A Sustainable Green Revolution for Global Food Security

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The Challenge to Feed the World

Food security has once more risen to the top of national and international policy agendas. Despite steady progress by many countries in the agricultural development necessary to underpin the food security of a growing global population, there remain formidable challenges to food production and to current and future food security. These challenges include:

- Significantly increasing demand for food due to population growth, and in Asia particularly, income growth. Global population is still growing by around 130 people/minute, with the highest rates of increase being in Africa, and in parts of Asia. When combined with rapidly increasing incomes and urbanisation, this has resulted not only in intensified demand for food, but also changing patterns of demand. There have been as a result unpredicted increases in the demand for meat, dairy products, oil crops, sugar crops, fish and fruits. Livestock feed requirements have also risen in line with the 'livestock revolution' in Asia, and elsewhere.
- Reduced supply of food resulting from a range of issues. Foremost amongst these is reduced land capacity for food production, arising from urbanization; from competing land uses including the production of biofuels; and from land and soil degradation. Combined with this, reduced availability of water for irrigation and other farm uses, arising from increased competition for water for urban, industrial, and environmental purposes, as well as declines in both water quality, and water infrastructure have also adversely impacted on productivity in many food-producing regions. Finite, or dwindling water supplies and a still rapidly increasing global population mean less water/capita for future food production, and in many parts of the world this will be exacerbated by climate change, particularly in the tropics and sub-tropics. A warming, drying climate especially in currently semi-arid regions will place further pressures on food production there. In addition, all farmers have been impacted to a greater or lesser extent by the increasing costs of fuel, energy, and other farm inputs, including fertilizer, that are dependant on a 'finite' oil supply and its generally rising costs.

  A combination of the above factors, together with a long-term substantial reduction of investment in agriculture, including in agricultural research, development, technology transfer and extension, has resulted in reduced rates of productivity growth for all the major food crops, at a time when significant productivity increases are not only necessary but essential, for future food security, particularly in many LDCs.

As a result of these imbalances - more people and more food needed, but a generally slowing and eroding global capacity to produce more food – feeding the world in the foreseeable future can only be assured by a revolution in sustainable agriculture, and associated management of land and ecosystems. The 'home grown, sustainable green revolution' must now be implemented with urgency.

Addressing Productivity

The growth in yields of the world's three most important food crops – rice, wheat and maize – has fallen substantially in the past decade, compared to the three decades before. For the period 1997-2006 average global yield growth rates (percent/annum) for rice, wheat and maize

were 0.8%, 0.9%, and 1.6% respectively, compared to 2.1%, 2.2%, and 2.7%, for the period 1967-1996. In developing countries, the reductions for rice and wheat were similar to the global values, but not as large for wheat where the reduction was from an earlier 2.7% down to 1.4% in the past decade. However, in all cases the recent growth in yields is below that required to meet the annual growth demand for cereals, particularly in LDCs. The net cereal deficits of these countries will increase in coming decades, and given the slowdown in crop yield growth globally, and the other disruptions to supply, it cannot necessarily be assumed that the gap will be bridged by increased surpluses from traditional grain exporters, or by new exports from countries in transition which are expected to shift from being net importers to net exporters.

These reductions in the rate of crop yield growth have not been generally realised, or taken into account by many policy makers. They add further uncertainty to future food supplies, and recent publications attribute these reductions in cereal yield growth rates, at least in part, to the substantial reduction in investments in agricultural productivity activities, especially research development and extension in the past 20 or so years.

Better varieties, better practices, adapted faster

Whilst new, substantially increased investment in R&D is essential to ensure future productivity gains, there must be a much greater current emphasis on communication and adoption of technologies and practices already available for utilization by farmers, in order to boost immediate productivity growth, a key component of the new sustainable green revolution.

These will include the provision of quality seeds of genetically diverse, improved varieties for crop and fodder production. Growing new varieties with greater tolerance to both pests and diseases, and to abiotic stresses (drought, heat, etc.), is one of the quickest ways for farmers to improve productivity, and adapt to changes in climate. Yield increases of up to 30% in a single year are possible.

In addition, better farming practices for crops (eg, reduced tillage, residue retention, diverse rotations) and for livestock (eg, pest and disease control) can contribute up to 60-70% of the necessary short-term productivity gains.

For farmers to use these tools to boost productivity within the next 3 to 5 years, access to these improved technologies must be accompanied by greatly strengthened and well-coordinated extension and communication strategies. These strategies will be built around the modern principles of knowledge management and communication – greater participation and leadership by farmers; improvement of both formal (government) and informal (NGOs; private sector) communication networks; and increased emphasis on partnerships, networks and local evaluations/demonstrations.

Building Sustainable and Resilient Farming Systems

The sustainable and resilient farming systems that form the basis of the new green revolution are dependant on three building blocks: appropriate conservation agriculture technologies to optimize returns whilst nurturing natural resources; capacity building, education and effective communication with farmers and rural communities; and an enabling policy framework that supports innovation, efficiency, productivity, and strongly discourages unsustainable resource use.

Conservation Agriculture and Sustainable Intensification

Conservation Agriculture (CA) and sustainable intensification of production will underpin the new agricultural revolution as they can increase productivity, and build sustainability and resilience into farming systems – including adaptation to climate change – at the same time as nurturing natural resources.

Conservation agriculture provides knowledge and tools to enable farmers to achieve acceptable

profits from high and sustained crop production levels while, at the same time, conserving resources and protecting the environment. CA methods enhance natural biological processes above and below the ground by reducing interventions such as mechanical soil tillage to an absolute minimum. They also ensure that application of external inputs, such as agrochemicals and mineral or organic nutrients, does not interfere with, or disrupt, biological processes.

CA offers farmers an array of practices, but at its core are three interlinked principles that can be applied in a variety of combinations to meet the needs of resource-poor farmers:

- Continuous minimal soil disturbance,
- Permanent organic soil cover,
- Diversified crop rotations of annual crops and plant associations of perennial crops.

Conservation agriculture is more than a zero-tillage-based cropping system. Farmers following the CA principles use low-cost tools and equipment and traditional crop varieties without herbicides or herbicide-tolerant varieties.

Sustainable intensification of agriculture will make increasing environmental and economic sense for farmers, small or large, as they intensify their most important enterprises on the higher potential parts of their farms using conservation agriculture to boost productivity, and protect their soils. This would leave other parts of their farms with less potential for high crop yields, to be utilized for livestock feed; for biomass/biofuels; potential biochar production; and/or for treelots/woody vegetation to sequester carbon, and provide other ecosystem services. With payments now in place, or planned for all of these options – a very different situation to the past – the measures that will boost overall farm and regional productivity and profitability, will also help to conserve soils, water, agro-biodiversity and agro-ecosystems generally, through better matching of farm enterprise to land and soil potential. This is one exciting and anticipated outcome from the new agricultural revolution – healthy people, and healthy ecosystems.

Adaptation to Climate Change

As climate change will place even greater strains on sustainability and resilience a major thrust of the new agricultural revolution must be to provide the technologies, education and advice to help farmers adapt to climate change. To achieve this farmers will need to understand:

- What is the most likely future climate scenario for my region?
- What are the consequent risks and opportunities arising?
- What technologies and systems will help me to overcome these risks, and take up opportunities?

In some regions, particularly parts of Africa, more frequent and more intense droughts will be a feature of climate change. Drought must be addressed in an integrated fashion with the other themes of the current CSD cycle, considering social, economic and environmental aspects. Strategies for drought prevention and management, should be incorporated into sustainable agricultural practices, soil conservation, crop and enterprise development, and integrated water management at both the farm and the basin levels. Adoption of such practices will help farmers adapt to a drying climate. Similarly, addressing desertification, and associated land degradation is also an essential part of adaptation to and mitigation of climate change. The policies and sustainable agricultural practices that help farmers achieve greater input use efficiency in years of average climate, are the same as those that will help them to remain viable in drier years. However, to help communities survive exceptional droughts, there will need to be appropriate food and social safety nets in place, together with adjustment and relocation strategies for intractable desertification. Policy coherence will be critical, in that all relevant policy areas should be focussed on sustainable development, and not on reinforcing the *status quo* where this is clearly unsustainable, due to climate or other reasons.

Sustainable Land Management

Major benefits flowing from the adoption of conservation agriculture and sustainable intensification of production, will be to sustainable land management (SLM). SLM is based on four common principles:

- land-user-driven and participatory approaches;
- integrated use of natural resources at ecosystem and farming system levels;
- multilevel and multistakeholder involvement; and targeted police and institutional support, including development of incentive mechanisms for SLM adoption and income generation at the local level.

These principles are common to the adoption of conservation agriculture and sustainable intensification, the practices that underpin sustainable land management in agricultural regions. They provide the crucial link between the productivity growth necessary for global food security, and the sustainable management of land that is crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of present and future generations.

An urgent requirement for building greater sustainability and resilience into farms and rural communities is the enhancement of human capacity, to facilitate the planning, management and implementation of the new approaches required. Farmers and communities must have ready access to the technologies, and knowledge required to help them create the agricultural revolution at the local level. The need for better communication and advice is even more urgent due to climate change; adaptation cannot successfully occur without better information for farmers and communities.

Lastly, but by no means least, for the sustainable green revolution to be implemented with the necessary urgency, each country will need a policy environment to facilitate and stimulate the required changes including: enabling policies on new technology development and uptake particularly related to conservation agriculture and sustainable agriculture intensification; on land and water use, ensuring these key resources are available for agriculture; on biofuel production, focussing on 'second' (and third?) generation systems, where biomass production from lower potential lands could be both economically and environmentally desirable; on carbon trading in line with the post-Kyoto 2012 agreements.

Ecosystem Services

In addition to food production, given that agricultural systems are by far the largest managed ecosystems in the world, farmers have an ever-increasing role to play in the maintenance and enhancement of agro-biodiversity, and the provision of other ecosystem services to the wider community. These include supply of drinking water, maintaining and enriching a stock of continuously evolving genetic resources, preserving and regenerating soils, fixing nitrogen and carbon, controlling floods, filtering pollutants, pollinating crops and much more. It is of course essential that the community pay for these important services.

However, 'ecosystem services' are not a one-way street and many of them provided by biodiversity, such as nutrient cycling, pest regulation and pollination, are critical in sustaining agricultural productivity. Sustainable intensification of agricultural production, based on conservation agriculture, has great potential to enhance agro-biodiversity, through the 'release' of land suitable for shrubs, trees and other diverse uses. The new home grown, sustainable green revolution will enhance ecosystem services, whilst simultaneously stimulating the productivity of food from farms.

Building the Value Chain for the Agricultural Revolution

The new home grown, green revolution does not begin and end at the farm boundary. Whilst

on-farm activities are the engine-room, it is not only critical that the inputs to 'feed' the revolution are readily available – including water, seeds, fertilizers, pesticides, animal feeds and remedies, etc. – but that there are also viable opportunities post farm 'gate' to transport, sell, add-value and build markets for the various farm products and outputs. This will entail attention to roads, transport, markets and other infrastructure.

Agro-enterprise development

These opportunities to process and add-value to farm products can be a key component of rural development, if the know-how, facilities and credit opportunities are made available to farmers and the local community. Infrastructure provision, largely a role for governments, can act as a major stimulus for private investment in processing, value adding and marketing. Key developmental steps include helping governments to:

- recognize and adjust to trends in farm commercialization;
- develop reliable farm-to-market and farm-agribusiness linkages;
- establish roles of the public sector as service providers in marketing and business management;
- provide the private sector essential marketing, finance, business and input supply services;
- support producer organizations; and
- overcome constraints to participation in export and high value product market channels

Such post-farm developments can also make an important contribution to eradicating hunger and poverty and achieving food security as well as to improved health, the empowerment of women, youth, indigenous people, and local communities.

Rural Finance and Investment

The beneficial multiplier effects of the productive and sustainable agriculture that will be a feature of the sustainable green revolution can be very high, but will be dependant on access to rural financial services. In order to improve and expand the provision of rural financial services, the following actions and approaches are necessary:

- increase economic opportunities and build the management capacity of rural entrepreneurs to use finance effectively through training and business-development linkages;
- mitigate risk in finance and investment through improving assessment tools and linking finance to the agricultural value chain;
- introduce cost-effective, flexible and longer term loan products that use new approaches and technologies to meet farm and agro-industrial needs;
- lower costs and promote effective management of diverse rural financial institutions by improving information systems and technologies;
- develop policies and mobilize support for sound interventions in financial markets.

An African Sustainable Green Revolution

There is a clear political commitment in Africa to speed progress towards meeting the MDG and WFS targets through enhanced agricultural growth. This is underscored by Head of African States' endorsement of the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa's Development (DEPAD) in 2003 in Maputo, Mozambique. NEPAD was established by African nations to collectively place the continent on a path of sustainable growth and development. The Maputo Declaration committed each Government to raising the share of its national budget allocated to agriculture and rural development to 10 percent within five years.

Notwithstanding this, many of the current problems related to productivity, sustainability, land

management, ecosystem services, and value-chain development described earlier, are generally greater and more complex in Africa. For example:

- land degradation is reducing agricultural GDP by 5 percent per annum;
- dependency on rainfed agriculture is making farmers vulnerable to drought;
- high investment costs of improved agricultural technologies (fertilizers, improved seed, irrigation schemes, etc.) are more productive and profitable when used in combination with good agricultural and natural resources management practices;
- well-managed agricultural, livestock, fisheries, forest and water resources contribute to improving productivity, broadening livelihoods, diversifying income and reducing poverty.

For these reasons CAADP has identified four key pillars, expected to make the most rapid impact in the transformation of African agriculture:

- expansion of the area under sustainable land management and reliable water control systems;
- improvement of rural infrastructures and trade-related capacities for improved market access
- enhancement of food supplies and reduction of hunger
- development of agricultural research, technological dissemination and adoption

Considerable investment is urgently required for these actions to be implemented (CAADP estimates US$ 251 billion). However, the returns from this investment will be critical if the challenge of global food security is to be met. If we cannot feed Africa, we cannot feed the world. The 'Harvest Choice' Project funded by the Bill and Melinda Gates Foundation has the principal aim of providing factual evidence as the basis for targeting the most appropriate factors for investment, in order to boost farm productivity and sustainability. It will provide valuable information to support the building of the four pillars critical to transform African agriculture through its own home grown sustainable green revolution.

Conclusions

The challenge to feed the world's rapidly growing population is arguably the greatest test humankind faces in the coming decades. What task could be more complex than doubling food production, on less land, with less water for irrigation, and the strong likelihood that a changing climate will have the potential to adversely impact on food production in many farming areas, in both LDCs and industrialized countries? To add to these complexities, the costs and availability of important farm inputs such as fuel, electricity, fertilizers and pesticides are all expected to markedly increase in price, and post-Kyoto climate agreements will scrutinize agriculture for its greenhouse emissions from livestock and crops. One could conclude from this scenario that it will all be 'too difficult' and conveniently look away. However, the reality is that there has never been a better opportunity for agriculture to not only achieve food security, but to also drive economic development. For the first time, farmers have the opportunity to not only be paid for their traditional food products, where demand and prices are increasing, but also for planting shrubs and trees suited to the lower potential parts of their farm, that will provide biomass for biofuel production, that will sequester carbon, add to biodiversity and provide other ecosystem services.

To meet these challenges and seize these unique opportunities, an agricultural revolution based on sustainable practices and sustainable intensification is urgently required. Substantial investment is essential for it to be implemented, but the returns for doing so will be great for both people and the environment – a 'win – win' scenario that has largely evaded us in the past. The consequences of not investing are too awful to consider.