Chapter 28

Promoting science, technology and innovation for sustainability in Africa

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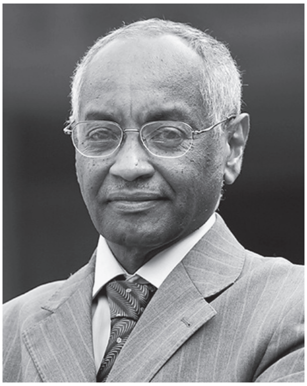

Mohamed H. A. Hassan, a native of Sudan, obtained his PhD in plasma physics from Oxford University in 1974. He taught at the University of Khartoum, Sudan, and was Dean of the School of Mathematical Sciences. His research areas include theoretical plasma physics, and the physics of wind erosion and sand transport. Hassan is President of the African Academy of Sciences. As Executive Director of the Academy of Sciences for the Developing World (TWAS) and the InterAcademy Panel (IAP), Hassan has promoted capacity building in science and technology in developing countries through a variety of South-South and North-South collaborative programmes. In collaboration with other partners, TWAS actively advances the scientific understanding of climate change vulnerability and adaptation options in developing countries.

This essay focuses on the challenges and opportunities for promoting science-, technology-, and innovation-based sustainability in Africa. That continent's recent history is punctuated by initiatives that began with high hopes; initiatives that were characterized by lofty declarations and detailed blueprints for action; initiatives, that received warm, enthusiastic applause at their inception, but were soon forgotten, only to be resurrected in the context of subsequent initiatives that followed a similar trajectory of hope and disappointment. The Potsdam Symposium took place during Africa's most sustained period of economic growth in decades. Between 2000 and 2003, Africa's annual gross domestic product (GDP) increased by 3.7 %. Between 2004 and 2006, the continent's annual GDP growth accelerated to 5.6 %. This has spurred an unprecedented sense of hope on the continent. Could things be different this time? Will Africa finally chart a course to sustained development? One that is designed and implemented by the people of Africa? One that achieves an unparalleled level of sustained economic progress?

Today there is growing consensus that progress will take place only if Africa designs and implements its own developmental agenda. Partners are encouraged to join the continent's efforts in sustainable development. But Africans are now determined to take the lead and to decide for themselves what is best for Africa. And they may finally be acquiring the resources, knowledge, and power to do just that. But we also need to remember that, for all of the good news, dark shadows of despair stubbornly persist. More than 40 % of sub-Saharan Africa's population – nearly 300 million people – continue to live in extreme poverty. Africa is the only continent where not a single country will meet all of the eight Millennium Development Goals (MDGs), and where most countries will not meet a single one. Poverty, disease, and degradation continue to plague the continent. As a result, progress remains tentative and perhaps unsustainable. Tensions are high. In many countries, the spectre of lawlessness and violence is constant. In short, we must not confuse aggregate economic growth with economic and social well-being. One can clearly exist without the other. Africa's situation is a case in point.

Yet, there are reasons for hope. In addition to steady annual growth in Africa's GDP, another promising trend deserves our attention: For the first time in more than a quarter century, African leaders are embracing indigenous capacity building in science, technology and innovation (STI) as strategic elements for economic growth and social well-being. If they succeed – and if such skills can become part of Africa's entrepreneurial spirit – then it may indeed be possible for the continent to chart a permanent path to sustainable development.

The STI landscape

Africa's limited but encouraging progress in science and technology capacity building cannot be fully appreciated without examining broader developments in science and technology capacity building in the developing world. The reality is that some developing countries have invested more in STI, while others have lagged behind. This has led to another development gap. In addition to the historic gap between developed and developing countries, there is now a South-South divide. Today, a more refined categorization of countries has emerged that better reflects their relative strengths in STI.

First, there are countries with strong STI capacity. These number about 25, largely consisting of countries that belong to the OECD (the Organization of Economic Co-operation and Development). They enjoy across-the-board strengths in all areas of science and technology, and have the capacity to convert scientific and technological knowledge into products and services that boost their economies. These countries are rich in STI, and they are financially well-off.

Second, there are countries with moderate STI capacity. These countries, which number about 90, include some of the largest countries in the developing world – China, India and Brazil. But the list includes others as well: Argentina, Chile, Malaysia, Mexico and South Africa, to name just a few. It is a diverse group with wide-ranging capabilities. The majority of these countries are competent in a select number of fields. But broad pockets of weakness remain. The scientific infrastructure (including classrooms and laboratories), although improving, still lags behind the quality of instruction and equipment found in countries with strong STI capacities. The ability of these 90 countries to bring their scientific knowledge and technical know-how to the marketplace is weak, although recent indicators suggest that this transition is becoming less problematic in a few countries. In February 2007, for example, the World Intellectual Property Organization (WIPO) reported that while the United States still leads the world in patent applications, Asia is rapidly catching up. China filed nearly 4000 patent applications in 2006, more than double the year before.

But there is also a third category of countries, and these countries have weak STI capacity. A survey conducted by the Academy of Sciences in the Developing World (TWAS) has identified 80 such countries, the majority of them in Africa. These countries have very limited capacity in any field of science and technology. They have poor teaching facilities and substandard laboratories. And they have scant ability to convert their knowledge and expertise into products and services, especially products and services that can compete in the international marketplace. These countries also lack the capacity to participate in cutting-edge scientific endeavours. Many of their most promising young scientists have migrated to other countries to pursue their careers. Moreover, in most of these countries there is minimal government support for STI. More generally, there is the absence of a culture of science.

Africa and the MDGs

Expanding the reach of STI to countries that have been left behind is one of the most critical problems of our time. But it is by no means the only one. In our interconnected world, where the Internet and airline travel have truly transformed our planet into a global community, no country remains unaffected by the problems that beset other countries. That is the message of the United Nations MDGs. The goals set targets to address the world's most pressing problems – problems that impede sustainable well-being in the developing world, and that threaten global peace and prosperity: poverty; hunger; the spread of infectious diseases; poor education; gender inequality; and lack of access to safe drinking water, sanitation, and energy.

Experts agree that the MDGs will not be met unless special attention is paid to the well-being of Africa. More than 40 % of all Africans do not have access to safe drinking water. More than 70 % do not have access to electricity. Twenty-five million Africans are infected with HIV. Ninety percent of the world's malaria infections occur in Africa. And more than 30 million African children go to bed hungry every night. Africa may be poor, but it is not small. Its land mass, which is more than 20 % of the Earth's land mass, covers an area larger than Australia, Brazil, Europe, and the United States combined. And Africa may be weak, but it is home to some 920 million people. That's more than three times the population of the United States and twice the population of the European Union.

Africa, in short, may be poor and weak, but it cannot be ignored. In many respects, the future of our planet lies with the future of Africa. Africa is where global attention must be focused if we are to make progress in meeting the MDGs. But that still leaves the question of what tools must be employed for our efforts to succeed. The MDGs will not be met without strong capacity to generate and utilize STI, and without vigorous and sustained international partnerships to help build this capacity. As the MDGs indicate, the vast majority of these problems are related to poverty, inadequate education, poor health, and degraded environmental conditions, all of which undermine Africa's ability to meet the basic human needs of the majority of its people.

Other global issues that affect the developed and the developing worlds in equal measures are growing in significance. Climate change is at the top of this list. But there are also issues related to energy security, access to adequate supplies of drinking water, and the over-exploitation of such natural resources as fisheries and forests. Reducing the gap between rich and poor countries, and ensuring that the most critical global issues are tackled with tools that only global STI can provide, are daunting challenges. These challenges will not be met without a critical mass of well-trained scientists in all countries.

Brain drain and brain mobility

Today, experts estimate that more than half of the scientists who have been educated and trained in universities in sub-Saharan Africa have migrated to the United States. Experience has shown that brain drain cannot be stopped unless the most talented scientists find favourable working conditions in their homelands. Once a scientist has established roots in another country, it is difficult to lure him or her back home.

Science is a global enterprise. Excellence in science has always depended on the ability of scientists to associate freely with their colleagues around the world. Such movement not only benefits international science, but also serves to deepen international understanding – a welcome by-product in today's troubled world. Yet, as we all know, the free movement of scientists, especially to the United States, has been severely restricted since the events of September 11. The scientific community fully recognizes that security interests take precedence over scientific exchange. Nevertheless, it also realizes that scientific exchange is an important instrument in the fight against ignorance, suspicion, despair, and terrorism. The US State Department, urged by the US National Academy of Sciences and others, has recently taken steps to ease the difficult process of entry into the United States for scientists travelling from abroad. But many scientists, particularly from Africa and the Islamic region, hope that more can be done. A major challenge impeding both international scientific cooperation and scientific capacity building in many countries of Africa is this: How can governments in scientifically advanced countries be persuaded to ease visa restrictions for African scientists to ensure their full participation in global science and R&D programmes?

The Internet and other forms of electronic communication have revolutionized the way in which scientific information is distributed and, increasingly, reviewed, edited, and published (see Sulston, this volume). These trends have had an enormously positive impact on global science. Never before have scientists enjoyed access to such an extensive amount of current information. Never before have scientists been able to communicate so easily and directly with colleagues in other parts of the world. And never before has international scientific collaboration been so easy to plan, organize, and implement. But African countries, particularly the continent's least developed countries, do not have sufficient resources to build and maintain up-to-date electronic communications systems. Broadband width is still too narrow in much of Africa, and expensive on-line subscription rates still prevent many African scientists from accessing the most current literature.

African leaders show the way

These obstacles have led Africa's leaders to make increasing commitments to both research and development and regional cooperation in science and technology. For example, at the African Union (AU) Summit, held in Addis Ababa in 2006, African leaders discussed regional strategies for the promotion of science and technology and announced that 2007 would be the year of 'African scientific innovation'.

Political leaders in Africa have on several occasions expressed support for science and technology. But their meetings were followed by meagre results and disappointment. The level of commitment – and enthusiasm – expressed at the AU Summit in Addis Ababa seemed different and likely to lead to concrete results in the following years. Leaders at the AU Summit strongly recommended that each African country should spend at least 1% of its GDP on science and technology. Such a recommendation had been made several times before. Following the AU Summit, however, it actually began to be fulfilled. Several African countries, most notably those that have also embraced democracy and good governance, have increased their investments in science and technology. These countries include Ghana, Kenya, Nigeria, Rwanda, South Africa, Tanzania, and Zambia. Yet, their number is still too small.

At the AU Summit, the president of Rwanda, Paul Kagame, announced that his country has dramatically boosted expenditures on science and technology, from less than 0.5% of GDP in previous years to 1.6% starting in 2006. He also announced that his country would increase investments in science and technology to 3% of GDP over the next five years. That would make Rwanda's investment in science and technology, percentage-wise, comparable to that of South Korea, and higher than that of most developed countries. A nation that was teetering on the verge of collapse less than a decade ago, and that still lives in the shadow of genocide, has embarked on a path to science-based sustainable development.

Working with Africa

What makes the prospects for building science and technology capacity in Africa even more encouraging is that Africa is not alone in this effort. Over the past several years, there have been increasing commitments by governments in the developed world to support STI in low-income countries, and especially in Africa.

At the G 8 Summit in Gleneagles, Scotland, in 2005, G 8 member countries unanimously pledged to provide USD 5 billion to help rebuild Africa's universities and an additional USD 3 billion to help establish centres of scientific excellence in Africa. The decision was greeted with enthusiasm in Africa and throughout much of the world. Yet, in 2007, G 8 member countries had officially authorized only

USD 160 million of funding, targeted for the creation of networks of centres of excellence proposed by the AU's New Partnership for Africa's Development (NEPAD). Equally distressing was the fact that little of this money had actually been transferred to Africa. The 'Science with Africa' initiative must continue to urge G 8 countries to fulfil the pledges that they made in Gleneagles and that were reconfirmed in subsequent meetings. Upcoming summits will provide yet another opportunity for the world's leading economic countries to live up to their word.

The World Bank, through the Science Institutes Group (SIG), headquartered at the Institute for Advanced Study in Princeton, New Jersey, has provided loans for the creation of scientific centres of excellence – so-called Millennium Science Institutes – in Brazil, Chile, Turkey, and Uganda. The institutes offer scientists from developing countries an opportunity to conduct world-class research and to pursue cooperative projects with colleagues in a broad-range of scientific fields. Several foundations have also given substantial support to science-poor countries in Africa through programmes that emphasize scientific and technological capacity building. Many of these efforts have focused on education and training for young scientists in the world's least developed countries. Rising levels of scientific excellence in developing countries – most notably, Brazil, China, India, and South Africa – have opened up new opportunities for South-South collaboration in education and research. These include the following:

- Agreements have been signed between TWAS and the governments of Brazil, China, and India, providing more than 250 scholarships a year for graduate students and postgraduate researchers in poor developing countries to attend universities in the donor countries. TWAS pays for the airline ticket. The host countries pay for all other expenses, including accommodation. This is the largest South-South fellowship programme in the world.
- Brazil's pro-Africa programme supports scientific and technological capacity building in the Portuguese-speaking countries of Angola and Mozambique. The programme includes research collaboration activities with Brazilian institutions.
- China's Development Fund for Africa, approved in 2006, will provide USD 5 billion over a five year period to assist African countries in achieving the MDGs through cooperation with China.
- The India, Brazil and South Africa (IBSA) tripartite initiative, signed by the respective ministers of science and technology, will provide funds to engage in joint problem-solving projects that focus on developing products with commercial value.

Agenda for action

In light of these trends, what must African countries and their partners do to promote STI? First, African countries must institute educational reforms that make science more interesting and attractive to young people. This means devising a more hands-on approach to scientific study in the classroom, emphasizing 'learning by doing' rather than the rote memorization that has historically characterized the teaching of science, especially biology in Africa. The initiative *La main à la pâte*[1], launched by the French Academy of Sciences a few years ago, has become a much-emulated strategy for educational reform in science. The results have been encouraging, providing a blueprint for success that others can follow.

Second, African governments must support programmes to increase scientific literacy among both children and adults. Rapid advances in science mean that science education must be a lifelong endeavour. The media can play a vital role in this effort. For example, the London-based electronic portal SciDev.Net, which is supported by a host of aid agencies and foundations, and which receives valuable assistance from Science and Nature magazines and TWAS, has helped raise global awareness of science and economic initiatives in the developing world.

Third, African universities must be reformed and strengthened. Each African country must have at least one world-class research university that sets national standards for quality education and research, and attracts the best and brightest students. World-class universities in Africa can play a critical role in advancing science and technology, both in Africa and internationally.

Fourth, African countries must train a new generation of problem-solving scientists, and turn science into a demand-driven exercise in which research questions are often determined by critical social and economic needs. The 'sustainability science' initiative, launched by a group of scientists several years ago, has proven to be a valuable first step in drawing science closer to society. But much more needs to be done.

Fifth, African countries must build and sustain scientific centres of excellence. This is especially important for the poorest developing countries where a culture of scientific excellence has yet to take hold. The G 8 pledge made in 2003 to provide USD 3 billion over 10 years to help build scientific centres of excellence remains an unfulfilled promise.

Sixth, African and other developing countries must learn to share their 'successful experiences' in the application of science and technology to address critical social and economic needs. The developing world's efforts in this regard have been largely hidden from view, but thanks to the work of such organizations as TWAS

[1] The closest English equivalent to this French expression is 'hands-on experience'

and the UNDP's Special Unit for South-South Cooperation, information about developing-world, science-based initiatives that have successfully addressed critical issues related to poverty, public health, and the environment, are now reaching larger audiences both in the developed and developing world.

Seventh, African countries must bolster their merit-based science academies. These academies often include a nation's most prominent scientists. Yet, they have often been relegated to the status of genteel men's clubs, and have failed to play a prominent role in national discussions related to science-based policy issues. The Network of African Science Academies (NASAC), the InterAcademy Panel on International Issues (IAP), and other institutions are actively seeking to change this mindset and to strengthen the capabilities of academies, especially when it comes to interacting with policy-makers.

Eighth, African countries must follow the example of other countries in establishing and supporting science foundations that provide merit-based, competitive grants to scientists and scientific institutions. In Africa there is only one nation – South Africa – with such a foundation in place. More countries should adopt this strategy.

Ninth, for too many years Africa has lamented the loss of scientists who were trained in their own countries but who subsequently pursued their careers in the North. As China and India have shown, this brain drain can be turned into a 'brain gain' by devising effective strategies to engage a nation's scientific diaspora for the benefit of their home countries. Scientific exchange programmes, visiting professorships, and joint research projects are examples of South-North scientific cooperation that can be advantageous for both scientifically proficient and scientifically lagging countries.

Tenth, the majority of African countries do not have sufficient resources and expertise to build and maintain up-to-date electronic communication systems. The 'Science with Africa' initiative should help African scientists gain electronic access to the most current scientific literature.

Conclusions

What does all of this rush of activity add up to? Is it just another episode of fleeting interest in countries and people that have been left behind? Or are we entering a new era marked by sustained investment in STI in Africa? I believe that we have more reason for optimism than cynicism. Indeed, I believe that we may be witnessing a transformational moment in the promotion of STI for sustainability in Africa. But for us to seize this moment, we need to develop and implement an action agenda designed to sustain – and expand – broad-based efforts for capacity building in STI in Africa.

The tripolar world of science and technology – anchored in the United States, Europe, and Japan – is being transformed into a multipolar world of science marked by the growing capabilities of Brazil, China, India, Malaysia, South Africa, and others. The critical issue is this: As the list of developing countries that gain strength in science and technology grows in the coming years, will Africa also join the fold?

The chances for success have rarely been brighter. At the same time, the consequences of neglect and indifference have rarely been more troubling. Africa, with the help of the international community, must seize the moment. If it doesn't, the promise of Africa will again remain unfulfilled with consequences that extend far beyond the continent. This course should not only boost Africa's economy and build the continent's scientific and technological capacity. It should also be designed to help reduce poverty and improve the lives of the hundred of millions of impoverished Africans.