that heat waves have become more frequent, and that frequency of heavy precipitation events has increased. There is *medium* confidence that agricultural and forestry management at higher latitudes in the Northern Hemisphere has changed, including earlier spring plantings of crops and disturbances of forests due to fires and pests. There are also things *that have not changed*, such as Antarctic temperatures and sea ice. There is no discernible trend in the meridional overturning circulation (MOC) of the oceans, and in small scale phenomena such as tornados, hail, lightning or dust storms. There is also no clear trend in tropical cyclones.

The modeling efforts suggest that, with greenhouse gas emissions at current or higher levels than in the past, it is *very likely that temperature changes during the 21st century would be faster* than in the 20th century, ranging from between 1.4 to 5.8 degrees Celsius depending on the scenario. The projected warming will follow similar patterns than the observed warming in the past: it will be higher over land than the oceans, highest in the most northern latitudes and least over the southern oceans near Antarctica and in the Northern Atlantic. Night temperatures *are likely* to increase more than day temperatures.

Increase of *precipitation* are *very likely* in the high latitudes, while decreases are *likely* in subtropical areas. While the Greenland ice sheet is projected to contribute to current sea level rises, the Antarctic ice sheet will remain too cold for widespread surface ice melting. While it is *very likely* that the meridional overturning circulation (MOC) in the Atlantic Ocean will slow down, it is *very unlikely* that it will undergo a large, abrupt transition. There is also a growing view that frequency and amplitude of extreme weather events may be increasing. It is *very likely* that hot extremes, heat waves, and heavy precipitation will increase.

Specifically for Africa, climate change and its impacts are estimated to be considerably more adverse than predictions for the developed World, but less alarming than for example for India and for Mexico. *Observed* precipitation changes have been complex: In West Africa a decline in precipitation has been observed since the end of the 1960s, ranging from 20 to 40 percent between the period of 1931-1960 and the period since then. A 10 percent increase in annual rainfall has been observed along the Guinean Coast, however. Eastern Africa has seen increasing rainfall over the northern sector and decreasing rainfall over the southern sector. In other regions, no long term trend has been noted. In different part of southern Africa a significant increase in heavy rainfall events has also been observed. Lake Victoria, Tanganyika and Malawi have risen by 1.7, 2.1, and 1.8 meters respectively through a combination of higher rainfall and/or higher runoff.

Very few regional to sub-regional climate change scenarios have been constructed in Africa. The global models imply that the highest *increases in temperature* are expected in the Mediterranean Region of North Africa and the extreme south of Africa. The role of land use and vegetation cover emerges as a key determinant of future temperature changes, with higher vegetation densities in the tropics, including in the tropics of Africa suggested to result in a year round cooling of 0.8 degrees Celsius. Sea level rises will significantly affect Africa's delta regions such as the Niger Delta.

Precipitation projections are generally less consistent across climate model than temperature changes. Nevertheless it is *very likely* that precipitation will decrease along the Mediterranean Coast and in the Northern Sahara, but is *likely to increase* in tropical and Eastern Africa. Austral winter rain is very probable to decrease. For the Western Sahel there are still discrepancies between the models, some projecting a significant drying and other simulating a progressive wetting with an expansion of vegetation into the Sahara. Discrepancies in model predictions are also large for Southern Africa (except the southernmost Mediterranean tip). Predictions of runoff vary widely, because small variations in extreme weather events can have a major impact on runoff. Nevertheless, water stress is expected to increase in Northern and

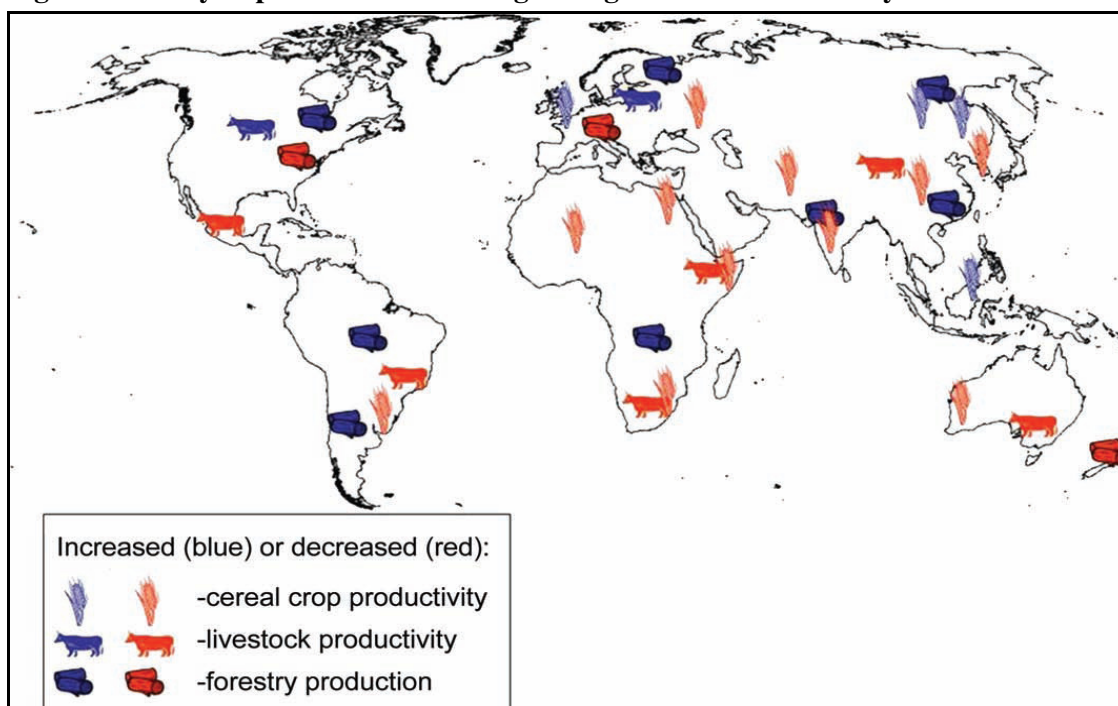
Southern Africa, while more people in eastern and western Africa will be likely to experience a reduction, rather than an increase in water stress. It is clear, therefore, that the most serious impacts of climate change are expected to affect the Mediterranean climate areas in the North and extreme South of Africa. By 2020, between 75 to 250 million people are projected to be exposed to increase water stress. On balance, by 2080 an increase of 5 to 8 percent in arid and semi arid and in Africa is projected under a range of climate models.

How much Impact will Climate Change have on Agriculture Countries?

The IPCC (2007) summary report states that approximately 20 to 30 percent of plant and animal species assessed so far are *likely* to be at increased risk of extinction if global average temperature increases exceed 1.5 to 2.5 degrees Celsius. Crop productivity is expected to increase slightly at mid to high latitudes for temperature increase of up to 1 to 3 degrees, but would be adversely affected if temperature rises were higher. In seasonally dry and tropical regions crop productivity is expected to decrease for even small local temperature increases of 1 to 2 degrees (*medium confidence*). As a consequence, global food production is *expected to increase* with temperature increases in the range of 1 to 3 degrees, but to decrease above this range. (IPCC 2007, chapter 5). Fisher et al. (2002, quoted in IPCC 2007, chapter 7) “quantify the impact of climate change on global agricultural GDP by 2080 as between -1.45% and + 2.6%”

Without climate change the report assumes that socioeconomic development would reduce the number of hungry people from 820 million today to the 100-230 million range. Scenarios with climate change project increases in the number of hungry people between 40 and 170 million relative to that base. Increases in extreme weather events may reduce food production below what is predicted for mean temperature rises. Potential adaptation to climate change would significantly reduce negative impacts. However, groups whose adaptive capacity is constrained would experience the negative effects on yields of low latitude crops, combined with high vulnerability to extreme events. Globally commercial forestry production rises modestly in response to climate change, with large regional variations. “Fisher et al. concluded that there will be major gains in potential agricultural land by 2080, particularly in North America (20-50% and in the Russian Federation (40-70%, but losses up to 9% in sub-Saharan Africa.” (IPCC 2007, Chapter 5). It should be noted, however, that currently Africa is only using about 32 percent of its potential arable land. A summary of global agricultural and forestry impacts is given in Figure 5.

Figure 5: Likely impact of climate change on agriculture and forestry across the World



Source: IPCC (2007)

The implications of this summary of the IPCC are that climate change is likely to have severe impacts on Africa, probably more negative than positive. The report, however, warns that “impacts research is hampered by the paucity of regional models for Africa, and by the uncertainties surrounding regional projections of climate change of global models, particularly precipitation”. In addition the report provides a long list of additional knowledge gaps, including lack of knowledge of CO₂ responses for crops other than cereals; poor understanding of the combined impact of elevated CO₂ and climate change on pests, weeds, and diseases; great uncertainty about the impact of changed frequency of extreme weather events, and poor understanding of adaptation capacity of food and forestry systems. For the remainder of this report this means that, for most specific agricultural production regions, it is still extremely difficult, or even impossible, to predict the likely impacts of climate change on agriculture and bio-diversity. This severely limits the scope of planning for adaptation to climate change at this time.

Despite these uncertainties, efforts to predict impacts of climate change on agriculture at regional and local levels have proceeded, the most comprehensive of which is Cline (2007). The book contains an excellent review of the prior literature. Contrary to the studies summarized in the IPCC report, the author finds that, taking into account an average 15 percent yield increase from carbon fertilization, climate change by the end of this century would have a modest negative aggregate effect on global food production. But similar to earlier findings, negative effects would be concentrated in the developing World, including Latin America, Africa and India. Without carbon fertilization the effects would be significantly more adverse.

The methodological features of the study by Cline (2007) are as follows: It is geographically very detailed and obtains impact estimates for more than 100 countries, regions, and regional subzones of the largest countries. It directly links six Global Climate Models to highly detailed predictions of the climate for a grid across the globe that has a total of 2800 land-based cells, and then averages these across the six models. The cell averages are then aggregated to the country level, or for large countries, to regional levels. The model therefore ignores all variability and uncertainty in outcomes that are significant across models, especially at regional and country levels. The averaging across climate models is justified, because emphasizing uncertainties might lead to policy paralysis. The book provides agricultural impact estimates with and without carbon fertilization; and it separately estimates climate impacts for irrigated and non-irrigated agriculture.

The baselines scenario used by Cline (2007) is the A2 Scenario of the IPCC. It assumes an extremely high population growth of all the scenarios to about 15 billion people by the end of this century, very much higher than UN population projections. It combines this with the lowest per capita income growth of all scenarios. Despite low income growth the typical developing country person will still have an income almost as high as today's developed country person. In addition, it assumes little technical change to reduce carbon emission and no abatement policies. Clearly this scenario is among the least favorable ones considered by the IPCC.

While for other regions it uses both “Ricardian” approaches as well as crop models to assess the likely impact of climate change on agricultural output, for Africa only the “Ricardian” Approach is used. “The classical economist David Ricardo developed the theory that the value of land depends on the difference between its fertility and that of the least fertile land just brought into cultivation at the margin. The seminal Ricardian agricultural impact model (Mendelsohn et al. 1994, as quoted in Cline 2007) argued that statistical regressions relating land values to climate differences could capture the impact of climate on agricultural productivity and thus be used to calculate prospective effects of global warming” (Cline 2007, pp. 4-5). Model estimates from many African countries come from World Bank data reported in Kurukulasuriya et al. (2006). For Africa, the model fits regressions of net revenue per hectare of land on average precipitation and rainfall in several seasons, and on their respective squared terms. The regressions are run separately for dryland and irrigated areas.

Using this approach assumes that net revenues observed in an area with different climate B would be the net revenues that farmers in a given climate A could obtain if their climate changed from A to B. In this approach it is assumed that farmers have a lot of time to adapt, and therefore that adaptation is costless. A weakness of the approach is that this ignores specific constraints or opportunities in area A that could either hinder or facilitate the adaptation process, relative to adaptation to what is currently occurring in area B. The

statistical assumption behind this approach is that both rainfall and temperature are totally uncorrelated with any other determinant of output that affects net revenues per hectare over space. Barring very long time series data, the validity of the assumption is not testable.

How tenuous these assumptions are is illustrated by the model predictions that result for irrigated agriculture when Egypt is included in the regressions for Africa: “(...) for variant A of the irrigated agriculture model (including Egypt), the median change [in value of output] is 24.4 percent. However, when variant B of the irrigated agriculture model is applied (excluding Egypt in the parameter estimation), negative results also dominate irrigated agriculture, with the median change at -11.1 percent” (Cline 2007, pp. 53-56). It appears that the results from the regressions including Egypt contain serious left out variable biases: Egypt is known to use much higher technology levels than sub-Saharan African agriculture. By not including any variables that could explain these higher productivities, the productivity effect is included in the coefficients of temperature and rainfall, which as a result are seriously biased. That this is indeed a major issue is illustrated by the fact that the IPCC stresses the high risks of global warming to Egyptian irrigated agriculture, because Egyptian irrigation water availability will be at risk and because temperatures are already extremely high, and further rises will likely lead to yield losses (IPCC 2007).

Cline (2007) comes to the following additional conclusions: “There is a predominant pattern of large negative changes [in the value of output] from business as usual warming (excluding carbon fertilization) in dryland African agriculture. The median change is -31 percent. (...) There is a high frequency of severely adverse effects for dryland agriculture, as five of the 28 countries or regions have complete shutdown. Another six have reductions in agricultural capacity by about half or more. However, four countries have only modest declines averaging about 3 percent, and two countries or regions have modest increases. (...) A second pattern is that several countries show major gains for irrigated agriculture if the model heavily influenced by Egypt and its Nile water is used (variant A), but the pattern shifts to dominant losses even in irrigated agriculture if the function omitting the Egypt observations is applied (variant B).”

The study further continues “For each country or region, the weighted average impact of climate change is calculated by weighting the dryland and irrigated estimates by their respective value shares in the base period. This estimate excludes the carbon fertilization effect. When this estimate is aggregated across all African countries and regions by weighting by base period agricultural output, the result is that African agricultural capacity would decline by an estimated 18.6 percent by the 2080s, before taking account of carbon fertilization. Excluding Egypt, the decline would be about 30 percent. A comparable set of estimates including carbon fertilization is obtained by applying a uniform 15 percent enhancement of yields from this effect by the 2080s, as discussed above. The result is a still substantial aggregate decline of 6.3 percent in the aggregate and about 19 percent excluding Egypt” (Cline 2007, pp. 53-56).

It is clear from the above quote, that despite the use of a single climate scenario, and despite the averaging of the results of this scenario across six different climate models, the final results remain highly uncertain. While left out variable bias appears to be quite clear for irrigated agriculture, there is no reason to expect that it does not affect the dryland regressions and predictions. The inclusion or exclusion of the carbon fertilization effects turns estimates from relatively benign to enormous.

The question therefore becomes: What can such country-specific estimates of agricultural impacts be used for? Clearly the country-specific climate estimates cannot be used for planning specific adaptations to climate change in particular countries or sub-regions. Apart from the uncertainties and weaknesses of climate modeling in Africa stressed by the IPCC reports and discussed above, and apart from the question of left out variable bias, the resulting country-specific climate estimates suppress any variations among climate models. But the average climate effect is not the one that is going to be realized. Rather only one of the models can be close to what is actually going to happen in a given country, and maybe none of them will. We are therefore left with estimates which can at best be used for advocacy, especially at the continental scale.

It is also important to put the various estimates of the impact of climate change into perspective relative to economic growth and anticipated or possible technical change in agriculture. First of all, the A2 “business as usual” scenario of the IPCC assumes that per capita income in Africa in the period 2080-2100 will be about six to eight times that of today. At such income levels, Africa could afford to import food from other, less severely affected regions. Second, even under the worst scenario of a 30 percent lower output that without

carbon fertilization, a rate of factor productivity growth of about one-third of a percent per year would be sufficient to offset the loss. *Except for Africa, most regions of the World have had total factor productivity growth in excess of 1 percent per year for decades. There is little reason to believe that Africa could not achieve similar rates, which would be more than enough to offset the impact of climate change under the worst case scenario without carbon fertilization.*

Key Issues raised by Climate Change

The basic questions raised by climate change now are, can the process be slowed, stopped or even reversed, and at what cost. This is the issue of mitigation. The second issue is adaptation i.e. how will the world adjust to the outcome. For African farmers the general challenges are obvious: They increase agronomic complexity and increase risks of shocks at the farm and community levels and imply additional changes in crops, cropping patterns, timing, agronomic practices, and seed needs. But the specifics of these changes cannot be predicted. Therefore, in terms of adaptation in Africa, what is required is strengthening of capacities of African agriculture and food systems to adapt to climate change, via improved technology generation and adoption systems, more and better irrigation and drainage, better markets, greater ability to import foods in bad years or on a year round basis, greater preparedness for extreme weather events, and better safety nets. However, all these improvements are also most urgently needed even if there were no climate change. Climate change, therefore, does not generate a separate agenda for agricultural and rural development, only reinforcements of existing agendas. Adaptation to climate change needs to be mainstreamed into this general agenda.

This point is not new: Yohe et al. (2007) in a section headed “Mainstreaming Adaptation into Development Planning”, conclude “(...) the tendency has been to treat adaptation to climate change as a stand-alone activity, but it should be integrated into development projects, plans, policies, and strategies.”(ibid p.2) Howden et al. (2007) make a similar argument “We argue that achieving increased adaptation action will necessitate integration of climate change-related issues with other risk factors, such as climate variability and market risk, and with other policy domains, such as sustainable development.”

We should also note that African farmers will be better able to do so if agriculture is highly profitable and they have the required savings to invest into these adaptations. This reinforces the profitability agenda that is heavily stressed in this paper. In addition, there may be areas which will go out of agriculture, or which may switch from agro-pastoral systems to extensive pastoralism, and require more outmigration. Therefore, as stressed elsewhere in the paper, regional integration will become more important to provide destinations for migrants, especially from countries such as Niger or the Sudan, and allow for free trade in food.

The debate about mitigation versus adaptation has recently been joined by Björn Lomborg in his book *Cool It: The Skeptical Environmentalist's Guide to Global Warming* (2007). Lomborg's case is that we should do a serious cost-benefit analysis comparing the benefits of spending a lot of money on minimal reductions on CO₂, or the same or less money on pressing current issues. For our purposes, his book is useful in highlighting that this is a real trade off and no-where is this more true than in tropical and sub-tropical agriculture, i.e. African agriculture. SSA is the continent contributing the least to global warming. It has the most urgent economic and social problems that press on the current generation, and that will be less for future, more wealthy generations. Except for land use changes discussed below, the case for putting less emphasis on mitigation in SSA, and more on dealing with the pressing current needs, and with capacity building for future adaptation is stronger here than anywhere else.

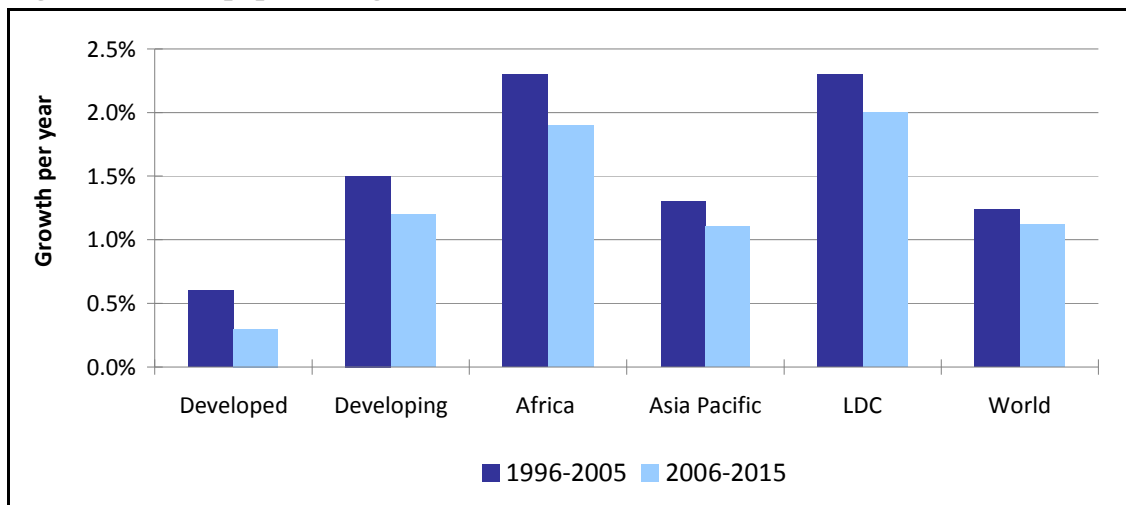
African agriculture, on the other hand, can take advantage of opportunities that climate change may present. The question is how it should do this. “Climate mitigation through carbon offsets and carbon trading can increase income in rural areas in developing countries, directly improving livelihoods while enhancing adaptive capacity”. (Yohe et al. 2007, p.1) “Land use change (18.2%) and agriculture (13.5%) together create nearly one-third of greenhouse gas emissions. (...) Achieving significant carbon mitigation in developing countries will require tapping carbon offsets from agriculture and land use change. While not as large as potential savings from reducing the consumption of fossil fuels, the total potential saving (...) is still substantial and is achievable at a competitive cost. With as much as 13 gigatons of carbon dioxide per year at prices of US\$10-20 per ton, this represents potential financial flows of US\$130-260 billion annually, comparable to ODA of US\$100billion, and foreign direct investment in developing countries of US\$150 billion.” (ibid p.3). It is clear that to take advantage of these opportunities will require the building of

appropriate policies and institutions at national, sub-regional and regional levels.

POPULATION GROWTH

Following several centuries of population stagnation attributable to the slave trade and colonization, the population of SSA increased from 100 million in 1900 to 770 million in 2005. Despite HIV and AIDS, the population growth rate remains at nearly 2 percent per year. Figure 6 shows that population growth for the World as a whole is slowing but remains at around 1 percent per year. The slowdown is happening in Africa as well, but the decline is from the highest level in the World at 2.3 percent to about 1.9 percent for the decade to 2015. As in other regions, population growth will be much faster in urban regions of Africa than in rural regions. From only one city with a population of more than 1 million in 1960 (Johannesburg) the number has grown to over 40. Despite rapid rural-urban migration, the high population growth rates mean that the absolute number of rural people will continue to grow in SSA, and poverty will remain concentrated in rural areas for a long time.

Figure 6: World population growth, 1996-2005 and 2006-2015



Source United Nations (2006)

While HIV and AIDS reduce population growth rates in the highest prevalence countries of East and Southern Africa, the UN population projections do not expect population growth to become negative in a single country (United Nations 2006). Therefore the latest United Nations projections, expect population in SSA to grow to between 1.5 to 2 billion by 2050. Already today, the population density of SSA is 32 persons per km², higher than in Latin America where it is 28 per km² (IRD 2007). This is of course much lower than Asia, and Africa and Latin America have the highest reserves of arable land in the World. SSA has an exceptionally high fecundity of five or more children per women, as less than 20 percent use any birth control measures as against more than 60 percent in Latin America and Asia. The region also has an exceptionally high mortality rate, and the average HIV and AIDS prevalence rate leads to a high death rate of prime age adults. As a consequence the region has more than two-thirds of its population under 25 years of age, twice the proportion in Europe. The high dependency rate is a drag on economic growth.

The Implications of High Population Growth for Economic Growth

Globally, declines in fertility rates seem to be linked to income growth, urbanization, girls' education, and reduced infant and child mortality rates, all of which have been delayed in SSA because of stagnant growth rates. The past failure to grow therefore is one of the main reasons for the failure of the population growth rate to decline as fast as for example in Asia and the Pacific. But the situation is changing: Since per capita growth is now around 4 percent in SSA, the demographic transition will undoubtedly accelerate in the next decades.

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But the relationship between population growth and economic growth also works the other way around. A very important reason for poor investment incentives and returns in Africa is that the demographic transition in Africa began later than elsewhere and is slower than in the rest of the World, leading to much higher dependency rates than elsewhere. The current situation results in a high level of age dependency, which reduces saving, reduces investment in human capital, and results in slower growth of the labor force. This creates both fiscal pressures for the government as well as household pressures. The delayed demographic transition in SSA consistently predicts two-thirds of the difference in growth performance with the rest of the developing World (Ndulu et al. 2007). Lower life expectancies are also shown to contribute to the poorer growth performance, and the AIDS epidemic has made this factor much worse, especially in Eastern and Southern Africa. A decline in the population growth rate would reduce dependency rates and lead to a population pyramid with a large adult labor force, compared to a much smaller population of the aged, and a relatively smaller population of children and youth. Dependency rates would decline.

This would set the stage for a population dividend in terms of growth. This is precisely what many Asian economies are currently experiencing. The needed policy elements are improvements in female education, generalization of AIDS, tuberculosis and malaria treatment and prevention, and family planning. Countries and donors are investing more in education and health, but donors have reduced their funding for family planning programs. It would be well to revisit the relative priority of investments in family planning.

But the population dividend in Africa is a long way off: SSA is home to over 200 million young people who are between 12 and 24 years old. The demographic transition to reduce the proportion of young people in the population has barely started, and a decline in absolute numbers will only come in the distant future. The poor quality of primary education severely limits their opportunities: in many countries fewer than half of women aged 15-24 can even read a simple sentence, and their drop-out rates are very high. Young adults are at greatest risk of HIV and AIDS, and the more so, the less they stay in school. In Kenya the probability that a 20 year old may die before age 40 is 36 percent while it would only be 8 percent in the absence of HIV and AIDS. Many young people become combatants and lose future opportunities as a consequence: They number 100,000 in Sudan alone. (World Bank 2006).

As in all regions of the World, unemployment is concentrated among the young. In most countries the share of unemployment of youth is more than 50 percent, and employment is the key concern among them (World Bank 2006). Among women, including the young ones, a low labor force participation rate persists. Schooling for both young men and women has increased, but is yet insufficient to ensure gainful employment of the young generation.

Development policies must therefore emphasize generating productive employment and improving the domestic investment environment. Since agriculture has a high employment intensity, both directly and via its rural and urban linkage effects, it should receive a very high priority in the countries of the Region.

Population Growth and Africa's Land Resources

Of Africa's most valuable resource, the 2007 African Development Report said it best; "Land is a critical natural resource in Africa and the basis of survival for the majority of Africans. (...) If sustainably managed, the African landscape, a rich and dynamic mosaic of resources, holds vast opportunities for the development of human well being." (African Development Bank 2007, p. xvi) Yet, it is frequently argued that this valuable resource is being severely degraded. Land degradations caused by nutrient depletion, soil erosion, salinization, pollution, overgrazing and deforestation are clearly major issues in African agriculture. Many are of the view that low and declining soil fertility is a critical problem in Africa. The InterAcademy Council says: "Depletion of soil fertility is a major biophysical cause of low per capita food production in Africa. (...) Smallholders have removed large quantities of nutrients from their soils without applying sufficient quantities of manure or fertilizers to replenish the soil." (InterAcademy Council 2005, p.47). Global attempts at dealing with the issues of desertification and the related issue of biodiversity loss are dealt with in various international accords including the Conventions on Desertification and Biodiversity. The new Gates / Rockefeller Foundations initiative Alliance for a Green Revolution for Africa (AGRA) has also identified soil health as one of its priority program areas.

Similarly, the World Bank in its News & Broadcast of November 7, 2007 article entitled "Desertification and Land Degradation Threaten Africa's Livelihoods" defines the issues and describes what action it is taking.

“Desertification is a very severe form of land degradation, involving the steady but gradual loss of agricultural productivity and distinct decline of ecological health. The phenomenon matters for Africa’s environmental future, more so for the brake it puts on economic activities directly tied to healthy ecosystems. Take the case of farming. Desertification, drought and lately, climate change are all adversely impacting farming, threatening the principal source of livelihood – and exports – for millions of poor people. To tackle the problem of land degradation more forcefully in Sub-Saharan Africa, in 2005 the World Bank and its partners, including the New Partnership for Africa’s Development (NEPAD), launched the TerrAfrica initiative tasked with promoting sustainable land management practices by mobilizing coalitions, knowledge, and scale up financing.”

It is troubling that most of the evidence for rapid and severe land degradation is however anecdotal, based on local soil surveys and multitudes of plot studies. (Stocking 1996). As far as we can determine, there has never been a comprehensive soil survey for most of Africa and, beyond soil vulnerability maps, there are no current or historical soil degradation maps. Fortunately the Global Environmental Facility has recently funded a global Land Degradation Assessment for Drylands (LADA) that is executed by FAO, UNEP, and a number of collaborating institutions. It is based on worldwide satellite measurement of vegetation covers in 8km x 8km grids with national and local follow up. The local follow up focuses both on hotspots, i.e. the areas with the most land degradation, as well as bright spots, where degradation has been reversed. It appears that globally and in most places vegetation cover has increased over the past 25 years, except in a number of hotspots, such as the former homelands of South Africa (personal communication Freddy Nachtergaele). A full analysis of the results has, however, not yet been published.

Neither higher population nor poverty necessarily leads to land degradation. In the transition from long fallow systems to permanent agriculture soil fertility initially declines and farmers eventually have to introduce new techniques to stem and reverse this decline. This they tend to do during the evolution of the farming system to higher land use intensity, as discussed so well by Boserup (1965) and Ruthenberg (1973). The so called “Boserup Effects” of higher population densities and market access include:

- The intensification of land use
- A shift from hand hoes to plows
- The increasing use of organic and inorganic fertilizer
- The shift to integrated crop-livestock systems
- Investment in land and irrigation facilities
- An increase in the use of agricultural labor
- Higher agricultural production per unit of land

These theories are consistent with a vast number of studies, which have shown that the normal processes of land improvement associated with agricultural intensification are taking place in many countries in SSA. (e.g. Pingali et al. 1987; Tiffen et al. 1994). For example, thirty years ago a World Bank sector report estimated that land losses in Burkina Faso amounted to something like 2 percent of GDP per year. Today the land supports nearly twice the population than in 1980. Kabore and Reij (2004) have documented how this was achieved. The change is visible to the naked eye: On a recent visit by the author of this paper, crops looked greener and healthier than the visitor had ever seen them before, crop livestock integration had happened in many parts, degraded arid lands were being recuperated via traditional and new techniques, and a number of new crop varieties had been introduced, there were more trees on the land. The experience of high population density countries such as China, Japan, the Netherlands or Italy is equally encouraging in terms of sustainable resource use under high population densities and developed markets.

Significant cases of soil degradation, on the other hand, are usually associated with open access regimes, insecurity of tenure, and other policy failure, which imply that the normal investment responses of individuals are impeded (Heath and Binswanger 1996). Clearly, the alarmist view that in many parts of the developing World land is being rapidly and irreversibly degrading is exaggerated. This does not mean that desertification and soil erosion are not problems worthy of attention, only that we can be more optimistic than the usual rhetoric implies. Approaches to deal with soil degradation have to focus on reducing open access, increasing security of tenure, and improving the profitability of agriculture, thereby raising investment incentives into land improvements.

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Of course, the fact that the situation is not as bad as the usual rhetoric implies does not mean that land resources can be left to themselves. Techniques for land improvements are well developed and widely disseminated and known. Their use depends primarily on farmers' incentives to apply them. For their arable land farmers need security of tenure, either within communal tenure systems, or where these are breaking down, via long term tradable leases or free hold tenure. High returns to agriculture are also needed to provide the necessary incentives to invest. Open access situation need to be avoided: Remedies require strengthening, rebuilding, or where they do not exist, building new local institutions that can control open access to all natural resources. The local institutions also require a supporting national and policy frameworks.

To sum up, a balanced view of the population challenge for African agriculture and food security therefore would stress both opportunities and challenges:

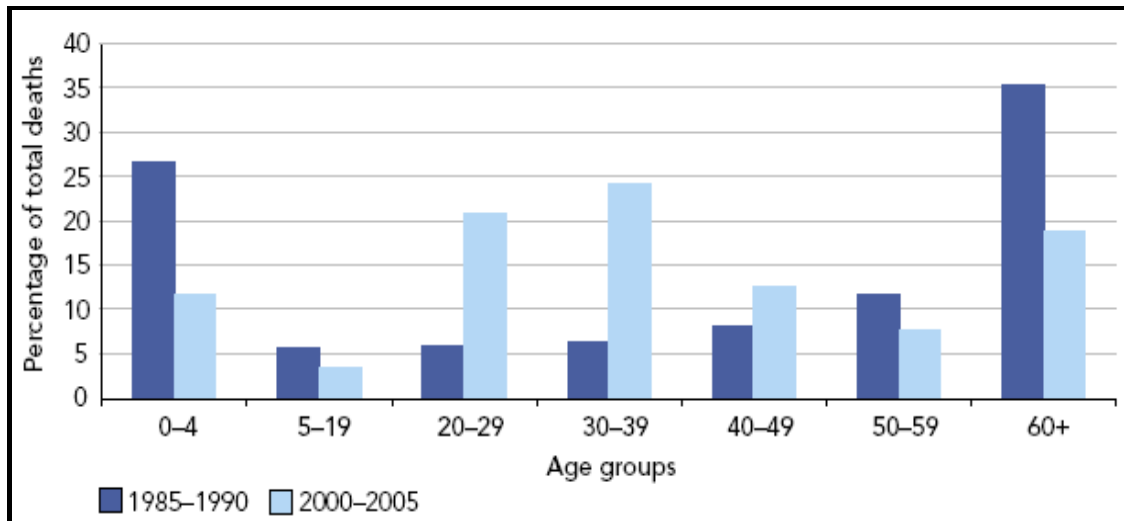
- Past population growth and high fertility rates lock in a considerable momentum of population growth that will lead to higher rural populations, extremely rapid urbanization, and high dependency rates, which in hard hit countries are accentuated by high adult mortality from HIV and AIDS.
- This not only is a drag on growth but also generates huge unemployment problems among youth; agricultural development should be seen as an opportunity to generate much more employment for rural youth and thereby help stem urbanization.
- While the demographic transition has barely begun in SSA, faster economic growth, higher female education, and a resumption of family programs could significantly accelerate it, and thereby create a population dividend for future economic and agricultural growth.
- The enormous land reserves of the continent cannot simply be harnessed by migration, but require enormous investments in infrastructure and technology. The examples from Brazil and Thailand discussed in Box 1 show that such areas can be developed and become internationally competitive. The expected higher agricultural price environment provides a major opportunity.
- Population growth, market access and higher incomes can contribute to more sustainable use of agricultural land and other resources. Local and national institutions to improve security of tenure and control open access are critical to prevent resource degradation.
- Climate change, desertification and bio-diversity losses really come together in the local government arena, communities and on the farms, requiring management and adjustment capacities. Conventions in all three areas provide financing opportunities, including the Global Mechanism hosted by IFAD, a financing instrument for the Convention of Desertification.

HIV AND AIDS

Following the wave of infections by around a decade, the wave of deaths from HIV and AIDS is now fully upon us, leading in a number of countries to a stabilization or slight decline of HIV prevalence rates. The third wave of orphans has also started but is as yet far from its peak, with predictions that it could reach 20 million in SSA in the next decade. Rural areas are now suffering almost as much as urban areas, and maybe even more from the orphan crisis, as many orphaned urban children are returned to rural homes.

Prevalence of HIV and AIDS vary enormously across countries of SSA, for reasons which are still poorly understood. Of the 28 SSA countries with recent population-based surveys prevalence rates range from 0.9 percent in Senegal to 33.4 percent in Swaziland. Four countries in Southern Africa have prevalence rates above 20 percent, another three Southern African countries plus the Central African Republic have prevalence rates between 10 and 20 percent. Three Eastern African Countries plus Cameroon have prevalence rates between 5 and 10 percent, while the 12 countries with prevalence rates below 5 percent were mainly in West Africa plus Ethiopia (UNAIDS 2007)

Figure 7: Age distribution of deaths in Southern Africa



Source: World Bank, World Development Indicators, 2006

The countries of Southern Africa and the Central African Republic will experience the biggest demographic impact (Figure 7). The impact on the age structure of these countries is very adverse. In 10 years, Southern Africa went from having one-third of annual deaths coming from the working age population to two-thirds. It is unclear whether fertility will increase or decrease. But age-dependency rates will increase and thus reduce economic growth rates. In this section we will not further review the evidence of the economic impact of HIV and AIDS in general, but focus on the various interactions between HIV and AIDS, food and nutrition and agriculture. Here we summarize the findings from a literature review by Binswanger (2006).

The Impacts of AIDS

The most dramatic welfare consequences of the epidemic are the enormous suffering of the dying person, his or her loss of life and human capital, and emotional pain suffered by the survivors.⁶ The demographic literature on the impact of HIV and AIDS, in all the dryness of its statistics, concentrates on these morbidity and mortality effects, and on the consequences for the demographic composition of the affected families, communities, and countries. Because the vital statistics and the demographic and health surveys used by demographers are well developed, and combine health and demographic information, these immediate consequences of the epidemic are far better documented than the subsequent secondary impacts on the economic welfare of the survivors (Zaba et al. 2004).

Even in high prevalence countries of Eastern and Southern Africa, these deaths will not lead to a population decline. The AIDS crisis has severely increased tuberculosis and malaria infections, making these diseases much more prevalent and dangerous. The diseases are aggravated by the growing crisis of multi-drug resistant tuberculosis and increased resistance of malaria to common, inexpensive drugs. Impact estimates on economy-wide growth range from the benign to the alarming.

Whatever these impacts of HIV and AIDS may be, they have, however, not prevented the resumption of growth even in the high income countries. Impacts on agricultural output growth are still poorly understood. A few years ago it appeared that HIV and AIDS could lead to AIDS famines, especially if combined with drought. The country most studied was Malawi, but agricultural growth has now recovered, thanks to better weather, and an input subsidies program. Therefore, the fears of HIV and AIDS famines have probably been

⁶ In some of the economic literature on the impact of AIDS these enormous losses seem to be of little concern, and the focus is instead on the economic consequences for the survivors. The most striking example of this neglect is the use of per capita income of the survivors as the yardstick of the economic impact of HIV and AIDS. This yardstick totally ignores the lifetime income loss of the deceased.

exaggerated. Of course, that does not mean that the high rates of mortality have no impact on food production and hunger.

The agricultural economic literature also focuses on the adaptations which household make to compensate for the losses of their members, and the speed and completeness with which they recover from these losses. Reviews of this literature and of the many remaining open research questions are Gillespie (2005 a, b), Gillespie and Kadiyala (2005), Mather et al., (2004), and Zaba et al. (2004). Therefore I will confine myself here to a few comments relevant for policy and programs to combat HIV and AIDS.

The literature on the impact of HIV and AIDS on households has suggested that the main adverse impact is labor scarcity. Helping the affected households overcome labor bottlenecks was seen as the critical issue for agricultural policy makers and researchers. The labor scarcity hypothesis arose from case studies, and from an implicit assumption that the loss of labor power associated with an adult death was more significant than losses in physical and human capital, or the pre-existing scarcity of land in poor households. However, impacted populations react in a dynamic way to their misfortune, and therefore all the issues of endogeneity, omitted variables, and disappearing individuals and households have plagued the investigators. The conclusion about the predominance of labor scarcity rested on a static view of the household, which underestimated the capacity of households experiencing an adult death to recruit new adult members. And when looking at rural wages, it was implicitly assumed that labor demand was going to be unaffected by the death of adults, and or that there were few unemployed or under-employed workers who could replace the ones who died.

Mahter et al. (2004) used the broad survey data emerging from the Michigan state effort to analyze the hardest hit countries in seven Eastern and Southern Africa. They conclude that AIDS is projected to erode population growth roughly to zero, resulting in a roughly constant number of working age adults. Many affected agricultural households quickly recruit new adults, and the agricultural labor shortages are likely to induce urban-rural labor migration. Therefore, for poorer smallholder households, land is likely to remain the primary constraint on income growth. HIV and AIDS is likely to progressively decapitalize highly affected rural communities: and increasing scarcity of capital (savings, cattle, draft animals) may come to pose the greatest limit on rural productivity and livelihoods in these communities.

Dorward et al. (2006) show that in rural Malawi communities with high HIV and AIDS impact, widespread reduction in household incomes and increased cash constraints also tend to depress agricultural demand and the demand for rural non-tradables. This reduction in aggregate demand would reduce labor demand, and induce a fall in rural wages, posing problems for poor households who are net suppliers of labor.

Differential adjustment in household composition also affects the welfare consequences for orphans. Of course, orphans usually face serious psycho-social consequences of the loss of one or both of their parents. The consequences for their food intake and nutrition, their growth, and their school attendance depend on the households within which they are placed. Extended families are most likely to choose better-off members as the fostering parents. As a consequence, studies have shown that orphan-fostering households are not necessarily the poorest and most vulnerable households (Seaman and Petty 2005; Senefeld and Polsky 2005). But all extended families do not have enough well-off members relative to the number of orphans they need to take care of. In a meta-analysis of national nutrition and health surveys in Sub-Saharan Africa, Rivers et al. (2004) show that orphaned children, regardless of the way they were defined, were not consistently more malnourished than non-orphaned children. On the other hand, households with more than one orphan reported significantly more food insecurity and hunger than households with no or only one orphan.

In terms of impact on agriculture, the review of the large representative rural household studies fostered by Michigan State University by Mather et al. (2004) shows that the average affected rural household has similar ex-post land cultivated, total land area, cultivation rates, and total income. The ex-post comparisons suffer from the fact that the affected households may have been better off to start with. The longitudinal data set in Kenya (Yamano and Jayne 2004) shows that the death of an adult male household head is associated with a larger negative impact on household crop production, non-farmer income, and crop production than any other kind of adult death. In addition the Kenya data show that the impact of adult mortality on household welfare is more severe for households in the lower half of the per capita income distribution.

The cross section comparisons in these data sets do not support the conventional wisdom that affected

households shift their cropping patterns away from high value crops towards roots and tubers. Nevertheless the longitudinal data sets for Rwanda by Gillespie (1989) and Kenya by Yamano and Jayne (2004) do show such effect for some household classes, and these effects are strongly conditioned by the gender and household position of the deceased, and the initial asset level of the affected household. The ex-post comparisons do inform on which households are likely to suffer more lasting consequences: Households with a head or spouse death have fewer ex-post prime age adults and higher dependency ratios than non-affected ones, or those where another adult died.

Few data sets adequately capture the usually prolonged period of morbidity which precedes an AIDS death. Most of the impact studies therefore concentrate on the impact of mortality. The impacts of morbidity on economic welfare (especially of women), asset depletion, agriculture, and nutrition deserve much more emphasis. So does research on strengthening community mechanisms to provide support to families who take care of the chronically ill.

Does better Food Intake or Nutrition reduce the Risk of HIV infection?

The huge disparity in prevalence rates across SSA, both across and within countries, has long suggested that cross country and within country environmental and biological-medical factors may be equally or more important than behavioral differences. Stillwaggon (2005) summarizes the bio-medical research on these topics: Malnutrition, combined with micronutrient deficiency (in particular of vitamin A) produces greater susceptibility to sexually transmitted diseases (STDs), particularly of the ulcerative type, and can contribute to higher viral loads. They therefore tend to increase mother to child transmission, as well as transmission among adults. Parasitic diseases such as malaria and helminthic and filarial infections stimulate HIV viral loads and increase malnutrition, and therefore correlate with risk of HIV transmission. Genital schistosomiasis is second only to malaria in its prevalence. Because some schistosomiasis species colonize the genitourinary tracts, it is perhaps the most important parasitic co-factor in HIV and AIDS transmission. Yet, unlike STDs, its treatment and eradication is not addressed in HIV prevention programs.

This literature does not directly show that better nutrition status reduces the rate of HIV infection in adults. The only area where such evidence exists is for mother to child transmission (MTCT). The literature suggests that micronutrient supplementation of pregnant women may improve pregnancy and birth outcomes, including neonatal child survival and birth weight (Fawzi et al. 1998; Coutsooudis et al. 1995; Kumwenda et al. 2002). In addition, multivitamin supplementation during lactation (with vitamins B, C, and E; not A) may reduce MTCT through breastfeeding, especially among women with compromised immunological and nutritional status (Fawzi et al. 2002). On the other hand, there is no convincing evidence that micronutrient supplementation during pregnancy reduced the risk of MTCT through in-utero, intrapartum and early breast feeding routes (Coutsooudis et al. 1995; Kumwenda et al. 2002).

The question is whether improvements in food and nutrition are sufficiently powerful to explain differences in prevalence rates across regions or countries. Unfortunately, there are no studies directly testing this question. However, higher socio-economic status is usually associated with better food intake and nutrition, so we look at whether higher wealth or income reduces HIV prevalence rates. However, major epidemiological studies cast doubt that such a relationship exists: Across countries in SSA, higher national income per capita, but not the poverty rate, is associated with higher prevalence rates (Gillespie et al. 2007). At the individual level, a single longitudinal study from Zimbabwe looked at the changing prevalence among men and women between a baseline from 1998-2001 and a follow up survey from 2001-2003 (Lopman et al 2007). At baseline prevalence for men and for women varied relatively little among three wealth groups. However, after adjusting for age and site type, prevalence declined faster for poor and better off women than for the middle group; it also declined faster for better off men than for middle and lower income group, suggesting that better off men were perhaps less likely to be become infected (ibid).

However, Mishra et al. (2007) used data from eight recent population-based, nationally representative surveys with HIV testing in sub-Saharan Africa, to conduct an in-depth analysis of the association between household wealth status and HIV. "This study found that, contrary to evidence for other infectious diseases and theoretical expectations, HIV prevalence is not disproportionately higher among adults living in poorer households in sub-Saharan Africa. In all eight countries included in the present analysis, wealthier men and women tend to have a higher prevalence of HIV than poorer individuals. In most cases, the positive

association between wealth status and HIV is considerably diminished when a number of underlying factors (such as education, urban/rural residence, and community wealth) and some of the behavioural and biological pathways (proximate factors, such as sexual risk taking, condom use, and male circumcision) are taken into account. The results indicate that much of the positive association between wealth and HIV is caused by these underlying or mediating factors. Even after accounting for these various factors, however, in most countries wealthier adults remain at least as likely as poorer individuals to be infected with HIV, if not more.”(Mishra et al. 2007, p. S25).

On balance therefore there is little support for the hypothesis that higher incomes are associated with lower incidence and prevalence. Then what explains the enormous differences in prevalence across countries and locations within countries? A four cities study by Auvert et al. (2001) compared two low prevalence cities (Cotonou, Benin and Yaounde, Cameroon) with two high prevalence cities (Kisumu, Kenya and Ndola, Zambia) to investigate the relative importance of environmental, biological-medical and behavioral factors, using samples of 1000 men and women in each city, for whom extensive blood tests, socio-economic background variables (but not nutrition) and sexual behavior variables were gathered. The study concludes that high risk sexual behavior was not more common in the high prevalence cities than in the low prevalence ones; but the rate of partner change was still contributing to HIV positive status. In the high prevalence cities men and women tended to marry earlier, and women had earlier sexual debuts; male circumcision was much more prevalent in the low prevalence cities. In addition, HSV-2 (herpes simplex) infections were much more common in the high prevalence than low prevalence cities; and HSV-2 infection was strongly associated with HIV status within all the cities and both sexes; associations with other STDs was mixed. Finally, among men, having a job was associated with higher probability of HIV infection in all cities, but there was no association with education or traveling in the past year.

The striking result of this study is that only three factors explain the largest share of difference in prevalence across cities, and being HIV positive within cities: Lack of circumcision, HSV-1 infection, and marriage (being married, having been married or marrying early). Behavioral variables do contribute to the probability of being infected within cities, but not nearly as much as the other three factors. The only one of the three socio-economic variables included that makes any contribution is whether one has a job or not. While nutrition status was not investigated, the fact that the socio-economic variables had no impact or in the “wrong” direction suggests that the nutrition factors, may not be as important in determining the spread of HIV as the literature reviewed by Stillwaggon (2005) or Gillespie and Kadiyala (2005) would suggest.

In another study in Tanzania (Bloom et al. 2002), community environmental effects were compared to individual behavior effects, using open cohort data with demographic surveillance and epidemiological surveys, as well as qualitative research. Data on the HIV and AIDS prevalence in 1994/5 and on the incidence between 1994/5 and 1996/7 among 2271 men and 2752 women were available. Adjusting for individual effects, the study found that four community factors had strong impacts on probabilities of being HIV positive: social and economic activity, ratio of bar workers per male population, level of community mobility, and distance to the nearest town. These factors were not related to differences in sexual behavior among the communities. For men, after adjusting for community effects, household assets, education, and type of work no longer mattered, while the protective effect of circumcision did. Condom use was low, but higher among those with more partners. Among men, it was associated with higher probability of infection, suggesting perhaps that it was a proxy for multiple partnerships.

Again it appears that the environmental factors, rather than individual behavior differences and socio-economic factors, are the most important ones. All socio-economic variables suggest that higher status is associated with higher risk. This again suggests that differences in nutrition could not be as important as the available reviews discussed above suggest.

Does better Food Intake or Nutrition prolong the Life of Infected Individuals?

In four longitudinal studies in Africa, the median survival rate after infection with HIV was estimated as between 8 and 9 years for individuals who were infected between 20-29 years of age (Porter and Zaba 2004). The largest and most reliable study of survival rates was carried out in Masaka district of Zambia, where the median survival rate was estimated at 8.6 years. Survival rates decline significantly with age at infection.

The rate observed in the Masaka study is only a little over two years less than the median survival rate of

10.9 years observed in developed countries prior to the introduction of the highly active antiretroviral therapy (HAART). The authors cite the following factors that could account for the difference between Africa and the developed world: background mortality rates from other causes than AIDS that are much higher in Africa than the developed world; the HIV-subtype (although little is known about the impact of subtype on disease progression), and the mode of transmission, which in Africa is mainly between males and females.

Other factors which could account for the difference are nutrition and morbidity from other infectious diseases. They are generally much worse in Africa than the developed world, but they are not discussed by the authors. A reason for not discussing these factors may have been that in a landmark San Francisco study of survival rates, no lifestyle factors were found to predict the rate of disease progression. Rather it was only the number of CD8 cells, and the related viral load after the first viremia following infection, which predicted the length of survival of an individual.

On the other hand, there are indications in the literature that food and nutrition status can influence survival rates in the absence of antiretroviral therapy (ART). Energy requirements are raised by 10-30% following HIV infection in adults, and 50-100% among children experiencing weight loss⁷ (WHO 2004). Nutritional support has the potential to prolong the asymptomatic period of relative health prior to the onset of AIDS (Piwoz and Preble 2000). Three different types of nutrition supplements have been considered: food rations to manage mild weight loss and nutrition-related side effects of ARV therapy and to address nutritional needs in food insecure areas; micronutrient supplements for specific HIV positive risk groups; and therapeutic foods for rehabilitation of moderate and severe malnutrition in HIV positive adults and children, but few of these interventions have been evaluated.

In a path breaking study in Tanzania, Fawzi et al. (2004) found that women who were randomly assigned to receive multivitamin supplementation were less likely to have progression to advanced stages of HIV disease, had better preservation of CD4+ T-cell counts and lower viral loads, and had lower HIV-related morbidity and mortality rates than women who received a placebo. Vitamin A appeared to reduce the effect of multivitamins and, when given alone, had some negative effects. The authors concluded that multivitamin supplements delay the progression of HIV disease. They and provide an effective, low-cost means of delaying the initiation of antiretroviral therapy in HIV-infected women.

We therefore have a major puzzle: Both nutrition and a variety of infectious morbidities have been shown in the reviews of Stillwaggon (2005) and Gillespie and Kadiyala (2005) to be potentially important factors influencing survival rates. And vitamin supplementation has in some cases also been shown to be beneficial for survival. But the survival studies leave little room for major impacts of these factors, as the rates in the developing World are too similar to the developed country rates, and background mortality alone is likely to explain a lot of the difference.

Interventions against HIV and AIDS in Rural Areas

We have seen that agricultural and food and nutrition interventions are not likely to be powerful interventions against the spread of the disease or the progression of an infected individual from infection to death. Instead direct prevention interventions are required, and making ART widely available in rural areas. On the other hand, agricultural and food and nutrition interventions are likely to be important in mitigating the impact of the disease on affected households, especially those with more than one orphan, households headed by women and grandmothers, and children headed households. And better and more food may also

⁷ Energy requirements are likely to increase by 10 percent to maintain body weight and physical activity in asymptomatic HIV-infected adults, and growth in asymptomatic children. During symptomatic HIV, and subsequently during AIDS, energy requirements increase by approximately 20 to 30 percent to maintain adult body weight. Energy intakes need to be increased by 50 to 100 percent over normal requirements in children experiencing weight loss (WHO 2004).

help the adherence of patients to ART.

A major difficulty for HIV and AIDS interventions in rural areas is that in *each of the areas of prevention, care and treatment, and mitigation, a number of activities are required*. This means that intervention programs are complex and involve several sectors and actors. Where interventions must become available to all populations, service delivery approaches relying on specialized government implementing agencies or NGOs, who each focus on one or a small subset of components of the required interventions, will not be scalable in rural areas. The main reasons for this are that (1) delivering a multiplicity of services via specialized providers in separate programs would lead to very high overhead and transport costs, and (2) in widely dispersed rural areas, holistic and multi-sector interventions can only be coordinated at local levels and implemented by the communities themselves.

Prevention: If people can be convinced to change their behaviors, and either abstain from sex or use condoms, they will be protected from infection. This is so regardless of the factors determining prevalence in any given environment, and regardless of the fact that it is not differences in behavior which determine prevalence rates. In rural areas of Africa, interventions not only require inter-personal communication, but participatory involvement of whole communities, such as the model of the Tanzania-Netherlands Project to Support AIDS Control (TANESA), which was scaled up to all villages in the entire Mwanza district. Therefore all rural development interventions should be designed to contribute to mainstream HIV and AIDS prevention efforts. This does not necessarily have to be a costly effort, as most rural development programs already strengthen community institutions. These can then be entrusted with the task. Mainstreaming HIV and AIDS prevention certainly should receive equal emphasis as other mainstreamed agendas, such as improving gender relations and the management of natural resources.

Treatment: The World Health Organization (WHO) guidelines for HIV and AIDS treatment, including ART (WHO, 2004) have been designed in such a way that a nurse in a rural health post, without laboratory equipment, can use syndromic management (i.e. diagnosis based solely on observable symptoms) to diagnose advanced HIV disease and prescribe a standard first line treatment to adults. The WHO guidelines recommend the strong involvement of communities in the provision of other components, such as training in healthy living and survival skills, provision of food and nutrition, and adherence support. FAO therefore needs to closely follow what is happening in terms of the scaling up of AIDS treatment in rural areas, and work with WHO on analysis and guidance for successful programs.

Care and support: Care and support involve psycho-social support, health care, home-based care, education, food and nutrition interventions, as well as livelihood support. The consensus of the literature is that care and support should take a holistic approach to the needs of affected families and individuals, rather than dealing with sector-specific interventions one at a time too hard to find, but common knowledge. However, very few holistic and community-based care and support initiatives have been scaled up beyond the level of small boutiques. We have seen that HIV and AIDS impacts are highly differentiated according to who is sick or dies in a family, how well off the household was before experiencing the impacts of HIV and AIDS, and how large and well off its extended family network is. Therefore, only a fraction of the affected households and individuals need care and support interventions from the outside. A better way to provide care and support in a holistic and multi-sectoral way in rural areas would be to design and financially support more general community-driven social safety nets, which would focus on all highly vulnerable households and individuals, irrespective of the source of their vulnerability. Box 3 presents a proposal for such a program.

The high prevalence of AIDS stigma means that it is rarely possible to provide care and support interventions only to families and individuals affected by HIV and AIDS. And why would one want to direct support only to families who have chronically ill HIV and AIDS patients, rather than all families with chronically ill patients? Or only to HIV and AIDS orphans, rather than just orphans? Care and support to HIV and AIDS orphans should therefore be approached within broad community-driven social protection programs.

KEY CHALLENGES OF AGRICULTURAL GROWTH, RURAL POVERTY REDUCTION, AND HUNGER

Neither population growth nor climate change will present insurmountable challenges to agricultural development in Africa, if Africa seizes the opportunities it now has. And both provide opportunities. Reducing the death and suffering from HIV and AIDS requires generalization of prevention, treatment and

care and support in rural areas, taking advantage of agriculture in the care and support area.

But there are other serious threats to the agricultural growth rate, and the reduction of poverty and hunger: Among them are the widening technology divide, slow development of input and output markets and the associated smallholder services, inadequate safety nets to deal with extreme poverty, risks and fluctuations, and the imperative of regional initiatives for agriculture. A number of additional important challenges are covered in Binswanger-Mkhize and McCalla (2008): Biofuels, the supermarket revolution, security of access to resources, land administration and land reform, gender equity, fisheries and forestry, investments in rural infrastructure such as rural roads, and irrigation. In the following, a number of these challenges are discussed in greater detail.

The Growing Technology Divide

Around 1961, average cereal yields were around 1 ton per ha in the developing world, and rose to nearly 3 tons per ha by 2005. They increased to around 4.5 tons in East Asia and the Pacific (EAP), to around 2.3 tons in the Middle East and North Africa (MENA), while they stagnated around 1 ton in SSA (World Bank 2007). In 2000, improved varieties covered 84 percent of the cereal area in EAP, 61 percent in MENA and Latin America and the Caribbean (LAC), while they covered only 22 percent in Africa. In 2002, fertilizer consumption had reached a staggering 190 kg per ha of arable and permanent crop land in East Asia and the Pacific, 73 kg in MENA, but only 13 kg in SSA. As a consequence, even the penetration of high yielding varieties led only to very limited yield growth in SSA.

Agricultural growth in SSA has primarily been a result of area expansion, rather than productivity growth in crops and livestock. This is not that surprising, because Africa has the largest agricultural land reserves in the world. Using soil, land cover and climatic characteristics a FAO study has estimated the potential land area for rainfed crops, with a total potential increase in rainfed agricultural land for the whole of Africa of about 300 million hectares. However these land reserves are very unevenly distributed across sub-regions and countries, with some countries already having very high population densities. Even where area expansion remains a major avenue for agricultural growth, it would be much more profitable if productivity were higher.

The challenges of productivity growth are higher in SSA than in other regions of the world: There are more different environments to deal with, more crops, and more crop and livestock pests and diseases than elsewhere. There are no dominant farming systems that extend over very large areas such as irrigated rice and wheat in Asia. Irrigation infrastructure is poorly developed. Climate change will significantly add to the technology challenge. As a consequence of these factors, Africa is less able to borrow technology from other tropical countries; and technology transfers between regions in Africa are also constrained.

In 2000, global agricultural research and development (R&D) spending was 36.3 billion US dollars, of which 37 percent was conducted by the private sector, while 63 percent, or about 23 billion US dollars, was conducted by public entities. Ninety three percent of private research was conducted in developed countries (all figures from Pardey et al. 2006). On the other hand, public agricultural R&D grew faster in the developing world, and is increasingly concentrated in China, India and Brazil. In stark contrast, public agricultural research in SSA grew at only about 1 percent per annum in the 1990s, and in 2000 was around 1.6 billion dollars. SSA has the lowest share of private agricultural R&D spending in the World, only 1.7 percent of already low public spending (ibid). Of total agricultural research spending, donors provide about 40 percent, and in some countries this rises to 60 percent. Only five African countries — Nigeria, South Africa, Botswana, Ethiopia, and Mauritius — are paying the recurrent budget of their national agricultural research system (NARS) from national sources. “Collectively these data point to a disturbing development—a growing divide regarding the conduct of [agricultural] R&D—and, most likely, a consequent growing technological divide in agriculture. (...) The measures also underscore the need to raise current levels of funding for agricultural R&D throughout the region while also developing the policy and infrastructure needed to accelerate the rate of knowledge creation and accumulation in Africa over the long haul.” (ibid, p. 68).

The changing nature of technology discovery: All around the world innovation is shifting away from a linear pattern that starts with scientific discovery and moves successively to technology development, adaptation to

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local conditions, and dissemination to farmers. In its place comes a broader and more circular paradigm: It is broader in the sense that innovations no longer concentrate on basic food or industrial agricultural outputs, but instead include the entire value chain from farm production, natural resource management, assembly, processing, marketing and retail to consumers. Driven by consumer demand changes, attributes of appearance, convenience, nature of the production process (organic, environmentally friendly, genetic and location origin) are assuming importance, most strongly so in developed countries, but increasingly in middle and low income countries. The growth in information and communications technology has transformed the ability to take advantage of knowledge developed in other places or for other purposes. Within this broader paradigm, private research and development plays an increasing role, facilitated by the development of broader intellectual property rights in agricultural technology which provide many promises but also induce high levels of anxiety about exclusion and high transactions costs for developing country agricultural innovation. A number of larger developing countries are taking advantage of greater private sector involvement, including most recently India which now boasts over a hundred private domestic and multinational seed companies. The private seed sector is also growing in Africa, with Kenya being perhaps the most advanced.

Biotechnology and the Privatization of Agricultural Research

Farmers have been genetically modifying plants and animals for 5000 years or more, and agricultural scientists have joined them ever since the Mendel revolution in the 19th century. Biotechnology (BT) includes a number of techniques, the most powerful is the development of trans-genic crops and animals. The controversial issue is only whether it is appropriate to transfer genes from one species to another. Evenson and Raney (2007) address these political and scientific issues. Among the developing countries, China and Brazil, followed by India, have invested significantly in agricultural biotechnology. On the other hand, the Consultative Group on International Agricultural Resear (CGIAR) system is spending less than 10 percent of its overall budget on BT research, perhaps because of resistance of important European donors. The great success of Bt cotton and the prospects of nutritionally fortified rice and other crops have taken some of the wind out of the sails of environmental critics. Bt cotton has resulted in dramatic reductions in pesticides use wherever it has penetrated, as well as higher yields and incomes of small farmers, and no observable adverse environmental consequences. Biotechnologies are regulated from the point of experimentation, to field trials, and ultimate release. Further regulations govern where and how the crops may be grown, and how and where the products may be sold.

As part of its effort to bridge the technology divide, it appears that Africa urgently needs to take advantage of the many possibilities that biotechnology holds. Eicher et al. (2006) review biotechnology development for six food crops and cotton in Africa, and find unexpected scientific, legal, economic and political barriers to the development of GM crops and long delays in developing and implementing national bio-safety regulations and guidelines. They unfortunately conclude that with the exception of Bt cotton, most genetically modified crops are at least 10-15 years from reaching smallholders in Africa.

The Acceleration Phase of the Molecular Biology Revolution: The potential of rapidly expanding knowledge of genomics and our increased capacity to modify useful plants and animals is just at its beginning and can become an important factor in adaptation to and mitigation of climate change, desertification, increasing resource scarcity and threats from pests and diseases. Possibilities for building in stress resistance (drought, heat, and cold), immunity to pests and diseases, and improved nutritional values, as well as manufacturing pharmaceuticals in plants, which 20 years ago were wild dreams, are now much closer to reality. For example, Monsanto and BASF have just announced a 1.5 billion US dollars research and development partnership using biotechnology research. "Focus of efforts will be on the development of higher yielding crops that are more tolerant to adverse environmental conditions such as drought." (CropBiotech Update 23 March 2007). But will these developments occur fast enough to bridge the widening technology gap of Africa?

The answers will come mainly by private sector proprietary research with intellectual property protection. The fundamental question is how the benefits of biotechnology can accrue to small African farmers in a world of privatized research. There also remain major public goods issues:

- *Conservation of global genetic resources:* Significant progress has been made on issues of preservation, conservation, access, ownership and returns from genetic modification for the 64 plant varieties under

Binswanger-Mkhize

- the International Treaty on Plant Genetic Resources (ITPGR); but what about the rest of the rest of the plant kingdom, including forests, animals, fish, and critical microbial life?
- *Bio-safety protocols:* While rules and regulation regarding the development and testing of genetically modified organisms (GMOs) are clearly national policy issues, competing and conflicting paradigms between North America and Europe put small developing countries at the mercy of large trading blocks when they attempt to decide whether they want to develop, import or consume GMOs. Can FAO help countries in Africa develop the necessary rules and decision processes?
 - *Access to promising genetic materials and techniques:* Current estimates suggest that six multinational firms dominate molecular genetic research on plants and animals. These firms include Monsanto, Syngenta, BASF, Bayer, Dow AgroSciences and Dupont. The challenge is to find ways these firms can share promising technologies with developing countries without compromising their legitimate right to garner profits from their investments in discovery. The Danforth Plant Science Center maybe one example. The African Agriculture Technology Foundation (AATF) discussed below is another model. But eventually regional research organizations must acquire the capacity to participate as peers as the molecular biology revolution plays out.

Even where gene technology is donated, there may be slow progress. Can Africa afford to be left behind China, India, and Latin America. Should it adhere to complex regulations dictated by others? Rather it should insist on more streamlined approaches. Whatever the answer to the above questions, biotechnology approaches must be nested and integrated into plant breeding programs. Special attention should be given to raising public awareness of and political support for biotechnology, and commitment to strengthening African capacity in biotechnology, biosafety, food safety and intellectual property rights, and the training of the next generation of African plant breeders and GM crop specialists

The African Institutional Framework for Agricultural Technology Generation

Sub-Saharan Africa has over 400 public and private entities engaged in agricultural research, of which nearly 200 are public research institutions, and another 200 are universities (compared to 20 in 1960). However, 40 percent of them have fewer than 5 researchers and 93 percent have fewer than 50 full time researchers (Beintema and Stads 2004). Sub-Saharan Africa has nearly 50 percent more agricultural scientists than India and about a third more than the United States, but all of SSA spends only about half of what India spends and less than a quarter of what the United States spends on agricultural R&D. Only a quarter of African scientists have a PhD, compared with all or most scientists in India and the United States.

All institutions engaged in research within each country are collectively aggregated into NARS. In the different sub-regions of Africa the NARS have created Sub-Regional Organizations (SROs), the strongest of which are CORAF/WECARD for West and Central Africa and ASARECA for Eastern and Central Africa. The SRO for Southern Africa is the SADC Food Agriculture and Natural Resource Directorate (SADC/FANR), and a North Africa SRO initially comprising Morocco, Algeria, Tunisia and Libya is also under development. The SROs foster research collaboration in their sub-Regions. ASARECA and CORAF/WECARD have established research grant funding mechanisms of their own, with significant support from the European Union (FARA 2007). In 2001, the three SROs for sub-Saharan Africa established the Forum for African Agricultural Research (FARA) that has its secretariat at the regional FAO office in Ghana. FARA has been entrusted by the African Union and the New Partnership for African Development (NEPAD) to coordinate Pillar 4 of its Comprehensive African Agricultural Development Program (CAADP) which focuses on agricultural research and technology dissemination.

In order to strengthen bio-technology research, four regional biosciences networks initiatives were established under the auspices of the NEPAD. The Biosciences eastern and central Africa Network (BecANet) facility was established in 2004. BecANet consists of a secretariat and hub located on the campus of the International Livestock Research Institute (ILRI) in Nairobi, Kenya (that should provide a common biosciences research platform, research-related services, capacity building and training opportunities), regional nodes, and other laboratories distributed throughout eastern and central Africa for the conduct of research on priority issues affecting Africa's development. In addition NEPAD has initiated three other African Biosciences Initiative which are networks of leading centers and consist of hubs and nodes in Northern, Southern and Western African, i.e., the Southern African Network for Biosciences (SANBio) with its hub at the Council for Scientific and Industrial Research, Pretoria, South Africa; the West African

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Biosciences Network (WABNet) with the hub at Institute Senegalais de Recherches Agricoles in Dakar, Senegal, and the Northern Africa Biosciences Network (NABNet) with the hub at National Research Centre in Cairo, Egypt. These hubs possess and are strengthening the necessary physical infrastructure to develop and implement regional and continental biosciences projects (NEPAD, 2007a).

In the early 2000s a public-private sector partnership to foster access to proprietary research was created, funded by the Rockefeller Foundation. The AATF is an international not-for-profit organization designed to facilitate and promote public-private partnerships for access and delivery of proprietary technologies that meet the needs of resource-poor smallholder farmers in SSA. Through a catalytic and facilitative role, AATF tries to serve as an honest broker between owners and/or holders of proprietary technologies and those that need them to promote food security and improve livelihoods for smallholder farmers in SSA. AATF was incorporated in the UK in January 2003 and in Kenya in April 2003.

The Consultative Group on International Agricultural Research (CGIAR)

The CGIAR supports the research of 15 international Centers, of which 13 are located in developing countries. In 2006 the CGIAR consisted of 1,115 internationally recruited scientists and a total staff of 8,154 working in over 100 countries. A strategic component of the system is the ex-situ germplasm collections of eleven of the International Agricultural Research Centers. Building on earlier independent initiatives, the CGIAR since the early 1990s, has rapidly broadened its focus from crop genetic improvement towards natural resource management, environmental issues, and policy research.

In 2006, of total CGIAR expenditures of 458 million US dollars, around 220 million US dollars, or 48 percent, went to SSA. Note that this is only about 10 percent of total research spending in SSA. Africa also benefited from the share of 9 percent share of CGIAR expenditures that went to North Africa and Central and West Asia. All Centers currently have programs in SSA. Two Centers are located in West Africa (IITA and WARDA), while two are in Eastern Africa (ILRI and ICRAF). There were a total of 162 CGIAR Centers' programs/projects in SSA in 2006. To implement these programs/projects, the Centers engaged a total of 389 internationally recruited staff, 121 regionally recruited staff, and 2607 local staff. However, as discussed previously, the CGIAR spends less than 10 percent of its overall resources on biotechnology research, and little of that is likely to be spent in or for Africa. The CGIAR is not the only set of advanced research institutes operating in or for Africa. France's Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), and the Institut de Recherche pour le Développement (IRD), formerly Office de la Recherche Scientifique et Technique Outre-mer (ORSTOM), also have operations on the continent. The combined budgets of these two institutes are as large as the entire CGIAR budget (NEPAD 2007b).

CGIAR research has made significant contributions to SSA agriculture. Many previous studies highlight successes such as the high-yielding cassava varieties that include resistance to mites, mealy bugs, cassava bacterial blight, tolerance to drought, low cyanogens potential, and good cooking quality; the famous biological pest control especially in cassava but also in other crops; biological pest control in potato, including via pest resistant cultivars; improved hybrids and open-pollinated varieties of maize in western, eastern and southern Africa; higher-yielding wheat in eastern and southern Africa; hybrid sorghum in Sudan; semi-dwarf rice for irrigated regions in West Africa; early maturing cowpeas in West Africa; and disease-resistant potatoes in the eastern and central African highlands.

Box 2: Estimated rates of return to investment in agricultural R&D

Region	Number of estimates	Median rate of return
Africa	188	34
Asia	222	50
Latin America	262	43
Middle East/North Africa	11	36
All developing countries	683	43
All developed countries	990	46

Source: Alston et al. (2000)

The adoption of new crop varieties in Africa has been significant. In the late 1990s the adoption rate of improved varieties of all crops was 22 percent of total area planted, and of this 11 percent was planted to CGIAR related varieties, usually produced in collaboration with the NARS. (Pardey et al. 2006 table 6). In eastern, central and southern Africa 10 million farmers are reported to plant and consume improved varieties of beans.

Alston et al. (2000) assembled more than 1500 rate of return estimates to agricultural research and extension (Box 2). The median of the rate of return estimates was 48.0 percent per year for research, 62.9 percent for extension studies, 37 percent for studies that estimated the returns to research and extension jointly, and 44.3 percent for all studies combined. Box 2 shows that the median return in the developing World is about the same as in the developed World, and that the median rate of return in Africa is slightly lower than elsewhere, but still very high at 34 percent.

Evenson and Gollin (2003) estimate CGIAR contributions to yield growth due to CGIAR research in SSA to be in the range of 0.11–0.13% per year. This range is much smaller than the 0.30–0.33% per year average yield growth across all developing regions (Evenson and Gollin 2003). Despite substantial introduction of new varieties there has not been a great aggregate impact on yields, compared with other regions, partly because of the much lower adoption rates and partly because of lack of irrigation, fertilizer, and inappropriate policies.

The most urgent need for action: The upshot of the discussions on the institutional framework and the returns to research is that the under-investment in agricultural research in Africa is not warranted either by low returns or low adoption rates. FARA has developed the Framework for African Agricultural Productivity (FAAP) that sets out guiding principles for how research is to be fostered, institutionalized and financed in Africa (FARA 2006). Under FAAP, FARA, the SROs, and the NARS will collectively guide the evolution and reform of agricultural institutions and services; foster an increase in the scale of Africa's agricultural productivity investments, and help align and co-ordinate financial support.

A joint donor evaluation analyzed FARA and its programs as follows: "FARA is a young organization (...) it has developed a strong organizational framework in its first three years of full existence. The Secretariat has demonstrated that it is both efficient and effective in its operations (...) with increasingly significant tasks being assigned to the FARA Secretariat and the various FARA constituencies, these (...) urgently need to increase their human resource capacity. (...) JEE believes that the FAAP provides a framework for harmonizing donor support, and that committing to consolidated funding of the FARA Rolling Work Programme & Business Plan [RWBPB] is the best means of pooling resources." (FARA 2007a, p.11).

Despite these favorable developments and external assessments, the work programs of FARA, of the SROs and of the NARS remain seriously under-funded.

Misallocation of Limited Research Resources

The limited research resources also seem to have increasingly misallocated. Given the heterogeneity, the poor borrowing opportunities, and the enormous challenges from pest, diseases and water stress, basic innovations at the science level are urgently needed in a wide variety of crops and livestock diseases. Yet, the proportion of research going to basic sciences has been declining in national and international research systems alike. Instead the resources have gone to agronomic and farming systems and environmental research that has little record of high rates of return. The African Challenge program continues the same unfortunate trend. Scarce scientific resources have also been diverted to implementation of programs, rather than research. While Africa has created not less than four regional centers for biotechnology, these remain severely underfunded. The blame for these factors may lie primarily with donors impatient for immediate results, or distracted by donor fashions. Despite their commitments to the CAADP agricultural priorities, national governments have also not significantly increased their funding for agricultural research in general or biotechnology in particular. They also have invested little in biotechnology capacity, probably for political reasons. In the meantime India, China and Brazil are sharply increasing their investments in biotech research.

There is some relief in sight. AGRA intends to fund training of 1000 plant breeders. However, unless they can be posted in better funded institutions, the best of them will be lost to emigration. Private sector technology research has grown considerably, albeit less than in Asia and Latin America. Nonetheless, unless

the science base improves, the gains from conventional breeding in the public and private sectors may be insufficient to close the growing technology divide. The Bill and Melinda Gates Foundation, a founding member of AGRA, has also invested in basic research in a number of crops, but given the enormous needs, the funding remains inadequate. There is therefore little hope that the crisis of the growing technology divide will see any rapid solution, unless African governments muster the political will to sharply increase the necessary agricultural science funding.

Agricultural Science and Education Institutions

“Africa now houses roughly 300 Universities. Three quarters of African countries offer some tertiary level training in agricultural sciences. At least 96 public universities teach agriculture and natural resources management. Of these, 26 are in Nigeria, 10 in South Africa, six in Sudan, five in Kenya and three in Ghana. Nineteen separate faculties of veterinary science exist in 13 countries, five of them in Nigeria alone” (Johanson and Saint 2007, p. 15). Despite these many facilities, agricultural aid funding “...has dropped precipitously. ... agriculture received a diminishing portion of a shrinking development assistance pie...” Country expenditure has paralleled the drop in donor assistance. What is left is a proliferation of institutions which have limited staff with virtually no research support money. The sad part is that now the need for agricultural technology development has regained high priority for Africa, the continent is left with a deteriorating, oversized and fragmented infrastructure, many vacant positions, an aging staff, outdated equipment, and no operating funds (Johanson and Saint p 34).

Johanson and Saint’s conclusion is poignant; “Agricultural education and training has been demonstrated to be a vital, but much neglected, component of agricultural development in Africa. It is *under-valued, under – resourced and under-provided*. Human capital in agriculture has been depleted by long neglect.” (p. 67). The InterAcademy study states “(...) It is the conviction of this study panel that much of what would be necessary to improve agricultural productivity and food security in Africa hinges on strengthening agricultural educational systems, more specifically the coverage and quality of higher education.” (p. 184)

However there are hopeful signs. “Seven American foundations have formed the Partnership for Higher Education in Africa and pledged to invest at least USD 200 million over the next five years (...) and (...) the Gates and Rockefeller Foundations recently formed a separate partnership, called the Alliance for a Green Revolution in Africa (AGRA)” (ibid). UNDP is supporting a community of practice, SEMCA – “Sustainability, Education and the Management of Change in Africa” focusing on agricultural education.

In conclusion of this science and technology section, it is clear that African regional and national institutions for agricultural science, technology and agricultural science education have started to respond to the enormous scientific and technological challenges faced by Africa. The challenges are intensified by increasing competition for resources, climate change, and rising international agricultural prices. These responses are occurring in a rapidly changing global research system including bio-technology, intellectual property rights and patent systems, and a growing range of players, especially the private sector. The significant institutional responses have not so far been matched by adequate funding from international donors and national governments, especially in the areas of bio-technology and science education.

Smallholder Services and Input and Output Markets

Improvements in technology will continue to lead to lower productivity gains, if services, inputs and output markets are not significantly improved. Rural finance is also insufficiently developed. Farmers’ organizations have made a lot of progress, but are still not able to provide much of the needed capacity. If smallholder services, rural finance, and markets were improved, however, a number of problems will be closer to a solution: Farm profit and investments will increase, nutrition depletion will be reduced, and food insecurity associated with poor markets will be reduced. The re-conquest of domestic and regional markets will then also be closer at hand. Again, relying on donor finance for these improvements will not be sufficient to solve these problems. Political will on the part of African governments is needed to provide the necessary finance.

Safety Nets

While emergency relief is relatively well developed in SSA, safety nets for the very poor are not, again in sharp contrast to India and China. For example, less than 1 in 100 orphans receives any kind of assistance in SSA (other than South Africa). While South Africa has a number of conditional grants programs for the

aged, children, and the disabled, few other SSA countries are experimenting with them. Support to traditional safety net mechanisms in rural communities is conspicuous by its absence. And few employment generation programs have more than spotty coverage. But the need for safety nets will not be reduced by growth or agricultural growth. Such growth tends to bypass the very poor and destitute. The population of old people without family support will go up with population growth and improving incomes and health. Climate change, HIV and AIDS, malaria, tuberculosis, and the growing orphan crisis require better safety nets. Growth is increasing the fiscal space of African governments and they need to take advantage of it to improve the safety nets.

In SSA, South Africa, Botswana and Namibia have developed significant cash transfer mechanisms to assist a number of the most vulnerable groups, the aged, the disabled, children, and people living with HIV and AIDS. These operate in both rural and urban areas. Financing such cash transfer programs may be beyond the reach of many of the poorest countries. Alternatives are to strengthen traditional community safety net mechanisms along the lines discussed in Box 3.

Box 3: A Burkina Faso Proposal for Scaling Up Social Protection

Communities and individual families are already part of an informal, if inadequate, social protection system. But they do need additional resources and support to expand these informal mechanisms into a more systematic effort, and to finance support to education, health care or home based care, etc. These resources should be provided as matching grants to the communities, with the latter providing the matching resources in cash or in kind, for example food needed for the most vulnerable.

While communities all over Africa are able to identify vulnerable families, and classify them by degree of need, they are not able to carry out proper needs assessment for these families, a task which normally is done by a social worker. In Sanmatenga there are nearly 300 villages and urban neighborhoods, but only three trained social workers, and there is no way the Ministry of Social Welfare can hire enough social workers to assist communities to do this job. Just as in the areas of agricultural extension, health, or veterinary medicine, it would therefore be necessary to develop a system of community-based social workers. Communities should select one or several members to be trained in basic family needs assessment and supervision skills, and they could then be remunerated via daily allowances for their work out of the community grants. The Ministry of Social Development would need to develop a curriculum, training program, and supervision program for them.

Assisting the chronically ill, orphans and the families which take care of them will require significant additional training of enough community members to manage the tasks. These community members cannot work as volunteers for a long period of time, and need to be provided with modest remunerations, such as per diems for every day they work or home visit they make.

The community members will encounter situations which they and the community as a whole cannot handle, such as medical emergencies, or child abuse. To deal with these cases requires the putting in place of proper referral systems so that difficult cases can be handled by health professionals, social workers or educators with the required skills. These same specialists need to be involved in designing and delivering the training and be available for facilitation and training on demand.

The same committee structures that were used for prevention at the provincial, district, and community level, the same training teams, and the same financing mechanisms can be reinforced and used to coordinate, manage and monitor the social protection program. In particular the committees can coordinate and provide financial resources to the NGOs and local offices of the respective government services so that they can become the facilitators, trainers and referral system.

Source: Hans Binswanger-Mkhize, personal observations

The Imperative of Regional Cooperation in Agriculture

Throughout this paper many critical issues were encountered that can best be, or only, solved by regional action, and more are yet to come; let's recall a sampling:

- Small countries dominate the African scene often lacking financial capacity for public goods investments;
- Small land locked countries generally do worse, and depend on regional integration to be able to do better
- Expanded regional trade in agriculture and food products is good for growth, farmer's income and regional foods security; the short run management challenges of the current food price spike and the long run opportunities arising from prices that are expected to settle at higher than past levels only add to this imperative
- Expanded regional trade and food security will be helped by the harmonization of standards and sanitary measures, and sub-regional and regional capacities to implement them;
- Freer borders and internal infrastructure should encourage private sectors traders;
- For small countries, regional infrastructure –roads, communications, ports – critical for access to each other and external markets;
- Reversing land degradation and desertification and preserving biodiversity require trans- boundary collective action;
- Managing crucial, but under threat, forestry and fisheries resources must be approached on a transnational basis;
- Defense against plant and animal disease epidemics require collective responses at sub-regional and regional levels;
- Success in agriculture crucially depends on indigenous scientific capacity to generate new technology; given small and poor countries is far better done on a regional or sub regional basis – FARA and the SRO's are on the right track but the effort needs to be greatly expanded;
- Biotechnology research is expensive with a large critical mass therefore two or three regional institutes is far superior to 48 or 24 underfunded, under resourced national institutions;
- Indigenous scientific capacity requires trained people, again better done by regional institutions which have critical mass and necessary financial support;
- Regional approaches to rural financial architecture may increase potential deposits and loanable funds and spreads risk.

These examples hopefully are enough to illustrate that the potential for regional approaches and an overall regional strategy for rural Africa are significant. *In most of these areas institutional development programs have been created. Yet they remain massively underfunded. The main reason for this is that the regional efforts produce regional and sub-regional public goods, and therefore their financing is subject to the familiar free rider problem of financing public goods. Except the largest countries which have an incentive to supply themselves with these regional public goods, countries will seek to benefit from the investment of others. Better coordination of funding by African countries, as well as external co-finance, could help overcome the underfunding. But donor finance remains both insufficient and unreliable for the task. The African Union, via the CAADP, the Economic Commission for Africa, and African Development Bank need to coordinate these efforts.*

CONCLUSIONS

African agriculture today faces a context of general economic growth in Africa, and in the medium term a brighter market outlook in international, regional and domestic markets than anytime in the last 40 to 50 years. Both macro-economic and sector policies are more favorable, although African farmers still face the worst agricultural incentives in the World. In most countries the institutional environment has also given local governments, communities and the private sector much more opportunities than in the past. And business climates are improving, albeit from a very low level. The smallholder dominated agricultural sectors of Africa have already responded in terms of a significantly higher growth rate.

Improved market opportunities will arise in traditional as well as non-traditional agricultural exports and they need to be seized. At the same time domestic and regional markets will present the most promising area

for medium to long term agricultural growth. That means that small farmers, despite the supermarket revolution and rising international quality standards, will be well placed to seize them.

While climate change is likely to affect most regions in Africa negatively, it will also open new opportunities in some regions where rainfall and other climate parameters will improve. Other opportunities arise from the possibility of carbon trade once the instruments for trading via land use commitments and changes are better developed. In the aggregate the impact on African agriculture will undoubtedly be negative, but climate models are not yet sufficiently well developed for Africa to predict what will happen with sufficient certainty to engage in detailed planning. As a consequence, climate change should be mainstreamed into the general agricultural and risk mitigation agendas. In particular much better capacities for agricultural technology development are needed.

Population growth is not yet slowing sufficiently fast to provide for a population dividend. At the same time the evidence for a generalized negative impact of population growth on agriculture is lacking, and instead in many areas population growth, combined with good market access has led to beneficial agricultural intensification.

HIV and AIDS has led to an enormous human tragedy and a reduction in growth prospects in hard hit countries. Agriculture and food interventions can help in mitigate the impact in rural areas. But neither prevention nor treatment programs have yet been scaled up adequately in rural areas, despite the fact that how to do that is well known, and scaling up of these interventions remains the most pressing issue.

The most neglected aspect of the agricultural agenda in Africa has been agricultural technology, and as a consequence the continent faces a growing technology divide. The continent has a large number of agricultural scientists, research institutions, and agricultural education and science education establishment. But these are mostly too small, donor dependent and underfunded. As a consequence Africa is not only lagging badly in traditional approaches to plant breeding and animal disease control, but is at great risk of missing the boat in the biotechnology revolution. Unless Africa, like China, India and Brazil, starts investing more of its own resources into agricultural science, science education and research, the huge existing technology divide will only deepen.

The agenda for action arising from the analysis of this paper is not new. The four most important among them are as follows:

1. Avoid backsliding on economy-wide and agricultural policies and further reduce agricultural disprotection in countries and commodities that still practice it.
2. Reduce barriers to intra-regional trade in food and other agricultural commodities and properly finance the regional institutions that support regional trade, quality and phytosanitary controls, and other regional agricultural public goods and services.
3. Sharply increase domestic and regional funding of agricultural science, science education, and research, and the associated centers of excellence; and thereby regain the technology agenda from the donors and pull them along in increasing their funding of priority areas.
4. Assist in the deepening of domestic markets and foster sharp improvements in smallholder services

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