

ENHANCING FOOD SECURITY IN AFRICA THROUGH SCIENCE, TECHNOLOGY AND INNOVATION

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Abstract:

The report focuses on the challenges of improving agricultural performance in Africa and the role of technology and innovation in raising agricultural production and incomes of all farmers, including smallholder farms. The report argues that the main challenge is to strengthen the innovation capabilities of African agricultural systems as a means of addressing poverty, improving food security and achieving broader economic growth and development.

keywords: Technology, Innovation, Smallholder farmers, food security

Sub-Saharan Africa is the developing region most likely to miss the first Millennium Development Goal (MDG1), aiming to reduce by half extreme hunger and poverty by 2015. Per capita food production in least developed countries (among which African countries are over-represented) has declined continuously since the early 1970s, so that in 2003-2005 it was one-fifth lower than in 1970-1972. While Asia and Latin America have seen significant increases in their agricultural productivity over the last three decades, Africa's agricultural productivity has stagnated. This has created serious problems of food insecurity and has presented a major development challenge given that the agriculture sector forms the basis of many African economies and provides the largest source of employment and livelihoods for the vast majority of the continent's population. The core challenge that confronts Africa is one of promoting steady growth in agriculture in the dynamic context of economic transformation of countries. Agriculture will remain important for food security but at the same time, building productive capacities in agriculture and identifying multi-sectoral linkages between agriculture and other sectors will be important to support sustainable economic development of Africa. The onus therefore lies in the identification and support of processes and linkages that promote technological change, productivity increases and innovation.

Technological innovation is not all composed of radical discoveries, and much of what is relevant to African agriculture relates to the ways in which incremental improvements in processes, products, inputs, or equipments are needed to adapt existing technologies to the local environment in ways that enhance productivity and lower costs. The ability to adapt, therefore, is a significant step in technological empowerment, which over a period of time, can lead to the creation of knowledge generation capabilities amongst actors that are demand-driven rather than simply those that aim to replicate the successes of other regions of the world.

Declining agricultural productivity in many developing countries can be reversed through building what are called agricultural innovation systems that provide the enabling framework not only for the adoption of existing technologies and the development of new ones that are suited for African needs. Agricultural innovation systems denote the network of economic and non-economic actors, and the linkages amongst these actors enable technological, organizational and social learning of the kind needed to devise context-specific solutions. The dissemination of already existing technologies from outside could help this endeavour, but a major challenge relates to the ways and means in which innovation that is relevant to African agriculture could be promoted.

However, the ability of the agricultural innovation system to be able to access, use and diffuse knowledge embedded in agricultural technologies depends on the presence of an enabling framework that supports the emergence of technological capabilities by strengthening existing linkages, promoting new linkages and fostering inter-organisational learning that leads to capital accumulation and technical change. Such an enabling environment, by definition, is one that strengthens the absorptive capacity of local actors while protecting their interests through a policy framework that recognises their legal rights and privileges, linkages, socio-cultural norms and historical context. This report defines an enabling environment for technology and innovation in agriculture as one that provides the actors, skills, institutions and organizations required to promote the use, dissemination, diffusion and creation of knowledge into useful processes, products and services.

Creating an enabling environment for technology and innovation is an essential requirement to enable African countries to address the following constraints that impede their agricultural development:

Declining investment: most developing countries already had investment deficits in agriculture well before the onset of the current financial crisis in mid-2008. The long decades of neglect of the agricultural sector in the Africa region are partly a consequence of the policy of strict fiscal austerity imposed on African countries, which has severely curtailed state support of agriculture. The perception that investment has merely to do with the provision of agriculture research has exacerbated the situation further. This has resulted in poor rural infrastructure, low coverage of extension services, reduced provision of subsidies for inputs and finance for farmers, and reduced investment in research and develop-

ment in the agricultural sector. As a result, farmers in Africa are now poorly equipped to deal with the new challenges that they face, which include climate change, desertification, competition from cheap imports, and highly concentrated global value chains dominating the world's commodity markets. Investing in activities that promote new forms of partnerships, use of local knowledge (including traditional agricultural knowledge), practices and preferences, as well as policy-driven demand-based approaches have been missing to promote the African response to its agricultural challenges.

Land tenure and credit access: access to credit is another fundamental institutional constraint that circumscribes the ability of African farmers to cope with the rising prices of land, seeds and other agricultural inputs. However, this clearly needs to be accompanied by an enabling framework that guarantees better physical and scientific infrastructure of relevance to African agriculture, and improved market access and demand forecasts. Guaranteed land tenure could be vital to accessing credit and investing in the medium and long-term productivity of the land.

A focus on small farmers: focussing on smallholder farmers has proven an effective means to contribute to a country's economic growth and food security. Smallholders make up over half the population in most developing countries and their farms are often efficiently run and enjoy significant growth potential. However, smallholder farms are diverse in terms of the challenges and limitations they face in the light of which adaptation of technologies and reconfiguration of supply chain roles and responsibilities will be critical to enable small-scale farmers to frame the issues of appropriate agricultural outputs and activities on their own terms. Their isolation makes them susceptible to both external and internal shocks, and also hinders resilient responses. A focus on smallholder farms is required to ensure that they are well networked into all available technical and institutional support mechanisms that is so critical for them to consolidate their activities.

Adapting to climate change: climate change is a global challenge with critical development implications. The negative impacts are especially severe in marginal lands. Some 300 million farmers in Africa live and work on marginal lands at increased risk of soil degradation, droughts, floods, storms, pests and erratic rainfall. Climate change technologies and innovations for mitigation and adaptation strategies are needed to accelerate the development, deployment, adoption, diffusion and transfer of environmentally sound technologies from developed to developing countries.

Bioenergy: energy is at the centre of the development challenge in many developing countries, with inadequate supply hindering capacities to expand production and improve human wellbeing. If properly man-

aged, the high technical potential of bioenergy in regions such as sub-Saharan Africa could make a significant contribution to fighting poverty while also addressing climate change and expanding trade opportunities in sustainable energy products.

Structural policy reforms: the thirty-year legacy of structural adjustment and trade liberalization has turned Africa from a net food-exporting continent to one that predominantly imports. The food insecurity situation in Africa is better framed in terms of missed opportunities as a result of serious failings of development strategies. Africa's agricultural sector implemented programmes designed to eliminate price controls, privatize state farms and state-owned enterprises, abate taxes on agricultural exports, remove subsidies on fertilizer and other inputs and encourage competition in agricultural markets. The anticipation that these measures would encourage the private sector to move in and provide these services was not matched by reality. Long-standing policy failures must be reversed. Experience from the most recent crisis also shows that countries that specifically aim to achieve food security can cushion the blows from a cyclical world market. Future trade agreements must ensure that the space to apply such policies is preserved and, indeed, strengthened.

Building locally relevant research and innovation priorities: African agricultural research has not been weak, but it has lacked the right impetus to bridge ongoing research with product development initiatives. There has been a tendency to focus on applying international models of agricultural development without questioning their applicability to local circumstances. An accompanying attitude that looked down on regional research, as against international research (where the latter was considered to be far more superior), has been entrenched since colonial times. In reality, patterns of knowledge change are related to the increasing convergence in the different areas of science and technology, and indigenous capabilities of countries matter. The benefits attending to convergence include new organizational production structures, advances in communication apart from global trade. This calls for policies that help re-orient actors towards local sources of technology and learning, and address the negative perception towards local research.

Amongst options available, **international cooperation** can potentially be a strong factor in helping relevant new technologies be adopted, adapted and diffused throughout host economies. In particular, a handful of South-South cooperation models have already proven their worth as mechanisms for ensuring the right technological tools are made available to African farmers. So-called triangular cooperation, where a Northern neighbour signs on as a sponsor to South-South technology sharing efforts, has also shown promise as a model for the international diffusion of technologies.

It is important to realize that there are no quick fixes. This can be seen in the case of other developing countries which are now benefiting from public and private investments that were made into the development of agricultural technologies and innovation capacity since decades. Brazil, for example, has achieved its current leading position in tropical agriculture technology and increased agricultural productivity as a result of more than three decades of public and private investment in the development of technological packages tailored to its own soil and local agro-ecological conditions.

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On this basis, when the new African Agriculture Revolution is eventually implemented, it is likely to be built on Africa's own indigenous technology and knowledge requirements, and the nutrition and food security needs of its people. Building capabilities for science, technology and innovation of relevance to local agriculture however, is the only path to achieve this.

Building innovation capabilities in African agriculture

Regardless of the theoretical viewpoints on the kind of approach best-suited to promoting agricultural development, the fundamental issue for a policy maker is how such an approach can be used to devise an agriculture development strategy. The innovation systems framework can be useful to help identify areas of weakness that could ideally be addressed through national policy action. A key issue is how to promote capabilities among African farmers and develop more effective innovation systems for agriculture at the national and sub-national levels.

An agricultural innovation systems approach is recommended as a policy instrument for African agriculture. Agriculture development strategies that incorporate the main components of the AIS approach can be transformed into a workable concept at the country level. The AIS approach depends on identifying the key actors and linkages that together strengthen knowledge flows and enable interactive learning that is important to build capabilities for agriculture. The linkages between these actors derive from two major sources: the policies and institutions (including the constitution, laws, rules, regulations and by-laws) are a very important to guide individual behaviour. Laws, rules and regulations are important offer specific incentives to individuals or groups to collaborate and engage in mutual learning. A second form of linkages derives from socio-political-historical attitudes and practices (that could stem from cultural norms) that dictate how or why individuals interact and

what benefits they perceive from such interactions. The chapter has identified short-term and mid-term policy actions that are meant to guide policy makers to enact the AIS approach within their national contexts.

The characteristics of these systems may vary significantly between (and even within) countries, which makes country-specific analysis necessary, but there remain some common issues that affect many African countries to a greater or lesser extent. Common challenges include poor linkages between farmers and others in food value chains and the research and education systems, weak bridging institutions between the two (extension services, for example), inadequacies in infrastructure and financing mechanisms, and policy frameworks that do not provide adequate support for smallholder farmers or may even create disincentives to technological development or innovation. Policy-makers need to ensure that national agricultural research systems involve farmers fully as partners, and gear research to solving the pressing production problems that they face. There is also a need for institutional innovations and different ways of organizing smallholders, linking them better to knowledge flows and to potential markets for their produce, and policy options to enable these have also been identified in the chapter. The specific policies needed at the national level will depend on existing capabilities and human and financial resources, the political, social and institutional contexts and agro-ecological conditions.

Adequate policy space is necessary to implement appropriate policies. Promoting the sharing of experiences and relevant knowledge flows internationally and at the national level provide a starting point. Designing effective public policies, however, requires adequately prepared policy-makers and may entail some degree of experimentation to find what works best in a specific situation.

There are other gains that flow from agriculture to non-agriculture based systems that will be important in the African context, and can accrue from building agriculture innovation systems. These include the flow of rural human capital as a result of increased rural spending on education (accruing from agricultural surpluses), the release of rural labour for industrial employment and enhanced foreign exchange earnings and increase in domestic savings, all of which are needed to enable the structural transformation of African economies.

Agriculture and national food security

Achieving food security means much more than simply producing more food. Without policies to improve poor consumers' access to food, policies that increase the availability of food only will not ensure national food security.

In Africa, improving the availability of and access to food demands strengthening local productivity and production. This is because, in Africa and other devel-

oping country regions, the vast bulk of food is produced and consumed locally. A lesson from the recent food crisis is that as food import prices rise and global stocks drop, the need to improve local production becomes more acute.

There are four main ways to improve local food production:

1. expanding arable land;
2. achieving higher levels of cropping intensity;
3. increasing yields; and
4. implementing agricultural policy reforms.

Increases in cropping intensity are, however, strongly dependent on increasing the availability of irrigation.

Yet the gains made through such strategies remain vulnerable to a variety of new challenges, particularly soil degradation due, among other factors, to climate change. Desertification is estimated to put the food security of one billion poor people at risk, particularly in dryland areas of Asia and sub-Saharan Africa.

Other important risks include the hollowing out of potentially productive rural communities caused by mass migration to the cities. While the explosive transfer of population from rural to urban settings can weaken the productive capacity of vulnerable agricultural sectors, experience suggests such trends can be slowed and even reversed by well designed policy interventions to improve the attractiveness of agriculture and rural livelihoods.

The failure of developed countries to recognize the negative impacts of their policy actions on food production and demand in the developing countries has in some instances resulted in suboptimal policy choices. To preserve policy coherence, renewed attention to agriculture must go hand-in-hand with the removal of farm and export subsidies for key commodities (cereals) in developed countries, to avoid depressing the prices that small farmers receive in developing nations.

Competition for the use of land from biofuels poses yet another new risk for food security, as acreage that might have been devoted to producing food for human consumption is diverted to the production of biofuel feedstocks. Evidence is mounting that competition over the use of land from biofuels has contributed strongly to the current food crisis. Competition for land to raise livestock and produce animal feed similarly tends to decrease the amount of food available locally for food consumers.

Challenges and opportunities to achieve food security

Financial resources are badly stretched in most African countries. Policy-makers need to invest in the most productive manner possible, putting resources into areas that are most likely to have a large impact on increas-

ing smallholder productivity and improving national food security. Nevertheless, there is also a need for African countries to increase their investment in agricultural development. A combination of smart targeting of investment and greater overall levels of public support for agriculture is needed. Today, only a handful of African countries devote the agreed target of 10 per cent of GDP in public expenditure in agriculture.

Some research from India points to investment in rural roads, research and extension and education as the most effective investments to combat rural poverty, but other evidence suggests that sub-Saharan African countries should also pay close attention to irrigation and rural electrification.

Unfortunately, the international community has shown decreasing interest in support for African agriculture over the past 30 years. Support for agriculture as a proportion of total international development assistance to African countries has fallen by as much as two-thirds from its peak in the early 1980s, as a result of the shift towards structural adjustment lending with an emphasis on liberalization. This has left many African countries badly positioned to face the challenges posed by volatile prices for agricultural inputs and food products and the impacts of climate change.

There are strong structural impediments to replicating an Asian-style Green Revolution in Africa. The heterogeneity of staple crops, farming systems and the paucity of rural infrastructure make it clear that no mechanistic replication of the Green Revolution technology package is possible, or even desirable, in Africa. Specific African challenges and conditions, and the need to pursue sustainable agricultural development, mean that a truly African Green Revolution should be very different from the Asian Green Revolution of the 1960s and 1970s. The package of measures needed must also go beyond appropriate technology mixes and address other constraints to smallholder farmers building stronger technological and innovation capabilities.

For too long, African agriculture has lagged farther and farther behind other developing regions in nearly every measure of agricultural productivity and production. African production growth has tended to rely on unsustainable increases in the area under cultivation, while yields stagnate. A new agro-ecological approach, sometimes dubbed the Rainbow Revolution, is needed to reverse these trends. The interventions needed range from the tried-and-true (increases in land under irrigation) to the use of appropriate innovations to radically increase productivity in African agriculture.

What has become clear, however, is that no intervention can hope to succeed unless African smallholder farmers are brought into the process. Their ability to participate, however, depends on much more than what happens on the farm. Which brings us to the next set of concerns: the need to understand and radically overhaul the enabling environment surrounding food production and extending outwards into financing agricultural investment, agricultural research, transport

and education systems, distribution and storage: the panoply of food-related activities that take place outside the farm itself that connect consumers with the food they need.

Transfer and diffusion of agricultural technology

Acquiring and adapting technologies new to the local agro-ecological system, either from abroad or from local sources (research institutes or universities, for example) is a key part of any serious strategy for achieving food security. Selection of technologies appropriate to the conditions within the host food system is crucial. State-of-the-art, high-tech solutions may not always be the most appropriate for the needs of smallholder farmers. Adopting a pragmatic mix of technologies (low-, medium- and high-tech) that best meets their needs is the ideal.

A balanced technology acquisition approach must balance the contrasting challenges of technology selection, adaptation and diffusion. It is not enough for a technique to be technically sound, it must also be adapted to suit the specific conditions found on the ground, and be made affordable and attractive enough to smallholder farmers to achieve wide diffusion. Models of public-private partnership that make not only public institutes but also for-profit enterprises into stakeholders for the diffusion model can be valuable in building a self-sustaining momentum behind dissemination efforts. Such a model stands the best chance of being demand-driven – succeeding because farmers demand its continuation, rather than due to a top-down bureaucratic decision.

International cooperation can also be a strong factor in helping relevant new technologies be adopted, adapted and diffused throughout host economies. In particular, a handful of South-South cooperation models have already proven their worth as mechanisms for ensuring the right technological tools are made available to African farmers. So-called triangular cooperation, where a Northern neighbour signs on as a sponsor to South-South technology-sharing efforts, has also shown promise as a model for the international diffusion of technologies.

Successful adoption and mastery of new technologies by smallholders requires adequate absorptive capacity on their part. Successful technology transfer is not necessarily easy to achieve and entails some cost on the part of the farmer to learn the technology. Still, the returns from successful technology transfer can be very large.

Technology mixes for small-scale farming

A wide range of production and post-harvest technologies are currently available for a wider range of crops than during those which were the subject of the Green Revolution. There is also a better (but still incomplete) understanding of the context and factors that determine technology adoption, diffusion and impact. As research is moving towards 'precision agriculture', efforts to build an enabling environment need to incorporate an understanding of contextual factors, and should incorporate efforts to utilize farmers' innovative capacity.

Local agro-ecological conditions play a vital role in shaping the overall technology acquisition strategy, which in turn requires close relationships with local grassroots initiatives coordinated by extension services, NGOs and private enterprise at the district level. Issues of sustainability (particularly in terms of water and energy use) are a major consideration in the choice of technologies, and must take centre-stage when discussing all aspects of technology adoption.

The urgent need for improvement underlines the importance of adopting and diffusing existing technologies as a matter of priority, and ensuring that public and private partnerships work toward the development, dissemination and adoption of technologies. Opportunities to reduce crop losses can be realized when farmers, processors and traders have access to reliable information and appropriate techniques and technologies to improve quality, throughput, labour and time efficiencies.

Technology needs assessments should identify gaps in technology, infrastructure or information in order to better facilitate the deployment and use of technologies that reduce post-harvest losses of smallholder rural produce.

In the future, climate change will render the need for new agricultural technologies more important for strongly affected parts of Africa. There is a need for: (a) increased agricultural R&D that is relevant to African agro-ecological conditions; (b) much stronger innovation capabilities among African institutions and smallholder farmers; (c) promotion of new techniques and technologies; and (d) training end-users in their application and improvement.

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