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AS THE RECENT FINANCIAL MELTDOWN HAS SHOWN, UNCONSTRAINED MONEY FLOWS COURSING THROUGH THE BROAD, POROUS CHANNELS OF INTERNATIONAL FINANCE CAN QUICKLY RUN DRY – LEAVING THE WORLD THIRSTY FOR CAPITAL.

What do these discouraging trends mean for science and technology, especially in the developing world? And how can countries avoid repeating the mistakes of the past?

Downturn up

The global economic downturn is expected to drastically reduce bilateral investments in universities and research centres in developing countries. Foundations, with much smaller endowments (in some cases 30% to 40% smaller) than last year, are bound to make fewer grants for scientific training and exchange. At the same time, private capital inflows to developing countries are projected to fall from more than USD900 billion in 2008 to USD165 billion in 2009. With a USD585 billion government bailout in place in China and a USD787 billion government bailout in place in the United States, it is likely that much of the world's capital in the near future will remain inside the borders of the most capital-rich countries. That will mean less money for scientific infrastructure and technological development in the developing world. Innovation, including innovation designed to address social and economic challenges in developing countries, could fall sharply.

In light of these worrisome trends, it might seem that the near future looks dim for science, especially for science in the developing world.

The greatest risk, however, may not lie in the crisis itself but in the response to the crisis. Will the world's poorest countries, particularly those in sub-Saharan Africa, repeat the same mistakes that they made in the 1980s? That's when a steep economic decline, spurred by daunting budget deficits and relentless demands by international lending agencies for 'fiscal responsibility', led governments in sub-Saharan Africa to drastically cut the budgets of their universities and research centres. The result was that Africa, home to some of the developing

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world's best universities in the 1970s, became the continent with the world's worst universities, a quick reversal in fortune that took just a decade to unfold.

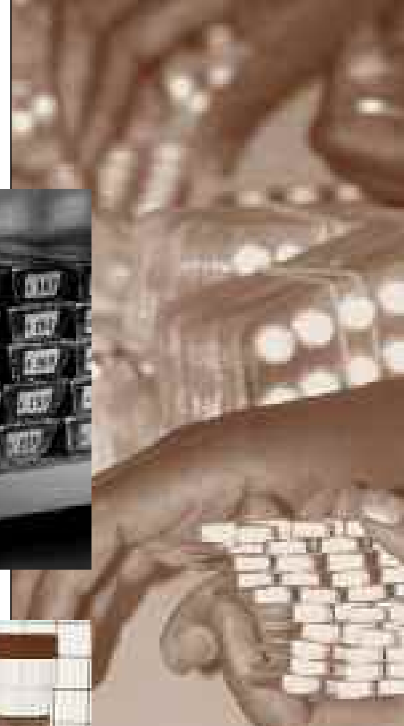
Sub-Saharan Africa has yet to recover from these fateful decisions. Short-sighted steps to deal with the immediate economic crisis led to a steep loss in the region's intellectual capital and a long-term decline in the region's economic and social well-being.

In response to the current global economic crisis, the developing world, and particularly sub-Saharan Africa, would do well to follow the example of Asia in the 1990s. There, countries refused to undermine their universities and research centres despite a currency crisis that shook the foundations of their economies. Throughout the crisis, Asian nations continued to provide – and, in some cases, to increase – financial support for science and technology. The brevity of Asia's currency crisis failed to test the full measure of the governments' commitments. Nevertheless, it is heartening to recall that these nations decided to continue to invest money in science and technology as an integral part of their long-term strategies for sustainable economic growth.

Today, developing countries have two other examples to draw on when considering how to respond to the global economic crisis. The governments of the United States and China, both facing major economic challenges of their own, have endorsed – and plan to diligently pursue – heavy investments in science and technology as critical elements in their overall strategies for reviving their nations' economic well-being. It is our hope that other countries, especially developing countries, will do likewise.

There is no doubt that one of the challenges facing developing countries in the months ahead is whether they will continue to invest in science and technology despite their slowing economies. Will more pressing social and economic matters compel them to cut back on such investments? Will the recent progress that has been made in building scientific and technological capabilities, in countries as diverse as Chile and Rwanda, be stymied – and perhaps

even reversed – by the immediate demands imposed by a global financial crisis? Will declining investments in science and technology also adversely impact South-South cooperation in science and technology, another recent trend that has helped propel science-based development in developing countries?



The current financial crisis, of course, is not for the scientific community to fix. But, like every other sector of society, the global scientific community has a big stake in the outcome. In the balance lies a future where scientific and technological capabilities continue to grow (or not) and, ultimately, where economic development continues to take place (or not).

Given the severe economic jolts that the world has experienced over the past year, no one can predict what lies ahead. But this much we know: previous divides between developed and developing countries are giving way to a world of shared anxieties.

If we are lucky – and, more importantly, wise – this crisis could reaffirm national efforts to build strong foundations for sustained development based on investments in science, technology and innovation. Recent history tells us this is the right thing to do – and recent history also tells us that this has not always been done. ■

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TWAS IN AFRICA

TWAS HAS FIVE REGIONAL OFFICES AND EACH PLAYS AN INCREASINGLY IMPORTANT ROLE IN ADVANCING THE ACADEMY'S GOALS FOR BUILDING SCIENTIFIC AND TECHNOLOGICAL CAPACITY IN THE DEVELOPING WORLD. IN THE FOLLOWING ARTICLE, THOMAS EGWANG (TWAS FELLOW 1997) AND JACKIE OLANG OUTLINE THE WORK OF THE ACADEMY'S REGIONAL OFFICE FOR SUB-SAHARAN AFRICA.

The TWAS Regional Office for Sub-Saharan Africa (TWAS-ROSSA) was launched in 2004, following the signing of a memorandum of agreement between TWAS and the African Academy of Sciences (AAS). In line with the agreement, AAS coordinates and promotes the Academy's agenda in sub-Saharan Africa, largely focusing on raising awareness among the region's scientists for the numerous fellowships, grants, awards and prizes that are sponsored by TWAS and TWAS-ROSSA. The agenda also focuses on fostering public support for science and technology and on highlighting the achievements of African scientists both within Africa and throughout the world.

The relationship between TWAS and the African Academy of Sciences (AAS) runs deep. Abdus Salam, TWAS's founding president, and Thomas Odhiambo, founding president of AAS, were both iconic figures in the annals of science and technology in the developing world in the late 20th century. Equally important, they were close friends who shared the same vision, commitment and enthusiasm for building scientific and technological capacity to enhance the economic and social well-being of hundreds of millions of people in the South.

Thanks largely to the combined efforts of Salam and Odhiambo, the blueprint that led to the creation of the AAS was formulated in 1985 at one of the most significant meetings ever organized by TWAS. The ties between AAS and TWAS remained strong throughout AAS's early years, marked by a continuous exchange of ideas and a number of joint ventures. Some 15 years AAS's inception, Mohamed H.A. Hassan, executive director of TWAS, was elected president of AAS in 2000, succeeding Odhiambo. Hassan has held the post since then.

The shared values and decades of collaboration between TWAS and AAS made AAS in Nairobi an ideal place to locate the secretariat of TWAS-ROSSA. The long-standing relationship between TWAS and AAS also ensured that TWAS-ROSSA would serve as an important link between the two science academies, each of which has earned a well-deserved reputation for the promotion of scientific and technological capacity in the South.

MANDATE

TWAS-ROSSA is responsible for a broad range of activities, including:

- Identifying and nominating scientists, especially young scientists, in the region for TWAS membership, awards and prizes.
- Organizing meetings, symposia and lectures on issues related to

YOUNG AND PROMISING

TWAS-ROSSA Young Affiliates are:

- *In 2008: Archana Bhaw-Luximon (chemistry), University of Mauritius; Albert Thembinkosi Modi (agriculture), University of KwaZulu-Natal, South Africa; Luna Kamau (molecular entomology), Kenya Medical Research Institute; Ola Safiriyu Odowu (animal reproductive physiology), Obafemi Awolowo University, Nigeria; Daud Kassam (fisheries ecology), Bunda College of Agriculture, Malawi.*
- *In 2007: Benedict Taele (condensed matter physics), National University of Lesotho; Emeka Oguzie (physical chemistry), Federal University of Technology, Owerri, Nigeria; Negussie Beyene (analytical chemistry), Addis Ababa University, Ethiopia; Aderoju Osowole (physical chemistry), University of Ibadan, Nigeria; David Ramanitrahasimbola (pharmacology),* Institut Malgache de Recherches Appliquées *in Antananarivo, Madagascar.*

TWAS-ROSSA Prize Winners are:

- *Christina Scott, a science journalist who served as the first African news editor of the web portal* scidev.net *– 2007 Prize for Improving Public Understanding of Science.*
- *Moyra Keane, academic advisor in the science faculty at the University Witwatersrand in South Africa – 2008 Prize for the Development of Educational Material and School Science Curricula.*

For additional information about TWAS-ROSSA young affiliates and prize winners, see www.nairobi.twas.org.

science, technology and sustainable economic development for both the scientific community and public.

- Enhancing TWAS's visibility in the media.
- Managing a website that provides information about the regional office and, more generally, TWAS.

YOUTHFUL OUTLOOK

One of TWAS-ROSSA's most important functions is to serve as a forum for Africa's young scientists. And one of the key strategies for advancing this goal is the sponsorship of annual conferences that provide opportunities for the region's most promising young scientists to discuss their research both before their peers and in large public settings. The conferences, which began in 2006, also call on Africa's senior scientists to serve as mentors for their younger colleagues.

Major themes that have been explored at the conference include the effective use of science and technology to address critical social and economic needs (2006), innovative applications of research and development (2007), and research initiatives to spark the development of renewable energy (2008). While the research draws on global scientific findings and perspectives, the focus is always on Africa. The next conference, to be held later this year, will examine the prospects for increasing the number of science and technology enterprises in Africa both in the public and private sectors.

In addition to the conferences, TWAS-ROSSA recognizes and honours deserving young scientists either by selecting them as TWAS Young Affiliates and/or awarding them prizes that are jointly sponsored by TWAS and the regional office.

Five Young Affiliates are appointed each year for a five-year period during which time they are given an opportunity to attend TWAS general meetings and are sent TWAS publications. TWAS-ROSSA prizewinners receive a check for USD3,000 to support their research efforts. (For a complete listing of TWAS Young Affiliates and prizewinners from the region, see box on this page). The selection process is highly competitive, ensuring that those who are chosen are among the most eminent young scientists in Africa.

NETWORKED NATIONS

TWAS-ROSSA also strives to enhance the activities of TWAS's national chapters in Africa, largely by supporting chapter initiatives for capacity building within each member country. While short-term

goals concentrate on providing educational and training opportunities, long-term goals also include generating increased public awareness and appreciation for the role that science can play in national economic development efforts.

With the help of TWAS-ROSSA, national chapters host public lectures given by TWAS members in Africa and encourage discussion groups and exhibitions as well.

TWAS national chapters in Africa are located in: Ghana, at the Institute of Mathematical Sciences in Accra; Madagascar, at the National Institute for Nuclear Sciences and Technology in Antananarivo; Senegal, at the *Académie des Sciences et Techniques du Senegal* in Dakar; and Zimbabwe, at the Scientific Industrial Research and Development Centre in Harare. In the years ahead, TWAS-ROSSA hopes to launch additional chapters in other countries in the region.

TWAS-ROSSA-sponsored public lectures have often been held in collaboration with other scientific institutions and universities, including AAS, the University of Nairobi and the International Centre for Insect Physiology and Entomology (ICIPE) in Nairobi; the University of Maseno in Kisumi, Kenya; and *Académie des Sciences et Techniques du Senegal*.

Among the outstanding African scientists who have given talks are Peter Anyang Nyongo, minister for medical services in Kenya; George Magoha, vice chancellor at the University of Nairobi; Bethwell A. Ogot, professor emeritus of history at the University of Maseno; and Salif Diop, senior environmental affairs officer at the United Nations Environment Programme (UNEP).

ADVANCING THE GAINS

TWAS-ROSSA, founded in 2004, is the second youngest of the Academy's regional offices – only the Arab regional office at the *Bibliotheca Alexandrina* in Alexandria, Egypt, is younger. TWAS-ROSSA operates in a region that is universally recognized by policy experts and researchers alike as the one most in need of scientific and tech-

DISCOVERY AND INNOVATION

TWAS-ROSSA, in collaboration with AAS and TWAS, supports the publication and dissemination of the peer-reviewed, multidisciplinary journal, Discovery and Innovation.
Launched in 1989, Discovery and Innovation *has become one of the most respected international journals in science published in Africa. It serves as a valuable source of information about scientific and technological developments on the continent and as a critical publication outlet for Africa's scientists and scholars, covering disciplines ranging from agriculture to space science. For more information, see* www.nairobi.twas.org.

nological capacity building efforts. Indeed in a recent survey conducted by TWAS, of the 80 countries that the Academy identified as scientific and technological lagging, 43 were in sub-Saharan Africa. Meanwhile, of the 50 countries that the United Nations Development Programme (UNDP) has identified as least developed countries (LDCs), 34 are located in sub-Saharan Africa. Not surprisingly, many of the same countries are on both lists.

Yet, despite this bleak picture, there is reason for guarded optimism. Over the past decade a number of African countries have begun to make significant investments in science and technology, including, for example, Ghana, Tanzania, Rwanda, Senegal, South Africa and Uganda. And these investments have begun to pay off. Before the recent global economic downturn, the average annual increase in the continent's gross domestic product exceeded 5% between 2002 and 2007. This represented the longest period of sustained economic growth in Africa in more than 40 years.

TWAS-ROSSA is proud of the modest contributions it has made to this effort not only as a respected voice for scientific and technological capacity building in Africa but also for the concrete steps it has taken in assisting the continent's young scientists and in promoting scientific exchange within the region.

Significant challenges remain, and the global economic crisis has added to the burdens that sub-Saharan Africa faces both in terms of growing its economy and strengthening its scientific and technological capabilities.

The struggle that Abdus Salam and Thomas Odhiambo gallantly waged thus continues on many fronts. TWAS-ROSSA, as one of the newest institutional members enlisted in this worthy campaign, intends to do all that it can to advance the cause of a science-based sustainable development in Africa. ■

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For more information about TWAS-ROSSA, contact j.olang@aasciences.org or see www.nairobi.twas.org.

THE AFRICAN ACADEMY OF SCIENCES

The African Academy of Sciences (AAS) was established in 1985 in Trieste, Italy. AAS, which had 33 founding members, now has a membership of 162 scientists representing 28 African countries. By honouring international African scientists and supporting scientists and scientific activities throughout the continent, AAS "aims to be the engine driving scientific and technological development in Africa." The Academy's overall objectives are to promote and strengthen scientific and technological capacity, mobilize scientific and technological resources in the continent and among the African diaspora, stimulate research and science-based development in fields of particular concern to the continent and distribute information about its activities as part of a larger effort to advance science-based sustainable development in Africa. For additional information, see www.aasciences.org.

SCIENCE AND CHANGE IN SOUTH AFRICA

FEW COUNTRIES IN MODERN HISTORY HAVE EXPERIENCED SUCH TUMULTUOUS CHANGE IN SUCH A BRIEF TIME AS SOUTH AFRICA.

In the early 1990s, South Africa was a politically isolated country, a pariah among nations for having doggedly followed a path of apartheid despite growing resistance from the majority black population, moral condemnation from the global community and an international embargo that had acutely sapped the strength of its economy.

> **"The time to build is upon us."**
> *Nelson Mandela, 1994*

Fifteen years after the end of apartheid, South Africa is a country with a vibrant democracy, despite the one-party domination of the African National Congress (ANC), and a strong and resilient economy, despite the steep global economic downturn of the past year. In April 2009, over 17.5 million South Africans participated in the nation's fourth presidential election. Jacob Zuma, head of the ANC, was elected president with just under two-thirds of the vote. The campaign was boisterous and contentious, and the public was fully engaged. Nearly 75% of the registered voters cast ballots.

With a nominal annual gross domestic product (GDP) of more than USD270 billion, South Africa has the world's 32nd largest economy – an economy that grew at nearly 5% between 2003 and 2007. The country, moreover, is rich in biodiversity. Indeed, with 20,000 different plant species (10% of the known species on Earth), a 2,500-kilometre coastline and ecosystems ranging from extreme desert in the northwest to subtropical forests in the southeast, it is one of only 17 countries considered 'mega diverse'.

Yet deep-seated social and economic problems persist, including crushing inequality (more than one-third of the population lives on less than USD2 a day) and high and chronic levels of crime and violence (South Africa's murder rate – 40 murders annually per 1,000 population – is seven times that of the United States). In addition, more than 10% of the population – an estimated 5 million people – is afflicted with HIV/AIDS. In 2007, the virus claimed the lives of 350,000 South Africans. That amounted to nearly 1,000 deaths every day.

The global economic recession, moreover, has begun to stymie economic growth. The International Monetary Fund (IMF) announced this spring that for the first time in nearly two decades, South Africa's GDP is expected to contract in 2009. Whether this is a small blip or the beginning of a long-term economic downturn remains to be seen.

Despite its daunting problems, South Africa has managed one of the most remarkable transformations in recent history. Today, as a multi-racial democratic nation with an abundance of natural resources, strong institutions in both the public and private sectors, a small but highly skilled workforce and large youthful population, South Africa seems as well positioned as any country to enjoy sustained levels of growth in the years ahead.

With a nominal annual gross domestic product of more than USD270 billion, South Africa has the world's 32nd largest economy.

AND SCIENCE

A political revolution, yes. But what about science? Did it have a role too? And if so, what role did it play – not just as a source of economic development but also as a wellspring of national unity, pride and identity? What part, in short, has science played in national efforts to build a multi-racial society where a growing number of people can live in peace and prosperity?

Unlike in many developing countries, science in South Africa is deeply woven into the fabric of society. It has been an essential element of continuity for the nation, stretching more or less seamlessly across the enormous gap in political sensibility separating the eras of apartheid and democracy.

Yet, during apartheid, science operated exclusively for the benefit of the ruling white class, which constituted less than 15% of the population (just 5 million people in a country of 40 million). Consequently, leaders in the newly democratic country faced a new challenge: How could South Africa reorient its scientific capacity to serve the needs of the majority?

At the same time, unlike, for example, the former Soviet Union, which also experienced tumultuous change in the early 1990s, science in South Africa was not exclusively a government enterprise. The private sector in in the country accounted for more than 50% of the investment in research and development (R&D) during apartheid, and it remained a key investor in R&D after democracy took hold.

The changes that jolted South Africa in the 1990s led to a steep reduction in public investments in scientific research (the portion of gross domestic product devoted to R&D declined from 1.1% in the late 1980s to less than 0.7% by the mid-1990s). Private sector investments provided a welcome cushion softening the impact on the scientific and technological agenda during a time of momentous change. Today, the private sector spends an estimated 9.2 billion South African rands (USD1 billion) on R&D. That is three times more than the government invests.

And, finally, unlike other countries in sub-Saharan Africa, which experienced a precipitous decline in the quality of their universities in the 1970s and 1980s, South Africa's privileged, largely white, universities have continued to function at a high level of excellence through the 1990s and into the new millennium.

TELESCOPING THE FUTURE

*The first astronomical observatory in South Africa was set up in 1685. Today, the nation is home to a large number of internationally renowned astronomers and astrophysicists, and hosts one of the world's most intricate systems of optical and radio telescopes. The Hermanus Magnetic Observatory (HMO), part of a worldwide network of magnetic observatories that monitors and models variations in the Earth's magnetic fields, is located in the Western Cape about 130 kilometres from Cape Town (*www.hmo.ac.za*). The Hartebeesthoek Radio Astronomy Observatory (HartRAO), which is the only major radio observatory in Africa, is situated 50 kilometres west of Johannesburg (*www.hartrao.ac.za*). The Southern Astronomical Observatory (SAAO), a world-class facility for the study of optical and infrared astronomy, is located near Sutherland in the Northern Cape about 370 kilometres from Cape Town (*www.saao.ac.za*). The Southern African Large Telescope (SALT), built in 2005, is the largest single-optical telescope in the Southern hemisphere capable of viewing distant stars, galaxies and quasars a billion times too faint to be seen with the unaided eye. SALT, which is located near the town of Sutherland, received funding from a consortium of nations comprised of South Africa, the USA, Germany, Poland, India, the UK and New Zealand (*www.salt.ac.za*). South Africa is currently vying with Australia to be the home for the Square Kilometre Array (SKA) radio telescope, which will be 50 times more sensitive and able to scan the sky 10,000 times faster than any previous radio telescope array. Its large viewing field and the speed and depth at which it can span the far reaches of space promise to shed new light on the origins and evolution of the universe. Astronomical institutions in 18 countries are participating in the project. A decision on the location of SKA is expected by 2012, and plans call for SKA to begin operations in 2020 (*www.skatelescope.org*).

Thus one of the critical challenges for post-apartheid South Africa was not to rebuild a national system of higher education (as much of sub-Saharan Africa still needs to do), but to provide opportunities for thousands of black students to enrol in the nation's best universities, while simultaneously upgrading the quality of both education and research in black universities that had been largely neglected during apartheid. This goal has made the task of improving primary and secondary schools even more urgent in order to ensure that black students are adequately prepared to meet the rigours of a university education.

WAY AHEAD

When it assumed power, South Africa's newly formed democratic government recognized that the country's legacy of apartheid included a strong foundation in science and technology. Global sanctions in the 1970s and 1980s had forced South Africa to become largely self-reliant. Along with a deeply rooted tradition of efficient administration and management dating back to the late 19th century, scientific and technological capacity was one of the few bright spots in an otherwise forbidding period in South Africa's modern history.

The problems were threefold. First, the research community was almost exclusively white and male. Second, the research agenda was fixated on issues of importance to the minority white society. And third, the success of South Africa's democracy would largely be determined by its ability to deliver goods and services to the nation's impoverished majority black population. That raised serious questions about whether there would be sufficient financial resources to continue to invest in science.

South Africa's strengths in science and technology were derived from the skills of a privileged white population who constituted only a fraction of the society.

FOUNDATION FOR SUCCESS

The National Research Foundation (NRF), which is the only active national science foundation in sub-Saharan Africa, supports and promotes research personnel, projects and facilities to foster knowledge and encourage new thinking and innovation in the natural and social sciences, engineering and the humanities. NRF provides fellowships (mainly to doctorate and post-graduate students) and serves as the main sponsor of major research facilities, including South Africa's astronomical observatories (see box on previous page), the National Zoological Gardens, iThemba Laboratory (see box on following page) and the South African Agency for Science and Technology Advancement, which is mandated to promote the public understanding of science. In cooperation with the Ministry of Science and Technology, NRF also sponsors the South African Research Chairs (SARCHI) and Centres of Excellence Initiative. In addition, NRF manages the Innovation Fund, which is designed to promote technological innovation through investing in late-stage research and development, the commercialization of novel South African technologies and intellectual property protection. NRF funding is largely directed towards academic research, developing high-level human resources, and supporting the nation's national research facilities. The foundation provides strategic advice and fosters national and strategic partnerships and knowledge networks for the purposes of enhancing South Africa's international competitiveness. See www.nrf.ac.za.

Not surprisingly, the fields of study in which South Africa had gained international recognition were narrowly cast in ways that provided only limited benefits for the new nation and the vast majority of its people.

For example, during apartheid South Africa devoted a great deal of its resources and capabilities to the development of nuclear power and weaponry. South Africa was one of only a handful of nations (officially five in all) that possessed the atom bomb. It voluntarily relinquished this capability in 1993, the first nation ever to do so.

Unlike in many developing countries, science in South Africa is deeply woven into the fabric of society.

Such R&D initiatives were part of a broader effort on the part of South Africa's apartheid government to gain energy independence in the face of a stringent global embargo and to acquire a strong military presence in a world that was deeply hostile to its racist and repressive regime. Expertise in nuclear R&D enabled it to make progress on both fronts, providing important buffers against the threats posed by external forces calling for radical change.

Even in research fields that held promise for societal improvement, the goals were narrowly cast. South Africa, for instance, had a world-class group of medical researchers who garnered international attention when Christiaan Barnard of Groote Schuur Hospital in Cape Town became the world's first surgeon to perform successful heart-transplant surgery in 1967. But such path-breaking medical procedures did little to improve the health of the hundreds of millions of people living in sordid conditions and without access to basic health-care.

The same disconnect between scientific excellence and social impact existed for agricultural R&D, where the vast majority of expertise and resources focused on the needs of corporate farmers and not small landholders. With less than 7% of the workforce employed as farmers (and less than 3% of the nation's GDP derived from agriculture), South African agriculture today resembles



that of a developed country more than it does a developing country. In sub-Saharan Africa, for example, 75% of the workforce is involved in agriculture (and agriculture accounts for 30% of the GDP).

FIRST THINGS

In 1996, the government of South Africa issued its first comprehensive report on the future of R&D in South Africa – *The White Paper on Science and Technology: Preparing for the 21st Century*. The report, prepared by the Department of Arts, Culture, Science and Technology, called for the creation of a "national system of innovation".

As the report observed, "no government can order innovation to take place. But government can help ensure that a competent pool of expertise, from which innovation can spring, is grown and maintained."

The key to South Africa's strategy for sustained development, according to the report, would lie in the promotion of "innovation." Such a strategy would broaden the scope of R&D to include such fields as engineering, design and marketing. While a system of innovation would emphasize the importance of science and technology, it would do so within the context of a broad range of factors that would all be part of an integrated effort to promote sustainable economic growth.

Put another way, South Africa's system of innovation would acknowledge the importance of basic scientific research and would seek to adequately fund such endeavours. As the report observed, "it is important that fundamental research not be regarded as impractical, because it is the preserver of standards without which, in the long-term, the applied sciences will also die."

Nevertheless, the national innovation strategy would

ACCELERATING FORWARD

iThemba LABS (iThemba Laboratory for Accelerator Based Sciences), established in 1977 as the nation's primary centre for the study of radiation medicine and nuclear science, is currently a multi-disciplinary research centre administered by the NRF. Specifically, iThemba provides particle beams, particle radiotherapy treatments and accelerator-produced radioactive isotopes both for medical research and cancer treatments. Particle beams from iThemba's state-of-the-art separated-sector cyclotron and a 6-MV Van de Graaf generator are used for research and training in biophysics, atomic physics and radiobiology. The cyclotron produces neutrons and protons suitable for cancer therapy. iThemba LABS is the only centre in South Africa that can produce such medical isotopes as 67Ga, 81Kr, 111In 123I, 201Tl and their compounds. These isotopes are too short-lived to be imported and would therefore be unavailable if iThemba did not produce them. At present, about 30 major hospitals and other institutions, as well as nearly 10,000 patients each year, benefit from these services. Research at iThemba Labs also contributes to technical knowledge and expertise in such fields as radio-frequency technology, computer science, electronic and mechanical engineering and fabrication techniques. See www.tlabs.ac.za.



place even greater emphasis on new products and services that could ultimately benefit the economic and social well-being of people, especially the poor. South Africa's 'national system for innovation', in short, would embody a strategy that extended well beyond the conventional definitions of R&D.

More specifically, the report stressed the importance of maintaining excellence in research and teaching while, at the same time, calling for measures to make the system more equitable, open and focused on societal needs. It called on the scientific community to develop an agenda that embraced scientific knowledge not only as an intellectual pursuit but also as a critical instrument for the creation of a more prosperous and equitable society.

FIELDS OF PLENTY

The *White Paper on Science and Technology* and all subsequent government reports – most notably, *South Africa's National Research and Development Strategy*, also published in 1996 by the Department of Arts, Culture, Science and Technology – highlighted a number of scientific fields in which the government would continue to strive for international excellence.

These fields included:

- Archaeology and human palaeontology, in which South Africa enjoys a number of global advantages related to the discovery of hominid fossils (for instance, *Australopithecus africanus* was found in the Sterkfontein Caves near Johannesburg in 1947).
- Astronomy, which not only has a long tradition of research excellence in South Africa's universities but for which researchers also enjoy an advantage due to the nation's position at the southern tip of Africa. This enables observation of parts of the sky not visible from elsewhere and helps to reduce atmospheric turbulence, making South Africa an excellent place for viewing and listening to the sky.
- Scientific and technological knowledge and skills for the mining of metals and minerals that dates back to

LIQUID COAL

Private companies have long played a major role in the economy of South Africa. Many of these companies, most notably in agriculture, armaments, energy and mining, also assembled worldclass R&D departments. The South African Coal, Oil and Gas Corporation (SASOL), which began as a government-operated agency in 1950, is currently an international leader in coal-to-liquids and gas-to-liquids technology. The company's roots lie in South Africa's efforts, as an oil-poor country, to shield itself from the vagaries of the international oil market. Over the past five decades, SASOL has developed cutting-edge technology for the commercial production of synthetic fuels and chemicals from low-grade coal. It is the first company to have produced liquified coal on a commercial scale. SASOL employs 30,000 workers and has a broad R&D agenda in exploration, mining, and science and technology. In 2001, it was purchased by the German CONDEA Group. See www.sasol.com.

COUNCIL-ING FOR SUCCESS

Founded in 1945, the Council for Scientific and Industrial Research (CSIR) is among the oldest and largest scientific councils in Africa. CSIR links scientific to industrial development and pursues multidisciplinary research to promote technological innovation and the development of goods and services that are designed to improve economic and social well-being in South Africa. Broad areas of research include the biosciences, information and communications technologies, laser technology, materials science and manufacturing, and natural resources and the environment. Nanotechnology, synthetic biology and mobile autonomous intelligent systems represent its newest research areas. CSIR operates on an annual budget of 1 billion rand (USD120 million) and employs more than 2,000 people. It receives 40% of its budget from parliament and generates the rest of its funds from research contracts with government departments and agencies at national, provincial and municipal levels, the private sector and research funding agencies in South Africa and abroad. It also derives a small part of its income from royalties, licences and dividends. See www.csir.co.za.

the discovery of diamonds, gold and other precious resources by European explorers in the 19th century.

- A treasure trove of indigenous knowledge, an advantage that it shares with many other developing countries and for which South Africa can provide added value because of its strong scientific base that allows for a melding of traditional and modern knowledge in the pursuit of new products and services, especially in agriculture and health-care.
- Processing of coal to liquid fuels based on the nation's long-standing expertise in advanced manufacturing. Indeed the South African Coal, Oil and Gas Corporation (SASOL) remains the only firm to have developed this process on a commercial scale.
- Development of fluorine-based chemicals, advanced irradiation processes and laser-based isotope separation technology that draws on the nation's military R&D efforts that took place during apartheid.

South Africa has called for additional funding to advance a number of enabling technologies.

In addition, the government of South Africa has called for additional funding to advance a number of enabling technologies, including information and communication technologies and biotechnology.

An important point is this: When it comes to science and technology, government officials, in many respects, view South Africa not as a developing country but rather as a middle-income country seeking to maintain – and improve upon – its international standing in R&D. The nation's average per capita GDP (at purchasing power parity) of USD10,119 (comparable to Brazil's USD10,326) supports this perception. Yet the fact that more than one-third of the population lives on less than USD2 a day suggests otherwise.

INNOVATE NOW

When it comes to advances in R&D, South Africa has certainly made significant strides.

Today, the country has a multi-tiered, vibrant university system led by 12 leading universities, including five listed in the 2007 Shanghai Jiao Tong University ranking of the top-500 universities: Cape Town, Pretoria, Stellenbosch, Witwatersrand and KwaZulu-Natal. It can also turn to a strong network of government-supported science

CONNECTION PLUS

SANReN (South African Research Network), launched in 2005 and led by CSIR's Meraka Institute, is designed to provide South Africa with a state-of-the-art research and education cyber-network. The overall goal of the project is to advance global scientific exchange in South Africa and, more specifically, to support the data and information needs of South Africa's large science projects (including the proposed Square Kilometre Array (SKA) telescope. When completed, SANReN will connect up to 108 sites in South Africa with cyber-networks in more than 3,000 research and education organizations worldwide.

councils in such fields as agriculture, energy, geology, industrial research, medicine and the social sciences. As mentioned above, the private sector continues to make significant investments in R&D, especially in deep mining technology, conventional and renewable energy and agriculture. Moreover, the nation's Ministry of Science and Technology, established in 2002, is considered to be one of the government's most effective ministries and a prime reason for broad-based public support for science and technology as major components of the nation's economic development strategy (see interview with Naledi Pandor, the country's science minister, beginning on p. 22).

South Africa's complex system of science governance is one of the best in the developing world.

South Africa, in short, has a complex and interwoven system of science governance that is undoubtedly the best in Africa and one of the best in the developing world.

To broaden student access to privileged universities, South Africa has launched an aggressive programme to enrol qualified black students. The result is that the country's leading universities have a rising number of black students in attendance. At the University of Cape Town, for example, nearly half of the student body is black. At Witwatersrand University, nearly two-thirds are.

Critics, however, contend that many of these students are ill prepared for university studies, a reflection of the poor state of primary and secondary education. They are calling for additional investments in all levels of education to ensure that students fully benefit from their university training.

Meanwhile, aging white professors continue to hold the majority of university positions. But most experts agree that it is only a matter of time before black professors dominate teaching and research positions.

MIGRATION: IN AND OUT

When it comes to brain drain, South Africa finds itself in a unique position, especially among developing countries. It is both a benefactor and victim of this phenomenon. Conflict and violence in other sub-Saharan African countries has pushed many skilled and educated workers to South Africa. At the same time, attractive job opportunities in developed countries have enticed South Africa's educated population to migrate to the North, most notably to the United Kingdom and the United States. An estimated 5% of South Africa's scientists working in government research institutes and more than 20% of scientists in academia leave each year. Moreover, such highly trained professionals as doctors, nurses and engineers have found lucrative



careers on other continents. For example, there are at least 3,500 South African doctors working in Britain, 2,000 in the US, over 1,000 in Canada and close to 500 in New Zealand.

To help counteract the loss of many of its educated citizens, some 72 research chairs of excellence have been established in such fields as bioinformatics, indigenous knowledge, math education and nanotechnology. Plans call for 210 research chairs to be in place by 2010. The positions are not only prestigious but also well endowed, receiving 2.5 million South African rand (USD280,000) per year for 10 years. The global financial meltdown and shrinking government budgets have recently put the programme on hold. But government has every intention of increasing the number of research chairs when the global economy improves.

Similarly, South Africa has launched a programme for the creation of centres of excellence that is designed to promote new knowledge and develop collaborative research projects on such critical issues as biomedical treatment for tuberculosis; research and development of strong materials (for example, alloys, metal oxides, ceramics and diamonds that retain their distinctive properties under extreme conditions); the impact of invasive species on biodiversity, ecosystems and tourism; and examinations of chemical catalysis, primarily for the conversion of gas to liquid fuels. Many of the centres operate collaborative multi-disciplinary ventures focusing on long-term challenges relevant to the nation's efforts to build its scientific capacity and enhance economic competitiveness.

The government has pinpointed critical fields of research deserving special attention and support because of the potential impact that advances in these fields could have on society and the economy. The nanotechnology initiative, for example, focuses on developing nano-applications for intelligent, slow-release drugs to treat HIV/AIDS, nano-sensors for precision environmental monitoring, and nano-filters for improving the quality of drinking water. The high-performance com-

DRIVING INNOVATION

The newly created Technology and Innovation Agency (TIA), which had been under discussion in South Africa for two years, was signed into law in July 2009. TIA has three key objectives: to stimulate technology development, spur the creation of technological enterprises, and help build a broader industrial base. It will serve as an umbrella for such existing projects as the Biotechnology Regional Innovation Centres, Innovation Fund, Advanced Manufacturing Technology Strategy, Advanced Minerals Initiative, Hydrogen Economy Competency Centres and Health Innovation Competency Centres. The goal is to help South Africa replicate the success of India in information and communication technologies and Brazil in the manufacture of small commercial jet airplanes. The TIA, in short, will be designed to foster the development of cutting-edge, technology-based companies comparable to Infosys in India and Empresa Brasileira de Aeronautica SA *in Brazil.*


puting centre, meanwhile, concentrates on developing reliable models for the potential spread of HIV/AIDS in the event of a pandemic; devising complex scenarios for the study of climate change; and creating web simulations for the design of the Square Kilometre Array (SKA) radio telescope.

South Africa has also invested substantial public resources in government institutes that are currently devoted to an array of areas that include energy and environmental research. These institutes pre-date the advent of democracy and are deeply rooted within the nation's multifaceted scientific enterprise. The key point of debate revolving around the future of these institutes today is the level of governmental funding that is necessary for them to function effectively and whether larger percentages of private funding would help them fulfil their mandates to produce R&D results that impact society.

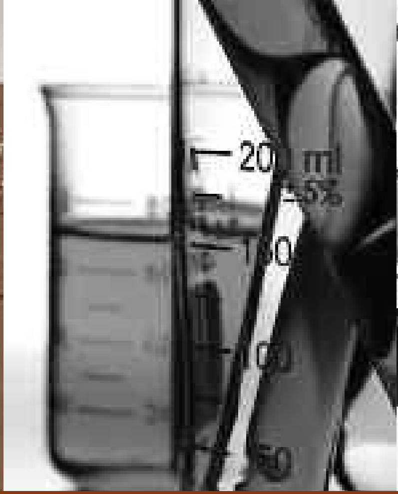
And finally, South Africa hosts a large and growing number of international scientific organizations. It is, for example, the home of the African Laser Centre (ALC), as well as the African Institute of Mathematical Sciences (AIMS). It serves as the headquarters for the World Association of Industrial and Technological

ACADEMY OF SCIENCE OF SOUTH AFRICA

The Academy of Science of South Africa (ASSAf) was launched in May 1996 in response to the need for an academy of science consonant with the dawn of democracy in South Africa: active in its mission of using science for the benefit of society and including in its ranks the full diversity of South Africa's distinguished scientists.
The Parliament of South Africa passed the Academy of Science of South Africa Act (Act 67) in 2001, which came into operation on 15 May 2002, making ASSAf the official national science academy.

The Academy's objectives are to:
- *Promote innovative scientific thinking in all disciplines.*
- *Encourage the optimum development of the intellectual capacity of all people.*
- *Provide advice and facilitate appropriate action to meet the collective needs, opportunities and challenges of all South Africans.*
- *Link South Africa with scientific communities worldwide, particularly within Africa.*

ASSAf provides direction, investigates and generates evidence-based advice on issues of public interest as they relate to scientific research. ASSAf regularly publishes its findings and recommendations and also acknowledges the achievements of South African scientists to help develop the intellectual capacity of the nation and promote innovative scientific thinking. The Academy enjoys continual interaction and knowledge exchange with other national science academies throughout the African continent as well as throughout the world. See www.assaf.org.za.



Research Organizations (WAITRO). In 2006, South Africa became the host for the International Centre for Genetic Engineering and Biotechnology's (ICGEB) third component after New Delhi, India, and Trieste, Italy. The country has begun construction on the Karoo Array Telescope (MeerKAT) and the Southern African Large Telescope (SALT). The latter is the largest single optical telescope in the Southern Hemisphere and the 10th largest in the world. South Africa, moreover, is one of two finalists (Australia is the other) for hosting the Square Kilometre Array (SKA) radio telescope, which will be 50 times more sensitive than the most powerful radio instrument currently operating.

R&D INVESTMENTS

South Africa has also made slow but persistent progress in its efforts to invest at least 1% of its GDP in R&D. In the late 1980s, during the final years of apartheid, the nation was spending about 0.9% of its GDP on R&D. That figure fell to just 0.69 % in 1994 and remained mired there for several years.

> ***SALT is the largest single optical telescope in the southern hemisphere.***

In the late 1990s, the government once again called for investing 1% of the nation's GDP (by 2008) on R&D. That goal has nearly been achieved, and a new target – to invest 2% of the nation's GDP in R&D by 2018 – has been set. Although South Africa has been jolted by the global financial crisis, the government remains confident that the nation will be able to reach this new goal.

This trend, of course, does not necessarily ensure that science and technology will gain the level of prominence that advocates hope. After all, how the money is spent is likely to be as important as how much is spent. It should be noted, moreover, that developed countries invest on average 2.5% to 3% of their GDP on R&D. (In 2006, Japan spent 3.39% of its GDP on R&D, and Finland 3.45%). So, while a 1% (or even 2%) funding goal represents a significant step forward, it also indicates that more work needs to be done.

Nevertheless, the rise in R&D expenditures is a clear sign of the government's commitment to long-term science-based development, and a willingness to devote limited resources to such endeavours despite the other formidable challenges that demand attention.

SOME SYSTEMS GO

The rapid integration of the country's researchers and research institutes into the international scientific community may be the nation's most noteworthy accomplishment in science since the demise of apartheid. The once outcaste nation is now a full and active participant in global science. In several fields of study, including archaeology, astronomy, plant and animal science, and mining research, it is considered among the world's leaders. At the same time, South Africa has succeeded in creating a more diverse research community, and it has proven particularly successful in rapidly increasing the number of blacks (and to a lesser degree, women) in the nation's universities and research centres.

Yet, in a number of critical areas, the nation has fallen far short of its goals. Today, South Africa has an estimated 18,000 active researchers (an additional 12,000 people work as technicians and support staff).

That translates into about 2.7 researchers per 1,000 population. Japan, in contrast, has 10.2 researchers per 1,000 population, Sweden 10.6, and Finland 15.8. The number of researchers in South Africa is clearly too small to advance its ambitious agenda for scientific capacity building and innovation.

The number of articles published by South African researchers in peer-reviewed international journals averaged just under 0.5% of the world total between 2005 and 2007. That was 0.2% less than in 1987. Surveys, moreover, indicate that the percentage of articles published by faculty aged 50 years or over has climbed from less than 20% in 1990 to more than 45% today. This trend forecasts future declines in output unless vigorous steps are taken to train and employ a new generation of world-class scientists and scholars.

In several fields of study, South Africa is considered among the world's leaders.

One of the most daunting unmet challenges that South Africa faces is to effectively use its impressive scientific and technological capabilities to address the critical social and economic needs of the poorest members of its society. With 22% of the nation's workers officially listed as unemployed by the government (and an additional 22% of the workforce who have stopped looking for work), the nation's bold efforts to create an innovation society marked by broad-based social and economic well-being has clearly not penetrated the nation's 'second' economy. And, although an increasing number of South Africans can satisfy their basic needs (most notably, access to potable water), 25% of households still lack access to both adequate sanitation and electricity.

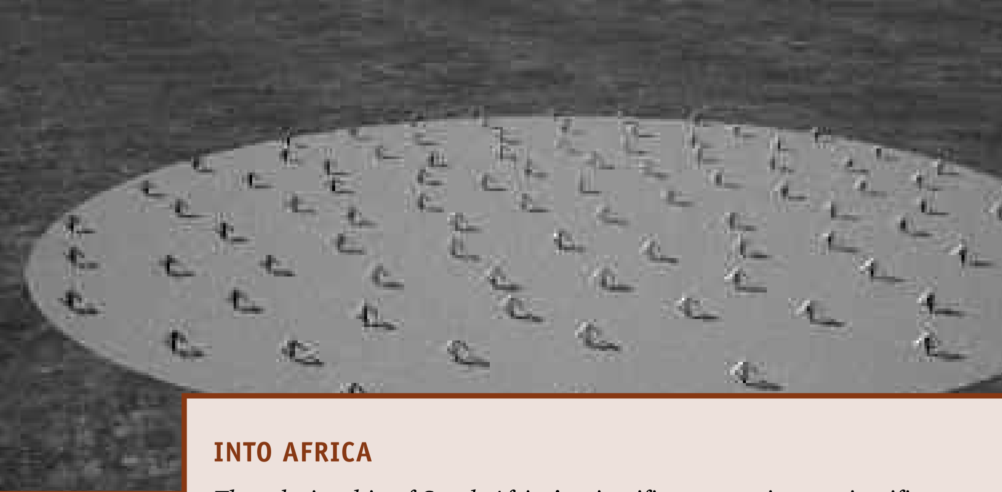
UNIVERSALLY UNIQUE

As an unusual country with an unusual history, from the moment that South Africa began its journey for democracy, it has deftly navigated the difficult terrain of its past to reach a better future.

South Africa, of course, was never a member of the first world of rich industrialized countries (pervasive poverty and apartheid kept it outside the circle of wealthy nations). Nor, of course, was it ever a member of the second world of communist countries. And, it is fair to say that South Africa was never a full-fledged member of the third world either – racism (sadly) and science (happily) made that so. Indeed it is useful to recall that South Africa was subject to international sanctions and an embargo that prevented both goods and people from travelling freely to other countries, including the neighbouring countries of Africa. That made South Africans strangers even on their own continent.

South Africa has thus had to make its modern journey of discovery (or should we say rediscovery), in large part, by devising its own roadmap for reform based on its unique cultural, social and scientific terrain.

Its efforts, nonetheless, reveal a great deal to the rest of the world about both science and our global society: for example, the ability of science to flourish in different political contexts, even within the same country, and to operate within each of these contexts in productive and useful ways; the fact that it is easier for modern science to serve the needs of innovation and global competitiveness than it is for it to fight poverty and improve the status of marginalized popu-



INTO AFRICA

The relationship of South Africa's scientific community to scientific communities in sub-Saharan Africa is a complicated one, burdened by history yet rich with potential. On the one hand, the advanced state of South Africa's scientific community offers endless possibilities for scientific exchange between South Africa and other countries on the continent. On the other hand, state-of-the-art research institutes and facilities in South Africa, along with a strong faculty and reliable communication networks, make it the destination of choice for scientists in the North seeking to partner with African scientists. That places South Africa in a privileged position when it comes to South-North cooperation in science. Since the advent of democracy, South Africa has taken an increasing interest in nurturing scientific collaboration with other nations in sub-Saharan Africa, and it has pursued this goal, in part, through the Southern African Development Community (SADC). Ironically, SADC was organized in 1980 as a loose alliance of nine southern African countries (Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe) that were seeking to devise an effective strategy to lessen their economic dependence on the then apartheid South Africa. A democratic South Africa joined SADC in 1994. Today, the organization is seeking to implement a coordinated plan of action that includes regional access for scientific exchange through, for example, Africa's Southern African Biosciences Network, the African Laser Centre and the African Institute for Mathematical Sciences. Each of these institutes is located in South Africa and each is mandated to promote scientific capacity across the continent. See www.sadc.int.

lations; the continuing relevance of the often forgotten truism that science is not an end-all to all of society's problems but simply a tool for progress that must serve a broad range of societal needs; and, ultimately, that fields of scientific inquiry operate best within a political environment whose primary goal is to both advance the economy and create a more equitable and harmonious society.

Over the past 15 years, South Africa's scientists and technologists have often been remarkably successful at applying their expertise to address the challenges of the 'first' economy – contributing substantially to the nation's efforts to improve its global presence in science and its ability to compete in the global economy. However, South Africa's scientific community – and, more importantly, government – have been less successful at utilizing scientific expertise to address the challenges of the nation's 'second' economy, including such issues as poverty alleviation, job creation and equity.

South Africa's growing presence on the international stage is undoubtedly a long way from where it stood less than two decades ago as an isolated and censured country. Yet, in its openness and relevance, what South Africa shows us all today is that we still have a long way to go in our efforts to create a paradigm for science-based sustainable development that proves beneficial for all.

South Africa is indeed a remarkable country finding its way in the remarkable times in which we live. And, for this reason as much as any other, it deserves the growing attention that it is now receiving from the rest of the world. ■

NALEDI PANDOR WAS APPOINTED MINISTER OF SCIENCE AND TECHNOLOGY OF SOUTH AFRICA BY PRESIDENT JACOB ZUMA IN MAY 2009. SHE HAS BEEN A MEMBER OF SOUTH AFRICA'S PARLIAMENT SINCE 1994 AND HAS PREVIOUSLY SERVED AS MINISTER OF EDUCATION.

MINISTER PANDOR ON SCIENCE

Naledi Pandor was educated in Botswana, South Africa, Swaziland, the UK and the USA. She earned an MA in education from the University of London and an MA in general linguistics from the University of Stellenbosch. She also holds diplomas in higher education from Bryn Mawr College and in leadership in development from the Kennedy School of Government, Harvard University, USA. Minister Pandor has lectured widely and chaired a number of committees, trusts and funds, including the National Council of Provinces, the Desmond Tutu Education Trust and the Tertiary Fund of South Africa.

In July, Minister Pandor conducted an email interview with the editor of the TWAS Newsletter. *An edited text of the interview follows.*

What are the major challenges facing South Africa today in its efforts to advance science and technology?

The major challenges we face are to make sure that our scientists contribute to improving the lives of the poor, boosting the economy and expanding knowledge.

For the past five years the Department of Science and Technology has provided broad-based support for research in a variety of disciplines, including astronomy, space science and technology, biotechnology and climate-change science. The department has also served as a nucleus for activities in technology development, transfer and commercialization.

Over the next five years we plan to make improved access to health care and education our top priorities. The Department of Science and Technology's innovation strategy aims to drive South Africa towards a knowledge-based economy, in which the production and dissemination of knowledge leads to economic benefits and enriches all fields of human endeavour.

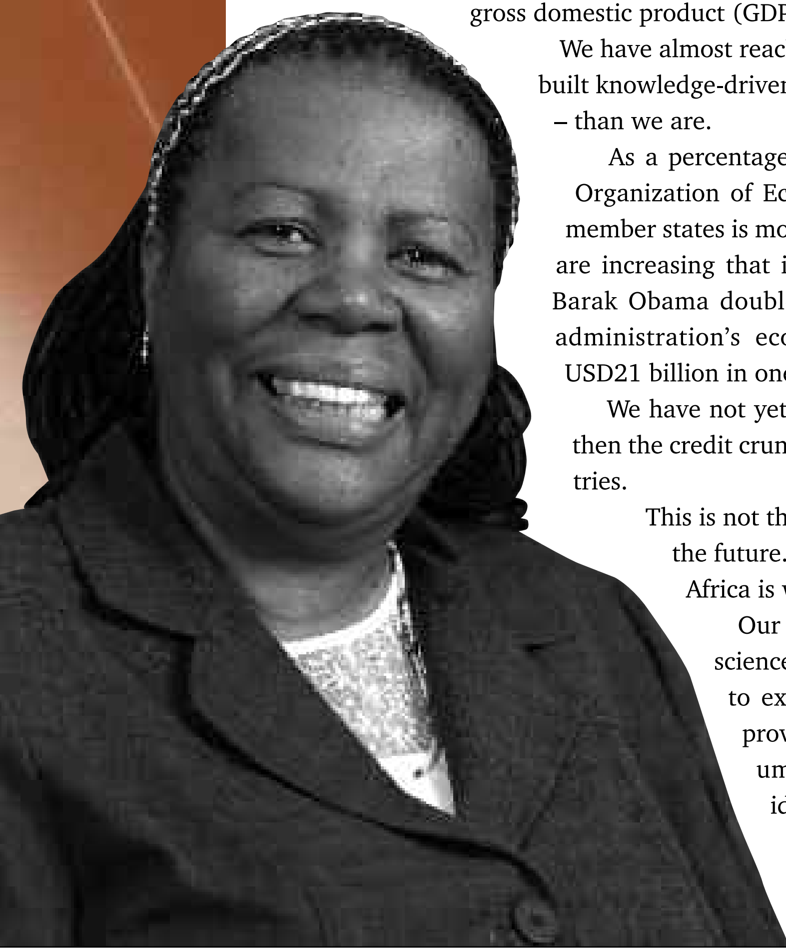
Research conducted by the World Bank tells us that over the next two decades there will be as many as one billion new jobs worldwide in science, engineering and technology. While the old economy, based on extractive industries and resources, will continue to shed jobs, new jobs

will be created in the new economy, based on services and knowledge.

Our major challenge is to ensure that South Africans are best prepared to fill as many of those new jobs as possible.

How has the global financial crisis affected science and technology policies in South Africa?

I think it is recognized at home and abroad (for example, by Fitch credit rating's recent decision to increase South Africa's investment grade) that South Africa is better positioned to weather the current economic recession than most other countries, largely owing to our public commitment to large-scale infrastructure development. This commitment has provided a unique opportunity for South Africa to improve its science, technology and innovation infrastructure, and to assist South African companies to progress up the value chain to become globally competitive suppliers.



Nearly 10 years ago, the government set a target to spend 1% of the nation's gross domestic product (GDP) on research and development (R&D).

We have almost reached that goal, but countries that have successfully built knowledge-driven economies are now spending more – much more – than we are.

As a percentage of GDP, the average annual R&D investment of Organization of Economic Co-operation and Development (OECD) member states is more than three times our own. And OECD countries are increasing that investment. For example, this year US President Barak Obama doubled the US investment in basic science, and his administration's economic stimulus package includes more than USD21 billion in one-off investments in federal R&D.

We have not yet introduced a stimulus package on this scale, but then the credit crunch began to affect us much later than OECD countries.

This is not the time to cut back on South Africa's investment in the future. It is the time to invest in key sectors where South Africa is well placed to lead.

Our policy is to protect and promote our investment in science, to make it easier for students and entrepreneurs to exploit their patents and form companies, and to provide a regulatory regime in which small and medium enterprises find it beneficial to market their ideas.

If we build on our recent success in expanding investment in research and development, we will

be able to develop new industrial processes that are both locally innovative and internationally competitive. Most local innovation will involve technology upgrading of core processes rather than focusing on basic research that is internationally competitive. That is because most of our enterprises operate far below the technological frontier. Yet both basic and apply research create jobs in industry and manufacturing.

Our future growth (more jobs, greater wealth) lies in increased research and development, accruing new patents and trademarks, developing new technologies for transforming traditional industries, creating new products, and training and developing a keen knowledge of international markets.

Since 2002, the National Research and Development Strategy has been the basis of most of our science and technology activities. With the intention of promoting South Africa's competitiveness, the strategy identified key technology missions and science platforms. The technology missions include biotechnology, nanotechnology, and information and communication technologies. The science platforms include Antarctic research, marine biology, astronomy and paleosciences.

In 2007, we adopted an innovation plan that identifies five grand challenges: developing South Africa's bioeconomy, developing space science and technology, providing energy security, responding adequately to global climate change and increasing our ability to anticipate the complex consequences of change due to human and social dynamics.

South Africa has the continent's strongest universities and best scientific research institutes. But its primary and secondary school systems remain weak. What measures should be taken to improve the nation's overall educational system?

Yes, it is certainly true that we have as yet been unable to overcome our historical legacy of disadvantage in regard to the teaching of maths and science in our schools. Yet, we have been improving, as recent systemic surveys and matrix results have shown. As far as the Department of Science and Technology is concerned, our Youth into Science Strategy aims to improve the quality of maths and science learning from the schooling sector through to the university sector.

Our approach is to increase the number of skilled researchers and technologists by way of specific interventions. Our interventions are focused both downstream (on established researchers and technologists) and upstream (on learners in schools).

At the downstream end, there is the South African Research Chairs Initiative (SARChI), the Centres of Excellence (CoE) Programme and the Postdoctoral Fellowship Programme. At the upstream end, there are Bursary Initiatives, Youth into Science and the Science and Engineering and Technology (SET) Awareness programmes.

What is the state of the relationship of South Africa's scientific community with other scientific communities on the continent?

We chair the Southern African Development Community (SADC) S&T group, which recently drafted a 10-year plan for the SADC. We also support the New Partnership for Africa's Development (NEPAD) flagship projects, specifically the African Institute for Mathematical Sciences (AIMS), the African Laser Centre and the Southern African Network for Biosciences (SANBio). South Africa also participates in the NEPAD/Southern African Regional Universities Association roundtable discussions on the implementation of the consolidated plan of action and engineering capacity-building for manufacturing.

South Africa has made great strides both in creating a strong foundation for economic growth and building world-class research communities in several fields. Yet poverty remains a serious problem. What can be done to help ensure that scientific expertise plays a key role in combatting poverty?

In general, we know that science creates wealth and jobs. We do not want to remain consumers of science and technology from other countries. We have to invest in science for ourselves.

At a less abstract level, science plays a critical role in the lives of ordinary people. Take energy. We need energy for industry, cars and trains. Yet ordinary people meet their energy needs by using paraffin, wood and liquid petroleum gas. Women in rural areas spend a lot of time fetching firewood, and in informal settlements people struggle just to get paraffin or coal, most of which emits poisonous gases that can create serious health problems. How many people are being treated in hospitals for breathing problems or burns from paraffin stoves that topple over or explode?

Science can help us find ways to produce cleaner, renewable energy that ordinary people can use in their homes.

Nuclear energy is an attractive option, with regard to cost, cleanliness and safety, and we have invested heavily in it. The point is that in energy research and development, as in all other areas of science and technology, we need to make advances that help people lead healthier and more productive lives. ■

COMING TO LIFE: BIOTECHNOLOGY IN AFRICA

BRINGING PROSPERITY TO AFRICA, WHILE SIMULTANEOUSLY PROTECTING THE CONTINENT'S ENVIRONMENT, WILL LARGELY DEPEND ON HOW QUICKLY AFRICA CAN SAFELY MASTER EMERGING BIOTECHNOLOGIES, SAY TWAS FELLOWS CALESTOUS JUMA (2005) AND ISMAIL SERAGELDIN (2001).

Regional economic integration in Africa should serve as the foundation for advancing technological innovation in general and biotechnology in particular. Action must reside primarily in 'local innovation areas' that are often home to a nation's most dynamic research institutions and business firms. International partnerships must also be forged for biotechnology to succeed.

These are the key conclusion of TWAS Fellows Calestous Juma, professor of the practice of international development at Harvard University, USA, and Ismail Serageldin, director of the New Library of Alexandria in Egypt. Juma and Serageldin recently served as co-chairs of the African Union's (AU) High Level African Panel on Modern Biotechnology. A detailed analysis of their findings can be found in Freedom to Innovate: Biotechnology in Africa's Development, *a report prepared for the AU and the New Partnership for Africa's Development (NEPAD).*

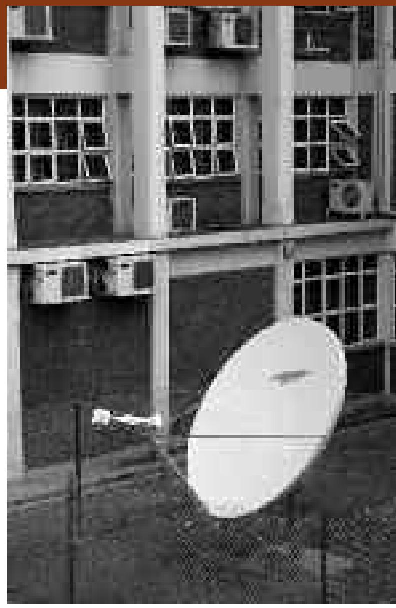
STI-LESS

It is no secret that Africa's history has been marked by a development process in which the vast majority of citizens have not shared in the benefits of science, technology and innovation (STI).

Thankfully, this is now changing as Africa's leaders increasingly embrace STI as prerequisites for human development, global competitiveness and ecological management.

Africa is fast becoming a continent with deep and diverse capabilities. The AU, to its credit, has provided valuable political guidance for applying STI to efforts geared to dramatically transform Africa's overall economy. But success will also require rigorous coordination through Africa's regional economic communities (RECs), as well as effective actions by local communities in each country.

RECs offer an excellent vehicle for mobilizing, shar-



ing and using biotechnologies. In some regions, such forward-leaning activities will emerge without prompting. In others, such activities will need to be carefully nurtured. In every case, however, what will undoubtedly be needed is a pool of talented and skilled people and a commitment from institutions – both new and old – to be willing to foment change.

BIO-PRIORITIES

Food security, nutrition, health care and environmental sustainability are among Africa's biggest challenges. Regional biotechnology efforts have a role to play in each of these areas. These roles can be successfully implemented through "long-term biotechnology missions". Clustering can take place around priority fields of biotechnology that have the highest potential for economic return and that will likely add value to regional and institutional centres where expertise currently exists.

Health-related biotechnology research and development (R&D), for example, is concentrated in southern Africa. Strengths in bio-pharmaceutical R&D are found primarily in northern Africa. Animal biotechnology has put down strong roots in east Africa. Crop biotechnology is located largely in western Africa, and forest biotechnology in central Africa.

Africa is fast becoming a continent with deep and diverse capabilities.

Africa's ability to effectively use existing and emerging biotechnologies will depend largely on the level of investment made in building human, physical, institutional and societal capacities that are responsive to Africa's needs. More specifically, RECs will need to concentrate on creating and reforming existing knowledge-based institutions, especially universities, to enable African institutions of higher education to gain the skills they need to effectively diffuse new technologies throughout the economy. Development cooperation proponents, in turn, will need to alter their focus from an historic dependence on relief models (focusing largely on short-term needs) to competence building (which can only take place over the long term).

Simply put, investing in key capabilities designed to promote STI must be an integral part of Africa's effort to utilize its resources and improve the social and economic well-being of all its citizens.

RESPONDING TO NEEDS

Africa should engage in policies to develop and expand national and regional human resources development strategies. These policies should include: (1) the development of a continent-wide biotechnology curricula – or curriculum guidelines – focusing on areas of study

with the potential to generate high economic returns both in different regions and the continent as a whole; (2) support for the creation of a consortium of universities mandated to develop and offer regional biotechnology training courses; and (3) an emphasis on female recruitment in the biosciences as well as engineering.

To take advantage of the opportunities that are likely to arise from biotechnology, Africa also needs to develop and expand programmes designed to upgrade and maintain strategically important infrastructure. At the same time, linkages must be established with both domestic and foreign research networks. All African countries, from the richest to the poorest, must identify biotechnology priority areas with the potential for regional R&D and product development, and then integrate these priorities into African regionalization processes and policies.

To improve commercialization and business capacity, Africa must support the following initiatives: (1) foster R&D cooperative partnerships at the local, regional and international levels; (2) create policy instruments that nurture business incubation and development; (3) build and sustain markets for economic growth; and (4) promote the role of technology, in general, and biotechnology, in particular, as part of a larger strategy for small- and medium-sized enterprise development.

The following mechanisms can – and should – be instituted to increase funding for biotechnology R&D in Africa: (1) raise overall national R&D budgets; (2) devise special funding mechanisms, including innovation funds and sectoral funding mechanisms under governmental ministries, some of which would generate funds that would be set aside for biotechnology research and development; (3) create targeted African funding schemes for facility renovations and expansions; (5) reform tax laws to promote research and innovation in biotechnology; and (6) enact national lotteries with a portion of the revenues obligated for universities and laboratories.

GOVERNING BIOTECHNOLOGY

Africa should embrace a strategic vision in which consumer protection goes hand-in-hand with the development of the biotechnology itself. Stakeholder partnerships, public awareness campaigns and well-publicized innovation competitions must be created to broaden citizen understanding and appreciation of biotechnology issues.

Emphasis should be placed on minimizing the risks associated with biotechnologies while reducing their negative impacts. Equally important, consideration should be given to the long-term implications of failing to adopt new biotechnologies. The essential point is


Calestous Juma

for Africa to develop and harmonize regulations governing such critical issues as regional integration, biotechnology R&D, biosafety (including field and clinical trials) and trade in biotechnology.

Africa's regulatory agencies need more transparency and greater scientific capacity in order to better assess biotechnology-related risks and to be able to regulate the technology's development quickly, safely and effectively.

There is an overall need to harmonize legislation and regulations based on good practices in international organizations, continental agencies and individual countries – all within the context and prevailing responsibilities of the RECs. The pursuit of such strategies could lead to regulatory frameworks and technology development that both protect the interests of consumers and allow for the rapid development of biotechnology. Organizations such as the African Academy of Sciences (AAS) and TWAS are well positioned to provide valuable assistance and advice in guiding this process.

The Pan-African Parliament (PAP) is another institution that could help harmonize biotechnology regulations in ways that could serve the interests of both biotechnology advocates and citizens. But for PAP to be truly effective, it must strengthen its engagement with other institutions dedicated to regional and continental biotechnology initiatives. Such efforts would require PAP to upgrade its advisory capabilities, issue evidence-based policy studies and provide its own committees with technology monitoring capabilities.

STRATEGIC CONSIDERATIONS

Africa needs to strategically promote the application of modern biotechnology for the purposes of regional economic integration and trade. The measures that will be necessary to achieve this goal include fostering the emergence of regional innovation systems in which biotechnology-related "local innovation areas" can play a pivotal role. Accomplishing this task will entail a

African countries must identify biotechnology priority areas with the potential for regional R&D.

UNLEASHING UNIVERSITIES IN AFRICA

Most African universities were not designed to serve as engines for development; nor were they intended to catalyze biotechnology innovation. For universities to pursue these new and urgent tasks, they must be reinvented; piecemeal reforms will not achieve the desired results.

Staff and students in the majority of universities in Africa face many obstacles, on a daily basis, that not only hamstring their efforts to contribute to innovation but also hinder their overall efforts to learn. The most critical obstacle of all is the low levels of funding from inside Africa.

A prime indicator of the deplorable state of African-based financing is the dominant place held by international organizations in funding R&D in Africa. International sources are responsible for nearly half of research funds flowing into the continent.

Another key indicator of the dreadful state of African-based financing is the tiny percentage of gross domestic product spent on R&D. For countries in Africa, the average is 0.3%. Throughout much of the developing world, it is approaching 1%. In many developed countries, it averages between 2% and 3%.

In Africa, only Egypt and South Africa have sufficient numbers of universities to meet the educational needs of their populations. There are 18 universities in Egypt and 36 in South Africa. The comparatively high number of universities found in these two countries account for the large percentage of scientific

articles published by their researchers, compared to the number published by researchers in other African countries. Indeed scientists in Egypt and South African account for roughly half of the scientific articles published by scientists living in Africa. Kenya, Morocco, Nigeria and Tunisia account for 25% of Africa's publication output. That means the other 43 countries that are members of the AU contribute only 25%.

Throughout the post-World War II era, universities in Africa focused on educating and training the sons and daughters of the elite. The goal was to provide these advantaged students with the education and skills they needed to secure posts with government. The state provided most of the funding. Industry's role was largely relegated to providing advice on technical education. Civic groups (charities, voluntary associations and faith-based organizations) were also been marginalized.

This same model was used in Africa's 'new' universities built just before and after independence, with this added caution: As universities in developed countries assumed increasing responsibility for research, universities in Africa continued to focus on teaching, following a path that had been laid down years before.

In colonial times, scientific research in Africa was the responsibility of laboratories managed by state-run institutes. Similarly, medical research was organized by laboratories tied to ministries of health. Agricultural research was mostly organized through state research institutes attached to ministries of food and agriculture, with few ties to farmers' organizations.

diversity of complementary measures that include upgrading regional capacities and forging international partnerships. The ultimate goal is to promote cities or regions in which research institutes, universities and businesses can be clustered for improved efficiencies and innovation.

Funding such initiatives will involve adopting a wide range of measures aimed at generating sufficient financial resources, which would include the launch of "innovation funds". Existing funding sources such as international and regional development banks could also play a key part in helping to commercialize products and services created by the biotechnology-related local innovation areas. Emphasis will need to be placed on technology 'prospecting' to identify existing biotechnologies worldwide and to commercialize biotechnologies in Africa.

The RECs must begin to uncover opportunities for biotechnology specialization and for fostering the development of the regional networking of biotechnology R&D centres that have successfully developed cross-cutting specializations in this field. More generally, Africa must facilitate North-South and South-South collaboration, as well as mobilize the expertise of its diaspora, as part of a larger effort to promote economic development.

Long-term initiatives for the development of biotechnology in Africa must go hand-in-hand with broader strategies to strengthen and advance regional economies. Africa should therefore facilitate the

process of regional integration and foster technological innovation as primary forces for promoting advances in biotechnology R&D. The economic payoff will likely be substantial.

Ismail Serageldin

THINK LOCAL

Local innovation areas hold the promise of creating competitive, biotechnology-driven African economies that benefit from geographical concentrations of innovators – universities, research institutes and technology-based business firms. Countries, through their RECs, need to identify biotechnology-related fields of local relevance, and facilitate local initiatives for innovation and development so that clustering of local institutions can occur.

Local innovation areas hold the promise of creating competitive, biotechnology-driven African economies.

A great deal of potential lies in developing North-South and South-South collaboration to support biotechnology R&D and capacity-building in African regional innovation communities and local innovation areas. The RECs therefore need to identify ways of improving cooperation with other regions (particularly Asia and Latin America) to effectively address issues pertaining to biotechnology.

The AU, despite its recent success, must also strengthen its capacity to provide political guidance to member states on the role of science, technology and innovation in development. At the same time, the AU must work to extend the autonomy and expertise of regional integration agencies and local authorities. Such a comprehensive strategy provides a reasonable roadmap for turning Africa's vision of a high-tech future, led by biotechnology and other cutting-edge technologies, into a reality.

What is true for biotechnology is true in general. Vision without action is empty; action without vision is blind. ■

For more detailed information, see:
http://www.nepadst.org/doclibrary/pdfs/biotech_africa rep_2007.pdf

Links between these research councils and universities in Africa were weak. And that remains true today. Universities worldwide over the past decade have been rapidly changing in response to the changing needs of their societies. Entrance to universities in a growing number of countries is no longer seen as a privilege for a chosen few. Rather, it is considered a right for the majority – or, at the least, as an opportunity that demands selection be based on merit, and not on wealth or family connections.

At the same time, the university's mandate has been evolving in reaction to the changing expectations of students. Employment in state government, with its steady paycheck and long-term security, often remains the preferred career option among graduates in Africa. However, industry is becoming an increasingly attractive destination for graduates, as are non-profit organizations and research institutions.

Universities need to have good relations with all of these sectors of the economy, and to be able to appreciate what each wants from new graduates in terms of knowledge and skills.

Governments, for their part, no longer seek graduates who are trained to work solely for the state. Instead they expect universities to provide students with the knowledge and confidence to pursue entrepreneurial initiatives that will create wealth and spur economic growth.

The financing of universities is changing too. From near-total reliance on the state, universities can now turn to a growing portfolio of funding sources that includes the private sector and civil society, which have increasingly supplemented and complemented the financial role of the state in funding higher education.

State financing, too, has become more innovative, for example, through the provision of tax incentives for R&D and low-interest, long-term loans. These diverse financial sources, however, do not come free of pressures, including pressure for universities to relinquish their independence, a fundamental aspect of places of learning that must not be compromised.

African universities cannot close their eyes to these global trends in higher education. In fact, they must change the ways in which they operate and become more responsive to the needs of their countries and communities. ■

EMPOWERING AFRICA

ONLY ONE IN THREE AFRICANS CURRENTLY HAS ACCESS TO ELECTRICITY. THIS CONSTITUTES A MAJOR STUMBLING BLOCK TO DEVELOPMENT AND TO ACHIEVING THE MILLENNIUM DEVELOPMENT GOALS (MDGS). AT THE SAME TIME, IF THE CONTINENT IS TO MITIGATE GLOBAL WARMING, IT MUST TRANSITION TO LOW-CARBON ENERGY SYSTEMS. THE TWAS-ROSSA YOUNG SCIENTISTS' CONFERENCE, 'ALTERNATIVE SOURCES OF ENERGY AND POTENTIAL FOR RENEWABLE ENERGY AND BIOFUELS IN AFRICA', SOUGHT TO EXAMINE THIS DUAL CHALLENGE.

With unstable (and often sharply rising) oil prices and growing concern over the effects on the climate of greenhouse gas emissions, researching and developing renewable energy resources has become more urgent than ever in Africa.

Two out of three Africans lack access to electricity. In the sub-Saharan region, this figure rises to 75% and, in rural areas, more than 90% must make do without electric power. According to the International Energy Agency (IEA), in sub-Saharan Africa alone, some 550 million people are living without electricity.

Lack of access to modern energy services not only deprives residents of basic comforts but also economic and educational opportunities. Indeed, there is a strong link between energy consumption and GDP growth. African countries, which collectively are home to nearly 850 million people or 12% of the world's population, consume only 5% of global annual energy production. In comparison, the United States, with just over 300 million people, consumes more than 25% of the world's energy.

The good news is that Africa possesses abundant energy resources. In terms of fossil fuels, the continent has some 10% of the world's oil and 8% of proven gas reserves. About 12% of the world's oil is drilled in Africa (chiefly in Nigeria, Libya, Angola and Algeria). More importantly, the continent is blessed with vast renewable energy resources, including biomass, solar, wind and hydro.

KEY RECOMMENDATIONS

Participants at the TWAS-ROSSA Young Scientists' Conference elaborated a number of key recommendations for renewable energy, including:

- *Governments should take steps to enhance renewable energy capacity throughout Africa.*
- *Local institutions and stakeholders should assess the potential role of renewable energy in meeting Africa's energy needs.*
- *Governments should identify promising policy actions and regulatory options required to stimulate broader and accelerated market-based dissemination of renewable energy.*
- *Stakeholders should assess challenges related to renewable energy technologies and discuss how they can be addressed.*
- *Public–private partnerships should be formed to enhance the development potential of renewable energy.*
- *Regional/continental energy database and information management systems on renewable energy should be established to facilitate dissemination of information among countries for accelerated deployment of new technologies.*

Africa, like the rest of the developing world, also has the opportunity of learning from the mistakes committed in the past and 'leapfrogging' directly to cleaner and more efficient renewable energy technologies.

YOUNG SCIENTISTS

The TWAS-ROSSA Young Scientists' Conference on 'Alternative Sources of Energy and Potential for Renewable Energy and Biofuels in Africa', held in Nairobi, Kenya, brought together some 25 scientists and experts from academic and research institutions and governments in 19 African countries. Representatives from the African Union (AU), the World Bank, and senior fellows of the African Academy of Sciences (AAS) and TWAS were also in attendance. The conference provided an opportunity to highlight current research being done by African scientists in various aspects of energy – including biofuels, solar, wind and hydropower.

The TWAS-ROSSA conference highlighted current energy research by African scientists.

Conference participants agreed that energy security was of strategic importance for both poverty reduction and wealth creation in Africa. They called upon African leaders and governments to work to bridge the energy gap with the developed world and to make energy the driver of economic development.

SOLAR ENERGY

Due to its position along the equator, Africa possesses enormous solar energy potential. Most of the continent has 325 days of strong sunlight per year. According to the European Commission's Institute for Energy, a mere 0.3% of the sunlight received by the Sahara and Middle East deserts could supply all of Europe's energy needs

"Africa experiences more hours of sunshine than anywhere else in the world, except perhaps the Arabian peninsula," says Michael Kwabena Osei, a research

TWAS REGIONAL CONFERENCES FOR YOUNG SCIENTISTS

Knowing that truly sustainable development in the South will depend upon the next generations of scientists, TWAS has increased its efforts to support young scientists in the developing world. Beginning in 2006, TWAS, in cooperation with its regional offices, has sponsored a series of Regional Conferences for Young Scientists.

TWAS is increasingly focusing on two key aims in its overarching strategy to build sustainable capacity in the developing world: strengthening its regional offices and providing much-needed support and recognition to promising young scientists in the South. The Regional Conferences for Young Scientists combine both goals. Initiated just a few years ago, the conferences are attracting growing numbers of enthusiastic young researchers eager to tackle challenges old and new.

In January 2009, the TWAS Regional Office for Central and South Asia (TWAS-ROCASA) sponsored a TWAS Regional Conference for Young Scientists on 'Energy and Climate'. Hosted by the Jawaharlal Nehru Centre for Advanced Scientific Research, in Bangalore, India, the meeting drew 75 young scientists from 15 Asian countries.

TWAS also sponsored travel grants for some 30 scientists from the developing world to attend the fifth edition of Biovision.Nxt, as part of the 2009 Biovision World Life Sciences forum in Lyon, France, in March 2009.

In May 2009, the 5th TWAS-ROLAC Conference for Young Scientists held at the Brazilian Academy of Sciences focused on Mathematics, Physics, Chemistry, and Earth and Space Sciences.

scientist at the Crop Research Institute in Ghana, who spoke about solar energy at the TWAS-ROSSA meeting. Osei also noted that there is great potential for solar power in Africa and that several African countries have developed solar power, including Algeria, the Democratic Republic of Congo and Morocco.

Yet current (photovoltaic) solar energy technology, he added, remains costly to produce and install. And, although ambitious plans (*e.g.*, huge installations in North Africa to export solar power to Europe) have been proposed, notably by the European Union, funding for such grand projects has been slow to materialize.

The good news is that a cheaper alternative may soon be offered by such new technologies as dye sensitized solar cells (DSC). Using low-cost organic materials, DSC can be engineered into flexible yet efficient energy-generating materials.

Bernard O. Aduda, chair of the physics department at the University of Nairobi, spoke about DSC technology at the Nairobi conference. “Solar energy can play a huge role in development, especially in allowing rural Africans to access power,” he says. “What is holding up the widespread use of solar power is the challenge of producing cost-effective solar cells.”

Because they are much cheaper, he explains, DSC “are potentially a breakthrough technology.” The problem, he says, is that “it has been difficult to produce DSC with performance efficiencies greater than 10%.” Aduda believes the cells’ low efficiency is due to a “sealing problem of the liquid electrolyte”, which leads to corrosion. The leakage problem, he adds, “could possibly be overcome by using solid or gel electrolytes.”

At present the technology is commercially available only for low-energy applications, such as cell phone batteries. Aduda advised conference attendees to “take advantage of TWAS fellowships to carry out additional solar power research.”

Some 50% of the energy consumed in Africa comes from firewood.

BIOFUELS

Like sunshine, biomass is plentiful in Africa and offers vast energy potential. Solid biomass – organic materials such as wood, agricultural crops and wastes, and manure – can be burned directly for energy (*e.g.*, burning wood or dung for heat and cooking) or used as a ‘feedstock’ to produce liquid biofuels (*e.g.*, ethanol, from maize or sugarcane, or biodiesel).

Although long considered environmentally friendly and a potential boon to poor farmers, biofuels have become an increasingly controversial source of energy that critics contend poses a potential threat to both food security and the environment. The ‘food vs. fuel’ debate came to the fore last year with a sharp rise in staple food prices.

The TWAS-ROSSA Conference paid special attention to the issues involved in biofuel development by including a working group on biofuels, comprised of nine members from seven African countries. The group discussed the complex interactions between energy, ecosystems and livelihoods, and the promise of biofuels in terms of sustainable energy security and mitigating climate change.

The group predicted that biofuels could account for as much as 10% of world fuel use for transport by 2025. This would enable Africa, if current trends continue, to reach the desired economies of scale for both widespread domestic use and export of this energy source.

Conference attendee Emeka Oguzie, associate dean of science at the Federal University of Technology Owerri (FUTO), in Owerri, Nigeria, believes biofuel is the most promising form of renewable energy in Africa. “Africa has abundant biomass resources,” he says, “but the energy potential of this resource has never been fully appreciated or utilized.” The challenge is to expand the use of biofuels without jeopardizing other critical goals that Africa is seeking to attain, most notably food security.

FOOD SECURITY

Biofuels have been widely blamed for the recent spike in food prices. The World Bank, for example, cited increases in maize prices – more than 60% from 2005 to 2007 – as an example of where biofuel production played a key role in threatening food security.

Yet proponents of developing biofuel production in Africa point out that only a small portion of arable land on the continent is currently exploited. A 2006 Food and Agricultural Organization (FAO) study, for example, found that arable land for rain-fed agriculture in Africa could be greatly increased. Might not the solution be to simultaneously increase food and biofuel crop production – in the latter case relying on land that does not readily lend itself to food crop cultivation? In Africa, could food and biofuel production co-exist, instead of being in competition with each other?

"The continent," says Oguzie, "is blessed with ample non-food land for cultivation of oil-bearing crops, such as jatropha, which could serve as feedstock for biofuel." With adequate improvement, he adds, "the technology for biomass conversion could be cost effective and easily adapted for traditional and small-scale applications." Such efforts would not only extend energy services, but also generate income and jobs in rural communities.

"Interestingly, poor energy infrastructure in Africa," he says, "means that large numbers of Africans currently rely on biomass for energy, though at a very rudimentary level, with very low energy efficiency and highly polluting potential (*e.g.,* firewood for cooking)."

Indeed, it is estimated that some 50% of the energy consumed in Africa comes from firewood.

Thus, for millions of Africans, the question is not so much whether biofuel production ought to be developed (it already is), but whether it can be produced with new technologies (for example, more efficient cooking stoves or as fuel stock for electricity) that will allow people to live more comfortable and healthier lives.

THE ENVIRONMENT

Biofuels have been widely touted as climate-friendly because of their 'carbon neutrality' – that is, the carbon dioxide they release in burning is absorbed by the growing feedstocks. (Complicating the equation is that energy is used in farming, processing and transportation.) Indeed, one UK government report found that biofuels reduce emissions by 50% compared to fossil fuels. Such findings led the European Union (EU) in 2003 to issue a directive calling for biofuels to meet 5.75% of the EU's transportation fuel needs by 2010.

But there is growing concern that the demand for biofuels is leading to the clearing of rainforests and peatlands for plantations, with an adverse impact on climate and the environment. This is a particular concern in Brazil and southeast Asia, with the conversion of peatlands in Indonesia for palm oil production, and deforestation in the Amazon for soy plantations. Such land clearings damage the environment by increasing greenhouse gas emissions. Forest destruction releases carbon into the atmosphere, and forest loss reduces an ecosystem's absorptive capacity. Clearing land for plantations can also reduce biodiversity.

Yet, such habitat destruction is not intrinsic to biofuel production. In any case, it is likely to be less of a concern in Africa, where extensive degraded areas could be used to grow biofuel feedstocks such as *Jatropha* that can help to combat erosion and improve soil quality.

The solution would appear to be to develop biofuel production in ways that neither harm the environment nor threaten food security. Two ways of doing this are to grow biofuel crops on lands not used for agricultural production and to produce biofuels and biogas from agricultural and other wastes.

WIND ENERGY

While Africa's position straddling the equator makes for significant solar power potential, in terms of wind energy, the area around the equator is a low pressure zone (once known to sailors as the doldrums), meaning that wind resources here are lower than at lower or higher latitudes. Yet, as the example of India – which now boasts the fourth-largest installed wind power capacity in the world – has shown, significant potential for wind energy exists in equatorial regions. The remoteness of much of Africa's rural population – which render connections to the power grid difficult and expensive – makes wind power more attractive.

It is estimated that Africa's wind power potential would exceed current energy demand.

"Wind farms are more feasible than solar power," for the continent, affirms Oguzie. "The technology is cheaper, easier to access and can be adapted locally, unlike solar cells, which require more advanced technologies."

Although the wind potential in much of the continent has yet to be assessed, estimates suggest it would far exceed current energy demand. The Maghreb region, South Africa and West Africa have especially high wind potential. Egypt, Morocco and Tunisia have been rapidly developing their wind power capacities, with Tunisia set to become the leader in Africa this year. In May 2008, South Africa's first commercial wind farm, just north of Cape Town, became operational, with an estimated power output of 5.2 MW.

Modern wind power conjures up images giant turbines towering over windy plains or studding coastlines. But researchers have recently developed technologies for small-scale wind power, which can be

YOUNG SCIENTISTS OF ASIA CONCLAVE

Acknowledging that growing demand for energy in the region presents both scientific challenges and opportunities, participants addressed ways in which the scientific community can better cooperate and exchange knowledge, both between countries and across disciplines.

Among the topics discussed were biofuels, solar energy, development of algae and other systems for carbon sequestration, and depleted water resources. In the conference Declaration, participants "acknowledged the opportunity provided by TWAS ROCASA to meet in Bangalore," the "importance of energy in the attainment of a better quality of life," and the "need for clean, affordable and reliable energy resources", both for development and environmental protection.

TWAS-ROCASA, which was inaugurated in September 2005, covers Afghanistan, Azerbaijan, Bangladesh, India, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Sri Lanka, Tajikistan, Turkmenistan and Uzbekistan.

used for water desalinization, water pumping and battery recharge. Generating particular interest lately are so-called micro-turbines, which – using low-cost, lightweight, yet robust materials – are small enough to be installed on the rooftop of a home.

Such small wind turbines, says conference participant El Hadji Ibrahim Diop, professor at the University of Dakar in Senegal, "could considerably improve the lives of rural folk, helping with water pumping and grain grinding." Yet, while "small 20kW turbines are easy to install," Diop adds, "wind power seems cost-effective only when its capacity factor is around 30%."

Africa's position straddling the equator makes for significant solar power potential.

Typically, modern wind turbines generate, over the course of a year, about 30% of their theoretical maximum output, due to variations in wind speed. The load factor of small-scale wind turbines (less than 50kW), however, is typically only 15–20%, in rural areas, and less than 10% in urban settings (where buildings often block the wind).

HYDROPOWER

In use for centuries, hydropower is the renewable energy resource whose worth has been most proven globally. Yet, only 5–7% of Africa's hydropower potential has been developed to date, compared, for example, to 65% in Europe.

Many African countries already rely heavily on hydropower for electricity supply. According to the International Energy Agency (IEA), the contribution of hydropower to net electricity generation is more than 90% in Cameroon, the Democratic Republic of the Congo, Ethiopia, Tanzania and Uganda, and more than 65% in Ghana and Kenya. Such overreliance runs the risk that drought and reduced river flows, brought on by climate change, will cause severe power shortages.

Thus, in Africa, hydropower represents both a major contributor to energy production and a significantly underdeveloped resource. But the paradox could be resolved: Having proven its value for many African states, hydropower should now be further developed throughout the continent, to help reduce energy poverty.

The subject of hydropower, despite its importance to Africa, was not a prominent one at the Nairobi conference. Perhaps for young scientists, eager to discuss the latest research advances, this 'old renewable' does not hold the same challenges or allure as solar and wind energy or biofuels. After all, it is not a lack of science and technology that is holding up hydropower in Africa, but such factors as cost and lack of political commitment.

Once constructed, hydropower plants have the advantage of low operational costs. But building the dams in the first place is another matter. The high up-front investment (and associated financial risks) involved and lengthy construction times continue to impede their development on the continent. Traditionally, hydropower has been publicly financed. In addition to the necessary political will, the construction of large dams requires both significant expertise and expenditure on the parts of governments.

Hydropower is a 'clean' energy resource in that it has no air quality impacts. Yet the building of large dams can have serious adverse consequences for ecosystems and the biodiversity of rivers. Too often there is also a human cost: large dam projects frequently require the displacement of local populations.

Yet, just as new technology has led to the development of small wind turbines, the same trend is happening with hydropower. Small hydropower systems – with up to 10 MW capacity – are increasingly seen as offering the best solution for providing electricity to Africa's rural poor. So-called 'mini-' and 'micro-hydro' units (with capacities of less than 1,000 kW and less than 100 kW, respectively) are even smaller installations, requiring only small streams (with no reservoir). As a result, they are suitable for small communities or enterprises.

"The potential for small-scale, stand-alone systems," says Oguzie, means that "that units could be installed close to the site of utilization." Such installations, he explains, "make for more efficient operation and maintenance than the huge and cumbersome central grid system, which has largely been a failure, at least in the African setting." Mini-dams also have the advantage of correspondingly mini ecological impacts and costs. For hydropower in Africa – if it is to most help the rural poor living remote from the grid – it might be time to think small.

LEARNING FROM THE PAST

Conference participants shared the belief that renewable energy – whether solar, hydro or wind power, or biofuels – holds great promise for Africa. Yet they also recognized the necessity of government action and support.

Many pointed to biofuels as having the greatest potential for the near term. "Biofuel production in Africa could be sustainable," Daniel Nyamai, of the World Agroforestry Centre, told conference attendees. "The climate is right, and we have sufficient land and human resources. All that is required is the political will to pursue effective policies."

"What is needed most," notes Oguzie, "is science and technology innovation driven by long-term, rather than short-term, planning."

In the end, Oguzie says, if Africa is to develop workable sustainable energy policies, the continent "must consider some hard truths based on past experience. Lofty and well-meaning ideas and projects have too often ended in failure and left the power system – and people and industries that depend on it – worse off. Like so much else about Africa, when it comes to renewable energy, the continent will need to learn from past experience (both its own and the experience of others) to 'power' and 'empower' itself to a better future." ■

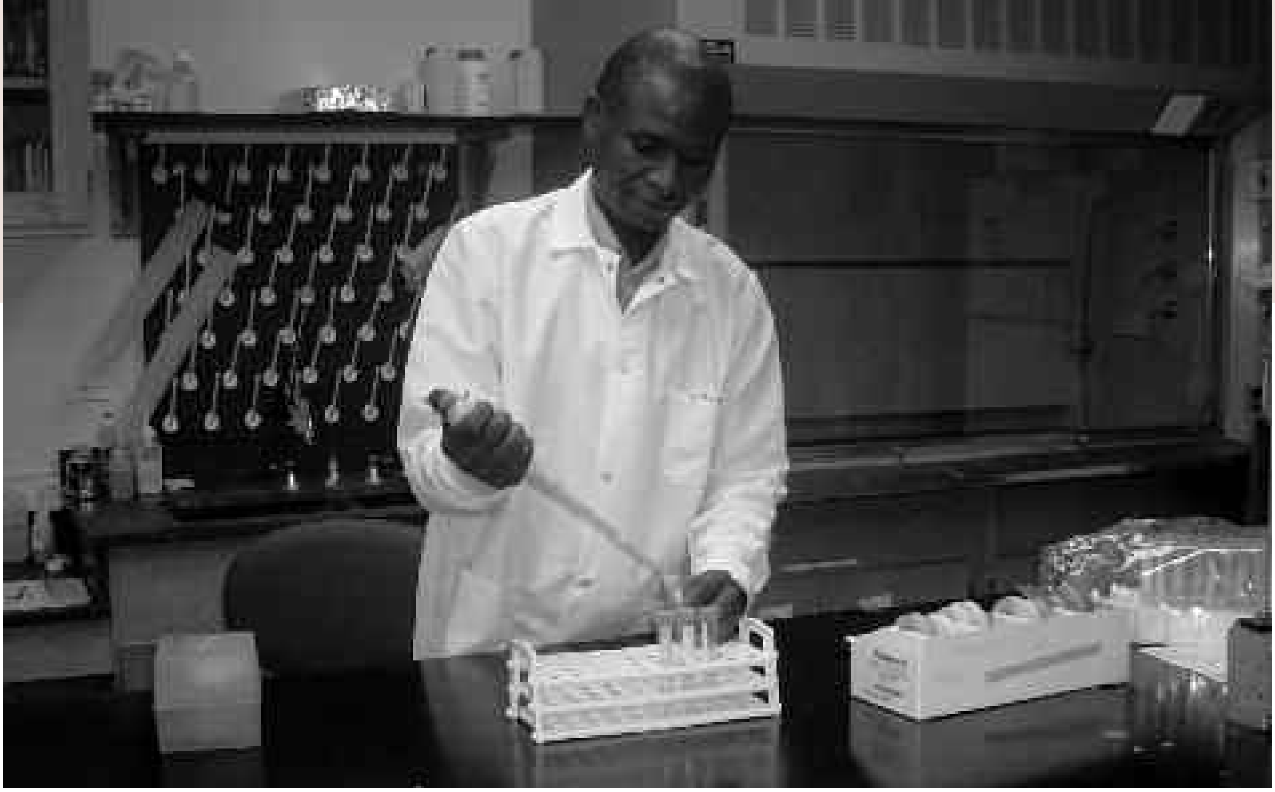
YIELDING A BETTER FUTURE

IN 2003, TWAS SIGNED AN AGREEMENT WITH BRAZIL, CHINA AND INDIA TO PROVIDE TRAINING FOR GRADUATE AND POSTGRADUATE STUDENTS IN POOR COUNTRIES. THE ARRANGEMENT CALLED ON TWAS TO PAY FOR TRANSPORTATION COSTS, AND THE HOST INSTITUTIONS TO PAY FOR ROOM, BOARD AND TUITION. SINCE THEN, THE PROGRAMME HAS EVOLVED INTO ONE OF THE LARGEST SOUTH-SOUTH FELLOWSHIPS PROGRAMMES IN THE WORLD. TODAY SIX DEVELOPING COUNTRIES COLLECTIVELY OFFER NEARLY 300 FELLOWSHIPS EACH YEAR. THE FOLLOWING ARTICLE DESCRIBES HOW THE PROGRAMME HAS BENEFITED KENYAN-BORN VITALIS WAFULA WEKESA.

"I did not begin my formal education until I was 10 years old", says Vitalis Wafula Wekesa, who was born in 1974 in Chebosi, a small village in western Kenya. "The reason I wasn't able to attend school is simple. I came from a family of peasant farmers and, as the second youngest of 10 children, I was called upon at a very young age to help my family make ends meet. School was simply a luxury my brothers, sisters and I could not afford, however much my parents wanted us to go."

Wekesa, who received a CNPq (the Brazilian National Council for Scientific and Technological Development)-TWAS postgraduate fellowship in 2005, has spent a lifetime making up for lost time.

He is undeniably a man in a hurry. Today, having earned a doctorate degree from *Universidade de São Campus Escola Superior de Agricultura* (ESALQ) in Piracicaba, Brazil, in December 2008, he is working as a post-doctorate research associate at the University of Florida's Institute of Food and Agricultural Sciences' Indian River Research and Education Center, in Fort Pierce, Florida, USA. There, he is designing an integrated pest management system to combat chilli thrips, a small exotic insect that attacks many different crops, including tomatoes. Indeed chilli thrips' large swarming populations and voracious appetites can cause damages estimated to cost US farmers USD3 billion a year due to crop yield loss. For those in the developing world,



more than lost revenues are at stake. The devastation caused by chilli thrips could place food supplies at risk.

Wekesa's work in Florida draws directly on his dissertation in which he studied potential microbial biological systems for controlling *Tetranychus evansi*, an invasive mite that has wreaked havoc on tomato plants in eastern and southern Africa. It has also proved to be damaging to cut flowers, French beans, eggplants and cucumbers.

His improbable career path has been assisted by a group of caring mentors, as well as by scientific institutions such as TWAS that are dedicated to supporting the next generation of African scientists who are determined to succeed if only given a chance.

Wekesa's improbable career path has been assisted by a group of caring mentors.

"My family", Wekesa says, "hails from a small village in western Kenya about 200 kilometres from where Barak Obama's paternal family lived. We are members of the Luhya tribe.

Obama's family belong to the Luo tribe. The members of Obama's tribe not only have more lyrical-sounding family names", he notes, "but they also have a higher social standing and greater wealth than members of my tribe."

In fact, Wekesa was only afforded the opportunity to attend school thanks the benevolence of ActionAid, a world-renowned international aid organization, launched in 1972, which currently operates in more than 40 countries. ActionAid, whose primary goal is to combat poverty in developing countries by working closely with local organizations, provided the funding for Namawanga primary school, which Wekesa was fortunate enough to attend.

Wekesa's intellectual ability was clearly on display from the start of his formal education. He was one of the top students in his class throughout primary school. Indeed he graduated as the best student in the Bokili region, beating out some 2,000 classmates for the honour. His ranking was based on the scores he earned in a national examination.

But a lack of money put his dreams for obtaining additional education at risk. Salim Juma, the headmaster of his primary school, recognized Wekesa's unique talents and agreed to pay his school fees, which amounted to USD200 a year. This benevolent gesture, on the part of a stranger who refused to allow Wekesa's poverty to stand in the way of his promising future, enabled Wekesa to enrol in Chesamisi Boys High School, not far from his hometown.

For three years, there was an uncommon calm and steadiness in Wekesa's life. His days largely consisted of attending school in the morning and afternoon, and then studying in the evening and often into the night.

But as he was about to enter his fourth and final year of high school, the calm that had descended on his world was rocked when Wekesa learned that the headmaster had lost his job and could no longer offer him financial support.

Without funding, Wekesa was asked to leave school and return home. He did. But this did not put an end to his learning. Although Wekesa could not formally attend school in his fourth year, he continued to work as diligently as he had in the past. The only difference – and it was a big difference – was that he was pursuing his education at home, hitting the books and completing the lessons by himself.

Wekesa's determination paid off. He passed the national entrance examination for university enrolment and was awarded a place at Jomo Kenyatta University of Agriculture and Technology (JKUAT), located in Juja, about 35 kilometres northeast of the capital city of Nairobi. The university, which is financed by the Japanese International Cooperation Action (indeed it is JICA's largest aid project), has an enrolment of 5,000 students. There, Wekesa continued to broaden his knowledge and refine his education, graduating with a bachelor's degree in the biological sciences in 1997 and a master's degree in microbiology in 2004.

While pursuing his master's degree, Wekesa also worked at the International Centre of Insect Physiology and Ecology (ICIPE), one of Africa's most renowned research centres, which was launched in 1970 by TWAS Founding Fellow Thomas Odhiambo, who passed away in 2003 (see *TWAS* Newsletter, vol. 3, 2003, pp. 34-35). It was at ICIPE that Wekesa first applied his knowledge of microbiology to the development of biological pest-controls to help curb the devastation caused by spider mites, a notorious agricultural pest that afflicts a wide range of crops. "A great deal of credit for advancing my education," says Wekesa, "goes to Nguya Kalemba Maniania, an insect pathologist at ICIPE who introduced me to the field of microbial pest control."

In 2003, after a brief stint with a pharmaceutical company working as a sales representative, Wekesa moved to the British-owned, Kenya-based cut-flower company, Homegrown. The company hoped to tap his knowledge of microbiology in order to develop effective biopesticides that would improve both flower yields and corporate profits.

"I was lured by the money," says Wekesa. "The company offered me a salary of USD500 a month, which was (and is) a good income for someone just out of school and with limited work experience. I was also motivated by the challenge of being asked to create a state-of-the-art biopesticide laboratory."

"I firmly believed," Wekesa adds, "that my efforts not only had significant scientific merit but also promised to help improve Kenya's economy." Kenya ranks second only

TWAS FELLOWSHIPS FOR YOUNG SCIENTISTS

The TWAS Fellowship Programme, launched in 2004 in partnership with Brazil, China and India, currently makes available nearly 300 fellowships each year through partnerships that have expanded to include institutions not only in Brazil, China and India, but also in Malaysia, Mexico and Pakistan. The programme works like this: Each year, under agreements with governments and international organizations in the participating developing countries, TWAS offers fellowships to promising young scientists from poor countries in the South to carry out postgraduate research in centres of scientific excellence in countries other than their own. TWAS covers the cost of transportation and the host institution pays for tuition and living expenses. It is among the world's largest South-South fellowship programmes. For additional information, please see www.twas.org and write info@twas.org.

to the Netherlands in the quantity of cut flowers that it produces. Indeed the cut flower industry in Kenya generates an estimated USD250 million in revenues a year, a significant sum of money in a nation with an annual growth domestic product of USD60 billion.

Despite his growing success in the corporate world, the lure of university teaching and research proved too strong for Wekesa to forsake his desire to pursue a career in academics. Yet a lack of opportunities to follow his dream made Wekesa believe that Homegrown would likely remain the centre of his work life.

"It was not a bad job," he says. "In fact, it was a good job. But it wasn't what I wanted to do." The truth is that, as in the past, the cost of continuing his education seemed to place his desire for additional degrees beyond his reach.

In Brazil, Wekesa focused his studies on a new field of inquiry: invertebrate pathology.

The opportunity that Wekesa had been hoping for came by way of phone call from Markus Knapp, his former faculty advisor at ICIPE and head of the organization's red spider mite project in Africa. Once again, someone who had recognized Wekesa's talents had gone out of his way to help him. Knapp contacted Wekesa to tell him about an advertisement he had seen for the TWAS fellowship programme for graduate study. He said that successful applicants would have their travel and living expenses covered in full while studying for their master's or doctorate degrees in universities or centres of research excellence in the developing world.

"It was an opportunity that I knew I couldn't pass up", says Wekesa. "And so I applied in August 2004 and was accepted four months later. Off I went to Brazil, where I would study etymology and microbiology – and learn Portuguese too."

"At the University of São Paulo and under the guidance of Italo Dalalibera, Jr. and Gilberto José de Moraes, who served as my advisors, I focused my studies – and ultimately my research – on a new field of inquiry: invertebrate pathology", Wekesa notes.

"The fact is that bacteria and viruses not only make plants and humans sick but they can make insects sick as well."

It's hard to think that insects can feel under-the-weather. But that is exactly what fungi, bacteria and viruses do to them. Insects, in fact, can catch a fever, which makes them feel ill and behave lethargically. Wekesa explains that certain species of termites care for their ill and even bury their dead to maintain the 'social' efficiency of their colonies by keeping potential diseases in check.

The point is that morbidity and mortality matter to insects. And, as Wekesa is quick to add, they should matter to us as well. That's because from the perspective of agricultural science, fungal, bacterial and viral infestations can reduce an insect pest's destructive powers and often lead to their death.

"I use the knowledge I have acquired in both entomology (the study of insects) and microbiology (the study of microorganisms) to detect disease-causing fungi, bacteria and viruses in insects," Wekesa says. "I then try to isolate these microorganisms and mass produce them for field applications as a way of biologically controlling the spread of insects in food crops and ornamental flowers."

There is an old saying in war and diplomacy: 'The enemy of my enemy is my friend'. This is a truism that applies to Weskesa's research as well. By identifying


and isolating fungi, bacteria and viruses that inflict illness and death in insects, Wekesa can then apply these pathogens in both controlled agricultural settings and greenhouses. This allows plant pests to be contained without having to apply excessive amounts of chemical pesticides that are potentially harmful to the environment and human health.

Here is an example of how Wekesa's research works.

Spider mites are sucking anthropods that can cause widespread damage to citrus fruit, cotton, tomatoes and many other plants. The mites are a global threat to agricultural productivity. But not surprisingly, the most serious threat they pose is in developing countries. In Zimbabwe, a country that suffers high rates of malnutrition, these mites can sometimes reduce tomato yields by 90%.

"I hold a special place in my heart for TWAS, which provided me with an opportunity to continue my education."

"We have discovered a fungus", says Wekesa, "that sickens and ultimately destroys spider mites. Effective applications of this fungus (which agricultural experts prefer to call a biopesticide) could substantially increase crop yields for farmers across the globe without posing risks to the environment. As Wekesa likes to say, "these are environmentally friendly pesticides."

This is exactly the same research technique that Wekesa is now using as part of a larger effort to minimize the damage that chilli thrips afflict on crops in Florida. "Insect pests do not abide by political boundaries", he says with a smile. "And neither do the fungi, viruses and bacteria that inflict harm on them. This means the research I am doing at the University of Florida could prove just as useful in Kenya as it is in Florida."

The broad applications of Wekesa's research, together with his personal desire to return to his home country, have given him added incentives to try to find a way back to Kenya, where he hopes to land a position in a university. By working in an academic setting, he believes that he will have the freedom not only to teach and train future generations of students but also to work closely with the private sector to help both agriculturalists and horticulturalists achieve better yields and higher incomes.

"Kenya is a country where agriculture continues to dominate the economy." Indeed about 80% of Kenya's population live in rural villages and most people earn their living by tilling small plots of land. More than half of the population lives on less than USD2 a day. "Such statistics", Wekesa states, "mean that, if you can help the farmers and horticulturalists, you can help virtually the entire population live healthier and more prosperous lives."

"Who would have thought when I was 10 years old, and starting school for the first time in 1984, that I would be where I am today. I have lots of people to thank. And I hold a special place in my heart for TWAS, which provided me with an opportunity to continue my education just when I had thought all of my opportunities had been exhausted." ■

TALKING POINTS

NEW INFORMATION TECHNOLOGIES HAVE GONE GLOBAL. YET, A NORTH-SOUTH GAP IN THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT OF THESE TECHNOLOGIES REMAINS STUBBORNLY IN PLACE. THE EUROAFRICA-ICT PROJECT IS DESIGNED TO HELP CHANGE THAT.

More than 320 participants from some 50 countries – including policy-makers and ICT researchers in both the public and private sectors – met in Brussels on 24-25 March to discuss the development of collaborative projects. The two-day event was organized by the European Commission Directorate General, Information Society and Media (DG INFSO) with the support of the African Union Commission (AUC) and the EuroAfriCa-ICT project, funded under the EU's Seventh Framework Programme (FP7).

Sally Kosgei, Kenya's Minister of Science, Technology and Higher Education, placed the subsequent discussions on ICTs into a broader context when she said: "Africa has developed a roadmap for development but we have only taken the first step. We need to take a thousand more steps. Otherwise, Africa will be left behind. We have received some bilateral support from some EU countries and some support from the African Development Bank. But there is a need for proper coordination and to assess where we are."

A video message from Viviane Reding, European Commissioner for DG INFSO noted that the Africa-EU Joint Strategy and Action Plan, signed in December 2007, supports research in science, space and the information society. "We look forward to working with all of you, in Africa and the EU, on ICT policy and research," she said.

"There are already tangible results of EU policy in research cooperation," added Jan Ostraja-Ostraszewski, DG INFSO. "For example, to date more projects have been supported under FP7 (2007-2015) than under the five years of FP6."

Vera Brenda Ngosi, Director, Directorate of Human Resources, Science and Technology, African Union Commission, thanked the EC for its determination to assist Africa, adding that the Forum provided "an excellent opportunity for addressing mutual concerns and partnerships. Expressing her optimism about the endeavour, she asserted that: "We are opening a new chapter, and Africans are ready to work shoulder-to-shoulder with our European partners."

"ICTs, in all forms, are the keys to people-centred development," said Abdul Waheed Khan, UNESCO's Assistant Director-General for Communication and Information, "and UNESCO stands ready to play a catalytic role with the organizations present at this Forum."




AFRICAN UNION

The African Union (AU) is Africa's premier institution and principal organization for advancing socio-economic integration across the continent. As a continental organization, it focuses on the promotion of peace, security and stability in Africa as prerequisites for implementing its agenda. The AU's policies are established by the AU Assembly, composed of heads of state and government or their duly accredited representatives. The AU Commission (AUC) manages the AU's affairs on a day-to-day basis. Among its responsibilities, the AUC drafts common membership-wide positions on critical issues; prepares strategic plans and studies for the consideration of the executive council and Assembly; and elaborates, promotes, coordinates and harmonizes the programmes and policies of the AU. For additional information, see www.africa-union.org.

ROUNDTABLE FORUMS

High-level sessions at the Forum were dedicated to Africa-EU cooperation on ICT, EU-AU partnerships, EU and AUC programmes, private and public partnerships, African participation in FP7, e-infrastructures, technology roadblocks and socio-economic goals and applications.

Africa's ICT deficit – the 'digital divide' – was the focal point of discussions at the session on EU and AUC programmes. Among the solutions proposed were greater regional integration and additional investments in ICTs, as well as regulatory reforms and better access to broadband communication.

ICTs are the keys to people-centred development.

In the session on public-private partnerships, which focused on experiences and lessons learned, participants agreed that a promising campaign to curb Africa's isolation was already being waged, and that there had been a noticeable shift in emphasis from the notion of cooperation *for* Africa towards cooperation *with* and *in* Africa, managed in Africa and by Africans themselves.

Aida Opoku-Mensah, Director, ICT and Science and Technology Division, UN Economic Commission for Africa (UNECA), observed that there were a number of successful public-private partnerships operating in Africa. She also pointed out that the increasing influence of countries such as China and India – in terms of providing venture capital – posed an increasing challenge to European companies and others present at the Forum. In her closing remarks, she observed that Africa needed to develop its own indigenous ICT.

The latter problem was also highlighted by Fabien Petitcolas, head of Intellectual Capacity Development, Microsoft Research, UK. He noted that the research branch of Microsoft, based in Cambridge, UK, hired about 80 PhD graduates each year, but so far had not offered a single position to any African. "The level of research in Africa does not reach the level of research on display at international conferences or journals," he explained.

Microsoft's efforts to counter this trend include the newly established TWAS-AAS-Microsoft award

scheme for young computer science researchers from Africa. Under this scheme, three talented young researchers from three different African countries will be honoured each year and provided with funds to pursue their research (see box, p. 50).

But laboratory research is not all that is required, said Daniel Annerose, CEO of Senegal-based Manobi, a private ICT company. "We also need research into business models," he said.

CONNECT AND COOPERATE

To achieve any of these desired goals, however, improved connectivity is required. African scientists need to be able to communicate and collaborate with their peers in neighbouring countries, in Europe and elsewhere. And private companies need to be able to turn a profit if they are to provide the infrastructure for such communication.

Africa is regarded as having one of the best locations on the planet for satellite connectivity. In contrast, South America can only realistically be connected to and through the United States. Africa's connectivity, however, has been constrained by low bandwidth and high latency (the time it takes for information to be transmitted), both of which have seriously handicapped the performance of the continent's existing electronic communications networks.

The good news is that two marine cables are in the process of being laid, one along each African coast. Jean Louis Permentier, chief operating officer of SEACOM, and John Sihra, chair of EASSy-WIOCC, both expressed confidence that cables being built by their companies would soon help resolve connectivity and bandwidth problems.

The less encouraging news is that plans must still be put into place to connect the interior of Africa. This goal could possibly be met in a stair-stepped fashion by forging interconnected local area networks (mesh-net-

DG INFSO

Through its portfolio, the Directorate-General of Information Society and Media (DG InfSo) represents an economic sector that is crucial for prosperity and the quality of life in the European Union. Areas covered range from underlying communications infrastructures to the content and services they deliver, encompassing telecommunication networks, broadband internet access and satellite communications; new communications technologies such as '3G' mobile communications and internet telephony; and digital material as diverse as cinema releases and advanced eHealth services. Research into ICTs, coordinated by DG INFSO, accounts for the single largest portion (over EUR 9 billion) of the EU's Seventh Framework Programme for Research (2006-2013). Objectives range from advancing basic research into such areas as nanotechnology and photonics to using ICTs to improve quality of life by utilizing ICTs to make roads safer and healthcare better. Other objects include enhancing industrial competitiveness through networked services and the development of new software. For additional information, see:
ec.europa.eu/dgs/information_society/index_en.htm

work systems), which would be designed to develop reliable electronic links first at the regional level, followed by the continental level, and finally globally.

However, as one participant cautioned: "Cables without traffic are useless. Therefore, there is a need to pursue efforts that enable African researchers to generate their own traffic." Thus, discussions also centred on African national research networks (NRENs) and how they could be linked to one another and to a similar research network in Europe, GEANT(2).

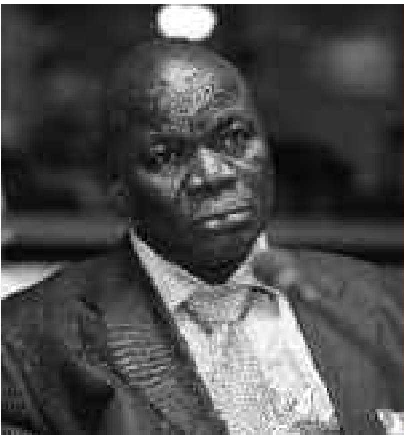
ROADBLOCKS

Technical solutions are available to address many of the challenges created by the digital divide. However, in many cases, these solutions need to be tailored to local conditions and situations. For example, end-user solutions to internet access in Africa seem to be focusing on the cell phone, which is more affordable and more flexible than the computer. Indeed, mobile phone use in Africa is currently increasing at twice the global rate.

Panelists in the session focusing on technology agreed that the real roadblocks to progress often relate to inadequate systems and processes that impede access to existing technology – and not to the development of technology *per se*. For example, past business models have often failed to meet the unique challenges for technology development and use in Africa.

Business plans, if they are to be successful, must be responsive to Africa's local and national conditions but also recognize the need for hardware and software industries to sell their products and services in sufficiently high volumes to be profitable.

Other roadblocks to success are linked more closely to policy. While acknowledging the rapid spread of mobile phones in Africa, Serge Ferré, vice-president, Nokia Europe, noted that in several of the continent's poorest countries, it is still considered a luxury to have one. "Is it a luxury to communicate? To do business? To obtain health information?" he wryly asked. In short, where the cell phone remains a luxury, economic progress is likely to remain a dream.



Another roadblock to the effective development and use of ICTs in Africa, as noted throughout the Forum, is the lack of trained personnel. Salaries, materials, access to journals and opportunities for exchange with colleagues in other countries remain extremely limited for African scientists and technologists in all fields of study, including ICT researchers. Nokia Europe is seeking to overcome this obstacle by supporting three research centres in Africa – in Kenya, Morocco and South Africa. Yet, the scope of the problem requires much more to be done if the needs of researchers are to be met.

The final discussion session focused on socio-economic goals and applications of ICTs, examining some of the successful initiatives currently in place. For example, Chris Morris, an ICT for Development specialist at Meraka Institute in South Africa, spoke about technologies that were making information accessible to rural communities. Meanwhile, Francesco Sicurello, president of the Italian Association of

EUROAFRICA-ICT PROJECT PARTNERS

The consortium implementing the EuroAfriCa-ICT project is composed of the following partners in addition to TWAS:

- *Sigma Orionis, based near Nice, France, act as the project coordinator. See:* www.orionis.com.
- *The Panos Institute West Africa (PIWA), Senegal, covers west Africa. See* www.panos-ao.org.
- *The Meraka Institute, Council for Scientific and Industrial Research (CSIR), South Africa, deals with southern Africa. See* www.meraka.org.za.
- *The Kigali Institute for Science and Technology (KIST), Rwanda, covers central Africa. See* www.kist.ac.rw.
- *Faculty of Computing and Information Technology, Makerere University, Uganda, covers east Africa. See* www.cit.ac.ug.
- *The Caribbean Academy of Sciences (CAS) is the project's Caribbean partner. See* www.caswi.org.jm.
- *The Africa Unit of the Association of Commonwealth Universities (ACU), London, United Kingdom, uses its network of some 500 universities to disseminate information about the project. See* www.acu.ac.uk *and* www.caast-net.org.
- Agence universitaire de la Francophonie *(AUF) is another major network of 659 higher education and research institutions with many members in francophone Africa. See* www.auf.org.
- *Thierry Devars, policy officer, DG InfSo, oversees the project on behalf of the European Commission. For additional information, see* euroafrica-ict.org/EuroAfrica-ICT_Overview.pdf

TWAS-AAS-MICROSOFT AWARD

TWAS, Microsoft Research, and the African Academy of Science (AAS) have become partners in two new programmes designed to recognize and assist scientists working in Africa in the field of computer science. The TWAS-AAS-Microsoft Award for Young Scientists will reward young scientists in Africa whose research in computer science promises to have a positive impact in the developing world. Each year, three winners will be selected from different countries on the continent. Scientists who have received their most recent research degree within the past 10 years will be eligible. Each recipient will receive a EUR 7,000 cash prize. The first winners of the prize will receive their awards at a ceremony hosted by AAS in Nairobi, Kenya. TWAS-AAS-Microsoft Grants for Scientific Meetings aim to encourage the organization of international and regional scientific conferences and workshops in Africa, again in the area of computer science. Support is available in the form of travel grants for some principal speakers from abroad and/or participants from developing countries other than the country in which the event is held. For additional information, see www.twas.org > Programmes > Meetings.

Telemedicine, provided an overview of a project that involves African doctors sending images to medical consultants in Italy so that experts there can confirm diagnoses and offer advice on treatment.

PILOTS TO PARTNERSHIPS

Summing up in the closing ceremony, Thierry Devars, Policy Officer, International Relations Unit, DG INFSO, concluded that, in the past, too few projects in Africa have moved from a pilot stage and emerged as a commercial model. And that fewer still have ever been tested in the market place. “This can (indeed should) be done,” he said, “by developing partnerships and friendships between the EU and AUC.”

In the opening panel session, Stefano Manservisi, Director-General, Directorate General Development (DG DEV), European Commission, noted that he was pleased by the high and enthusiastic level of participation at the Forum. “Five years ago, this would not have been possible,” he acknowledged. What accounts for this welcome development? Manservisi observed that the seeds of political will in Europe to assist Africa have been successfully sown since then, and that there is now sufficient capacity in Africa to be able to nurture these seeds into something viable.

The connections made and the potential opportunities for collaboration explored during the First Euro-Africa Cooperation Forum on ICT Research give reason to believe that the Forum’s goal to increase European and African cooperation for ICT research and development will soon be marked by significant advances – to the lasting benefit of both continents.

“The EU-ACU partnership is real,” proclaimed Vera Brenda Ngosi, and, as events such as this Forum clearly indicate, “it is advancing.” ■

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ROYAL MEDAL

• **C.N.R. Rao** (TWAS Founding Fellow and immediate past president) has been awarded the Royal Medal by the Royal Society, London, for his contributions to solid state and materials chemistry. The Royal Medal will be presented to him in London in November. Rao is National Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India.

HONORARY DOCTORATE

• **Farouk El-Baz** (TWAS Fellow 1985) has received an honorary doctorate of humane letters from the American University of Beirut. El-Baz is research professor and director of the Center for Remote Sensing at Boston University and adjunct professor at Ain Shams University in Cairo, Egypt. He participated in NASA's Apollo programme and also established and directed the Center for Earth and Planetary Studies at the Smithsonian Institute in Washington, DC, USA

HONORARY DOCTORATE

• **Ismail Serageldin** (TWAS Fellow 2001) received an honorary doctorate degree in Arts from Beirut Arab University (BAU) in June. This is the second honorary degree granted by BAU; the first was granted to the late Prime Minister of Lebanon, Rafiq El-Hariry, in 1994. Serageldin is director of the *Bibliotheca Alexandrina* in Alexandria, Egypt.

WALDO E. SMITH MEDAL

• **Harsh Gupta** (TWAS Fellow 1995) was awarded the American Geophysical Union's 2008 Waldo E. Smith Medal for extraordinary services to geophysics. Gupta is Raja Ramanna Fellow, National Geophysical Research Institute (NGRI) in Hyderabad, India.

FIRST CLASS ORDER

• **Adel El-Beltagy** (TWAS Fellow 2005) was awarded the Sultan Qaboos 'First Class' Order for Culture, Sciences and Arts for his contribution to the Development of Agriculture in the Dry Areas. The Order was presented in Oman by HRH Sayyid Shihab Bin Tariq Al Said, Advisor to the Sultan, in May. El-Beltagy holds a number of positions, including chair of the Global Forum on Agricultural Research (GFAR), advisor to the Minister of Agriculture for Research and professor at Ain Shams University.

TWAS YOUNG AFFILIATES

• The TWAS Regional Office for Central and South Asia (TWAS-ROCASA) has announced its five TWAS Young Affiliates for 2009. They are: **Orhan Aydin**, vice president of Karadeniz Technical University in Trabzon, Turkey (engineering sciences); **S. Chakrabarti**, research scientist at L.V. Prasad Eye Institute in Hyderabad, India (biological sciences); **Farooq Anwar**, assistant professor in the Department of Chemistry and Biochemistry at the University of Agriculture in Faisalabad, Pakistan (chemical sciences);

Harsh Gupta

H.V.Y. Deepani Siriwardana, lecturer in the Department of Parasitology, Faculty of Medicine, University of Colombo, in Sri Lanka (medical sciences); and **Hamidov Sadig**, research fellow at the Institute of Physics, Azerbaijan National Academy of Sciences, in Baku, Azerbaijan (physical sciences).

IN MEMORIAM

• **Ernesto Paterniani** (TWAS Fellow 1994) died on 18 June 2009 at age 81. Paterniani was an internationally recognized expert in the genetic improvement in maize. At the Superior School of Agriculture Luiz of Queiroz (ESALQ), he served as head of the department of genetics, director of the Institute of Genetics and coordinator of the post-graduate courses in genetics and plant improvement. He was also a consultant for the Brazilian Agricultural Research Corporation (EMBRAPA), member of the Technical Advisory Committee and founding member of the Academy of Sciences of the State of São Paulo. For his contributions, he was awarded EMBRAPA's Frederico Menezes Veiga Prize and the Supreme Cross of Brazil's National Order of Scientific Merit.

Ernesto Paterniani

WHAT'S TWAS?

TWAS, THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD, IS AN AUTONOMOUS INTERNATIONAL ORGANIZATION THAT PROMOTES SCIENTIFIC CAPACITY AND EXCELLENCE IN THE SOUTH. FOUNDED AS THE THIRD WORLD ACADEMY OF SCIENCES BY A GROUP OF EMINENT SCIENTISTS UNDER THE LEADERSHIP OF THE LATE NOBEL LAUREATE ABDUS SALAM OF PAKISTAN IN 1983, TWAS WAS OFFICIALLY LAUNCHED IN TRIESTE, ITALY, IN 1985, BY THE SECRETARY GENERAL OF THE UNITED NATIONS.

TWAS has more than 900 members from 90 countries, 73 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a secretariat, headed by an Executive Director and located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Italian government.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North cooperation between individuals and centres of science and scholarship.

In 1988, TWAS facilitated the establishment of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of some 150 scientific organizations in the South. In September 2006, the foreign ministers of the Group of 77 and China endorsed the transformation of TWNSO into the Consortium on Science, Technology and Innovation for the South (COSTIS). COSTIS's goals are to help build political and scientific leadership in the South and to promote sustainable development through broad-based South-South and South-North partnerships in science and technology. **costis.g77.org**

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2,500 women scientists from 87 developing countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 100 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. **www.interacademies.net/iap**

The secretariat of the InterAcademy Medical Panel (IAMP), a global network of 65 medical academies and medical divisions within science and engineering academies, relocated to Trieste in May 2004 from Washington, DC, USA. IAMP and its member academies are committed to improving health worldwide, especially in developing countries. **www.iamp-online.org**