High-level Segment of the
17th Session of Commission on Sustainable Development

Round Table 2
Realizing a Sustainable Green Revolution in Africa

Discussion Paper
by
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Summary and Questions for Discussion

During the High-level Segment of the 17th session of the Commission of Sustainable Development, three Ministerial roundtables are being organised. The purpose of these roundtables is to promote frank and interactive dialogue among Ministers and other stakeholders with regard to realising a sustainable green revolution in Africa.

Strong economic performance in Africa is needed to ensure an enabling environment for sustainable development. African countries have taken the leadership in addressing sustainable development challenges, including challenges for sustainable agricultural development, and charting the way forward through such initiatives as the New Partnership for Africa's Development (NEPAD). The challenges, including insufficient investments in agriculture, need to be addressed with a sense of urgency.

Africa needs a uniquely African green revolution to help boost agricultural productivity, food production and national and regional food security. An African green revolution does not only depend on improved seeds and fertilizers. It must be built on a range of complementary investments, many of which will need to be undertaken by the public sector, in rural development — including rural roads, electricity, health and education. The role of Governments is critical in providing rural infrastructure, in supporting agricultural research and development, and in creating an enabling policy environment that provides incentives to innovation and risk-taking by farmers.

Furthermore, agriculture depends on a variety of ecosystem services for its productivity, including those provided by forests, and biological diversity in agricultural ecosystems can provide such benefits as resilience with respect to pests, climate, and other threats and disturbances.

Questions to guide the Round Table Discussion

1. The current food crisis has particularly affected Africa, highlighting the continent's food security challenges. Climate change will compound those challenges.

What are the key issues facing Africa over the coming decades in feeding its growing population, and how can governments, with the international community, best address them?

2. Improving agricultural productivity and strengthening rural development are key to overcoming poverty and achieving food security on the continent.

What are the main agricultural productivity and rural development challenges? What are Africa's research, other priorities to boost food and other crop and livestock productivity on a sustainable basis?

3. Land tenure and ownership, including by women, are among the key issues for African countries in ensuring a wide sharing of productivity improvements.

What are the ways of ensuring that a sustainable African green revolution benefits small scale and resource poor farmers, including women?

4. Sustainable agricultural practices, including land and water management, are crucial to combating drought and desertification.

What can be done to scale up sound and sustainable practices? How can enhanced agricultural extension and farmer training programs contribute?

5. A variety of ecosystems provide important services to African agriculture, yet these are being degraded by a variety of stressors, threatening the long-term sustainability of agricultural production.

What can be done to ensure that such ecosystem services are properly valued and protected?

6. What key messages should go out of this round table to be incorporated in the shared vision?

1. Introduction

The Johannesburg Plan of Implementation (JPoI) adopted by the World Summit on Sustainable Development in 2002 called for achieving "significantly improved sustainable agricultural productivity and food security" in Africa in furtherance of the MDGs, in particular to halve by 2015 the proportion of people who suffer from hunger. In June 2008, the MDG Africa Steering Group convened by the UN Secretary-General called for "launching an African Green Revolution within the framework of [NEPAD's] Comprehensive Africa Agriculture Development Programme (CAADP) to double agricultural yields, accelerate economic growth and combat hunger" (MDG Africa Steering Group, 2008).

Africa as a whole has so far not benefited from a Green Revolution. Public investment in agriculture has remained at low levels since the early 1980s. Yields have stagnated in recent decades, leading to a fall in per capita food availability since the early 1970s (FAO cited in UN-DESA, 2008a).

Today, 300 million Africans face chronic hunger. Net food importing countries have suffered as prices rose. The high food prices more than doubled Africa's food import bill to over $15 billion in 2008. The fiscal, economic and social impacts of the food crisis are widespread. There is need for a paradigm shift: African countries need to move away from reliance on food imports to securing their food supplies through rapid, sustainable increases in food production. Africa must start to view food security with the same priority given to national security (Adesina, 2009).

Proven and cost-effective technologies exist today to launch an African green revolution that can double per hectare yields among smallholder farmers in a short period of time. In particular, smallholder farmers must have access to good extension services that focus on sustainable soil and water management practices and on improving livestock husbandry practices (MDG Africa Steering Group, 2008), and gain access to basic agricultural inputs, such as agro-ecologically adapted seeds and fertilizers.

A particular focus of a sustainable green revolution in Africa needs to be on support to smallholder farmers, who are predominantly women and account for 80 per cent of the continent's farmers. Policies and institutions need to build on their indigenous knowledge and support their fuller integration into domestic, regional and global agricultural markets.

The last green revolution increased agricultural productivity at the expense of other ecosystem services. The decline in these ecosystem services has caused not only declines in other aspects of human well-being but has also put in jeopardy the long term sustainability of the agricultural sector (MA, 2005). There is therefore a need to ensure that the African green revolution is designed in a manner that provides for the ecological sustainability of agricultural production.

The emerging demand for biofuels and food for export offers opportunities but also risks. The opportunities are for an injection of much needed capital, infrastructure, and technology into African agriculture, which can spill over into domestic food production. Also, there can be complementarities between the two, especially on a small-scale. For example, multipurpose crops such as sweet sorghum provide grain for consumption, sugar to process in bioethanol, as well as valuable by-products such as feed and fodder. The risk is that biofuels and export crop production could worsen food insecurity if it competes for fertile land and scarce water with domestic food production, or if it causes land and water right consolidation in fewer hands, disenfranchising smallholders with insecure land tenure. A further risk is that expansion of such production on a large scale could further degrade ecosystem services which support agriculture.

This policy brief, which has been prepared as background for the High-Level Roundtable of CSD-17 on Achieving a Sustainable Green Revolution in Africa, points to the policy challenges and responses, at national, regional and global level, which will determine whether the African continent is able not merely to launch but to sustain an agricultural productivity revolution which will secure food supplies for its growing population and their improving diets during the 21st century.

2. The Context: Multiple Challenges

Africa as a continent faces a very serious problem of hunger and malnutrition. Figure 1 shows the prevalence of moderate to severe malnutrition among children under 5, based on weight. As a region, Sub-Saharan Africa suffers from serious malnutrition, exceeded in 1990 only by South Asia. What is striking is that Sub-Saharan Africa is the only region projected to have a higher proportion of malnourished children by the target date for reaching the MDGs (2015) than in the base year (1990). While the period of the early 2000s almost certainly saw malnutrition decline in many African countries with rapid economic growth, this progress has been curtailed if not reversed by the global food price crisis which began in early 2008 and now by the steep global economic downturn.

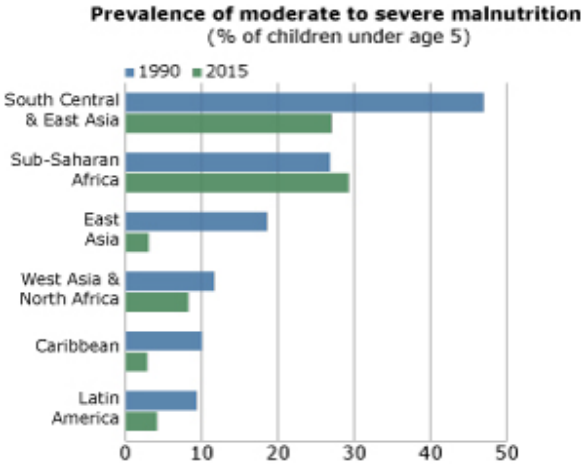

Figure 1.

Source: World Bank MDG database.

Africa's agriculture has been plagued by stagnant productivity growth for many decades. Cereal yields have risen only very marginally over the past half century. They reached a peak of just over 1,000 kg per hectare in the early 1980s and, with small annual variation, have hardly risen since. Meanwhile, East Asia has seen its cereal yields quadruple from a level in 1960 only slightly higher than Sub-Saharan Africa's to over 4,000 kg per hectare by 2005 (FAO, as cited in UN-DESA 2008b).

What is needed to boost agricultural (and particularly food) productivity in Africa on a sustainable basis to meet the growing demand of a rapidly expanding population, not to mention the unmet demand of current population as reflected in high rates of hunger and malnutrition?

Agriculture in Africa is highly heterogeneous in terms of agro-climatic conditions as well as cropping systems. This diversity has to be factored into efforts to boost productivity. There is no standardized approach which will be applicable across all those conditions and systems. This suggests the need for devoting effort to strengthening local and regional research and extension initiatives, drawing more extensively on local knowledge, and linking research more closely to farmers in the field and to local physical and social realities.

Those efforts will need to happen in the context of a decline in a variety of ecosystem services, including water provisioning and regulation, nutrient cycling, and pollination among others, caused by a range of drivers including climate change, invasive species, deforestation and habitat change, overexploitation of soils and water resources, and pollution in much of the continent. Here, more organic based intercropping systems are vital (IAASTD, 2009; UNEP, 2009). The use of perennials, intercropping and agroforestry systems, including the use of nitrogen fixing leguminous trees, are ways to increase nutrient availability, and enhance water availability and pest control (Sanchez, 2002).

Africa's rural population and labor force continues to be debilitated and rural societies decimated by the effects of HIV/AIDS, malaria and other communicable diseases.

Also, key rural institutions – notably extension services and marketing organizations – which support agriculture have atrophied or been weakened by neglect and underfunding. Agricultural insurance markets are underdeveloped and use of commodity futures markets for hedging risks is minimal. Recent high food price volatility has highlighted the vulnerability of both producers and consumers, in Africa as elsewhere, in the absence of adequate mechanisms to dampen price fluctuations.

To meet the MDG1 target on poverty and hunger will require a strong agricultural growth rate of 7.5% per annum, according to IFPRI calculations. Government agricultural spending will need to increase by $4.8 billion a year beyond the Maputo Declaration level to $13.7 billion a year. The incremental annual costs for a partly publicly funded input financing scheme that reaches the poorest 50 percent of farmers in Africa would amount to an additional US$2.3 billion per year (Fan and Rosegrant, 2008).

The IFPRI analysis of investment priorities using its IMPACT model suggests that the biggest increment in investment will be needed in rural roads – almost a quadrupling over baseline levels to 2015, compared with a rough doubling of investments in agricultural research and in irrigation. In short, rural road development is likely to have the biggest impact on poverty.

3. Ecological sustainability for a sustainable green revolution

In Africa, agricultural productivity is still significantly below the global average and the potential for increasing productivity is large. Yet, the present approach relies mainly on the expansion of cultivated land.

Expansion of agricultural land will affect the delivery of other ecosystem services in three ways: (i) the conversion of biodiversity-rich systems like forests and wetlands into less diverse agro-systems; (ii) by the choice of crop species and the pattern of cropping in time and space; and (iii) by the manner in which crops, soil, and water are managed at the plot and landscape levels.

The Millennium Ecosystem Assessment (MA) defined ecosystem services as the benefits ecosystems provide for human well-being. Four broad classes of services were defined. These were provisioning services, regulating services, cultural services and supporting services. Food production is classified as a provisioning ecosystem service.

The production of food depends on water provisioning, nutrient recycling and pollination among others. Water provisioning in turn depend on water regulation. While food production has been increasing over the last 50 years, many other ecosystem services have declined, partly as a result of expanded food production using unsustainable practices (see Table 1).

Table 1. Trends in the Human Use (HU) of Ecosystem Services and Enhancement (E) or Degradation (D) of the Service around the Year 2000

Service	Sub-category	HU	E/ D	Notes
Provisioning Services				
Food	Crops	↑	↑	Food provision has grown faster than overall population. Primary source of growth from increase in production per unit area but also significant expansion in cropland. Still persistent areas of low productivity and more rapid expansion, e.g., sub-Saharan Africa.
	Livestock	↑	↑	Significant increase in area devoted to livestock in some regions, but major source of growth has been more-intensive, confined production of chicken, pigs, and cattle.
	Capture Fisheries	↓	↓	Marine fish harvest increased until the late 1980s and has been declining since then. Currently, one quarter of marine fish stocks are overexploited or significantly depleted.
	Aquaculture	↑	↑	Aquaculture has become a globally significant source of food in the last 50 years and, in 2000, contributed 27% of total fish production.
	Wild plants and animal food products	**NA**	↓	Provision of these food sources is generally declining as natural habitats worldwide are under increasing pressure and as wild populations are exploited for food at unsustainable levels.

Genetic resources		↑	↓	Traditional crop breeding has relied on a relatively narrow range of germplasm for the major crop species. Genetic resources have been lost through the loss of traditional cultivars of crop species (due to the adoption of modern farming practices) and species extinctions.
Freshwater		↑	↓	Human change to ecosystems, watershed management and vegetation changes have an impact on seasonal river flows. Between 15 and 35% of irrigation withdrawals exceed supply rates.
Regulating Services				
Climate regulation	Regional and Local	↑	↓	Changes in land cover, for example, tropical deforestation and desertification have tended to reduce local rainfall.
Erosion regulation		↑	↓	Land use and crop/soil management practices have exacerbated soil degradation and erosion.
Water purification and Waste treatment		↑	↓	Globally, water quality is declining. Nitrate concentration has grown rapidly in the last 30 years. Loss of wetlands has decreased the ability of ecosystems to filter and decompose wastes.
Pest regulation		↑	↓	In many agricultural areas, natural pest control has been replaced by pesticides. Such pesticide use has itself degraded the capacity of agroecosystems to provide pest control.
Pollination		↑	↓	Losses in populations of specialized pollinators have directly affected the reproductive ability of some rare plants.
Natural hazard regulation		↑	↓	People are increasingly occupying regions and localities that are exposed to extreme events, thereby exacerbating human vulnerability to natural hazards. This trend has led to continuing high loss of life globally and rapidly rising economic losses from natural disasters.

↑ / ↓ = Increasing/ Decreasing (for Human Use column) or enhanced/ degraded (for Enhanced or Degraded column)
NA = Not assessed within the MA. In some cases, the service was not addressed at all in the MA (such as ornamental resources), while in other cases the service was included but the information and data available did not allow an assessment of the pattern of human use of the service or the status of the service

Source: Millennium Ecosystem Assessment (2005).

The inter-dependency of ecosystem services implies that difficult choices on ecosystem services trade-offs will need to be made when evaluating different agricultural strategies. Both expansion and intensification can cause declines in other ecosystem services. The choice of the strategy will depend on the specific ecological and social context.

The inter-dependency among ecosystem services also offers opportunities to the agricultural community in terms of new markets and a diversified source of income. Sustainable agriculture will provide a flow of other ecosystem services including water provisioning, flood protection if farms are situated upstream, carbon sequestration if agro-forestry and sound soil carbon management methods are used, and biodiversity offsets if agro-biodiversity is conserved. These are potential sources of income which can be secured in addition to income from agricultural systems. Payments for these ecosystem services have been established on a limited scale in some countries, but the potential for further development of payments for ecosystem services seems large.

There are four key challenges facing Africa in increasing food production over the next few decades.

Challenge 1: To increase the productivity of existing agricultural land. Two key win-win strategies which have emerged with improved agricultural knowledge systems to achieve this while minimizing the negative ecological impacts and maintaining the functional integrity of socio-ecological-agricultural systems are: (i) intensive management of specialized cropping systems and use of improved soil, crop, and water management practices; and (ii) designing more diverse crop (agro-biodiversity systems) and agro-forestry systems that provide improved livelihood options as well as supporting greater levels of biodiversity and the delivery of other ecosystem services (MA, 2005). These strategies will need to incorporate the uncertainty of climate change in their strategies such that adaptation options are fully part of the agricultural strategy.

Challenge 2: To minimize the post harvest losses from the present agricultural system (see Figure 2). Post harvest losses are the largest in small-scale farm operations. This offers substantial gains in increasing the food supply at little cost.

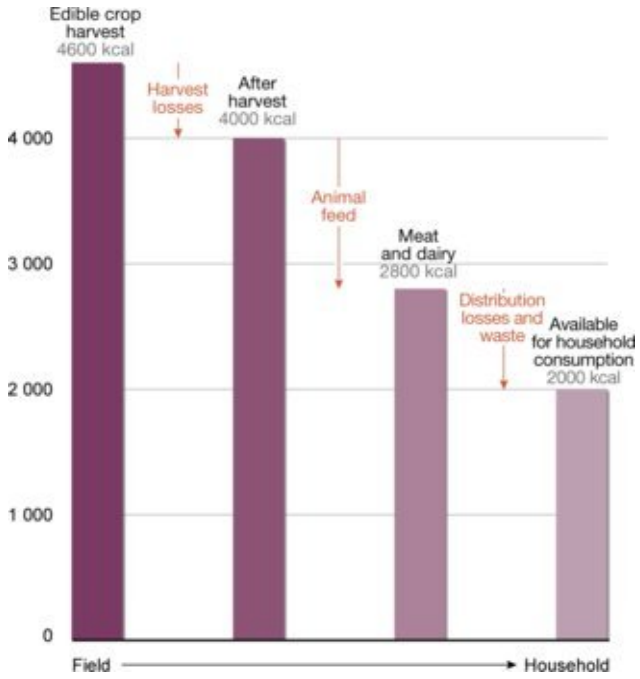

Figure 2: A gross estimate of the global picture of losses, conversion and wastage at different stages of the food chain. As a global average, farmers produced the equivalent of 4600 kcal/capita/day in the late 1990s (Smil, 2000), i.e. before conversion of food to feed. Counting down the losses, conversions and wastage at the various stages, roughly 2800 kcal is available for supply (mixture of animal and vegetal foods) and, at the end of the chain, 2000 kcal on average is available for consumption – only 43% of the potential edible crop harvest (Source: UNEP 2009).

Challenge 3: The third challenge for the African sustainable green revolution is that, once productivity gains from existing agricultural lands plateau, any further expansion of land under cultivation needs to occur in a manner that still ensures the supply of other ecosystem services. NEPAD's Action Plan of the Environment Initiative, adopted by the

African Union in July 2003, provides a useful framework[1]. Protecting ecosystem services through sustainable agricultural systems can provide additional income opportunities for agricultural communities. Payment schemes or markets can be created for the multiple ecosystem services. Examples include carbon sequestration, water regulation, water purification and flood protection among others.

Challenge 4: Achieving the first three challenges ensures ecologically sustainable agricultural production. It does not, however, guarantee that all farmers will benefit from the activities suggested under each of the challenges (Pascual *et al*., 2009). The probability of a few large farms or external stakeholders capturing the profits from the increased supply is high if the incentives and institutional mechanisms do not protect the interests of small holders and their communities, including those holding customary rights in land and water. Institutions ensuring broad ownership, security of tenure, transparency and freedom of participation in decision-making are critical if the benefits of the sustainable green revolution are to be enjoyed by the vulnerable and disadvantaged rural agricultural communities in Africa.

4. Boosting agricultural productivity: the role of research and extension services

Investment in agricultural research can have a potent effect on poverty reduction, even if not as dramatic as certain other investments like rural transport infrastructure. IFPRI estimates that a 50% increase in the budgets of research institutions in Sub-Saharan Africa affiliated with the Consultative Group on International Agricultural Research (CGIAR), from $606 million in 2008 to $933 million in 2013 would reduce the number of poor people by close to 70 million between 2008 and 2020 (von Braun *et al*., 2008).

The research institutes affiliated with the CGIAR saw international financial support plateau in 1990 then decline for the next decade before recovering by the early 2000s to early 1990s levels (UN-DESA, 2008b). A coordinated African research effort is needed, with regional and local variation as per different agro-ecological conditions, crops and cropping systems; this could be facilitated through international and regional support to the Forum for Agricultural Research in Africa (FARA), sub-regional organizations, and African centres affiliated with the CGIAR.

Priorities for research need to be spelled out in close consultation with farmers and farmers' organizations. The MDG Africa Steering Group outlines the following priorities: research into high-yielding crop and livestock varieties as well as sustainable agricultural practices that are also resistant to drought and the anticipated effects of climate change. Genetic improvements to plants developed by the biotechnology industry have tended to focus on breeding pest and herbicide resistance into food and other crops. Meanwhile, African agriculture needs greater emphasis in plant research on drought- and heat-resistant varieties. IFPRI estimates that investing $100 million in research on

[1] The Plan addresses: combating land degradation, drought and desertification; conserving Africa's wetlands; prevention, control and management of invasive alien species; combating climate change in Africa; and transboundary conservation or management of natural resources.

drought-tolerant maize for Africa could benefit some 320 million people (von Braun *et al.* 2008).

Soil enrichment programs combining organic and inorganic nutrients have potential to yield significant crop productivity improvements. IFPRI estimates that $55 million invested in research on enhancing soil fertility with a combination of organic and inorganic nutrients could ultimately benefit some 400 million people worldwide, many of them in Africa (von Braun *et al.,* 2008).

Large increases in yields can be attained even with existing varieties and integrated soil and water management. Yields in Africa, at an average of one ton per ha, are 30% of the world average. If African farmers could only converge to the world average, this would represent a huge boost to productivity (almost comparable to the yield increase enjoyed by Asia during the Green Revolution). Once farmers can create a surplus crop which they can sell, they can start buying purchased inputs and further increase yields.

Depending on time horizon as well as understanding of the key constraints to productivity enhancement in Africa, the emphasis of crop research and demonstration efforts tends to differ. One emphasis is on improving plant genetics (the traditional green revolution approach but perhaps with less need of the conventional input package if improved varieties require less water and fewer chemical nutrients). An alternative emphasis is on improved soil, plant and water management to boost yields immediately even where inputs (improved seeds, inorganic fertilizers, pesticides, water) are scarce.

In an indication of sustainable agriculture's potential to boost yields, a review of 286 sustainable agricultural projects carried out between 1999 and 2000 across eight categories of farming systems in 57 developing countries in Africa, Asia, and Latin America, concludes that farmers increased yields by an average of 79% by adopting sustainable agricultural practices (Pretty *et al.,* 2003). In those projects, many practices were used but three types of technical improvements have played substantial roles in yield increases: more efficient water use in both dryland and irrigated farming; improvements in organic matter accumulation in soils and carbon sequestration; and pest, weed, and disease control emphasizing on-farm biodiversity and reduced chemical pesticide use. The System of Rice Intensification, without any external inputs, has increased rice yields by an average of 50% in places in Africa where it has been implemented (UN-DESA, 2009).

Multi-cropping systems have always been part of the strategies small farmers used to increase resilience against weather shocks. The need for these systems is even more pronounced now in the face of increased weather variability and extreme events due to climate change. Financial mechanisms to accompany crop diversification such as weather-risk insurance would be needed to help farmers hedge against risks.
Both research and extension services could benefit from a better understanding of the ecosystem approach to improving agricultural productivity. This will involve improved understanding of the bundle of ecosystem services associated with food production as well as their contribution separately and jointly to enhancing farm-level productivity and

strengthening the resilience of farming systems. Such understanding could also help in valuing food related ecosystem services as basis for the possibility of payments for ecosystem services.

Models of extension services have evolved in the past two decades, from predominantly supply-driven government-financed services, often with poorly paid and poorly trained extension workers to a variety of models which are more demand-driven, provided by farmers' organizations, NGOs, private input suppliers or other private extension agents, and large commercial farmers as part of out-grower schemes and, in some cases at least, financed by the farmers. These have not completely supplanted the supply-driven model, which can be important for diffusing sustainable land management practices about which farmers are not sufficiently informed to demand training in them (Nkonya, 2009). The supply-driven may also be more effective in reaching poor farmers in remote areas who are often underserved by private and NGO providers.

Extension agents in supply-driven models may need to obtain further training, as they currently have limited capacity to provide training in such practices as integrated soil fertility management and make limited use of indigenous knowledge, e.g., of soil and water conservation techniques. Also, they often lack capacity to provide guidance to farmers on post-production technologies and marketing, focusing exclusively on boosting production (Nkonya, 2009).

The Windhoek High-Level Ministerial Declaration[2] concludes that a Green Revolution for Africa: (1) is not only about seeds and fertilizers, but must consider sustainable land management and agricultural practices, crop diversity, and ecosystem services; (2) must focus not only on crops but also include livestock; (3) must support small holders through secure land rights, quality extension and training, support to farmers' associations, credit availability, risk management instruments, rural infrastructure; (4) depends on reformed and improved extension services, in particular in order to facilitate farmer-to-farmer diffusion of knowledge and know-how; and (5) must integrate the transformation of African agriculture into the broader demographic and economic challenges facing Africa.

5. Strengthening rural institutions and infrastructure

A variety of rural institutions is important to supporting a vibrant agricultural economy. The role of adequately resourced research institutes and of refocused and revitalized extension services was discussed in the preceding section. This section focuses on agricultural supply chains and a variety of supporting institutions, including input and machinery suppliers, agro-processors, marketing organizations and credit and insurance providers. This section also considers the role of rural infrastructure in supporting sustainable improvements in farmers' incomes as well as in rural income diversification.

There are a variety of reasons for high input prices in Africa. Take the case of fertilizer. African agriculture is characterized by a strikingly low level of fertilizer use. On average, 9 kilograms of nutrient are used per hectare of arable land, compared with 107 kilograms

[2] http://www.un.org/esa/dsd/susdevtopics/sdt_pdfs/meetings/hml0209/Windhoek_final_declaration.pdf

for all developing countries. A combination of currency devaluations and the phase-out of fertilizer subsidies caused domestic fertilizer prices to rise even before the steep energy price increase of 2008. Factoring in high transport costs and poor distribution systems, fertilizer prices in Africa can be triple world prices. In the current context, an argument can be made for government's targeted use of subsidies to help small farmers to afford fertilizer and other key inputs. Malawi, for example, has met with considerable success in boosting food productivity and achieving food security through provision of such subsidies.

At the same time, policies focused primarily on providing farm input subsidies have drawbacks, beyond the strains they impose on government budgets. First, broad subsidies have been shown to be regressive, with large farmers capturing most of the benefits. Second, subsidies compete for government resources with other possible uses. Investment in public goods such as extension services, road and market development, and small-scale irrigation projects have broader distribution effects and do benefit the poor. Extension services have an estimated social rate of return of 80% (Alston and Pardey, 2000). In some countries, there are large tracts of arable land not currently being used for lack of infrastructure and market access, and efforts could be made to provide better access as well as tenure rights to poor farmers settling those lands and training in sustainable agricultural practices.

In many parts of Africa, there are relatively few local suppliers of improved seeds, fertilizers (whether organic or inorganic) and simple tools and farm machinery. Quite a few national markets are small, and trade restrictions can make production for a regional market uneconomical.

The provision of credit and other support to local input and equipment suppliers could encourage entry but might require infant industry protection. This would initially raise domestic prices even higher in the absence of subsidies. Even where domestic supply is not economically feasible, making credit available to agro-dealers could significantly enhance availability of quality inputs to farmers. By organizing at district level into purchasing groups, such dealers could benefit from bulk purchase discounts. Small-scale farm equipment manufacture could have potential, as such equipment may need to be customized to local conditions and its production is less sensitive to scale economies than standardized inputs like fertilizer.

As sustainable agricultural practices may have the potential to raise yields significantly with only modest input requirements, a greater emphasis should be given to adoption of such practices. One input often in short supply is biomass for applying to soils to improve soil organic matter. The widespread use of traditional biomass as cooking fuel is one key reason. Thus, measures to make available alternative, affordable, clean cooking technologies could yields enhanced supplies of biomass as organic fertilizer.

Prodded by external policy advice during the 1980s debt crisis, a number of African countries diminished the state's role in crop and input marketing and in subsidized credit systems, however reluctantly. IFPRI research finds that such reforms did have some

positive influence on the prices farmers secured for their crops through greater competition among buyers (Kherallah *et al.*, n.d.). The new marketing arrangements, however, tended to benefit export crops more than food production, and use of both credit and fertilizer has declined significantly with reduced subsidized provision. In many instances the vacuum left by the state was not filled by the private sector due to a variety of factors, including prohibitive risks, high transaction costs, and lack of access to information.

As noted above, extension services seldom provide farmers with useful information about the marketing of their products. This needs to change. Also, farmers' organizations like marketing cooperatives can be a valuable means of obtaining a higher and more stable price, as such cooperatives can often provide bulking and storage facilities which make possible the phased sale of produce over the year. Farmers' organizations can also be an important source of extension knowledge about good practices, new technologies and improved seeds and other inputs.

Crop insurance schemes have traditionally only survived with government subsidies, as they involve moral hazard, high monitoring costs and systemic risks in the event of area-wide crop failure. New types of insurance such as index-based weather insurance have the potential to lower some of these costs, making insurance financially viable and affordable with only modest subsidies. Such insurance has relatively heavy historic data requirements for estimating, e.g., rainfall-yield correlation, and so can be adopted everywhere. Malawi has introduced such insurance with some success among groundnut farmers (UN-DESA 2007). Such insurance can also provide protection to rural institutions whose business is closely dependent on the economic well-being of farmers, like rural financial institutions and input suppliers.

African agriculture is handicapped by a lack of irrigation, which limits opportunities for multi-cropping; poor roads, which limits marketing opportunities; and inadequate rural electrification, which constrains the growth of agro-processing and non-farm enterprises. A shortage of grain silos and crop storage facilities as well as of cold chain storage for livestock and fisheries products results in high rates of spoilage and post-production losses.

Only about 4% of agricultural land in Sub-Saharan Africa is irrigated, with arid and semi-arid regions of the Sahel and sub-Sahelian Africa as well as parts of southern Africa (Botswana, Namibia) having especially low irrigation coverage (UN-DESA, 2008a). Using IFPRI's IMPACT simulation model, Fan and Rosegrant (2008) estimate that Sub-Saharan Africa would need roughly a billion dollars a year in irrigation investment to make substantial progress towards achieving MDG1.

Investments in rural roads have consistently been found to yield very high returns in terms of rural poverty reduction and the same model projects investment requirements of almost $3 billion a year in rural roads to close the MDG1 gap (Fan and Rosegrant, 2008). The fact that rural road development, even as it contributes to poverty reduction, can

complicate efforts at protecting natural habitat, biodiversity and ecosystem services highlights the complexity of the task facing African policy makers.

Investments in ecological infrastructure such as forests and wetlands can provide high returns for sustainable agricultural productivity. The key word here is sustainability and the rate of return needs to account for the long term supply of key critical ecosystem services needed for food production and not short term returns that fail to account for declining ecosystem services which lead to declining food production. The maintenance of ecosystem services in agricultural lands reduces actual production costs for, inter alia, gaining primary productivity, improving soil fertility, controlling pests and stabilizing nutrient supply (Zhang et al., 2007).

6. Policies and measures to make it happen

African farmers need immediate support to sustain food production and enhance productivity, even as the groundwork is laid for sustaining over the long term a uniquely African green revolution.

Quick Wins

Among short-term measures to be considered are:

Address urgently bottlenecks in the timely availability of affordable inputs and credit for small-scale farmers, to provide them and those they feed with food security in the current crisis.

Provide incentives, including through greater tenure security, for improving agricultural productivity of existing agricultural lands in a sustainable manner, including through sustainable land and water management methods.

Provide knowledge and information to small farmers, through improved extension and training services, on ecologically sustainable agricultural methods, ones which can significantly boost yields with a minimum of purchased inputs through sound plant, soil and water management. A special effort should be made to target training at women, who can act as effective extension agents serving women farmers.

Enhance biomass availability for soil carbon enrichment through programs that provide affordable, clean alternatives to traditional biomass for cooking and heating, freeing up traditional biomass such as crop residues and livestock dung for soil recovery while improving women and children’s health, freeing women’s time for productive activities.

Adopt low-cost post-harvest technologies for crop processing, grain storage, and transportation systems to reduce post harvest losses and augment farmers’ incomes. Mobilize resources at the community level for the needed investments, including through low-interest bank loans, group savings schemes, and microfinance.

Long-term solutions

Among long-term measures to be considered are:

Increase investment in locally tailored research on adapted crop varieties and cultivation methods as well as livestock raising methods, including to cope with climate change.

Invest more in research into methods of restoring and enhancing soil organic matter and fertility in those large parts of Africa where these are severely depleted.

Link research more closely to extension services and to farmers, in order to maximize the impact on farmers' productivity and incomes.

Broaden the emphasis of extension training beyond production to post-production processes and technologies and improved marketing.

Strengthen farmer-to-farmer extension services and farmers' organizations, including rural cooperatives. Build the infrastructure and institutions to integrate farmers better into national and regional markets.

Mobilize the Green Economy through the development of sustainable agricultural technologies and, where appropriate, payment schemes for ecosystem services to help rural communities diversify their incomes while protecting natural resource base.

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