
In Search of the Right Solutions for Africa's Development

KANAYO F. NWANZE, SAVITRI MOHAPATRA AND PIERRE-JUSTIN KOUKA

*Africa Rice Center
Abidjan, Ivory Coast*

What are the right solutions for Africa? Put together, the United States, Europe, India, China, Argentina, and New Zealand are smaller than Africa. For a continent so diverse—in its demography, in its peoples, their cultures and traditions, and untapped resources—to suggest that one can prescribe a set of solutions, let alone find them, is presumptuous.

In examining the problems and possible solutions for Africa, we will limit our focus specifically to sub-Saharan Africa (SSA), a region of multiple natural and man-made disasters that generate horrifying statistics defying the laws of probability. Our paper attempts first to highlight the formidable challenges that face SSA, then opens a window to a thin ray of hope that is piercing the haze of despair. We will present a few examples of remarkable successes in agriculture and the potential—and concerns—regarding agricultural biotechnology.

Our examples of the signs of hope are drawn from the creation of the Africa-led New Partnership for Africa's Development (NEPAD) and the prospects of cutting-edge science. Contributions from centers supported by the Consultative Group on International Agricultural Research (CGIAR), in strong partnership with national programs in SSA, are highlighted. The reasons why highly promising Africa-specific agricultural technologies have not had the expected and much needed impact in SSA are also discussed.

The last section briefly presents the potential of biotechnology as one of the tools to address some of SSA's intractable problems. It also raises the major concerns for SSA regarding biotechnology, such as the predominant role of the private sector in biotechnology, with very little research on poor people's crops; proprietary science; the high cost of biotech research; the general lack of biosafety guidelines, policies and regulations; the absence of informed public awareness on genetically modified organisms (GMOs) in SSA; and, finally, the risk of SSA being left out of the biotechnology or gene revolution.

The concluding section draws from experiences and observations from over 30 years in agricultural research and development, and discusses the prerequisites for sustainable solutions to Africa's problems such as good governance, political commitment, better institutions, infrastructure and a favorable policy-environment that must accompany promising technologies. We call upon African leaders and all Africans for action!

MAJOR CHALLENGES

The challenges facing SSA are multiple and multi-faceted. They are usually illustrated by a number of statistics for which Africa excels. The stark figures do not reveal the underlying individual tragedies and dreadful human suffering. For the purpose of this paper, only selected major challenges and those related to agriculture are presented.

*In SSA, about 300 million people live on less than
US\$1 per day and nearly 200 million people are
chronically hungry.*

Hunger and Poverty

In SSA, about 300 million people live on less than US\$1 per day (Runge *et al.*, 2003) and nearly 200 million people are chronically hungry. In 2003, 25 million Africans required emergency food aid. In 2000, Africa had 44% of the world's hungry. If present trends continue, the number may be 73% by the year 2015 (ERS/USDA, 2000).

About 32 million African children of less than 5 years of age are underweight (Runge *et al.*, 2003). SSA is the only region where the number of malnourished children will rise over the next 20 years. The predicted increase of 6 million under current trends may prove to be an underestimate (Runge *et al.*, 2003).

SSA is also the only region of the world where poverty is increasing. The number of its poor is likely to rise from 315 million in 1999 to more than 400 million by 2015 (UNECA, 2004).

Population Growth

In the past three decades, Africa's population has grown faster than in any other region. It doubled between 1975 and 2000, from 325 to 650 million. In less than three decades it is projected to double again from the current level (Rosen and Conly, 1998). The rate of growth in the population is projected to be twice that of the growth in food production (Pinstrup-Andersen and Pandya-Lorch, 1999).

Epidemics

The epicenter of the global HIV/AIDS crisis and malarial infestation, SSA suffers the world's highest rates of deaths from HIV/AIDS (81%), malaria (90%) and tuberculosis (23%) (WHO, 2001). HIV/AIDS is ravaging the continent, changing its demography, decimating a generation, and creating the phenomenon of "AIDS orphans." Twelve million African children have lost their parents to AIDS, and this number is expected to reach 28 million by 2010 (UNAIDS, 2000). This is the only continent where polio is still a threatening disease, thereby endangering a whole generation of tomorrow's leaders.

It is estimated that the population of SSA will decrease by 84 million by 2015 as a result of the HIV/AIDS epidemic (UN Population Division, 2001). Much of this reduction is likely to come from rural areas where the incidence of the disease is highest. SSA's agricultural labor force is already devastated and will continue to be so for generations, depleting the region of its food producers, generating a spiral of acute poverty and threatening to compromise any economic, social and democratic progress in the region.

Epidemics and inadequate healthcare and social services are affecting life expectancy, which is now less than 50 years in SSA.

Over the past two decades, per-capita food production has declined significantly, partly due to neglect of the agricultural sector.

Low Agricultural Productivity

One of the biggest challenges facing SSA is how to feed its population. Over the past two decades, *per-capita* food production has declined significantly, partly due to neglect of the agricultural sector. African states and governments did not invest in economic growth and rural development, resulting in current severe food shortages and insecurity. This issue is accentuated by a number of factors, including:

- the dependence of agriculture on rainfall (making it vulnerable to droughts and low productivity),
- the lack of a significant number of sizeable agricultural businesses,
- limited use of inputs; lack of market infrastructures,
- the inadequacy of policies and regulations aimed at providing incentives to agricultural production and related businesses.

Unlike Asia, where it was possible to prevent famines thanks to Green Revolution technologies that could be applied consistently across millions of hectares of land, SSA is confronted with specific challenges—poor soils, unsuitable conditions for irrigation, and large variations in growing conditions. Green Revolution technologies, which were targeted to high-potential areas of Asia, were not suitable for SSA.

The imbalances of agricultural production are exacerbated by the lack of appropriate policies and regulations in the agriculture sector and high deficits in trade balances of African economies. While most African countries depend heavily on the export of one to two crops or of crude oil, imports meet much of their need for agricultural products to close the gap between production and consumption, making most of SSA dependent on the rest of the world. In addition, conditions imposed by international trade tariffs, anti-dumping regulations and trade barriers are not favorable to African nations.

Prescribed structural adjustment programs introduced in the 1970s aimed at eliminating government control, and subsidies and increasing guaranteed prices to the producers of tradable agricultural commodities have had a tremendous adverse impact on African economies. This situation has accentuated the non-competitiveness of SSA in the international market.

Many experts in agriculture consider decreasing soil fertility as the fundamental cause of declining food security in SSA

Environmental Challenges

Many experts in agriculture consider decreasing soil fertility as the fundamental cause of declining food security in SSA (Sanchez *et al.*, 1997). This statement remains true today as the use of fertilizer has declined in many countries with the disappearance of agricultural subsidies, poor to non-existent roads, high transportation costs, and currency devaluation which has caused fertilizer prices to rise significantly. Farmers in SSA use an average of 9 kg of fertilizer per hectare compared to 241 kg for East Asian farmers and 125 kg for those in developed countries.

Another major environmental threat in SSA is drought, which affects food production. There have been seven major droughts in the region over the last four decades. In 1972–74 and 1981–84, massive displacements and suffering resulted.

*Food security cannot be achieved in an environment
of turmoil.*

Conflicts and Instabilities

Food security cannot be achieved in an environment of turmoil. Poverty's corrosive effects often lead to social and economic instabilities in SSA, which, in turn, keep the populations impoverished and food-insecure. This is a deadly spiral, from which African nations must escape in order to begin to achieve development.

In addition to poverty, the artificial demarcation of Africa that occurred during the colonial period into relatively small political entities and the consequent disruption of existing political and social systems are some of the major causes of current conflicts. Bad and inefficient governance prevalent in many SSA countries has an exacerbating effect.

Decreasing Agricultural Aid

According to the World Bank, agricultural aid to SSA fell from US\$4 billion in 1990 to US\$2.6 billion in 1999, a loss of 35% (World Bank, 2003). Increasingly, the reduced aid is diverted to emergency relief rather than long-term development.

SIGNS OF HOPE

In spite of the bleak picture painted by the challenges described above, there is reason to believe that hope is on the agenda for Africa. Several initiatives and progress made within the region provide tangible positive signs.

New Partnership for Africa's Development

SSA stands on the verge of exciting opportunities that could place its countries—individually and collectively—on a path to sustainable growth and development. There is a heightened sense of responsibility in the international community as a whole and African leaders are increasingly taking over the reins to define where they want to take Africa.

NEPAD is an ambitious action program launched by a new generation of African leaders and embraced by the newly formed African Union (AU). Its long-term goal—to end poverty in SSA—is underpinned by peace, democracy, good governance, the development of social and physical infrastructure and the full engagement of African countries in international trade. It provides a framework for SSA's stakeholders to:

- target financial and human resources more efficiently as part of a coordinated effort for the sub-continent, and
- to measure their impacts.

NEPAD recognizes the role of agriculture in economic development and has placed agricultural growth as the cornerstone of its poverty-reduction program.

NEPAD recognizes the role of agriculture in economic development and has placed agricultural growth as the cornerstone of its poverty-reduction program. Its Comprehensive Africa Agricultural Development Program (CAADP) has identified technological interventions that can improve food security and the productivity of the region's agricultural sector.

NEPAD and the Forum for Agricultural Research in Africa (FARA)—the apex body of the sub-regional organizations in the continent—are collaborating on the large-scale Dissemination of New Agricultural Technologies in Africa (DONATA). The main objective of DONATA is to increase agricultural production and investment, and thereby reduce food insecurity and raise incomes by disseminating improved agricultural technologies such as NERICA rice (New Rice For Africa), tissue-culture banana and new cassava varieties and by institutionalizing links between major national, sub-regional and regional stakeholders in scaling up promising new technologies.

Endorsing the NEPAD action plan, the G8 countries unveiled the G8 Africa Action Plan at the historic Kananaskis Summit in Canada, 2002. Several G8 countries announced increased assistance for Africa. The Canadian government—a strong supporter of NEPAD—has pledged CAN\$500 million for SSA's development. The recent statements from the Sea Island G8 Summit are a far-reaching declaration of commitment to NEPAD and Africa as a whole. The future will assess to what extent commitments are translated into action.

Emerging or Improved Democracies

In spite of the increased number of armed conflicts in some sub-regions, a few countries provide reason to believe in the future of democracy in Africa. With the abolishment of apartheid, South Africa leads SSA on the democratic path and in good governance. Senegal, Mali and Ghana have been cited at different forums for similar significant progress. A recent addition to this list is Uganda, a country poised for major progress in this century. Good governance is high on the agenda of the AU.

Frontier Science

Advances in science and technology such as biotechnology, informatics, geographic information systems (GIS) and sophisticated simulation modeling have opened new frontiers in agricultural research and development. These advances provide hope that solutions to global challenges will also be within the reach of African people.

Today, mankind is on the brink of the golden age of plant science, when we can understand plants so precisely that it is becoming relatively easy to incorporate traits like pest resistance, durability and increased nutritional value in our crops.

Support from International Research Organizations

About 70% of Africans live in rural areas and depend, directly or indirectly, on agriculture. Therefore, agriculture must be at the heart of any effective solution to the problems of poverty, food insecurity, and environmental destruction that beset Africa. The CGIAR centers work closely with national programs to address the agricultural development gap in SSA and help to bring the benefits of modern science to the rural and urban poor.

The research outputs of the CGIAR constitute “global public goods”—freely available to all. This is particularly invaluable for SSA, during a period when a large part of agricultural research and development is moving inexorably towards the private sector.

Several research breakthroughs, including some based on basic molecular genetics, are making a difference in the lives of poor farmers and consumers.

SUCCESS STORIES

Stories from SSA often paint such a bleak picture of its sub-regions that good and positive stories often go unnoticed because they do not represent the image tagged to Africa.

Several research breakthroughs, including some based on basic molecular genetics, are making a difference in the lives of poor farmers and consumers. Two main factors have contributed to the success of several breakthroughs highlighted in this paper.

A priority-setting process and subsequent involvement of national programs in the development and a sense of ownership of new or improved technologies have provided the opportunity for creating technologies that are tailor-made for Africa. This led to major development and extension efforts that were needed to provide a boost to the up-take, out-scaling and up-scaling of research results.

Other factors are the adaptability and sustainability of new or improved technologies. A number of technologies introduced to sub-regions have suffered from lack of sustainability. Large-scale irrigation schemes provide a good example of failures over the past three decades. Projects conducted over specific life spans without consideration of the priorities of the recipient countries and little involvement of national programs in their conception were doomed to fail. Lack of funding for continuation of projects beyond the initial phase led to a proliferation of bad experiences that are often cited to make a case against any hope for Africa's development.

Biological Control of the Cassava Mealybug

Cassava, introduced from South America several centuries ago, has become one of the major food items in SSA, feeding over 200 million people. In the early 1980s however, a major pest—the cassava mealybug—caused crop losses of about 80% and threatened to completely wipe out the crop (Herren and Neuenschwander, 1991)

Researchers at the International Institute of Tropical Agriculture (IITA) in collaboration with national programs set up a mass-rearing and distribution of a predator of the cassava mealybug using data from earlier research by the International Center for Agricultural Research (CIAT) and the International Institute of Biological Control (IIBC). By 1988, the mealybug threat had been successfully controlled throughout Africa. Conservative estimates place the value of production saved at over US\$2.2 billion (Noorgard, 1988).

Banana Tissue Culture

Soil degradation and infestation/infection of orchards with pests and diseases have led to rapid declines in banana production in East Africa over the past 20 years. Applying tissue-culture technology, researchers at the Kenya Agricultural Research Institute (KARI), in collaboration with a local private biotechnology company, successfully produced *in vitro* banana plants commercially. The tissue-culture plants roughly doubled both yield and income under farmers' conditions (Qaim, 1999; Wambugu and Kiome, 2001). The technology shortened maturity time from 15 to 9 months, benefiting mainly women who tend the crop, thereby reducing the gender gap.

Banana currently accounts for more than a quarter of caloric consumption in countries such as Rwanda and Uganda, and the adoption of tissue-culture banana and its further dissemination engineered by the Africa Harvest Biotechnology Foundation International, a private non-governmental organization, is contributing to the economies of rural populations.

Soil Fertility

Leading scientists believe that replenishment of soil fertility will trigger rapid growth in African agriculture in the same way that improved germplasm ushered

in the Green Revolution in Asia (Borlaug and Doswell, 1994; Conway, 1997; Sanchez and Jama, 2000).

Joint research by the International Center for Research in Agro-Forestry (ICRAF) and national programs has found that a system involving improved 1–2 year fallow with nitrogen-fixing leguminous shrubs coupled, where available, with an application of local rock phosphate, effectively enhances soil fertility. This research result is currently being practiced by about 20,000 farmers in southern Africa with the possibility of quadrupling maize output (Sanchez and Jama, 2000)

Quality Protein Maize

Maize means survival for hundreds of millions of people in Africa. Quality protein maize (QPM) developed through traditional plant breeding by the International Maize and Wheat Improvement Center (CIMMYT) contains nearly twice as much usable protein as other types grown in the tropics, and yields 10% more grain. It can prevent malnutrition among millions of people in SSA and elsewhere. The varieties produce 70 to 100% more of the two essential amino acids, lysine and tryptophan—building blocks of proteins needed by all cells in the human body—than the most modern varieties of tropical maize.

For millions of people in West Africa, food means rice.

New Rices for Africa

For millions of people in West Africa, food means rice. Unfortunately, imported rice accounts for roughly 40% of local consumption (WARDA, 2001). The Green-Revolution successes in Asian rice proved difficult to transfer to SSA because the new varieties of rice, wheat and maize could not achieve their yield potential under African conditions. In 1991, researchers at the Africa Rice Center (WARDA) embarked on a wide-crossing exercise that led to the development of the New Rices for Africa (NERICAs): a range of varieties that combine the best traits of Asian and African species.

*NERICAs offer many advantages to farmers:
yield increases of 25 to 250% under farmers' conditions.*

The NERICAs offer many advantages to farmers: maturation in 90 to 100 days compared to 120 to 150 days for traditional varieties, less labor due to reduced weeding time, drought tolerance, and yield increases of 25 to 250% under farmers' conditions with minimum inputs.

NERICAs now occupy about 30,000 ha in Africa and are spreading rapidly to central and eastern Africa. The adoption of NERICA varieties, predicted to reach about 70% by 2006 (WARDA, 2004), is expected to save millions of dollars in rice imports and to increase farmers' incomes and overall well-being.

NEPAD has identified NERICA as one of Africa's best practices, worth scaling up and out, and has endorsed its expansion across the continent as part of its DONATA program to boost agricultural production and food security in SSA.

Absence of Large-Scale Impact of Successful Technologies

Good news is coming out of Africa. However, it is equally true that new or improved technologies that have shown great promise have not had the desired large-scale impact that would provide the necessary leap to African agriculture. The success factors mentioned above also provide some of the reasons for limited impact, one of them being lack of a proactive private sector to lead the development of large-scale farming toward an agricultural revolution.

Nonetheless, the above stories represent seeds of hope and are a good indicator of the tremendous potential of Africa's agriculture. As a vivid testimony to this potential, the leaders and researchers credited for four of these technological breakthroughs—cassava biological control, QPM, the soil fertility initiative and NERICA—were recipients of the prestigious World Food Prize in 1995, 2000, 2002 and 2004.

It is, therefore, fair to conclude that the lack of wide-scale impact of technology on Africa's agricultural development lies elsewhere, that science and technology are on the right track and the onus is on our political leaders and policymakers to provide conducive and favorable policies, a stable environment and the political will to sustain the adoption and dissemination of high-impact technologies.

AGRICULTURAL BIOTECHNOLOGY: POTENTIAL AND CONCERNS

Potential

Biotechnology is a powerful ally in agricultural research. It provides a variety of tools that are more precise, faster and allow scientists to improve plants and animal breeds in ways that conventional breeding can not. These include:

- tissue culture for improved and more rapidly available planting material,
- embryo rescue for crossing distant relatives that would not normally produce a viable offspring,
- anther culture that enables breeders to develop a complete plant from a single male cell,
- molecular markers to better understand genetic diversity in crops, livestock and their pests.

Thanks to markers, initial breeding can be done in a laboratory, saving the time and money required to grow several generations in the field.

For SSA, agricultural biotechnology can be especially valuable because it helps develop crops that need fewer expensive or otherwise unavailable inputs such as pesticides and fertilizers and vaccines for livestock. An important feature of this technology is that it is packaged in a convenient form: the seed. This is especially useful for resource-poor farmers. It means providing solutions for difficult problems.

Agricultural biotechnology can help boost crop productivity and enhance the nutritional content of staple foods. The latter is especially important in SSA, where more than half of the population suffers from micronutrient deficiencies, e.g. of vitamin A and iron. In short, food and nutritional security can be improved using biotechnology.

CONCERNS

Unfortunately, biotechnology has become synonymous with GMOs or transgenics, although these are only one aspect. For SSA, as in other parts of the developing world, economic, health and environmental issues are among the main concerns with respect to the use of agricultural biotechnology.

Very little research in transgenics is being conducted on subsistence crops of relevance to farmers in SSA.

Socioeconomic

The current focus of biotechnology research is on crops and diseases that are of economic relevance to developed rather than developing countries. Very little research in transgenics is being conducted on subsistence crops of relevance to farmers in SSA.

Most private-sector research focuses on solving problems faced by farmers in industrialized nations because that is how research costs can be recovered. SSA farmers need more drought tolerance in varieties of cassava, maize, sorghum, millet, and rice that are high-yielding and resistant to common pests and diseases.

Once such improved crop varieties are created, they must be within the purchasing power of the small farmer who has evolved complex, cheap and effective systems to save, exchange and use seeds from one harvest to the next. In such an environment, patented GM seeds are completely unsuitable, especially if they cannot be saved for replanting.

Patented GM genotypes, therefore, threaten to restrict the ability of small farmers to conserve, use and sell seeds, which would seriously impact their means of survival and increase their dependence on private monopolized agricultural resources.

Health

The second major concern regarding the use of biotechnology is that most SSA countries are not equipped to address any potential risks to human and animal health.

In 2002, Zambia rejected the GM maize that was offered by the United States as food aid to help an estimated 2.4 million people. Zambian experts cited the absence of conclusive evidence on the food's long-term effects on several factors, including human health, the country's long-term food-production capacity and impact on the environment and trade.

The health concerns in SSA echo those in other parts of the world. For example, in 2004, Monsanto suspended plans to introduce the world's first biotech wheat, bowing to protests from around the world. However, discussing environmental or ethical issues is hard with destitute people who have lost dignity and hope because they have nothing to eat.

Other Concerns

SSA lacks several key factors that are necessary for the region to fully harness biotechnology for its agriculture: appropriately trained scientists, good research facilities, proper biosafety regulations and efficient protocols for transformation and genomics. The high cost of biotechnology is also a serious constraint. At the same time, many leaders are concerned that Africa cannot afford to miss the biotechnology revolution.

ADDRESSING MAJOR CONCERNS AND CONSTRAINTS

Socioeconomic Concerns

It is true that the private sector dominates biotechnology research and needs intellectual property rights (IPR) and equity with respect to its products. But at the same time, it is in the private sector's interest to ensure that farmers in the developing world can afford their products. Novel partnerships are being formed between the private sector, donors and non-profit organizations to find common and acceptable grounds.

*The African Agricultural Technology Foundation's mission
is to acquire technologies through royalty-free licenses
along with associated materials and know-how for use on
behalf of SSA's resource-poor farmers.*

For example, the Rockefeller Foundation, the United States Agency for International Development (USAID) and the Department for International Development (DFID), are providing ways for North-South partnerships to open up African markets in a mutually beneficial and sustainable manner by facilitating the African Agricultural Technology Foundation (AATF), launched in 2003. AATF's mission is to acquire technologies through royalty-free licenses along with associated materials and know-how for use on behalf of SSA's resource-poor farmers, while complying with all laws associated with the use of these technologies. Four major biotechnology and agrochemical companies have agreed to freely share their technologies with African agricultural scientists through the AATF.

Specific technical challenges—improved nutrient uptake and rooting, biological nitrogen fixation, responses to carbon dioxide, tolerance to key environmental stresses, *etc.*—are difficult to handle through traditional breeding or simple biotechnology. Transgenics offer great possibilities, for example in addressing deficiencies in protein, vitamins and iron. Unfortunately, resistance to complex environmental stresses is governed by multiple genes, making it difficult to achieve even via genetic engineering. It will probably be a long time before farmers and consumers benefit from such research. Most of the short-term successes in biotechnology would be derived from marker-assisted breeding and diagnostics rather than from transgenic crops.

Contributions from the CGIAR Centers

The following are examples of biotechnology research projects by the CGIAR and SSA national agricultural research systems (NARSs) for smallholder farmers:

- HarvestPlus is a major global Challenge Program initiated by the CGIAR for addressing malnourishment using both conventional methods and biotechnology. The International Rice Research Institute (IRRI) is developing improved rice varieties enhanced in beta-carotene, iron and zinc, which would greatly benefit millions of people who depend mostly on rice.
- Researchers at WARDA where NERICA rice was developed are using anther culture and molecular-marker technology in collaboration with their partners to evaluate hundreds of varieties to exploit the genetic diversity present in indigenous rice, and transfer desirable genes from cultivated and related wild species into suitable varieties.
- Rosette virus disease is a scourge of groundnuts in Africa and no effective control has been found. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed transgenic groundnuts with a viral coat-protein gene; it is ready for testing in SSA.
- Similarly, the discovery of *Bt* toxins highly effective against the African sweet potato weevil—by the researchers of the International Potato Center (CIP) and their partners—will open the way to the development and deployment of transgenic sweet potato varieties in SSA.

- CIMMYT and its partners have been trying to develop varieties tolerant of *Striga*, a major parasitic weed of maize in SSA. A gene identified from maize itself offers the most exciting possibility.
- Grass pea is an important source of dietary protein for the poor in Ethiopia. Able to grow in harsh conditions and during drought, it is the only hope for the poor. However, it contains a neurotoxin that induces “lathyrism” or paralysis of the legs. Plant regeneration protocols have been used at the International Center for Agricultural Research in the Dry Areas (ICARDA) to obtain plants with low concentration of the neurotoxin through somaclonal variation.

Health and Environmental Concerns

Several African countries are signatories to the Cartagena Protocol on Biosafety, which deals with the conservation of biological diversity and the equitable sharing of benefits from the use of genetic resources.

The Protocol seeks to protect biological diversity from potential environmental risks posed by living modified organisms (LMOs) and GMOs resulting from modern biotechnology, taking into account risks to human health and focusing on trans-boundary movement of LMOs. It establishes an advanced informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the importation of such organisms.

The Program for Biosafety Systems (PBS) is another important initiative that has been established to assist national governments in studying the policies and procedures necessary to evaluate and manage potential harmful effects of modern biotechnology on the environment and human health. Awarded about \$15 million by USAID, the program’s unique approach addresses biosafety as part of a sustainable development strategy, anchored by agriculture-led economic growth, trade, and environment objectives.

Awareness remains the key to narrowing the gap between the public’s understanding and this rapidly advancing field of science. More transparency on the part of the organizations conducting biotechnology research or testing its products would reassure the public and other stakeholders.

Increasing Biotechnology Research Capacity in SSA

NEPAD has proposed a continent-wide network of Centers of Excellence in biosciences with four hubs: one in each of four sub-regions to develop the capacity of African scientists to conduct their own cutting-edge bioscience research and develop programs addressing high-priority problems. In 2003, the Biosciences Facility, hosted by the International Livestock Research Institute (ILRI) in Nairobi, Kenya, on behalf of NEPAD, was launched for East and Central Africa with CAN\$30 million funding from Canada. The core scientific competencies of the Biosciences Facility will be genomics, bio-informatics and their functional applications.

Technological innovation is just one piece in a large and complex mosaic.

CONCLUSIONS

From the foregoing, it is clear that technological options, both conventional and non-conventional, are available in Africa and to Africans for ensuring food and nutrition security while sustaining the environment. But the right solutions for the region require more than just technology. Science and technology alone will work no magic in SSA, nor will technology provide a “quick fix” to result in increased and sustained agricultural growth. Technological innovation is just one piece in a large and complex mosaic.

There are two essential pieces in that complex mosaic: The right leadership and a favourable external environment but with one common thread: a shift in paradigm.

New Forms of Partnerships

Africa features prominently on the G8 agenda. Sea Island was the third G8 summit in succession to which African leaders were invited for what is described as “dialogue”: a euphemism in this context for exchanging pious declarations and empty promises. The G8 has endorsed NEPAD and is on record that they would spend 0.7% of national income on development assistance. Yet aid to Africa has dropped on a *per-capita* basis from \$33 in the 1990s to \$20 today. At the G8 summit in Kananaskis, Canada, South African President Thabo Mbeki’s challenge for a Marshall Plan for Africa was met with deafening silence.

In response to Africa’s worsening food and political crisis, the United Kingdom recently created the International Commission on Africa to heal the scar of Africa’s poverty. The United States has embarked on a series of initiatives to fight hunger in Africa. Kofi Annan’s Water, Energy, Health, Agriculture and Biodiversity (WEHAB) initiative, the UN Millennium Development Goals (MDGs), their various task forces and a host of others run parallel to NEPAD’s development agenda that each is supposedly committed to support. So far, only Ottawa has provided funds to NEPAD. Where is the coordination?

Beyond immediate humanitarian aid, Africa needs long-term development assistance embedded within the framework of NEPAD. This type of assistance has helped Uganda to turn the corner on AIDS, has put more than a million Kenyan children in school and has helped sustain growth in Tanzania and Mozambique. This is where a definite shift in paradigm must occur, on how the North relates to the South.

Africa's solutions are in Africa.

African leaders should cease trooping to Washington, Tokyo, Ottawa, London, Paris, Bonn, Brussels, the Hague, *etc.*, to be lectured on how Africa's problems can be solved only to return home with empty promises. Africa's solutions are in Africa. If they must wine and dine with the G8, then they should aggressively negotiate with countries in the Organization for Economic Cooperation and Development (OECD) who spend close to \$1 billion/day on farm subsidies and impose trade barriers that cost SSA \$20 billion a year in exports and prevent Africa's poor farmers from participating in simple market economies in their own sub-regions.

Good Governance and Wise Policies

At independence, the new leaders of emerging African nation-states embraced the new form of western democracy modeled after their colonial masters in London, Paris, Brussels and Lisbon. They then proceeded to invest in building modern state capitals and administrative structures at the expense of rural development. That was the first mistake we made. Copying and imitation is not development. Development is a natural and intrinsic process, generated from within, phenotypically manifesting itself in the beauty of forms and cultures. It is homegrown, reflecting cultural values and our heritage. But we strove to become modern overnight, forgetting that the West had gone through centuries of development. Agriculture—once the backbone of our economies—was relegated to the background, if not altogether forgotten. Africa's food crisis was predictable 40 years ago. It is a simple but sad truth: at independence, Africa did not invest in agriculture and rural development!

The right solutions for SSA call for fundamental changes in the mindset both of leaders and followers: good governance, accountability, wise policies, improved infrastructure and the spirit of self-reliance. Billions of dollars of development assistance or a plethora of successful technologies cannot revive SSA's agriculture as long as there is widespread corruption, inefficient governance and lack of leadership and vision. Africa will benefit from technologies when agricultural policies are favorable and consistent, when there is political support at the highest level, and the technologies are nurtured and shepherded by the producers of the technologies.

Our governments have committed to spending at least 10% of their budgets on agriculture. It is a laudable step. Effective extension services and public-awareness campaigns must spread the word about improved technologies. "Farm lobbies"

*Our governments have committed to spending at least
10% of their budgets on agriculture.*

are urgently required for the region so that farmers can put political pressure on governments to support agricultural technologies, to institute policies that guarantee prices, create access to credits, inputs and markets, and establish equitable land-tenure systems and safety nets and subsidies to support vulnerable groups.

Rural Development

In the same vein, emphasis should shift to rural development, investment in rural infrastructure, including reliable power supply, good roads linking farmers to markets, and adequate communication facilities. Local agro-industries should be encouraged particularly in terms of post-harvest processing and the transformation of local produce into value-added products. These must not be done by governments, but should be devolved to the private sector. Only when domestic markets are viable and vibrant will competitive regional markets emerge and farmers will aspire beyond existing boundaries.

Women produce up to 80% of basic foodstuffs in Africa.

Governments continue to undermine the role of women in the agricultural sector. Women produce up to 80% of basic foodstuffs in Africa, yet our policies continue to marginalize them. Studies have clearly shown that when female farmers have access to resources such as land, credit, technology, training and marketing, they are more productive than their male counterparts. They invest in child health, nutrition and education and are better heads of single households than are men.

Investment in Human and Institutional Capacity Development

Africa's economic renewal and sustainable development will not be achieved without effective investment in science and technology. But Africa must also have its own capacity to generate these technologies. SSA should not remain just a client of technology. It must take an active part in it, both as an innovator and as a user as part of a holistic strategy for SSA's resurgence, so that the sub-continent can achieve the MDGs and usher in the "Doubly Green Revolution" called for by Gordon Conway (Conway, 1997).

We must, therefore, engage in massive investment in human capital and create institutions that will provide a conducive environment for our scientists. Human-capacity development without parallel favorable and conducive institutional environments have undermined our development efforts, and continue to encourage the steady erosion of our brain power into the diaspora, with thousands of frustrated skilled professionals migrating westwards and northwards for opportunities in the developed world. This loss in human capital has been estimated at 70,000 scholars annually while the region spends \$4 billion annually to recruit, educate and train 100,000 expatriate replacements (Ofori-Sarpong, 2003).

Self-Reliance

African people have a rare capacity for resilience and optimism. Centuries of oppression have not dimmed this extraordinary source of strength. And we have proof that when provided adequate resources, with the right leadership, with commitment and conviction, Africans are capable of remarkable achievements. But prophets are never recognized by their own people, which is why our leaders continue to look beyond their boundaries for advice and for development strategies hatched elsewhere and delivered by so-called experts.

We know of no country, no people, whose economic and political development was not an indigenous and intrinsic process, engraved in its own culture and adapted to the soil, climate and race.

We strongly believe that Africa's problems cannot be solved by its partners. The onus is on Africans themselves. For we know of no country, no people, whose economic and political development was not an indigenous and intrinsic process, engraved in its own culture and adapted to the soil, climate and race. Africans should decide for themselves what is best for them. A meaningful partnership begins only when we know what we want for ourselves. Only then would help from others add value to our efforts. We should select the most useful technologies, whether conventional or novel, push the frontiers of science and technology, harness the best of biotechnology and evolve the right policies for our needs so that we can benefit from the powerful economic forces of market liberalization and globalization.

The paradox of our times is to live in a world of plenty, with spectacular technological advances, yet witness millions trapped in tragic poverty. If African leaders continue to treat hunger, disease, and malnourishment as second priorities to building sports facilities and monuments, they should be brought before the International Court of Justice for crimes against humanity, crimes they have committed against their peoples over the past four decades.

ACKNOWLEDGMENTS

Information contained in this paper on the success stories and contributions of the CGIAR Centers to African agricultural research and development was provided by the centers. A draft of this paper was reviewed by Shellemiah O. Keya and Samuel Bruce-Oliver who also contributed to its finalization.

Views expressed in this paper are those of the authors and not of the CGIAR nor of the Africa Rice Center (WARDA)

REFERENCES

- Borlaug N Doswell CR (1994) Feeding a human population that increasingly crowds a fragile planet. In: Supplement to Transactions 15th World Congress of Soil Science. Chapingo: International Society of Soil Science.
- Conway G (1997) *The Doubly Green Revolution: Food For All in the 21st Century*. London: Penguin Books Ltd.
- Economic Research Service of the United States Department of Agriculture (ERS/USDA) (2000) Food Security Assessment Project, December 2000. Washington, DC: United States Department of Agriculture.
- Herren HR Neuenschwander P (1991) Biological control of cassava pests in Africa. *Annual Review of Entomology* 36 257–283.
- Noorgard RB (1988) The biological control of cassava mealybug in Africa. *American Journal of Agricultural Economics* 70 366–371.
- Ofori-Sarpong E (2003) Effects of Brain Drain in National Development. Accra: Ghanaian Chronicle.
- Pinstrup-Andersen P Pandya-Lorch R (1999) Securing and sustaining adequate world food production for the third millennium. In: NABC Report 11: World Food Security and Sustainability: The Impact of Biotechnology and Industrial Consolidation (Weeks D *et al.* Eds). Ithaca: National Agricultural Biotechnology Council.
- Qaim M (1999) A socioeconomic outlook on tissue culture technology in Kenyan banana production. *Biotechnology and Development Monitor* 40 18–22.
- Rosen JE Conly SR (1998) Africa's population challenge. Washington, DC: Population Action International.
- Runge CF *et al.* (2003) *Ending Hunger In Our Lifetime: Food Security and Globalization*. Baltimore: The Johns Hopkins University Press.
- Sanchez PA Jama BA (2000) Soil fertility replenishment takes off in east and southern Africa. International Symposium on Balanced Nutrient Management Systems for the Moist Savanna and Humid Forest Zones of Africa, Cotonou, Benin, October 2000.
- Sanchez PA *et al.* (1997) Soil fertility replenishment in Africa: an investment in natural resource capital. In: *Replenishing Soil Fertility in Africa* (Buresh RJ *et al.* Eds.). Madison: Soil Science Society of America and American Society of Agronomy.
- Joint United Nations Program on HIV/AIDS (UNAIDS) (2000) Report on the Global HIV/AIDS Epidemic. Geneva: World Health Organization.
- United Nations Economic Commission for Africa (UNECA) (2004) Press Release No. 12/2004. Addis Ababa: UNECA.
- UN Population Division (2001) *World Population Projections. The 2000 Revision: Highlights*. New York: United Nations.
- Wambugu F Kiome R (2001) The Benefits of Biotechnology for Small-Scale Banana Farmers in Kenya. ISAAA Briefs No. 22. New York: ISAAA.

- WARDA (2001) *Bintu and Her New Rice for Africa: Breaking the Shackles of Slash-and-Burn Farming in the World's Poorest Region*. Bouake: WARDA.
- WARDA (2004) *Annual Report 2002–2003*. Bouake: WARDA.
- World Health Organization (WHO) (2001) *World Health Report 2001, Mental Health: New Understanding, New Hope*. Geneva: WHO.
- World Bank (2002) *Africa Database 2002*. Washington DC: World Bank.
- World Bank (2003) *African Development Indicators (ADI) 2003*. Washington DC: World Bank.
-



KANAYO F. NWANZE has served as director general of the West Africa Rice Development Association—now known as the Africa Rice Center—since December 1996. The Africa Rice Center is an autonomous intergovernmental agricultural research association of African member states and one of fifteen international agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR). Dr. Nwanze has 30 years experience in international

agricultural research, research management, and development work in sub-Saharan Africa (anglophone and francophone countries) and Asia, at CGIAR Centers in Niger, Nigeria, Congo (DRC), Burkina Faso, and India.

He has published extensively and is a member of several scientific associations and a board member of several Africa-based institutions. In 2001, he was conferred with the title of “Commander of the National Order of Merit of Côte d’Ivoire” in recognition of his outstanding leadership of the Africa Rice Center and service to the West African sub-region.

He is the current chair of the Center Directors Committee that groups the directors general of the fifteen centers supported by the CGIAR. Nwanze holds a BSc in Agricultural Biology from the University of Ibadan, Nigeria, and MS and PhD degrees in entomology from Kansas State University.