

# The African Green Revolution moves forward

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**Abstract** The African Green Revolution is starting to gain momentum and there is now optimism about sub-Saharan Africa's ability to rapidly increase its agricultural productivity. This is partly due to some key successes—at the local and national levels—of policies that support smallholder farmers. The 80 Millennium Villages, which comprise approximately 400,000 people in ten countries of sub-Saharan Africa, have drastically increased production of staple food crops, transforming food deficits into crop surpluses. Maize yields more than doubled at the village scale, from 1.7 to 4.1 tons ha<sup>-1</sup>. In Malawi, because of a smart input subsidy program implemented by the government, maize harvests have greatly surpassed those of previous years, turning that country from a recipient of food aid into a food exporter and food aid donor to neighboring countries. Other countries are beginning to implement similar efforts. They will require novel financial mechanisms from the donor community to support them adequately. There is little question that sub-Saharan Africa can greatly improve food security with an ecologically-sound African Green Revolution supported by science-based policies,

community mobilization, gender empowerment and effective governance.

**Keywords** African Green Revolution · Food insecurity · sub-Saharan Africa · Agricultural productivity · Poverty · Millennium Development Goals

The African Green Revolution, called for by the former UN secretary-general (Annan 2004), is starting to gain momentum, creating a sense of optimism about sub-Saharan Africa's ability to rapidly increase its agricultural productivity, a necessary condition for economic transformation. The emerging African Green Revolution is largely the result of scientific advances in agricultural research and a new political determination to harness those advances through new policy instruments. For twenty years, influential donors to Africa argued that markets alone would be sufficient to support Africa's agricultural transformation. That view is now changing (UN Millennium Project 2005a; AGRA 2007; World Bank 2007a, b; FAO 2008; Bellagio Working Group for the African Green Revolution 2008; Sachs and Denning 2008), and a new policy activism is coming to the fore, which calls on African governments, scientists, foundations, donors, the private sector and civil society to work in partnership to promote the rapid uptake of improved agricultural practices at national scales.

The Hunger Task Force (UN Millennium Project 2005a; Sanchez and Swaminathan 2005a, b) identified the need to assist Africa's impoverished smallholders gain access to agriculture inputs—primarily fertilizers, high-yield seeds, and small-scale water management equipment—all within a comprehensive strategy for rural development (UN Millennium Project 2005b). The need for “smart subsidies” is based on the notion of a poverty trap, where the poorest of the poor cannot

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invest in the critical inputs necessary to escape from poverty. A temporary investment over a period of a few years can enable these populations to permanently escape from the poverty trap (Sachs et al. 2004; Sachs 2005).

Political support for this new approach is manifested by the following actions: The development of the Common African Agricultural Development Program of the New Partnership for African Development (NEPAD) of the African Union (CAADP 2002); the endorsement of the African Green Revolution by all UN member states at the 2005 UN summit (United Nations 2005), by African heads of state at the 2006 Abuja Africa Fertilizer Summit (IFDC 2006), as well as by UN Secretary-General (Ban Ki-moon 2008) and his high-level task force on Africa (United Nations 2008). There is consensus that increasing agricultural productivity in hungry countries is a key response to the current world food crisis. In its 2008 *World Development Report*, the World Bank urged that agricultural development must be at the center of solving Africa's hunger, beyond relief operations like food aid (World Bank 2007b). Political will is being demonstrated through bold action by over a dozen African governments. Private philanthropy created the Alliance for a Green Revolution in Africa (AGRA 2007), which is chaired by Kofi Annan. AGRA is now investing several hundred million dollars in 13 African countries. In addition, the Millennium Villages Project, largely supported by private philanthropy, is investing over \$150 million in agriculture-based integrated rural development (Sanchez et al. 2007; Millennium Promise 2008). The private sector is also providing strong support, including Yara's annual Oslo Conferences on the African Green Revolution and the World Economic Forum's Business Coalition against Chronic Hunger (Yara Foundation 2008, <http://www.africangreenrevolution.com>; World Economic Forum 2008). These and leading official development organizations have proposed the establishment of an agile coordinating funding mechanism for the African Green Revolution (Bellagio Working Group 2008).

We describe examples of progress and challenges at the local, national, and global scales, and the implications for international action in the midst of the instability of food and fertilizer prices since mid-2007 and the financial crisis that surfaced in September 2008.

### Local scale: the Millennium Villages

The Millennium Villages Project began in late 2004, to apply the recommendations of the UN Millennium Project (2005b) by empowering impoverished farming communities with science-based and community-led interventions to achieve all Millennium Development Goals by 2015 (Sanchez et al. 2007). Currently 80 Millennium Villages,

with an overall population of approximately 400,000, are in operation in ten African countries. Villages are grouped in 14 clusters, each cluster representing a major agroecological zone and farming system that is a hunger, poverty and disease hotspot in sub-Saharan Africa (Fig. 1).

Village interventions are aimed at increasing several kinds of capital: natural (soil nutrients), human (health, education, skills), social (community organization, gender empowerment, farmer organizations), infrastructure (roads, power, water, telecoms), and financial (household assets, banking, credit). The key is to raise capital stocks above a threshold level, beyond which the villages can move towards self-sustaining economic growth. Villagers and scientists agree on priority interventions in agriculture, nutrition, health, water and sanitation, energy, infrastructure, business enterprise development, internet connectivity, all within an overarching framework of community leadership, gender empowerment and environmental sustainability.

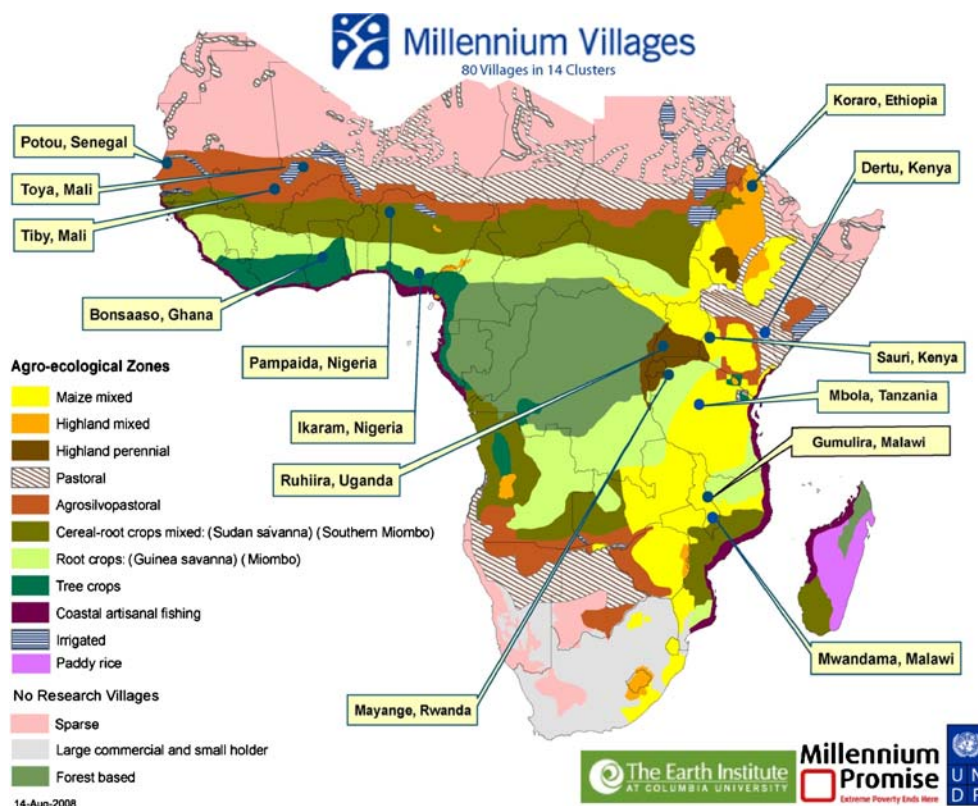
*Agronomy* With the interventions requested by farmers and vetted by scientists, the production of staple food crops increased dramatically, transforming previous food deficits into crop surpluses. We show data of maize, the most widespread basic staple crop, although many other crops, as well as livestock and fishery interventions are also taking place. Maize yields more than doubled at the village scale, with yield increases averaging  $2.4 \text{ t ha}^{-1}$  and ranging from 1 to 5 tons  $\text{ha}^{-1}$  (Table 1).

Similar ranges in yield increases were obtained in diversified cereal-pulse cropping systems in Ethiopia, and rice, millet- and root-based cropping systems in other clusters, with two exceptions. Millet failed in the Potou cluster in Senegal in 2006 due to drought and locust attacks, and the 2007 maize crop failed in half of the Mayange, Rwanda cluster due to drought. No crops grow in the desert pastoralist village of Dertu, Kenya, where the main interventions are camel veterinary services and livestock marketing.

Despite the high price of fertilizers, averaging \$451 per ton of DAP (diammonium phosphate) and \$419 per ton of urea from 2005 to mid-2007, the cost to produce one extra ton of maize averaged \$82. The Mbola, Tanzania 2007 crop, where the yield increase was the highest— $4.9 \text{ tons ha}^{-1}$ —achieved the lowest production cost of an additional ton of maize. The highest cost for extra production came from the Koraro, Ethiopia 2006 crop where maize yields only increased by  $0.8 \text{ tons ha}^{-1}$ . Koraro probably is the most degraded site among the Millennium Villages.

Fertilizer prices increased dramatically during 2007, peaking in April 2008 when the villages reported average costs of \$1,060 per ton of DAP and \$682 per ton of urea, a 135% increase in DAP and a 63% increase in urea from the previous year. The price of improved seeds of the recommended maize hybrids or open-pollinated varieties

**Fig. 1** The 80 Millennium Villages in 14 clusters and their agroecological zones and farming systems



increased much less, by 29%—from \$1.4 per kg prior to mid 2007 to \$1.8 per kg in April 2008.

We then recalculated the input costs to produce an extra ton of maize at April 2008 prices, which increased \$135—by 64% as shown in Table 1. Average local maize prices also increased drastically during this period, to \$471 per ton in April 2008—by 93%. Such prices are but a fraction of what it costs to place a ton of maize in Africa via US food aid—\$806 (USAID 2008).

Bumper crops, however, often result in steep declines in crop prices (UN Millennium Project 2005a; Staatz and Dembele 2008). The cereal bank or contact buying schemes instituted in the Millennium Villages usually doubled the

price of grain received by farmers, compared to what they would have received just after harvest when prices were lowest. Therefore, not only yields increased by 141%, but the price at which farmers sold their surpluses increased by about 100% from the harvest price. In addition, many farmers increased their area planted (Sanchez et al. 2007), creating a multiplying effect in food security and crop surpluses. Crop surpluses not only minimize risks of food shortages in subsequent years but also serve as the entry point to the cash economy.

The value to cost ratios, defined here as the ratio of the value of the grain yield increases to the cost of inputs, averaged over 4, with a range from 1 to 14 using the 2005–

**Table 1** Village-level maize production increased 141%

	Mean	Range
Maize grain yield with interventions (tons ha <sup>-1</sup> )	4.1	1.4–6.2
Maize grain yield without interventions (tons ha <sup>-1</sup> )	1.7	0.6–2.8
Maize grain yield increases (tons ha <sup>-1</sup> )	2.4	0.8–4.9
Actual input costs to produce an extra ton of maize (\$)	82	24–165
Input costs to produce an extra ton of maize at April 2008 prices (\$)	135	49–279
Value to cost ratio at actual prices	4.6	1.3–14.3
Value to cost ratio at 2008 prices	4.3	1.3–11.0

Average of 14 cropping seasons in seven Millennium Research Villages: Sauri, Kenya (3 harvests); Mwandama, Malawi (3); Ruhiira, Uganda (2); Koraro, Ethiopia (2); Mbola, Tanzania (2); Bonsaaso, Ghana (2); Pampaيدا, Nigeria (2), all during 2005–2007. Each value is the average of 30 to 90 farms per village; measured in 2–3 plots ranging from 9–25 m<sup>2</sup> samples per farm and corrected to 14% grain moisture. The actual maize prices are the ones at which the villagers sold their surplus maize, after storing the grain in cereal banks for an average of 6 months in order to sell at peak prices

2007 prices. These did not change markedly with the drastic increases of both fertilizer and maize prices, as shown in Table 1. Value to cost ratios of two or more are considered profitable (Morris et al. 2007). Therefore, the food and fertilizers price hikes have had little effect on the bottom line so far. This situation however, can change swiftly if crop prices decline while fertilizer prices remain high.

*Other interventions* Villagers have met their caloric food requirements, built or refurbished clinics now staffed by government health workers, cut the prevalence of malaria drastically, and increased primary school attendance—particularly by girls—through locally-produced school meals and improved facilities such as separate latrines for boys and girls (Sanchez et al. 2007). Some villages are using improved cooking stoves, have access to clean drinking water, have close access to fuelwood with nitrogen-fixing trees, and have introduced soil conservation practices, reforestation and internet connectivity.

Food security, therefore, is only part of the picture, and would be of little lasting value if it is not accompanied by key interventions in health, education, water, sanitation, energy, infrastructure, communications and the environment. For example, in Koraro, Ethiopia, one of the more remote sites located 54 km from the nearest all-weather road, a 5-ton truck was provided by the project. A women's group now manages it on a commercial basis. This allows farmers to transport their surpluses to the nearest market in Hauzien twice a day. Previously, the trip took 2 days each way on the backs of donkeys and camels. The village truck can also serve as an ambulance.

*From subsidies to a credit economy* Millennium Village farmers were initially supplied with subsidized fertilizers and improved seeds, as well as up-to-date agronomic training by government extension officers. The level of subsidy has decreased with time in many clusters according to agreements between village residents and project scientists. In Sauri, Kenya, farmers received a 68% subsidy in the first cropping season (2005), with the inputs given to all farmers who requested them at no cost, but with an obligation to return 10% of their surplus to the village's school meals program. In the second year, subsidies were reduced to 45% to all farmers. In the third year, they were reduced to 20% and were largely limited to the poorest and most vulnerable farmers indicated by the community. Credit schemes were brought in to finance most of the fertilizer needs.

In Tiby, Mali, a different scheme was developed by the community, based on decreasing the subsidy from 50% to 25% to zero in three years for all farmers. The scheme was managed by community leaders in a transparent manner. About 1,700 tons of fertilizer was distributed to nearly

5,000 households feeding approximately 68,000 people. Payment was in-kind at harvest, put in a cereal bank and sold when prices increased. The repayment rate was over 95%. A revolving fund was created, which currently has an equivalent of \$445,000 in local currency. The scheme continues with emphasis on farmer capacity building, strengthening farmer organizations and new market opportunities (Kaya et al. 2008).

By the end of the fifth year, we expect all villages to shift to credit financing. This is likely to be a challenging task that will require intensive training of villagers and local financial institutions.

*From sub-subsistence to small-scale entrepreneurs* No matter how high the yields, few farmers are likely to escape absolute poverty by growing less than a hectare of maize or other staple food crops. Thus, following increased food production, diversification to higher-value crops began. Villagers are now putting part of their land into high-value crops such as onion, tomato, cabbage, melons, orange-fleshed sweet potatoes, traditional African vegetables, tissue-cultured bananas, peanuts, sunflower, chili peppers, hibiscus, and others. Improved germplasm of these different crops was either purchased or obtained free of charge from national and international research institutes or seed companies operating in the ten countries. In some cases, seed multiplication was done by village farmers under supervision of agricultural extension officers, for example groundnuts in Malawi and agroforestry trees in Kenya. Outside crop fields, many villagers are raising poultry in confinement or free range, goats, camels, fish in aquaculture ponds, mushrooms, honey, passion fruit, and many fruit and timber trees. Dairy cattle fed by napier grass (*Pennisetum purpureum*) and the legume *Calliandra calothyrsus* produce much milk and manure, often without the need of commercial feed supplementation. Small-scale irrigation is being developed for some of these high-value crops, including diverting small rivers during the dry season in Malawi and Nigeria, major rainfall harvesting systems to store subsoil moisture in Ethiopia, and drip irrigation in Senegal. Such small-scale irrigation is crucial for enterprise diversification.

Farmers are being trained in market access and the requirements for a steady and sanitary food supply to local supermarkets, as well as potentially export to large African cities and to Europe, North America and the Middle East. Several companies are facilitating links with other parts of the food chain. Microfinance mechanisms, including but not limited to micro-credit, are being established, including training in record keeping and accounting. In Malawi, Opportunity International has established a mobile bank in the Mwandama cluster, where anyone with as little as the equivalent of \$5 can open a bank account and use a biometric smart card for identification. A community bank

has been running successfully in Ruhira, Uganda for 2 years. Crop insurance schemes are being developed to reduce risks of future crop failures caused by drought, but many challenges remain to make them functional. Governments and institutions like AGRA, the World Bank and Millennium Promise are involved in developing such initiatives to finance agriculture.

Once farmers undertake the transformation to small-scale entrepreneurs, the villages will be economically sustainable. Whether the villages will be sustainable in receiving public goods such as health, education, infrastructure, and agricultural extension depends on governments and donors delivering on their promises.

An external review conducted by the Overseas Development Institute concluded that “the Millennium Villages Project has achieved remarkable results and has demonstrated the impact of greater investment in evidence-based, low-cost interventions at the village level to make progress on the Millennium Development Goals” (Buse et al. 2008; Beattie 2008). The review provided a forward look for the project to scale-up to national levels.

### National scale: Malawi’s emerging green revolution

A landlocked country with a population of 13 million, a GDP per capita of \$600, and a history of recurring famines, Malawi is the first country to implement a green revolution strategy at the national scale in response to Kofi Annan’s call (Denning et al. 2009). Maize is the staple food crop, grown by virtually all 2.4 million farm families. Rainfall is erratic, often resulting in catastrophic drought spells during the rainy season at critical stages of maize growth. Even in years with good rainfall, the nitrogen-depleted soils cannot produce sufficient maize to feed the country, a condition common in much of sub-Saharan Africa (Sanchez 2002). Malawi’s agricultural policy history is full of u-turns and drastic changes, often prompted by influential donors shifting their approaches and leading to a sense of despair that all policy options have been exhausted. Examples of the debates are publications by Blackie et al. 1998; Carr 1997; Conroy 2006; Chisanga 2007; DFID 2007; Gilbert et al. 2002; Government of Malawi 2006; Levy 2005; Smale and Heisey 1997; Smale and Phiri 1998.

In April 2005, the country’s maize harvest reached only 57% of the country’s requirement, due to both water and nitrogen droughts (Denning et al. 2009). As a result, approximately 5 million Malawians required food aid. Despite strong opposition from major donors, the government instituted a “smart” input subsidy program for the October 2005 planting, by which farm households were given a voucher that entitled them to two 50-kg bags of fertilizer and 3–5 kg of improved maize seed, available at about 37% of the

market price. The inputs provided through the scheme are sufficient for a 0.4-ha (1 acre) farm but are not intended to distort the fertilizer market for larger purchases. Whether that will happen or not will depend on future market prices (Staatz and Dembele 2008) and other actions such as the training and development of a private agrodealer network.

The April 2006 harvest greatly surpassed previous years. Maize production more than doubled nationwide, from 1.2 to 2.6 million tons, exceeding the national food requirement of 2.1 million tons and resulting in an 18% surplus (Table 2).

Two-thirds of the maize yield increases was due to the input subsidy while one-third was due to better rainfall distribution (Denning et al. 2009). If Malawi had not instituted the targeted input subsidy policy, good rains would have increased national maize production to only 1.8 million tons, still falling short of the national food requirement by 0.3 million tons. *Policy makers should note that good rains are not sufficient to achieve food security.* The use of improved seeds and fertilizers is essential.

Buoyed by this success, the government continued the subsidy policy for the next planting season. Again, rainfall distribution was good, and the 2007 harvest reached a record 3.4 million tons, generating a 53% surplus above basic food needs. Malawi exported about 400,000 tons of maize to Zimbabwe from the 2007 harvest, generating foreign exchange, to the amazement of food-deficient neighbors. Malawi actually became a food aid donor to neighboring Lesotho and Swaziland. President Mutharika concluded: “*Enough is enough. I am not going to go on my knees to beg for food. Let us grow the food ourselves. And indeed we have*” (Mutharika 2008).

Continuing the policies, this time with significant donor support, the 2008 harvest reached a 16% surplus partly due to less favorable rainfall distribution. Exports increased, not only to Zimbabwe but also by major purchases from the World Food Program for its food aid activities all over Africa. Such yield and production increases echo those of the Asian Green Revolution of the 1960s (Conway 1997). While initially opposed to the program at its inception in 2005, DFID is now investing £20 million providing logistical support to the subsidy program.

The Malawi Green Revolution shows what can be done with science-based enabling government policies and

**Table 2** Malawi achieves and exceeds its maize requirements in three consecutive years (Denning et al. 2009; FEWSNET 2008)

Harvest year	Maize production (million tons)	National average yield (tons ha <sup>-1</sup> )	% maize requirement
2005	1.22	0.81	-43
2006	2.61	1.59	+18
2007	3.44	2.04	+53
2008	2.78	1.69	+16

strong political will. It has provoked a lively debate. In their comprehensive analysis, Denning et al. (2009) highlighted several lessons learned:

- Knowledge exists to increase smallholder maize productivity and sharply reduce food insecurity in rainfed agriculture.
- Political will and action provide the foundation for change. A national-scale program of this urgency is feasible even with poor road and communication infrastructure.
- It makes economic sense to support an inputs subsidy rather than rely on an output subsidy such as food aid. A marginal return on investment was at least 230% in just 6–9 months. It currently costs \$135 in inputs to produce an extra ton of maize by African smallholders, while it costs \$806 to put the same ton of maize in Africa via US food aid.
- The cost of achieving food security is fiscally manageable and responsible. The national budgetary allocation represented less than \$5/person/year, a remarkably small price to pay for achieving national food self-sufficiency and widespread household food security.
- Pro-poor “smart” input subsidies work. This has effectively buffered Malawi from the economically and socially destructive effects of the global food price increases of 2007 and 2008.
- Future challenges will arise to continue this surplus production. These include the effects of unreliable rainfall and climate change, high fertilizer prices and the need to complement mineral fertilizers with organic nutrient sources, as well as coming to grips with high post-harvest losses.

### **Ethiopia—the next green revolution?**

Another landlocked country, but with a huge population (77 million) and also victim of spectacular famines, Ethiopia has made remarkable progress, although far from approaching food security while absolute poverty remains endemic. Production of cereals and grain legumes has more than doubled in the past 13 years, from 5.9 million tons in 1993, to 10 million in 2003 and 15 million in 2006, sustaining an annual GDP growth of over 10% for the past few years (Abera 2008). This is the result of science-based policies supported by strong political will, and implementing a very sensible *Plan for Accelerated and Sustained Development to End Poverty* (MoFED 2005). This plan is based on scaling-up what works—increasing access to improved seeds, fertilizers, small-scale water harvesting systems, market liberalization and export promotion (which now reaches \$800 million per year). Major investments have been made

in human capital, particularly training tens of thousands villagers as para-professional agriculture and health workers (Abera 2008). The senior author was present at one of the stakeholder meetings, where the Prime Minister stated that the government was ready to implement the plan on its own, but it would go faster if the donors would contribute. The Ethiopian treasury ended up contributing \$120 million and the donors \$700 million (Personal Communication with Belay Ejigu). Nevertheless, much remains to be done.

### **Global scale: political will and action**

The national and village level examples suggest that food production can markedly increase as Africa undertakes its own green revolution. There is little question that sub-Saharan Africa can greatly improve food security with an ecologically-sound African Green Revolution supported by science-based policies, community mobilization and effective governance. Many countries are now following and adapting the Malawi input subsidy programs. Examples are Tanzania and Kenya that have both started voucher-based smart subsidies programs. In the case of Kenya, this has mostly been financed by national budgets.

The tide is turning positively to scale-up the African Green Revolution. AGRA is investing over \$500 million over 5 years in improved seeds, soil health, agrodealer development, credit guarantees for African banks to finance the above, as well as in massive training programs to produce hundreds of African PhDs in genetic improvement and soil health. The Gates Foundation and AGRA are also investing in an African Soils Information System, based on digital maps designed to support evidence-based policies for more effective implementation of the reversal of soil nutrient depletion and land degradation in this continent. A group of African ministers of agriculture and finance, scientists, foundations, private sector organizations, NGOs, UN and donor agencies representatives made a call for a new financial coordination mechanism to provide counterpart support to national government investments (Bellagio Working Group for the African Green Revolution 2008, Sachs and Denning 2008). A high-level UN coordinating body is orchestrating coherent, rapid responses across donor and UN agencies (United Nations 2008). A group of ten countries involved in the Bellagio Working Group met in Oslo this past September. They requested \$668 million of donor funds to support farm inputs for the next planting season, and pledged \$490 million as counterpart funds from their budgets, reflecting their commitment and political will.

The current financial crisis could undermine such efforts, giving donors an excuse for postponing their commitments to fight global hunger. This is shortsighted and dangerous; Africa’s chronic problems will become more acute with a

global food and financial crisis. The Bellagio Working Group for the African Green Revolution (2008) estimates that \$8–10 billion is needed annually to increase agricultural productivity in Africa in a definitive way. The good news is that the economies of African countries are growing and the governments are increasing their budgets to the agricultural sector. Development partners need to come forth with their contributions in a significant and timely manner.

Climate change adds further uncertainties, with predictions indicating more droughts in southern Africa, more wet periods in eastern Africa and no clear trends in West Africa. The global biofuel boom also adds additional uncertainties. Both require answers from a revitalized agricultural research system composed of the national and international agricultural centers. While such uncertainties pose additional challenges, the path towards making the African Green Revolution deserves continuous support. It can be done, and when it is done, the poorest region will join the rest of the world and become a major trading partner.

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## References

- Abera Deresa (2008) The take-off Ethiopian agriculture. Ministry of Agriculture and Rural Development, Addis Ababa, 31p
- Alliance for a Green Revolution in Africa (AGRA) (2007). <http://www.gatesfoundation.org/GlobalDevelopment/Agriculture/Announcements/announce-060912.htm>
- Annan K (2004) Africa's green revolution: a call to action. Proceedings of the July 5th, 2004 high-level seminar, Addis Ababa, Ethiopia, convened by the Government of Ethiopia and the UN Millennium Project. Nairobi: MDG Centre. Speech available at [http://www.africangreenrevolution.com/en/green\\_revolution/addis\\_call\\_to\\_action/index.html](http://www.africangreenrevolution.com/en/green_revolution/addis_call_to_action/index.html)
- Ban K-m (2008) Report of the Secretary-General. Background note for high-level event on the MDG's. Committing to action: achieving the MDG's. United Nations, New York. <http://www.un.org/millenniumgoals/2008highlevel/pdf/committing.pdf>
- Beattie A UN village project boosts Africa. Financial Times, p.1. November 3, 2008.
- Bellagio Working Group for the African Green Revolution (2008) Fund for the African green revolution. The Earth Institute at Columbia University, New York February 22, 2008, 7p
- Blackie MJ, Benson TD, Conroy A, Gilbert RA, Kanyama-Phiri G, Kumwenda JDT, Mann C, Mughogho S, Phiri A (1998) Malawi: soil fertility issues and options. Rockefeller Foundation, Lilongwe, p 55
- Buse K, Ludi E, Vigneri M (2008) Beyond the village: the transition from rural investments to national plans to reach the MDG's. Sustaining and scaling-up the Millennium Villages Project. Overseas Development Institute, London
- CAADP (Comprehensive Africa Agriculture Development Programme) of the New Partnership for Africa's Development (2002). <http://www.fao.org/docrep/005/y6831e/y6831e00.HTM>.
- Carr S (1997) A green revolution frustrated lessons from the Malawi experience. *Afr Crop Sci J* 5:93–98
- Chisanga B (2007) Reclaiming policy space: lessons from Malawi's fertilizer subsidy programme (London Future Agricultures). <http://www.future-agricultures.org>
- Conroy AC (2006) Poverty, aids and hunger: breaking the poverty trap in Malawi. Palgrave MacMillan, London
- Conway G (1997) The doubly green revolution. Penguin, New York
- Denning GL, Kabambe P, Sanchez PA, Malik A, Flor R, Harawa R, Nkhoma P, Zamba C, Banda C, Magombo C, Keating M, Wangila J, Sachs JD (2009) Input subsidies to improve smallholder maize productivity in Malawi: towards an African green revolution. *PLoS Biology* 7(1):e1000023. doi:10.1371/journal.pbio.1000023.
- DFID (2007) Case Studies. A record harvest in Malawi. <http://www.dfid.gov.uk/casestudies/files/africa>. 8 May 2007.
- FAO (2008). Boosting Food Production in Africa's "Breadbasket Areas". New Collaboration among Rome-based UN Agencies and AGRA. <http://www.fao.org/4> June 2008.
- FEWSNET (Famine Early Warning System). (2008) Malawi Food Security Update. June/July 2008. [http://www.fews.net/doc/Publications/malawi\\_fsu\\_2008\\_06\\_and\\_07.pdf](http://www.fews.net/doc/Publications/malawi_fsu_2008_06_and_07.pdf)
- Gilbert RA, Komwa MK, Benson TD, Sakala WD (2002) A comparison of best-bet soil fertility technologies for maize grown by Malawian smallholders. A research report of the results of the nationwide 1998/99 and 1999/2000 seasons. Maize Productivity Task Force, Ministry of Agriculture, Lilongwe, p 58
- Government of Malawi (2006) Malawi growth and development strategy, from poverty to prosperity, 2006–2011. [http://siteresources.worldbank.org/MALAWIEXTN/Resources/MGDS\\_2006\\_Final.pdf](http://siteresources.worldbank.org/MALAWIEXTN/Resources/MGDS_2006_Final.pdf)
- IFDC (2006) Africa Fertilizer Summit Proceedings, Abuja, Nigeria, June 9–13 2006. Florence, Alabama: International Fertilizer Development Center, 182 p
- Kaya B, Niang A, Palm C (2008) The millennium villages project's community based input strategy: an example of successful community participation from the Ségou region, Mali. Power Point presentation. <http://www.mvpafrica.org>
- Levy S (ed.) (2005) Starter packs: a strategy to fight hunger in developing countries? CABI, Nairobi
- Millennium Promise Alliance (2008). <http://www.millenniumpromise.org>
- Morris M, Kelley VA, Kopicki R, Byerlee D (2007) Fertilizer use in African agriculture: lessons learned and good practice guidelines. World Bank, Washington, pp 45–61
- MoFED (2005) Ethiopia: building on progress: a plan for accelerated and sustained development to end poverty, 2005/06–2009/10. Ministry of Finance and Economic Development, Addis Ababa, 132p.
- Mutharika B (2008) President Bingu wa Mutharika statements at the World Economic Forum on Africa, Cape Town, South Africa, 4 June 2008. <http://www.youtube.com/watch?v=rMujwIj35V4>
- Sachs JD, McArthur JW, Schmidt-Traub G, Kruk M, Bahadur C, Faye M, McCord G (2004) ending Africa's poverty trap. Brookings Pap on Econ Act 1:1–100
- Sachs JD (2005) The end of poverty. Penguin, London, p 396
- Sachs JD, Denning GL (2008) Global fund for smallholder agriculture. The Earth Institute at Columbia University, New York 18 October 2008. 7p
- Sanchez PA (2002) Soil fertility and hunger in Africa. *Science* 295:2019–2020
- Sanchez PA, Swaminathan MS (2005a) Cutting world hunger in half. *Science* 307:357–359
- Sanchez PA, Swaminathan MS (2005b) Hunger in Africa: the link between unhealthy people and unhealthy soils. *The Lancet* 365: 442–444

- Sanchez PA, Palm CA, Sachs JD, Denning GL, Flor R, Harawa J, Jama B, Kiflemariam T, Konecky B, Kozar R, Lelerai E, Malik A, Modi V, Mutuo P, Niang A, Okoth H, Place F, Sachs SE, Said A, Siriri D, Teklehaimanot A, Wang K, Wangila J, Zamba C (2007) The African millennium villages. *Proc Natl Acad Sci* 104:16775–16780
- Smale M, Heisey PW (1997) Maize technology and productivity in Malawi. In: Byerlee and Eicher, (eds) *Africa's Emerging Maize Revolution*. Lynne Reiner, Boulder, pp 63–79.
- Smale M, Phiri A (1998) Institutional change and discontinuities in farmers' use of hybrid maize seed and fertilizer in Malawi: findings from the 1996–97 CIMMYT/MoALD survey. *Economics Working Paper 98-01*. CIMMYT, Mexico
- Staatz J, Dembele NN (2008) *Agriculture for development in sub-Saharan Africa*. World Bank paper cited in World Bank (2007b). *World Development Report 2008. Agriculture for Development*. Washington
- UN Millennium Project (2005a) *Halving hunger: it can be done*. UN Millennium Project Task Force on Hunger, London: Earthscan, 245p. <http://www.unmillenniumproject.org/html/tf2docs.shtml>
- UN Millennium Project (2005b) *Investing in development: a practical plan to achieve the millennium development goals: overview*, London: Earthscan, 329p. <http://www.unmillenniumproject.org/html/about.shtml>
- United Nations (2005) *General Assembly. 2005 World Food Summit Outcome*, Document A/60/L.1. New York: United Nations.
- United Nations (2008) *High-level meeting on Africa's development needs: a response to the World Food Crisis*. <http://www.un.org/ga/president/62/ThematicDebates/adn/worldfoodcrisis.pdf>
- US Agency for International Development (2008) *U.S. International Food Assistance Report 2007*. USAID, Washington
- World Bank (2007a) *Assistance to sub-Saharan Africa: an independent evaluation group review*. World Bank, Washington, p 142
- World Bank (2007b) *World development report 2008. Agriculture for Development*, Washington, DC, p 365
- World Economic Forum (2008) *The business role in achieving a green revolution for Africa. A report on the experience to date of the World Economic Forum's Business Alliance Against Chronic Hunger*. Geneva, 27p



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