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HOPE AND DESPAIR; POVERTY AND PROMISE; PROGRESS AND TRAGEDY — ALL COEXIST AS PART OF AN INTRICATE AND EVER-CHANGING SOCIAL, ECONOMIC AND POLITICAL LANDSCAPE. AFRICA IS INDEED A CONTINENT OF CONTRADICTIONS.

Africa's renewed ambitions in a changed world

Against this background, Africa must seek to accelerate its economic growth and to ensure that all its citizens share in the wealth that is created.

Likewise, African universities must play a key role in advancing Africa's economic progress, again in ways that benefit everyone.

A fine-tuned economic engine does not run on its own. It needs fuel not just to get going but to keep going. And one of the most important fuels driving economic growth is good governance and democracy.

This represents the first fundamental challenge for Africa today. Each African nation must pursue political reforms based on democratic principles, openness, transparency and accountability. Such reforms will help drive out corruption and promote the development of strong political and financial institutions that both attract foreign investment and pave the way for productive partnerships with international institutions.

It is no coincidence that countries that have pursued effective political reforms have also experienced accelerated economic growth. These countries include Ghana, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Tanzania and Uganda.

It is also no coincidence that these same countries have relied increasingly on science and technology to propel their growth. Science, after all, progresses in an environment that encourages openness, transparency and accountability.

Thus the second major challenge facing African nations is to improve the quality of education and research.

Just three decades ago, universities and research centres in sub-Saharan Africa were often as good as any in the developing world. In fact, the University of Khartoum, where I taught, was considered among the best institutions of higher education in the South. Unfortunately, that is no longer the case.

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But this reversal in fortunes, however long-standing, doesn't have to continue. Conditions can improve – and improve quickly – if sufficient resources and willpower are brought to bear on the problem.

That's why one of the key challenges for each and every African nation is to build at least one world-class university.

But building a world-class university is not enough. For African nations to take full advantage of a well-educated citizenry, they must also provide university graduates with challenging and rewarding career opportunities.

We all know what happens when jobs don't await graduates. The best and brightest emigrate to other countries, taking with them the skills and knowledge that a nation needs to succeed. This is exactly the current situation in Africa today. More university graduates from sub-Saharan Africa live and work in the United States than in their native countries.

This brings me to the third critical challenge facing Africa. The continent must forge successful strategies for linking research to action. Put another way, the world-class scientists that Africa hopes to educate must be trained to address local and regional problems.

That does not mean Africa's scientists will be relegated to doing second-rate research. In fact, the key is to put cutting-edge science and technology to work in combatting the continent's most critical problems: reducing poverty, overcoming food deficits, providing greater access to safe drinking water and improved sanitation, upgrading healthcare, and increasing the production of energy, especially renewable energy.

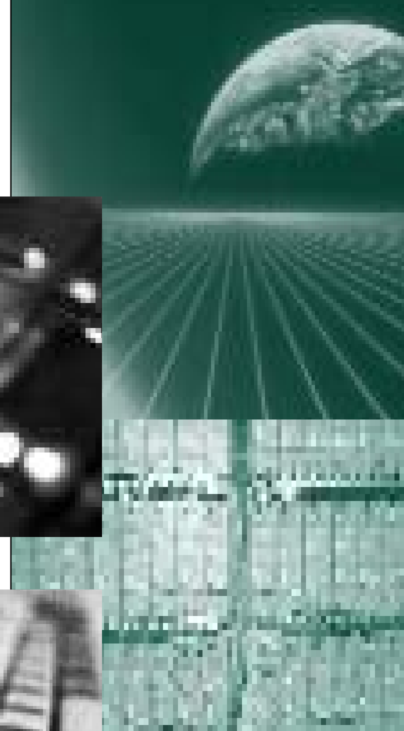
These critical needs are all part of the United Nation's Millennium Development Goals (MDGs), and they must play a central role in Africa's efforts to develop an effective strategy for sustainable economic growth.

This brings me to the fourth and perhaps most critical challenge: how will Africa fund such efforts?

The key is to establish institutions that support basic and applied research through a transparent and competitive process of evaluation that rewards the most meritorious proposals. South Africa's National Research Foundation is the only institution of this kind in sub-Saharan Africa. Nigeria's recent decision to launch a National Science Foundation, with a US$5 billion endowment, offers hope that times are indeed changing.

The fifth and final critical challenge facing Africa is: how can the encouraging rhetoric about the future of Africa be turned into reality?

The past few decades – and particularly the past several years – have witnessed a series of well meaning declarations issued by well meaning, often powerful, institutions. The Lagos Plan of Action in 1980; the Declaration of the UN Special Session on Africa in 1986;



the Kampala Declaration on Intellectual Freedom and Social Responsibility in 1990; the New Partnership for Africa's Development's (NEPAD) Declaration on Democracy, Political, Economic and Corporate Governance in 2002; the G8 Summit's Declaration on Africa in 2005; the European Commission/African Union Declaration in 2006, and many others.

I am sorry to say, however, that while words have been plentiful, action has been in short supply.

We can only hope that the declaration issued by the African Union at its Summit on Science, Technology and Innovation to be taking place in Addis Ababa, Ethiopia, in January 2007, will be different: that it won't mark so much the end of an event, but the beginning of an effective strategy for science-based sustainable development in Africa.

Each of these challenges is daunting enough. Collectively, they will test Africa's ability to engage in meaningful reform and to create a better future for all of its citizens.

Every sector of society must play a role if progress is to be achieved. Yet, in a world where knowledge – particularly scientific knowledge – is so critical for success, universities must take centre stage.

So, what measures should African universities pursue, both on their own and in concert with others, in accelerating Africa's economic growth?

Universities, of course, need resources to fulfil their promise. But they also need imagination, drive and commitment to foster and then sustain a learning environment where the faculty and students alike can reach their potential.

That's why university administrators and professors have an obligation to pursue curriculum reforms based on innovative teaching methods that can successfully nurture a new generation of scientists dedicated to using their knowledge to solve Africa's problems.

First-class universities must also contain dynamic research units of excellence equipped with state-of-the-art facilities within their faculties and departments. Such units offer the best way forward for raising the quality of research in Africa and for linking research to the outside world.

Africa's scientists must take the lead in solving Africa's problems. But they can only do so if they are given the opportunity to work in excellent research facilities and if they can forge partnerships with leading universities in other parts of the world, especially the developing world.

We could well be entering a golden age of South-South cooperation, and Africa could well be the greatest beneficiary of this new era. But a positive outcome will only take place if African scientists receive the training that they need to participate in this process as full partners.

That is why I am encouraged by programmes like TWAS's fellowship scheme for doctoral students and postdoctoral researchers. This programme, funded by the governments of Brazil, China and India, and managed by TWAS, offers up to 250 fellowships each year for

students to attend universities and research centres located in the sponsoring countries. Many of the recipients come from Africa.

The assistance provided to individual scientists, especially young scientists, however, must be complemented by programmes that promote joint research projects among institutions.

Brazil's sponsorship of cooperative projects between scientific institutions in Brazil and those in Portuguese-speaking African countries represents an encouraging trend. The recent tripartite agreement between Brazil, India and South Africa to pursue joint research projects also speaks for a better future.

The Third World Network of Scientific Organizations (TWNSO), an affiliate organization of TWAS that has recently been transformed into the Consortium on Science, Technology and Innovation for the South (COSTIS) under a cooperative agreement with the Group of 77 and China, has also contributed to this effort. TWNSO has highlighted successful experiences in the use of science and technology to address critical social and economic needs. It has also sought to create institutional networks in such critical areas as access to safe drinking water, the development of renewable energy, and the conservation and wise use of medicinal plants. Institutions in sub-Saharan Africa have been well represented in all these efforts.

All of this bodes well for the future. But more, much more, needs to be done.

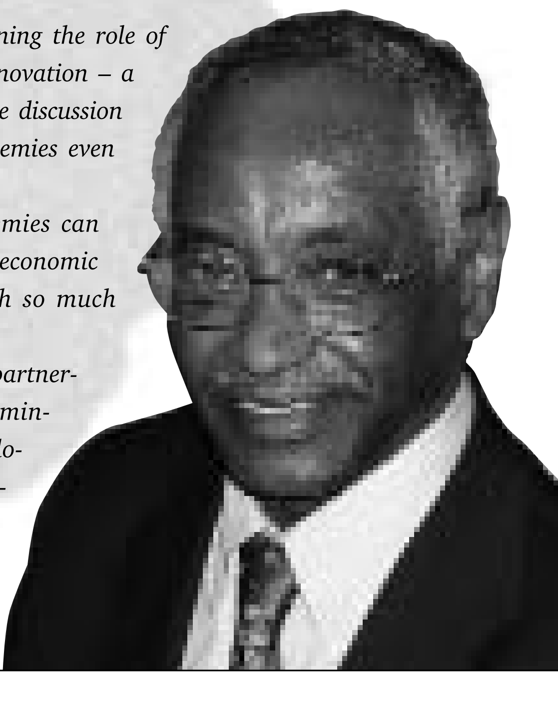
Like universities and research centres, merit-based science academies in Africa have been underutilized. In fact, only 13 of the 53 nations in sub-Saharan Africa have merit-based national science academies. That's three more academies than existed just a few years ago. Africa's science academies and universities would be well served by joining together in a closer partnership. After all, the vast majority of academy members are also university professors.

That is why I am encouraged by the recent joint statement by the InterAcademy Panel (IAP) and the Network of African Science Academies (NASAC) expressing support for higher education in Africa, and by the InterAcademy Council's (IAC) 2004 report calling for a revitalization of African universities and research centres.

The IAC's upcoming report focusing on strengthening the role of African university research in national systems of innovation – a report requested by NASAC – promises to broaden the discussion between the continent's universities and science academies even further.

The truth is that universities and science academies can each make important contributions to accelerating economic growth in Africa. But together they can accomplish so much more.

Universities in Africa also need to forge stronger partnerships with government institutions – for example, ministries of agriculture, finance, and science and technology – and with the institutions affiliated with the Consultative Group on International Agricultural Research (CGIAR) institutions located in Africa – for example, the International Livestock Research



Institute (ILRI) in Kenya, the International Institute of Tropical Agriculture (IITA) in Nigeria, and the African Rice Centre (WARDA) in Benin.

Stronger partnerships between Africa's universities and these international organizations would likely prove mutually beneficial, generating synergies that would benefit all Africans. More than 65 percent of Africans live in rural areas, and nearly 70 percent of Africa's total income is derived from agriculture. Partnerships between universities and UN-related organizations, most notably the United Nations Environment Programme (UNEP), the secretariat of which is located in Nairobi, would likely spark similar beneficial results.

Finally, it is essential for universities to forge closer partnerships with Africa's nascent private sector, especially with knowledge-based companies that require large numbers of educated and skilled workers.

Such firms not only provide challenging and lucrative employment opportunities for university graduates, helping to stem the brain drain; they also serve as venues for innovation capable of transforming university-created knowledge into products and services that benefit society.

The first order of business for Africa is to build its scientific and technological capacity within universities and research centres. The second order of business is to build and encourage the creation of such capacity in the private sector. Given the pace of global change, Africa must address both challenges simultaneously. That is the reality the continent faces. There is no way around it.

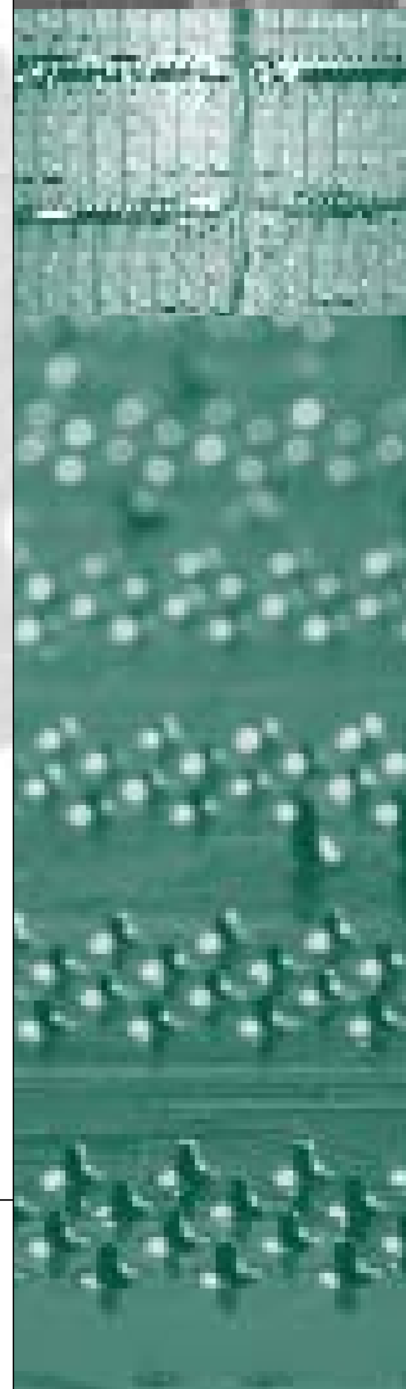
As recently noted in a joint statement of the science academies of the Group of 8 and NASAC: "Without embedding science, technology and innovation in development, Africa's ambitions will fail."

Yet, for the first time in a long time, there is a growing alignment between the continent's ambitions and its ability to achieve them.

We simply cannot afford to waste this opportunity. As Africa's recent past shows, second chances are hard to come by. And third chances may be too much to ask for. ■

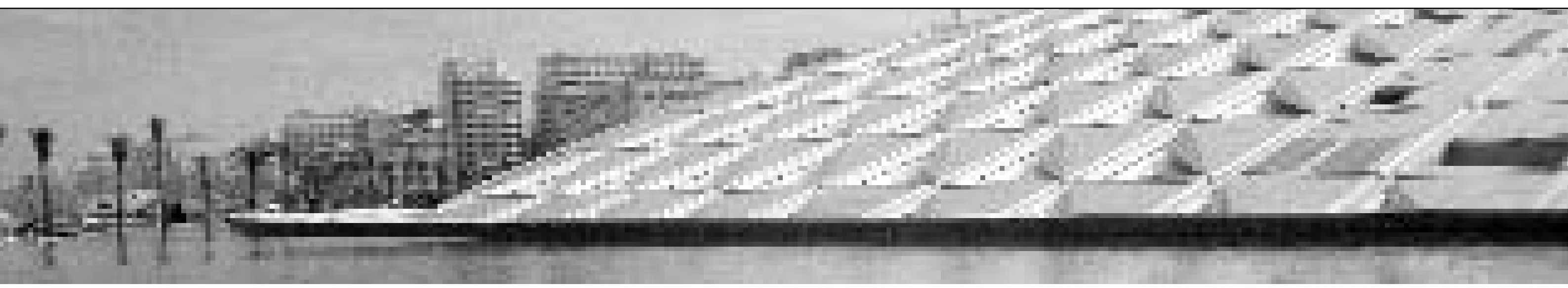
Mohamed H.A. Hassan
TWAS executive director
Trieste, Italy

Adapted from a speech delivered at the African University Leaders Forum, Cape Town, South Africa, 19-21 November 2006.



SCIENCE ACADEMIES FORWARD TOGETHER

FOLLOWING THE FIFTH GENERAL ASSEMBLY OF THE INTERACADEMY PANEL ON INTERNATIONAL ISSUES (IAP) HELD IN ALEXANDRIA, EGYPT, IN DECEMBER 2006, YVES QUÉRÉ STEPPED ASIDE AS ONE OF THE ORGANIZATION'S TWO CO-CHAIRS. HERE, HE RECOUNTS THE HISTORY AND IMPORTANCE OF IAP SINCE ITS INCEPTION IN 1993. HE ALSO OUTLINES HIS HOPES FOR THE FUTURE OF THE ORGANIZATION.



When discussing the origins of learned societies and academies, three cities come to mind: Athens, Alexandria and Rome, each on the shores of the Mediterranean sea.

Athens is where Plato gathered his disciples in the garden of Akademos *to practice the art of reasoning. Alexandria is where much of the knowledge of the ancient world was recorded on 700,000 scrolls in the city's renowned library, a unique centre for science and philosophy that Ismail Serageldin (TWAS Fellow 2001) has revitalized so brilliantly in the new Alexandria Library. Rome is where the first modern academy of sciences was established in 1603 under the tutelage of an 18 year-old Roman, Federico Cesi, whose inspirational monograph,* 'Il naturale desiderio di sapere' *('The natural desire to know'), spurred the creation of the* Accademia dei Lincei.

Other regions and nations across Europe soon followed the *Lincei*'s example, creating not just forums for debate but privileged centres for discovery: the Royal Society, London (1660), the *Académie des Sciences*, Paris (1666), the *Deutsche Akademie der Naturforscher Leopoldina* (1687) and the Royal Swedish Academy of Sciences (1739).

During these early years, royal families would often seek to control or channel the debates that took place at science academies and, at times, even put a halt to such 'dangerous' ideas as 'the natural rights of man'.




Nevertheless, academies, from the time of their origins in the ancient world to their reincarnation in 17th century Europe, have always viewed themselves as centres of intellectual ferment and influence and as homes of innovation and progress. It is a sentiment that has persisted to this day and it is a sentiment that led to the creation of the InterAcademy Panel on International Issues (IAP) nearly 15 years ago.

Participants at what came to be the founding conference of IAP, in New Delhi in 1993, called for the creation of a 'global assembly of academies of sciences' that would draw on the long and fruitful history of science academies as repositories of scientific knowledge and forums of scientific debate and discussion: in short, that would help academies, the 'symphonies of science', play their enduring notes of science-led progress on an even larger stage.

What, then, do these 'symphonies' have in common and how can academies work in concert to take advantage of their collective expertise? Here are three principles that set academies apart from other institutions.

Scientific talent. Science academies are designed to include some of the most accomplished scientists in their countries. Members are elected solely on the basis of merit. "An academy," in the words of one learned academy member, "is good if, and only if, it is not possible to form a better one with scientists who do not belong to it."

Independence. Science academies must honour and protect freedom in speech, writing and action. At the same time, science academies, which are often sponsored directly by government, must recognize that their independence is not an absolute. There are always political and financial matters to consider. And it is also true that external cultural and even ideological factors sometimes shape an academy's agenda as well.

Perfection is impossible. Academies, after all, are part of the imperfect world in which we all live. Academies, however, must not mortgage their soul. They must, in effect, act at all times in accordance with their principles. That means they must give forceful expression to the power of reason and unflinching support to human dignity. That was the case in the 1970s when the academy of sciences in the former Soviet Union refused to expel the dissident physicist Andrei Sakharov despite intense pressure from the government to do just that.

Stability. Academies must embrace – indeed take advantage of – the stability that infuses their institutions, largely because members are elected for life. Stability could prove an increasingly valuable attribute, especially in societies where leaders come and go and societal debates often spur more discord than harmony. But stability could lead to stagnation if, as is true in some cases, the institution becomes a home for the aged. To counteract this problem, several academies have reformed their voting procedures to encourage the election of ‘younger’ scientists – for example, by requiring half of all newly elected members to be less than 50 years old.

These are some of the shared attributes that the founders of IAP hoped to build on when they came together in New Delhi in 1993 to begin the process that would lead to the creation of IAP.

The founders had two interrelated concepts – objectives, if you will – in mind: to help academies undertake more determined actions in their own countries and to encourage cooperation among academies, especially for the purposes of promoting scientific and technological capacity in the developing world.

Translating the concepts outlined in New Delhi into a functioning network of science academies would occur gradually over the next decade.

The heart of IAP would reside with its membership consisting of merit-based national science academies. Sherwood Rowland, a Nobel Laureate in chemistry (1995) and foreign secretary of the US National Academy of Sciences, and Prakash N. Tandon, president of the Indian National Science Academy (INSA), were appointed co-chairs of the fledgling organization. A steering committee was formed, consisting of 11 academies. The Royal Society in the UK graciously agreed to serve as a temporary secretariat.

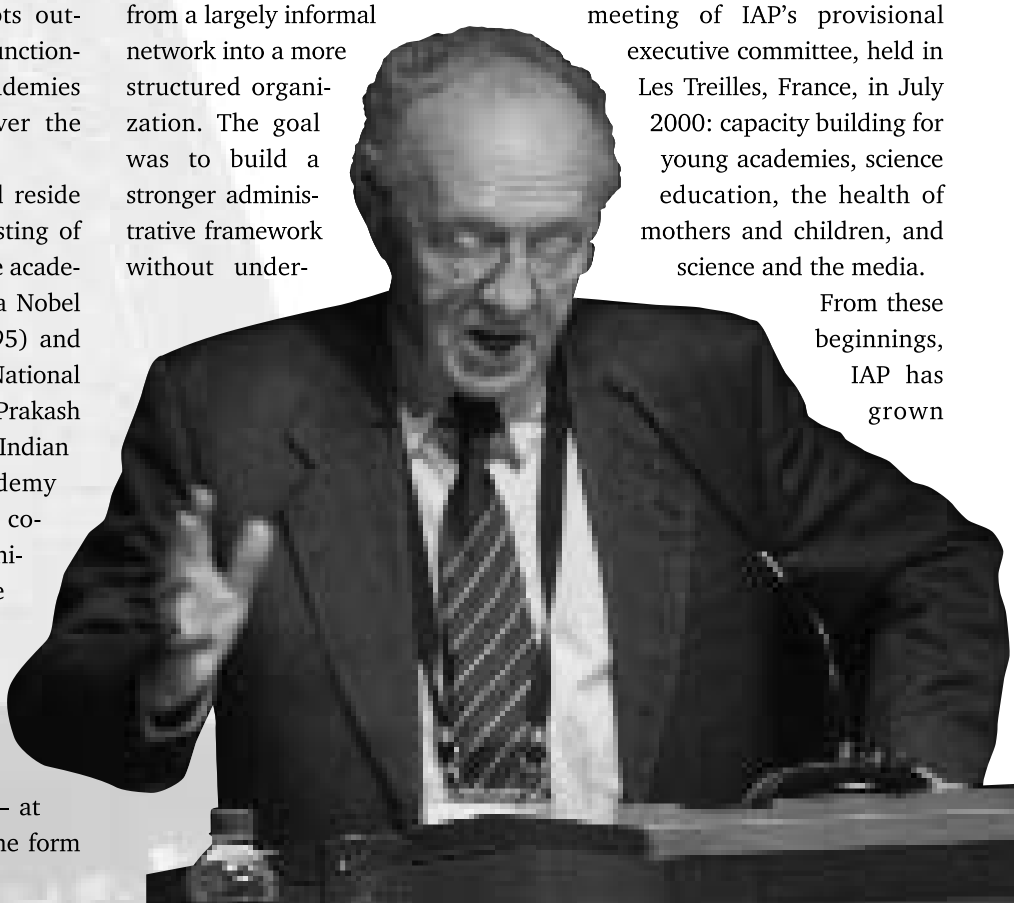
IAP’s first visible signs – at least to the public – took the form of membership-authorized statements on critical science-based issues: a statement on ‘Population Growth’ in 1994 and another on ‘Urban Development’ in 1996 reflected the membership’s collective concerns and outlined how the involvement of the global scientific community in general and national science academies in particular could play a critical role in addressing these issues.

IAP concluded its first decade by organizing a general conference, ‘Transition to Sustainable Development’, which took place in Tokyo in May 2000.

In Tokyo, IAP members took several important steps designed to transform the organization from a largely informal network into a more structured organization. The goal was to build a stronger administrative framework without undermining the collegiality and goodwill that had helped to get IAP off to such an auspicious start. Participants in Tokyo adopted provisional statutes, elected two new co-chairs (Eduardo Krieger, president, Brazilian Academy of Sciences and Yves Quéré, foreign secretary, French Academy of sciences), chose TWAS to serve as the new host academy for the secretariat and created a provisional executive committee comprised of five science academies from the developed world and six from the developing world.

Realizing that action and not simply words were required to induce the academies to cooperate effectively, four programmatic themes were selected at the first meeting of IAP’s provisional executive committee, held in Les Treilles, France, in July 2000: capacity building for young academies, science education, the health of mothers and children, and science and the media.

From these beginnings, IAP has grown



into a vigorous organization that is now recognized worldwide as a significant voice for the promotion of science-based development. The organization has retained its collegiality by ensuring that the members remain the primary force driving the programmes and initiatives.

One member organization is usually given lead responsibility for a major activity (for example, TWAS oversees IAP's capacity building programme for young academies). Other member academies serve on internal evaluation committees, host their own meetings and conferences based on IAP programmatic themes, partner with other scientific or development organizations, and seek to interact with their governments on science-related issues of critical concern to their nations.

IAP's executive committee helps coordinate the organization's efforts, moving things ahead in an orderly manner. The committee meets twice a year and, throughout its six years of existence, attendance at the meetings has never been below 95 percent. That is a tribute to the commitment and dedication of its members and a strong indication of their belief that IAP is a valuable, results-oriented organization.

Workshops, symposia, reports and documents have been staple features of each of IAP's major, long-term programmes. These include capacity building for young academies (led by TWAS); science education (Chilean Academy of Sciences); women's health education (French Academy of Sciences); and water research and management (Brazilian Academy of Sciences).

Let me cite one example of how a single IAP activity spurs multiple events, much like a good interest rate in a savings account has a salutary compounding effect on the capital that has been invested. IAP's science education programme helped to generate 'An Evaluation of Inquiry Based Science Education' (IBSE). This, in turn, gave rise to four lively and intensive meetings: two symposia in Stockholm in 2005 and Santiago in 2006, and two workshops in Washington, DC, and Paris in 2006. All told, 15 science academies and numerous outside organizations have been involved in this effort, offering reports and recommendations that have helped to influence discussions on science education around the world.

IAP's short-term initiatives often lead to the publication of a report or statement. Examples include a project exploring the current state of access to scientific information (led by the US National Academy of Sciences); biosecurity (the Royal Netherlands Academy of Arts and Sciences); genetically modified organisms (Union of German Academies of Sciences and Humanities); and natural disaster mitigation (Chinese Academy of Sciences).

IAP has issued a total of 12 statements, each ratified by a large number of member academies. The consensus opinion offered by IAP in these statements is designed to add authoritative insight into debates that are often fuelled by passion and suspicion. In 2003, IAP published a statement on human reproductive cloning (coordinated by the Royal Society in the UK); in 2005, it issued a statement on biosecurity (coordinated by the Royal Netherlands Academy of Arts and Sciences); and in 2006, it published a statement on the teaching of evolution (coordinated by the French

Academy of Sciences and US National Academy of Sciences).

Some of these statements have carried significant weight. For example, the statement on human cloning received a great deal of attention at a debate held by the UN General Assembly in November 2003. And the statement on biosecurity was widely distributed at the UN meeting of experts of the biological weapons convention in Geneva late last year.

One measure of IAP's growing strength is the expanding range of contacts that it is forging with other organizations.

On the international level, contacts include the United Nations Educational Scientific and Cultural Organization (UNESCO), the International Council for Science (ICSU), the InterAcademy Medical Panel (IAMP) and the InterAcademy Council (IAC), where IAP members have served as advisors in the preparation of reports on critical science-related issues. On the regional level, this has led to close cooperation with regional science academy networks in the Americas, Europe, Asia, Africa and the Islamic region, each of which is now an official observer of IAP. At the national level, it has led to increasing interaction with, for example, ministries of science and technology and education, as part of a cooperative effort to improve national science and technology policies and reform scientific education.

From its uncertain beginnings in New Delhi to its first efforts in Tokyo to transform itself from a fraternity of good will into an organization of action and results, to its most recent efforts to become a major force in the world of science and development, IAP has evolved into a mature institution with great promise. What does the future hold for IAP and, more importantly, what are the prospects that the organization will make even more significant progress in achieving its goals in the future?

At IAP's 5th General Assembly in Alexandria, the membership officially endorsed a strategic plan for 2007-2009, skillfully drafted by Albert Koers, who until recently served as the executive director of IAC. More than 40 members offered comments and suggestions on the plan, which greatly improved both its purpose and clarity.

While the plan contains many details for action, it is largely driven by the notion that IAP need not radically change course. The plan does not propose a revolution. Instead it focuses on the mundane but critically important task of achieving greater efficiency.

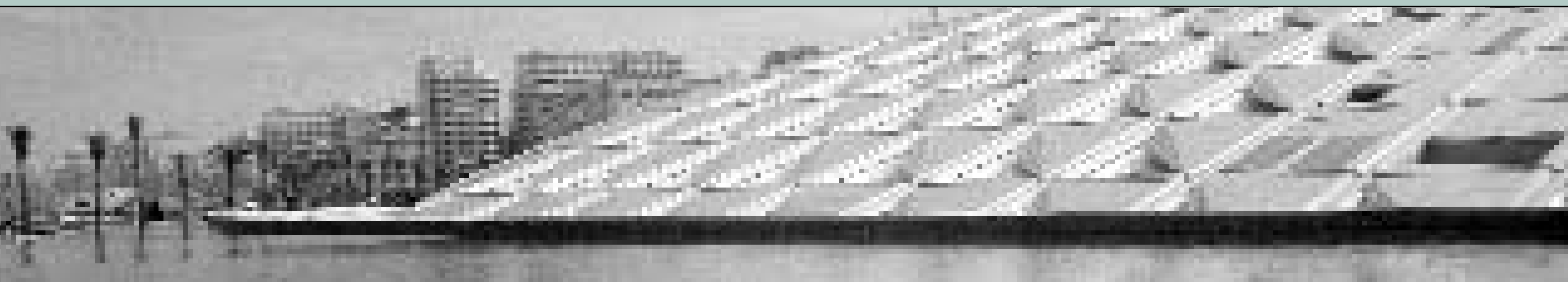
IAP is not a cosy club where the world's most critical problems are discussed leisurely among friends lounging in leather arm-chairs. But neither is it a hotbed of radical debate and ferment.

Instead IAP is an institutional network where reflection and action come together as part of a larger effort to elevate the presence of science within society. IAP, in brief, seeks to serve as a forum where the most critical issues of the day can be discussed in an atmosphere infused with reason, openness and intelligence.

When I recently asked a group of French teenagers what they thought an academy of science was, one boy, after a long silence, ventured: "I think it is a club of old gentlemen."

A *club*? Certainly an accurate description of its past. *Old*? That's often been true in body and sometimes in mind. Of *gentlemen*? Here, the teenager touched a nerve. After all, women constitute less than 5 percent of the membership in most academies.

These perceptions, which at least partially reflect reality, must



be overcome if IAP and its members are to advance their goals.

Imbued with scientific talent, driven by intelligence and independence, enjoying great stability in a time of unprecedented and often unexpected change, science academies have an obligation to speak out and to become more actively involved in society.

Academies must have their say and do so with the vigour and authority equal to their knowledge and expertise. But they must approach the discussions with a sense of humility based on the notion that they have acquired their wisdom through long periods of study and reflection and that others must also have their say for society to chart a better course of action for addressing the complex issues that we all face.

We live at a time of great risk and great opportunity. We have witnessed a period in which the importance of science to society has been reaffirmed and embraced. IAP has been a part of this welcome trend.

I am honoured to have served as co-chair of the organization during these challenging years of growth and development. I would like to thank everyone who has made my participation in IAP so enjoyable and productive: our many partners and supporters, most notably the Italian government for their generous contributions; the dedicated and hardworking members of the secretariat in Trieste; my energetic, committed and talented co-chairs serving on the executive committee, initially Eduardo Krieger and subsequently Chen Zhu; and, of course, the representatives of IAP's member academies, the backbone of our organization and the reason for its success. It has indeed been an honour to work with all of you.

Let me conclude by outlining the principles that I believe have guided IAP's development to this point and that will continue to guide IAP in the future.

First, that science is a necessary force for development, and therefore a source of hope for the most deprived people on our planet; and that, in the decades and centuries to come, it may be recognized as the only effective tool for defending this planet against the stresses we place upon it.

Second, that science, in its unity of purpose, its commitment to excellence and as a symbol of human culture at its best, sheds light not only on what we know but on what we don't know, guiding our curiosity towards new questions in an endless quest for human understanding and betterment.

When examined carefully, the methods by which science works and accomplishes its goals provide a useful warning against the pitfalls of arrogance, for which scientists are not always innocent. The purpose of science is not to dictate the truth about the world, but to discover scattered elements of truth, among other equally valuable scattered elements of truth in art, philosophy, religion and all other human endeavours.

IAP will undoubtedly enlarge its scope of action, not only spurring change among its member institutions but also emerging as a unique institution in its own right, dedicated to advancing the growing conviction across the globe that science must play a key role in promoting sustainable and equitable development both as a moral right and a pathway to a more peaceful and harmonious world. ■

Yves Quéré
IAP co-chair (2000-2006)

IAP HOLDS FIFTH GENERAL ASSEMBLY

THE INTERACADEMY PANEL ON INTERNATIONAL ISSUES (IAP) HELD ITS FIFTH GENERAL ASSEMBLY AND THIRD GENERAL CONFERENCE IN ALEXANDRIA, EGYPT, FROM 1-5 DECEMBER 2006. THE MAJOR THEME OF THE THE CONFERENCE WAS 'THE UNITY OF SCIENCE'. MORE THAN 100 SCIENTISTS FROM 60 COUNTRIES ATTENDED THE EVENT.

"The linkage between science and economic growth is undeniable," stated Chen Zhu, vice president of the Chinese Academy of Sciences (CAS) and IAP co-chair, "and over the past few years, there has been a great deal of discussion about the central role that science must play in efforts to promote sustainable economic growth."

"But science," he continued, "not only serves as an instrument for advancing the well-being of people; it is also an intellectual pursuit that reflects both a fundamental and universal aspect of our humanity. The boundaries between basic and applied science have become increasingly blurred in recent years, and that trend is likely to accelerate in the future."

"For all of these reasons," noted Chen Zhu, "IAP concluded that this was an opportune time for our organization to emphasize the critical importance of the unity of science."

"Progress in all facets of knowledge," added Yves Quéré, outgoing IAP co-chair, "has revealed a profound sense of unity not only within all fields of science but also between science and other areas of inquiry. For example, no one would contend that knowledge in a single scientific discipline holds the key to our understanding of climate change, and no one would argue that science alone can solve the problem. The same is true for issues related to the conservation of biodiversity, halting the spread of infectious diseases, or developing alternative sources of energy. As the challenges we face become more com-

The melding of disciplines has never been more significant than today.

plex and more global in scope, the need to bridge the divide between basic and applied science and between the natural and social sciences becomes ever more acute. This concern served as the major theme of our conference in Alexandria.

Speakers at the opening session of the conference included not only Chen Zhu and Quéré but H.E. Hani Helai, Egypt's minister of higher education and research; Gérard de Puymege, UNESCO culture programme specialist in Cairo; Ismail Serageldin, director, *Bibliotheca Alexandrina*; and Mohamed H.A. Hassan, executive director, TWAS, and president, African Academy of Sciences.

Each speaker noted that the unity of science was by no means a new concept. As Serageldin observed, in the ancient Alexandria library, which was the global centre of knowledge and discovery for some six centuries, learning was based on studies that drew inspiration from spheres of thought ranging from astronomy to medicine to philosophy.

Yet, the speakers also observed that the melding of disciplines has never been more significant than today. They pointed to the way in which new insights into physics, chemistry and biology were enhancing our understanding of genetics and how interdisciplinary explorations of computer science, mathematics and physics have changed the way in which we communicate through the creation and widespread use of the internet.

As Chen Zhu noted: "The frontiers of scientific research have never been more exciting or dynamic. This has not only energized the global scientific community. It has encouraged developing countries to recognize the critical role that science can play in their efforts to promote both knowledge and sustainable economic growth."

The speakers agreed that for the full potential of science to be realized, two important trends would have to continue: first, investments in all facets of science, both basic and applied, would have to be maintained and, in fact, increased, especially in poor countries; and, second, developing countries would have to pursue initiatives designed to increase their scientific capacity.

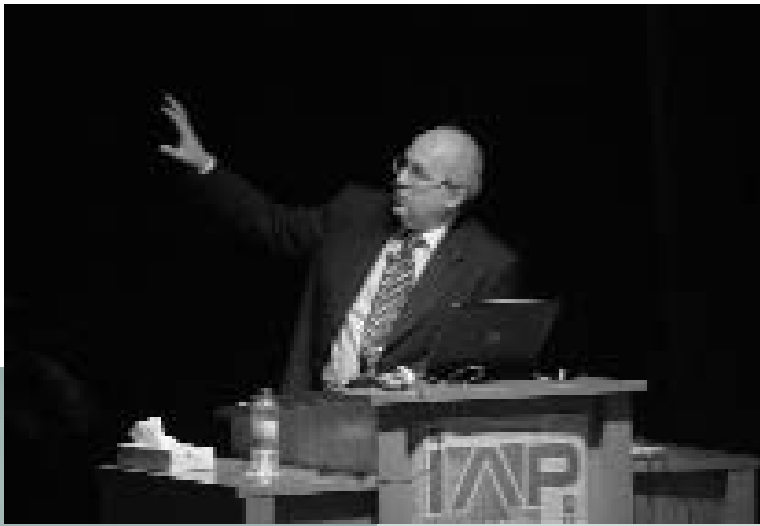
The opening speakers congratulated IAP for the role that it has played in both of these efforts, and they called on IAP to find new ways to pursue its goals with more vigour and effectiveness in the future.

The talks that followed the opening remarks were divided into five main sessions, largely tracking the overall theme of the conference, 'the unity of science', as well as placing a spotlight on the basic sciences: biology, chemistry, mathematics and physics. There was also a session examining the relationship between science and society.

Here's a sampling of the presenters and their presentations.

Jean-Pierre Kahane, professor emeritus, *Université de Paris-Sud* in Orsay, France, spoke about the unique 'unifying' role of mathematics as the language of science. Ashok Jhunjhunwala, professor of electrical engineering at the Indian Institute of Technology in Chennai, examined how new information and communication technologies were levelling the playing field for knowledge, not only between nations but among their citizens. David Gross, Nobel Laureate (Physics, 2004), director and Frederick W. Gluck chair in theoretical physics at the Kavli Institute, University of California, Santa Barbara, USA, analysed how physics has served as a unifying source of insight for science through its focus on nature's fundamental elements and forces. Zhang Jie, director general of the Bureau of Basic Sciences, Institute of Physics, Chinese Academy of Sciences, Beijing, spoke about the broad applications of intense lasers for nuclear science, energy and diagnostics. Teresa Lago, professor of astronomy, University of Porto, Portugal, highlighted the increasing levels of cross-disciplinary cooperation – and thus unification – in astronomy that has enhanced our understanding of the origins of the universe and the counter-intuitive behaviour of subatomic particles.

Chris Rapley, director, British Antarctic Survey, Cambridge, UK, focused on growing evidence of climate change in Earth's polar regions and the way in which scientists are using this evidence to learn more about the behaviour of our global climate. Such efforts, he noted, will undoubtedly have important implications for national and international efforts to



combat and adapt to global warming. Bruce Alberts, professor of biochemistry and biophysics, University of California, San Francisco, USA, examined the rapid pace of change in biology over his 40-year career. Alberts noted: “While we have successfully developed a catalogue of cellular pieces, we still have a long way to go to understand how they all work together to make living things.” Hu Zhihong, general director, Wuhan Institute of Virology, Chinese Academy of Sciences, explored recent developments in microbiology, noting that such research could have significant implications for issues related to agricultural productivity and public health.

Kurt Lambeck, professor of geophysics at Australian National University, spoke about the forgotten discoveries of the Greek mathematician, geographer and astronomer Eratosthenes, who, while conducting research at the original *Bibliotheca Alexandrina*, accurately determined the circumference of the Earth more than 1,500 years before Copernicus. He noted that the work of Eratosthenes and other scientists and scholars in Alexandria at that time clearly exemplified the universality of science. Keiko Takahashi, group leader, Earth Simulator Centre, Japan Agency for Marine-Earth Science and Technology, set her analytical lens not on the past but on the future of the earth sciences. She suggested that advances in computer simulations would provide the most detailed knowledge of the Earth in history, illustrating in vivid and insightful detail how the Earth serves as a common stage for all of humanity.

The scientific community must re-establish a relationship of trust and respect with the public.

Turning to the relationship between science and society, Johanna Sengers, fellow emeritus, National Institute of Standards and Technology, USA, and Manjula Sharma, lecturer in physics, University of Sydney, Australia, each explored the increasing role of women in science and why the global scientific community needed to continue to foster gender equality. This, they said, is especially true regarding the integration of more women into science academies. Pieter Drenth, professor emeritus, Free University Amsterdam, spoke about the need for the scientific community to become more actively engaged in their societies and to re-establish a relationship of trust and respect with the public. Many countries, he noted, have made progress in drawing science closer to their societies. This has been especially true in terms of the public’s growing awareness of science as a critical source of knowledge that is essential for sustainable economic development. Nevertheless, Drenth said that science still remains a largely alien subject for much of the public, something that many people keep at bay because of scientific ignorance and more pressing daily concerns.

Édouard Brézin, professor of physics at the *École Normale Supérieure* and president of the French Academy of Sciences, gave the concluding talk, ‘A Synthesis: Where Does Science Go?’

Brézin asserted that a deep and expanding understanding of science is necessary for addressing our most serious problems, for a better understanding of our universe and for enhancing knowledge about ourselves. Unfortunately, he added: “Our fellow citizens are increasingly scared and reluctant to accept scientific explanations and contributions.” To address this problem, Brézin

urged scientists to make science "a treasure of humankind that concerns everyone." He also called for supporting life-long science education "to advance rational thinking and to form mature citizens."

NEW TEAM

In addition to the conference, IAP held its 5th General Assembly, which took place 4-5 December 2006. Decisions rendered at the assembly will shape IAP over the next three years. Highlights included:

- The farewell address of Yves Quéré, who has served as the co-chair of IAP for the past six years. Quéré outlined the progress IAP has made in fulfilling its objectives to help member academies work together to advise citizens and public officials on the scientific aspects of critical global issues. He focused particular attention on IAP's efforts in helping to forge regional networks of science academies and its contribution to launching academies in nations where they did not exist. IAP member academies extended a hearty, well-deserved "thank you" to Quéré. They not only wished him success in his future endeavours but also looked forward to drawing on his enormous skills and experience in the future (see Commentary, p. 7).
- Election of Howard Alper as new co-chair of the IAP executive board. Alper is visiting executive at the International Development Research Centre (IDRC) and distinguished university professor at the University of Ottawa, Canada. He is a former president and current foreign secretary of the Academies of the Arts, Humanities and Sciences of Canada (RSC).
- Election of four new member academies to IAP: the Islamic World Academy of Sciences; the Serbian Academy of Sciences and Arts; the Tanzania Academy of Sciences; and the Zimbabwe Academy of Sciences. IAP's membership now stands at 94.
- Election of 11 members of the executive committee for 2007-2009: the Australian Academy of Science; the Bangladesh Academy of Sciences; the Brazilian Academy of Sciences; the Cuban Academy of Sciences; the Academy of Scientific Research and Technology, Egypt; the Union of German Academies of Sciences and Humanities; the Science Council of Japan; the Academy of Sciences Malaysia; the Royal Netherlands Academy of Arts and Sciences; the *Académie des Sciences et Techniques du Sénégal* and the Royal Society, UK. Academies that have completed their terms of office and will be leaving the executive committee include: the Indian National Sci-

ence Academy; the Nigerian Academy of Sciences; the *Accademia Nazionale dei Lincei*, Italy; the Royal Swedish Academy of Sciences; and the US National Academy of Sciences.

• New observing institutions: the InterAmerican Network of Academies of Sciences (IANAS) and the InterAcademy Medical Panel (IAMP). These institutions join the following international and regional organizations that also have observer status: the International Council for Science (ICSU); the Network of African Science Academies (NASAC); the Federation of Asian Scientific Academies and Societies (FASAS); the Caribbean Scientific Union (CSU); the European Academies' Science Advisory Council (EASAC); the All European Academies (ALLEA); the Association of Academies of Sciences in Asia (AASA); and the InterAcademy Council (IAC). TWAS, which hosts IAP and provides administrative and communications support for the organization, will continue to serve as an ex officio member.

• Approval of IAP's *Strategic Plan 2007-2009*, which calls for empowering member academies (through statements, initiatives and programmes) and strengthening the organization (through fundraising and increasing international awareness). "A primary focus of the strategic plan," noted Chen Zhu, "is to help member academies become more prominent institutions within their nations, especially in their relationship with governments. Another goal of the strategic plan is to seek funding sources, beyond the generous contribution made by the Italian government, to help ensure a stable and successful future."

• Endorsement of a communiqué in support of the Israel-Palestine Science Organization (IPSO), especially its work in promoting peace through scientific cooperation.

PROGRESS REVIEWED

Participants at the IAP General Assembly also reviewed and assessed IAP's major programmes: capacity building for young academies (led by TWAS); science education of children (led by the Chilean Academy of Sciences); health education of women (led by the French Academy of Sciences); and water research and management (led by the Brazilian Academy of Sciences).

• *Capacity building*. "One of IAP's primary goals," noted Mohamed Hassan, speaking for the lead academy of this programme, "has been to help build the capacities of science academies, especially young academies in developing countries." Through small grants and institutional exchange programmes, IAP has helped fledgling academies, especially in sub-Saharan Africa and the Islamic region, to strengthen their administrative structure and, more importantly, increase their influence within their nations by gaining the skills that are necessary to provide independent advice to governments on critical science-related national and global issues. "One of IAP's most important actions has been to create and strengthen regional networks of science academies in Africa, the Americas, Asia, the Caribbean and the members states of the Organization of the Islamic Conference (OIC)," said Hassan. "These regional organizations have emerged as important networks in their own right. On the one hand, they have helped to raise public awareness of issues of particular concern to the region and, on the other hand, they have disseminated information about the importance of science academies to national and regional leaders, ultimately shedding positive light on the work of IAP." Eduardo Krieger, president of the Brazilian Academy of Sciences and former co-chair of IAP's executive committee, added that the networks created and supported under this programme will "play an important role in the implementation of the IAP strategic plan."

• *Science education*. This programme was launched to spur reforms in science education through fostering hands-on inquiry-based learning, especially in primary and secondary schools. Its recent activities have included: the launch of an interactive electronic portal (in cooperation with the International Council for Science, ICSU), highlighting 'best practices' in science education and providing opportunities for science educators and students to exchange ideas and experiences; creation of a working group on international collaboration in the evaluation of Inquiry Based Science Education (IBSE) in cooperation with other international organizations; sponsorship of a regional symposium with the Network of African Scientific Academies (NASAC) on science teaching in Africa, hosted by the Senegalese Academy of Sciences and attended by representatives from six African countries; and the organization of a meeting in Santiago, Chile, examining regional science education issues held in partnership with the InterAmerican Network of Academies of Sciences (IANAS). M. Shamsher Ali, president of the Bangladesh Academy of Sciences, praised "the diversity of this programme", which he said "spans all continents and is of global interest." He added that "the programme's innovative focus on inquiry-based teaching should serve as a model for future efforts to promote science education."

• *Health*. IAP has collaborated with the InterAcademy Medical Panel (IAMP) to examine ways of improving the health of mothers and children, especially in developing countries. The programme is designed to raise awareness among women about the unique health challenges that they face and to encourage public health officials and researchers to pay particular attention to these challenges. Two of the project's most noteworthy activities have been: the creation of a website (*www.whep.info*) and the launch of a pilot project, supported by the World Bank, focusing on the Senegal River basin. André Capron, foreign secretary, French Academy of Sciences, noted: "Health education in the Senegal Basin largely depends on the relationship that people, particularly women and children, have

Networks will play an important role in the implementation of IAP's strategic plan.

with water. Some 80 percent of all diseases in developing countries are due to a lack of access to safe drinking water." Capron went on to say that education and training programmes in developing countries must recognize that "women are at the heart of all domestic usages of water" and that this reality "must be reflected in each nation's water policies and programmes." In 2005, the French Academy of Sciences began collecting information from IAP members on the state of health education among children aged 6 to 15 and convened a workshop in Paris attended by more than 50 participants. The workshop concluded with a call for a comprehensive global review of existing basic health education systems that would place special attention on sub-Saharan Africa.

• *Water*. This IAP programme promotes science-based solutions for improving access to safe drinking water and for mitigating major sources of pollution in freshwater systems. Recent activities have included IAP's European regional workshop on water resources and management, two regional water workshops in South Africa and Brazil, and a workshop on water security in China. An international symposium on groundwater sustainability was also organized in Alicante, Spain, in early 2006 with the support of UNESCO's Division of Water. The symposium, attended by nearly 250 participants from 50 countries, examined the pros and cons of intensive groundwater use. It concluded with the 'Alicante Declaration', calling for "more responsible use, management and governance of groundwater."

In addition to its major thematic programmes, IAP has launched four other initiatives devoted to an examination of codes of conduct on biosecurity (led by the Royal Netherlands Academy of Arts and Sciences); access to scientific information (led by the US National Academy of Sciences); natural disaster mitigation (led by the Chinese Academy of Sciences); and public attitudes and concerns towards genetically modified organisms (led by the Union of German Academies of Sciences and Humanities).

IAP has published 11 statements, ranging from its first statement on the global challenges resulting

> ***Unity of science and society will remain the major concepts driving IAP's agenda.***

from incessant population growth, issued in 1994, to a statement issued late last year that presented a consensus membership position voicing unequivocal support for the teaching of evolution. The statements, which have received broad international coverage, have helped to shape policy debates on critical science-based issues both in the national arena and within international organizations.

"It has been a full agenda that has had increasing impact within nations and across the globe," noted Chen Zhu. "We hope we can build on the momentum that our programmes and initiatives have generated as we move forward."

COMMON RESOURCE, COMMON HERITAGE

As Edouard Brézin noted in his opening talk: "Scientists must specialize to be able to create." But he added: "Science will only flourish if it is a common resource for everyone."

Science not only helps us understand who we are and sheds light on the universe in which we live. It provides a schematic for building fundamental tools used to combat such critical issues as poverty and inequality, environmental degradation and public health. It also plays a key role in wealth creation and innovation and is a critical, irreplaceable element of human civilization. As the Nobel Laureate Abdus Salam and the founder of both the International Centre of Theoretical Physics (ICTP) and TWAS noted: "Science is the common heritage of all humankind."

This is the spirit that drove both the creation of IAP and the early years of its development.

Today's world presents unprecedented opportunities and challenges that make the work of IAP and other international scientific organizations so essential and so promising. Problems – whether related to science, society or both – are now global in scope and can only be solved through global cooperation.

'Unity in science' was the overarching theme of IAP's 5th General Assembly and 3rd General Meeting, and unity of science – and society – will remain the major concepts driving IAP's worthy agenda as it seeks to fulfil its promise in the years ahead. ■

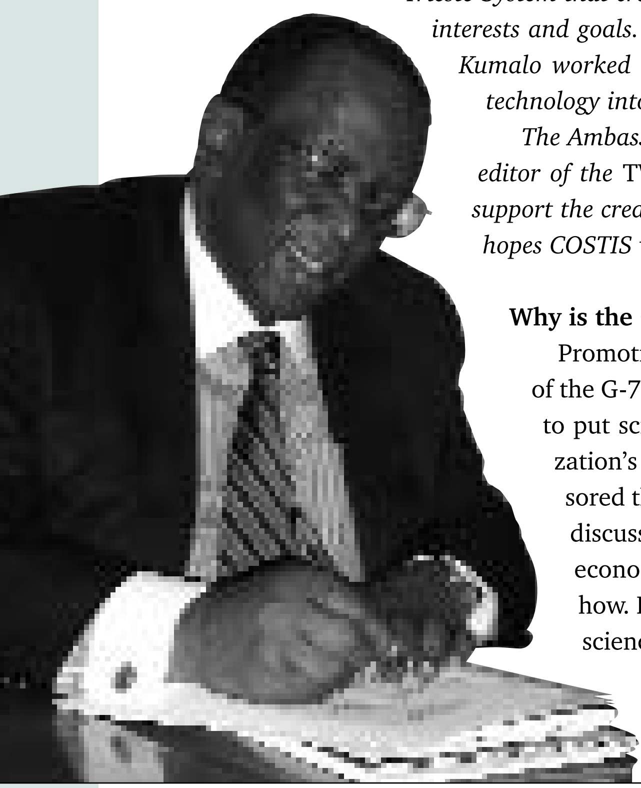
JANUARY 2007 MARKED THE LAUNCH OF THE CONSORTIUM ON SCIENCE, TECHNOLOGY AND INNOVATION FOR THE SOUTH (COSTIS). THE NEW ORGANIZATION REPLACES THE THIRD WORLD NETWORK OF SCIENTIFIC ORGANIZATIONS (TWNSO).

FROM TWNSO TO COSTIS

COSTIS will function under a unique collaborative arrangement between the Group of 77 and China (G-77), the largest member-state organization within the United Nations, and the Trieste System, an informal network of international scientific institutions located in Trieste, Italy.

Dumasani S. Kumalo, South Africa's Ambassador to the United Nations and the 2006 chair of the G-77, served as the guiding light for TWNSO's transformation into COSTIS. He convinced the member states of the G-77 and the international scientific organizations belonging to the Trieste System that creating an organization like COSTIS would serve their shared interests and goals. Indeed, with Mourad Ahmia, the G-77's executive secretary, Kumalo worked tirelessly to bring the idea of a consortium on science and technology into focus – and ultimately into reality.

The Ambassador recently responded to a series of questions posed by the editor of the TWAS Newsletter *describing the factors that led the G-77 to support the creation of COSTIS. He also outlined the activities that the G-77 hopes COSTIS will pursue in the years ahead. Excerpts follow.*



Why is the G-77 interested in science, technology and innovation?

Promoting science, technology and innovation has been a key goal of the G-77 for years. Yet, the first fully fledged effort within the G-77 to put science, technology and innovation at the top of the organization's agenda did not take place until 2000 when the G-77 sponsored the First South Summit in Havana, Cuba. The major focus of discussion at the Summit was the intricate relationship between economic development and scientific and technological know-how. Delegates in Havana were particularly eager to discuss how science and technology could be put to work to address critical social and economic needs in developing countries both to curb poverty and to create wealth. One of the key

recommendations was to create a consortium to promote cooperation in science and technology in the South. Two years later, as a follow-up to the summit in Havana, the G-77 convened a high-level Conference on Science and Technology in Dubai, the United Arab Emirates. The G-77 enlisted TWAS's help to organize conference sessions focusing on the current state of science in the developing world and the role that science could play within broader efforts to promote sustained economic growth in the South. This marked the first time that the G-77 worked closely with the Academy and Trieste's other international scientific institutions. In fact, it marked the first time that the G-77 had worked closely with any science academy. The meeting proved invaluable not only in making the G-77 more aware of the work of TWAS (and *vice versa*) but also in showcasing the role that science could play in advancing the G-77's long-standing goal to promote sustainable development. This summit, in short, reaffirmed the G77's keen interest in science and technology and marked the first step in forging a close strategic partnership between the G-77 and Trieste's international scientific institutions. The Second South Summit took place in Doha, Qatar, in June 2005, and again science and technology were among the top items of discussion. Yet the relationship between the G-77 and the institutions of the Trieste System continued to evolve slowly through a series of communications, and it was not until the summer of 2006 that formal talks began to transform the Trieste-based Third World Network Scientific Organizations (TWNSO) into the Consortium on Science, Technology and Innovation in the South (COSTIS). Once these talks began, events unfolded rapidly. I met with officials from Trieste's international scientific institutions in July. At that meeting, we mapped out a realistic strategy for achieving the transformation of TWNSO into COSTIS over the next six months. The membership of TWNSO approved the proposal at the organization's 9th general assembly held in Brazil during the first week in September. Ministers of science and technology of nations belonging to the G-77 also convened at the TWNSO general assembly, where they endorsed the proposal. The science ministers also officially urged their nations' ministers of finance, who were scheduled to meet at the G-77 annual meeting (held in conjunction with the UN's General Assembly in late September) to approve the recommendation to create COSTIS, which the ministers of

THE TRIESTE SYSTEM

The Trieste System includes TWAS, the Abdus Salam International Centre for Theoretical Physics (ICTP), the International Centre for Genetic Engineering and Biotechnology (ICGEB), the International School for Advanced Studies (SISSA) and the International Centre for Science and High Technology (ICS), the University of Trieste and a number of scientific institutions located in the AREA Science Park, including the Elettra *Synchrotron radiation facility.*

finance unanimously did. Statutes and bylaws were drafted in late autumn and the first meeting of the COSTIS task force will take place in January 2007 in Rome, Italy, where a tentative programme of activities will be outlined. You might say that COSTIS was long time coming, but once the G-77 and Trieste's international scientific organizations officially agreed to do it, arrangements were quickly finalized.

Why have science and technology gained such prominence among G-77 member states over the past five years or so?

The effect of science and technology on economic growth has been widely documented. There is growing, irrefutable evidence that the 'emerging' economies of the developing world – Brazil, China, India, South Africa and others – have 'emerged', in part, because they have capitalized on the opportunities that science and technology affords for sustainable economic growth. Many of these economies have achieved rapid rates of growth. In fact, the developing nations that have grown at the fastest pace over the past 5 to 10 years are those that have sustained the highest levels of investment in science and technology. The globalization of science and technology has provided both opportunities and challenges for developing countries. On the one hand, rapid advances in science and technology make sustained economic growth possible not only because of the advances themselves but also because of the pace at which information is now distributed over the internet and other forms of electronic communication. On the other hand, countries that fail to keep up with these advances fall farther behind ever more quickly. They are finding it increasingly difficult, moreover, to compensate for their lack of scientific knowledge and technical expertise by drawing on their low-wage workforce and their abundance of natural resources as competitive advantages in the global market place. That's why we must ensure that all countries have the capacity to utilize science and technology as key elements in their economic development strategies. The G-77 is proud to have been a pioneer in emphasizing the important part that science and technology must play in the United Nations development agenda. For example, the G-77 had an instrumental role in the establishment of the UN Commission on Science and Technology for Development in 1992, an early effort to raise the profile of science and technology as a key aspect of the UN's overall efforts to curb poverty and generate wealth across the developing world.

What accounts for the increasing role of South-South cooperation in science and technology?

It has become increasingly evident that scientific knowledge and technical know-how are among the best pathways to address issues related to poverty and sustained economic growth. As a result, the G-77 has consistently emphasized the importance of relying on scientific knowledge and technical know-how to address such critical areas of social and economic well-being as access to safe drinking water, increased agricultural productivity, improved public health, greater energy production and applications of biotechnology to the needs of the poor. The slow response of the international community to vigorously address these critical issues has led developing countries to explore the potential benefits of South-South cooperation in science and technology. Countries in the South share similar development challenges. Studies have demonstrated that these challenges can be more effectively tackled if the countries of the South pool their resources and skills to engage in collaborative projects. An excellent example of a successful initiative in South-South cooperation is the IBSA (India, Brazil and South Africa) Trilateral Forum, launched in 2003. The forum, which enjoys support from the highest levels of government, seeks to develop results-oriented cooperative projects on critical issues related to health, the environment, transportation, job creation, and trade and investment. The three nations have placed a great emphasis on scientific and technological capacity building through the development of joint research projects and science-based development initiatives.

Why do you think Trieste's international scientific organizations will serve as excellent partners in G-77's larger efforts to promote science and technology?

The Trieste System is a unique entity. There is nothing quite like it anywhere else in the world. Its long and successful track record of promoting scientific cooperation and serving as a 'home away from home' for many scientists from the developing world has played a major role in helping overcome the isolation and despair that many scientists from poor countries experience when trying to pursue their careers. Ever since the launch of the Abdus Salam International Centre for Theoretical Physics (ICTP) more than four decades ago, the international scientific institutions that are part of the Trieste System have helped to build scientific capacity and to transfer scientific and technical knowledge to developing countries. As these institutions have grown in number and size, so too has their impact. In other words, the Trieste System has helped scientists and technologists from developing countries to acquire knowledge – and ultimately to conduct research and engage in projects – that have proven invaluable to larger efforts to spur sustainable economic growth. The system's emphasis on education and training – giving people, especially young people, the knowledge and tools that they need to learn and to do – has been the key to its success. This experience, combined with the Trieste System's credibility among the developing world (credibility, which I might add, has been earned through hard work and is well deserved) makes Trieste a logical partner for a G-77 consortium on science, technology and innovation.

COSTIS FORWARD

Like its predecessor, the Third World Network of Scientific Organizations (TWNSO), the newly constituted Consortium on Science, Technology and Innovation for the South (COSTIS) will seek to promote the advancement of science, technology and innovation in the developing world. And like TWNSO, it will seek to achieve this goal largely by bringing the policy and scientific communities together to pursue common interests related to science-based sustainable development. COSTIS hopes to advance these objectives as part of a broad agenda for science-based sustainable development established by G-77 member states.

The founders of COSTIS envision a wide range of activities – for example, the sponsorship of international conferences and workshops designed to explore such critical developmental issues as access to safe drinking water, the development of energy resources, particularly renewable energy resources, and the conservation of biodiversity. They also envision the creation of joint research projects designed to provide practical solutions to critical problems. The projects, which will focus on successful experiences in the application of science and technology to solve critical problems, will be designed to encourage developing countries to learn from one another.

The founding membership of COSTIS will consist largely of ministries of science and technology, scientific research councils and science academies in the developing world, the same organizations that previously belonged to TWNSO. But unlike TWNSO, COSTIS will also be open to other member categories, e.g. *South-based private-sector organizations with an interest in science and technology. COSTIS, in short, hopes to meld the diplomatic savvy of the G-77 with the scientific and technological expertise of its TWNSO-based membership to create a powerful and effective forum for science and science-based development in the developing world.*

What specifically about TWNSO speaks directly to the mandate and goals of COSTIS?

A great deal. That's why TWNSO's statutes and bylaws served as a model for the statutes and bylaws of COSTIS. And that's why COSTIS will continue to sponsor many of the programmes that were administered by TWNSO. These include a South-South joint research programme, which requires the participation of scientists working in institutions in the least developing countries, and a best practices programme, which offers opportunities for scientists and economic development specialists from the developing world to share experiences on successful applications of science and technology to address critical social and economic needs. In short, COSTIS plans to strengthen and expand TWNSO's institutional network and to build on the success achieved by TWNSO's programmes, which also included efforts to promote South-North exchanges in science and technology. TWNSO's principles, in short, provide a blueprint for COSTIS, and TWNSO's operational structure serves as a viable framework for COSTIS's future programmatic activities. The primary challenge faced by COSTIS is to build upon the achievements that are already in place and to take advantage of the opportunities that are bound to arise as a result of close interaction between the member states of the G-77 and the scientific institutions that will comprise COSTIS.

What will be the overall mandate of COSTIS?

COSTIS will promote science-driven economic development in developing countries by encouraging governments in the South to nurture their own scientific enterprises and by supporting and promoting the integration of science and technology into national economic development plans. COSTIS will also encourage the sharing of experiences and best practices in harnessing science and technology for development and will seek to strengthen partnerships between institutions involved in education, science, and research and development. Our efforts will focus on South-South cooperation. But we will explore opportunities for South-North cooperation as well.

What will be the first steps in achieving this mandate?

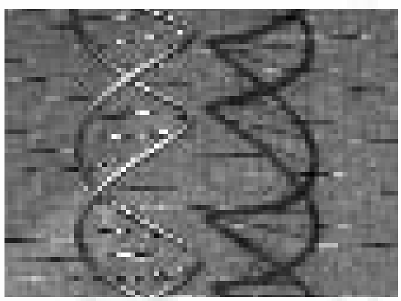
In addition to the ongoing activities I have already mentioned, COSTIS will be involved in several high-profile ministerial events in 2007. In partnership with the Malaysian government, COSTIS will organize its first forum on science and technology in September 2007 in Kuala Lumpur and, in October, on the eve of UNESCO's General Conference in Paris, we will hold a follow-up meeting. We will also sponsor an international achievement award for significant contributions to water management in the South. The winner of the first award will be announced at a COSTIS ministerial forum scheduled to take place in Oman in 2008.

What obstacles need to be overcome for COSTIS to reach its full potential?

TWNSO sought to build capacity and leadership in science and technology in the developing world, mainly through encouraging larger investments in science and technology and greater exchanges and partnerships both among individuals and institutions. COSTIS will seek to advance these same goals but on a wider scale. Melding the diplomatic expertise of the G-77 with the scientific and technical expertise of the Trieste System, I believe, places COSTIS in a good position to respond effectively to the challenges faced by developing countries. COSTIS's early success, and I have no doubt that it will succeed, will bolster support for the organization. That, in turn, will earn it even greater backing for its activities. The problems faced by developing countries are, no doubt, daunting. But COSTIS represents an unprecedented opportunity to bring extensive intellectual and financial resources to bear on critical problems. The Third South Summit is scheduled to take place in Africa in 2010. By then, we should be able to measure the impact of COSTIS. I am confident that any assessments at that time will render positive results and that the value policy makers place on science and technology as fundamental tools for sustainable development will have reached new heights – thanks in part to the work of the Consortium.

MORE CROP PER DROP

AS THE WORLD'S POPULATION INCREASES AND GLOBAL CLIMATE CHANGE IS PREDICTED TO MAKE RAINFALL MORE ERRATIC, THERE IS A NEED TO IMPROVE CROP PRODUCTION, ESPECIALLY IN MARGINAL AGRICULTURAL AREAS. BIOTECHNOLOGY WILL UNDOUBTEDLY PLAY A KEY ROLE IN MEETING THESE CHALLENGES. AGAINST THIS BACKGROUND, TWAS HAS ENTERED INTO PARTNERSHIP WITH THE INTERNATIONAL CENTRE FOR GENETIC ENGINEERING AND BIOTECHNOLOGY (ICGEB) TO PROMOTE RESEARCH ON TOLERANCE TO ABIOTIC STRESS IN PLANTS.



Global population currently stands at six billion. By 2050, it is predicted to reach nine billion. That means three billion more mouths will need to be fed, most in developing countries.

Climatologists also predict that it is precisely these countries that will be most severely affected by atypical weather patterns, with droughts likely to become more frequent and prolonged.

REVOLUTIONS REQUIRED

The Green Revolution of the 1960s successfully increased crop yields through conventional plant breeding practices, thanks largely to the efforts of such eminent scientists as M.S. Swaminathan (TWAS Founding Fellow) and Norman Borlaug (TWAS Associate Fellow 1985).

Borlaug, who won the Nobel Peace Prize in 1970 for his fundamental contributions to the Green Revolution, now contends that we need a 'Blue Revolution' – that is, one based on the more efficient use of water in agriculture. Farmers, he says, need to produce "more crop per drop".

While improved irrigation practices and crop husbandry techniques, including no-till methods and the use of cover crops, can help meet this challenge, biotechnology will also play a critical role.

There is also a need for a 'Doubly Green Revolution', as Sir Gordon Conway, currently scientific advisor to the United Kingdom's Department for Overseas Development (DfID), put it in his 1999 book *The Doubly Green Revolution: Food for All in the 21st Century*. This latter-day version of the Green Revolution, Con-

way contends, should be based on carefully managed biotechnology applications and the use of sound ecological principles.

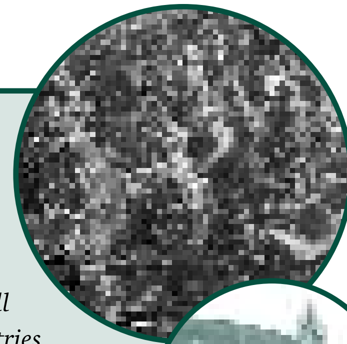
Although issues related to genetically modified (GM) or biotech crops are being hotly debated in many countries, especially in Europe, they are enjoying a phenomenal increase in popularity among farmers, including those in developing nations.

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA), some 400 million hectares of GM crops have been planted since they were first introduced in 1995. Currently, more than 90 million hectares are planted each year by some 8.5 million farmers, including 7.7 million poor subsistence farmers – of which 6.4 million are in China, another one million in India, and several thousand in both the Philippines and South Africa.

In total, 21 countries have approved the production of GM crops, which are showing an annual growth rate of more than 10 percent – a rate that is being maintained in both developed and developing countries.

To date, however, almost all of the GM crops approved for commercial production contain genes designed to make the plants resistant to such biotic stresses as insect pests, virus diseases or competition from weeds. For example, China now grows some three million hectares of insect-resistant cotton; virus resistant papayas have been successfully grown in Hawaii since 1997 and the technology is now being transferred to such countries as the Philippines and Thailand; and Argentina and Brazil are among the

ANCIENT ANDEAN GRAIN TO AFRICA



Domesticated by the Inca of Latin America some 3,000 years ago – and still widely grown in such countries as Argentina, Bolivia, Chile, Colombia, Ecuador and Peru – quinoa (Chenopodium quinoa) *has received little attention outside its natural home. That's despite the fact that the grain crop was as important as potatoes and maize in the Inca diet, and that it contains balanced levels of amino acids. Indeed, unlike such cereal grains as rice and wheat, quinoa seeds contain all the essential amino acids required in a healthy diet. Given its long history and wide geographical spread, many landraces of quinoa are grown today, many of them with tolerance to dry or saline conditions.*

Under the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants, Andrés Zurita Silva, Centre for Advanced Studies in Arid Zones, La Serena, Chile, has teamed up with Sara Maldonaldo, University of Buenos Aires, Argentina, to investigate the tolerance strategies of quinoa under salt stress. Field trials in these two countries will be used to select the best lines, which will then be transferred to another network partner, Amadou Coulibaly at the University of Mali in west Africa. He will screen the same varieties under field conditions in Mali.

"In Mali, we do not yet grow quinoa," says Coulibaly. "But our climatic conditions are similar to those experienced in Chile, so we are confident that the crops will do well here."

The final network partner is Fabiana Antognoni, University of Bologna, Italy, who, along with Zurita Silva, will investigate gene expression during the critical change in growth pattern from the vegetative to the flowering state. The team will also aim to identify genes that can be correlated with stress tolerance.

MODEL SPECIES

Sabina Vidal Macchi obtained her PhD from the Swedish University of Agricultural Sciences in 1998 and returned to take up a position in her native Uruguay in 2000. She is currently an associate professor at the Universidad de la República*, Montevideo.*

She intends to put her doctoral research to work in the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants by re-acquainting herself with a plant that she worked on for her thesis.

*"*Physcomitrella patens *is a moss," explains Vidal Macchi, "that can tolerate drought, salinity and osmotic stress. It is also unusual in that we can directly make mutant varieties, something that is not possible in other plant species. This will help us in our search for the genes related to stress tolerance in this plant."*

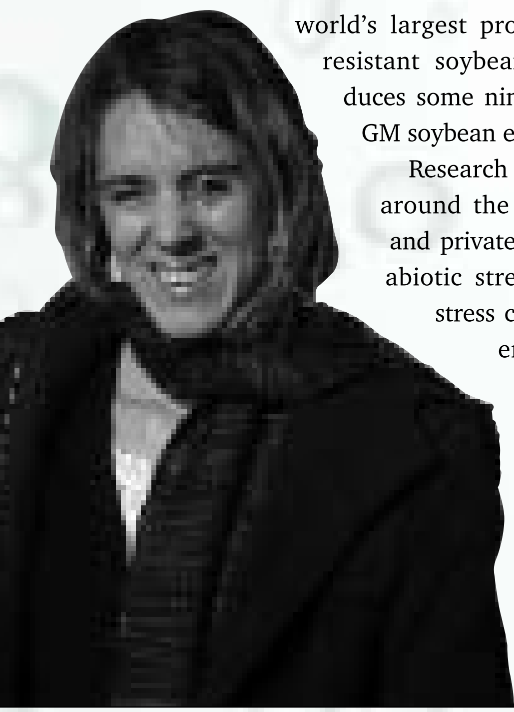
Vidal Macchi's research team also includes Virginia Luna, Universidad Nacional de Córdoba*, Argentina; László Szabados, Institute of Plant Biology, Szeged, Hungary; and Aldo Rojas, coordinator of the national biotechnology programme, Managua, Nicaragua.*

The team will also focus on a second model plant species – this time one native to Latin America.

*"*Prosopis strombulifera *is a legume that is unusual in that it can tolerate highly saline soils and is still able to fix nitrogen," explains Vidal Macchi. "It is native to Argentina and Uruguay and, although not frequently cultivated, it is used for its fibres and sometimes as animal fodder."*

As in the project with Physcomitrella patens*, the aim is to identify the genes that enable* Prosopis strombulifera *to survive and thrive in such adverse conditions.*

"Uruguay has a temperate climate, but experiences erratic rain and prolonged droughts, especially in spring and summer" adds Macchi. "These droughts are becoming more and more frequent. Because Uruguay's economy is based largely on agriculture, there is a real need to find a way to reduce crop losses due to plant stress. I hope, through our involvement in the TWAS-ICGEB project, that we can begin to address this problem."



world's largest producers of herbicide-resistant soybean. Brazil alone produces some nine million hectares of GM soybean each year.

Research in many laboratories around the world – both public and private – is also focusing on abiotic stress in plants. Abiotic stress can be caused by such environmental factors as lack of water, excessive sunlight and soils that are either highly saline (often caused by poor irrigation practices) or contaminated with heavy metals. Many of the genes and technologies under investigation are nearing the stage when they can be introduced into test varieties and then further developed into commercial products.

Given the need for 'Blue' and 'Doubly Green' revolutions, especially in developing countries, TWAS joined with the International Centre for Genetic Engineering and Biotechnology (ICGEB) in a programme designed to promote research into abiotic stress in plants. Launched in late 2005, the programme is intended to create small research networks, each composed of two to four institutions, one of which must be in a least developed country (LDC) or another science- and technology-lagging country (S&TLC).

PHASE ONE

Some 59 applications were received in response to the first call for proposals. Of these, a joint committee

comprised of TWAS members and ICGEB experts selected 13.

Researchers from institutions that were involved in these 13 proposals were invited to an international coordinating workshop, 'Increasing Tolerance to Abiotic Stress in Plants', held in Santiago, Chile, on 17-19 June 2006. The event was organized by the *Red Latinoamerica de Ciencias Biologicas* (RELAB) and supported by TWAS, ICGEB and the government of Chile.

The workshop had three major objectives:

- Stimulate research in plant biotechnology in the field of tolerance to abiotic stress.
- Facilitate collaboration in research in this topic among developing countries, especially LDCs and S&TLCs.
- Provide information to selected researchers on the goals and objectives of the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants, outlining how to proceed with the next phase of the application process.

The workshop also featured presentations by internationally renowned experts, including Marc van Montagu (TWAS Associate Fellow 2001), Institute of Plant Biotechnology for Developing Countries (IPBO), Belgium,

THE RESURRECTION PLANT

The rocky crevices of South Africa's Drakensnberg Mountains collect water when it rains. But the soil is thin and plants growing there must survive between showers.

*That is exactly what a spindly-looking plant, known as the resurrection plant (*Xerophyta viscosa*), does. Unlike most other plants, it can survive long periods without water, seemingly dying away to its straw-like stems. When it rains again, the plants quickly take in water and resume their full metabolic functions within two to three days.*

"We put together a collection of some 20 of these plants," explains Dahlia Garwe, Molecular and Cell Biology Division, Tobacco Research Board, Harare, Zimbabwe. "We then grew them under different conditions of water stress and made a comparison of the genes that were either activated or deactivated under each condition."

One particular gene, known as XVSAP1*, is expressed when the plant's water content falls below 50 percent of its usual level, but does not continue to be expressed as the plant reaches a completely dry state.*

"This gene codes for a highly hydrophobic protein," explains Garwe. "We therefore assume it plays a role in the cell membrane. We have since introduced it into bacteria, which grew well under a high osmotic stress, and Arabidopsis*, a 'model' plant used in many laboratories, which also survived when challenged with osmotic or heat stress."*

The team involved in this Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants project, is led by Jennifer Ann Thomson, Department of Cell and Molecular Biology, University of Cape Town, South Africa, and also includes Jesse Machuka, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya. The aim is to identify and isolate other genes that confer the resurrection plant its unusual properties and to transfer them into tobacco and maize with the hope of developing drought-tolerant varieties of these crops that are essential to both the economy of Zimbabwe and the food security of the entire southern African region.

SEEKING SOLUTIONS TO SALTY SOILS

Rhodospirillum rubrum *is a primitive bacterium that has developed adaptations to a diverse range of stressful conditions. Indeed, it deals with high concentrations of sodium ions by isolating them in its vacuole — in much the same way that the wheat studied by Khaled Masmoudi does (see box, 'Improving wheat', p. 33).*

Konstantin Skryabin and his colleagues Nikolai Ravin and Andrey Rakitin, Centre "Bioengineering" of the Russian Academy of Sciences, Moscow, Russia, have isolated the key genes that enable the bacteria to survive in saline conditions.

"Experts predict that, by 2050, salinity will affect some 50 percent of the worlds arable land. So these genes could have great potential if transferred to crop species," says Ravin.

To test this hypothesis, the Russian scientists have teamed up with Zafar Ismailov, University of Samarkand, Uzbekistan, with the goal of developing salt-tolerant potatoes – an important crop in both countries.

"The Aral Sea, in the north of Uzbekistan, has dried out significantly in recent years. What it has left behind is essentially a salty desert," explains Ravin. "Since 1990, potato yields in this region have fallen by some 25 percent."

The laboratory in Uzbekistan also aims to search the saline soils surrounding the Aral Sea for other halophytic – or salt-loving – bacteria, and to isolate key genes from these species that the Russian team will then use to transform potatoes.

"We have experience in such commercial projects as producing virus- and insect-resistant potatoes," continues Ravin. "We now hope to use this project to put science into practice and develop salt-tolerant varieties of potato that will be useful in Uzbekistan and elsewhere."

who examined 'Plant Biotechnology, an Imperative Topic for Developing Countries', and Sudhir Sopory (TWAS Fellow 2005), ICGEB, India, who spoke on 'Experimental Development of Transgenic Plants Resistant to Abiotic Stress'.

Concluding the workshop were two discussion sessions. The first, which focused on 'Strategies for Research in Plant Biotechnology in Developing Countries', was chaired by TWAS executive director Mohamed Hassan and included participants from Azerbaijan, Bolivia, Ecuador, Eritrea, Nicaragua, Nigeria, Uzbekistan and Zimbabwe. The second, chaired by ICGEB's Decio Ripandelli, highlighted the goals and activities of the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants.

At the conclusion of this workshop, participants were asked to submit full-length project proposals.

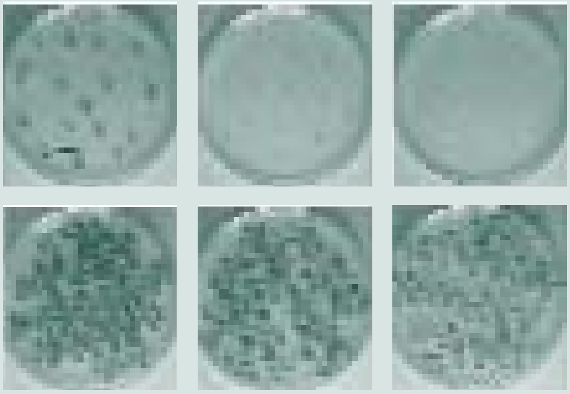
PHASE TWO

A panel of experts appointed by TWAS and ICGEB examined the full project proposals, selecting five for support. Each of the projects will receive US$20,000 a year for three years, half provided by ICGEB and half by TWAS. Among the conditions of the grant award are that most of the money must be spent in the participating LDC or S&TLC and that young researchers in these countries must receive training, preferably by allowing them to visit the participating laboratories in the more scientifically advanced countries.

Among the proposals selected were those headed by:

- Andres Zurita Silva, Chile, with collaborators from Argentina, Mali and Italy;
- Konstantin Skryabin, Russia, with a collaborator from Uzbekistan;

IMPROVING WHEAT



Southern Tunisia receives just 200 millimetres of rain each year. Wheat is widely grown in the north of the country, however, where rainfall reaches 800 millimetres a year. "Even so," explains Khaled Masmoudi, Centre de biotechnologie de Sfax, *Tunisia, "drought and salinity are major constraints to wheat production in Tunisia – as well as other countries in north Africa and the Middle East.*

Masmoudi has teamed with Michael Baum, a German biotechnologist working at the International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria, to provide training for researchers at the Eric Danquah, Department of Crop Science, University of Ghana, and other young scientists in Ghana. Indeed, this linking of laboratories in LDCs and S&TLCs with such centres of excellence as the Centre de biotechnologie de Sfax *and ICARDA, is a major component of each project supported by the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants.*

During drought stress, concentration of sodium ions can reach toxic levels in plants. By analysing more drought tolerant lines of wheat, Masmoudi and his colleagues have identified two genes that affect the plant's capacity to withstand drought stress. This is achieved by actively transporting sodium ions into the vacuole of each cell and sequestering them there – thereby removing sodium from the cell cytoplasm where the metabolic activity of the plant occurs.

Arabidoposis *plants containing these genes survived highly saline and drought conditions in laboratory tests.*

"We have developed a way of transforming durum wheat which, until now, has been quite recalcitrant. Our aim is to introduce these genes, and others that we may discover, into durum wheat both individually and 'stacked' together to improve the drought tolerance of wheat lines," adds Masmoudi.

- Jennifer Thomson, South Africa, with collaborators from Kenya and Zimbabwe;
- Khaled Masmoudi, Tunisia, with collaborators from Ghana and Syria; and
- Sabina Vidal Macchi, Uruguay, with collaborators from Argentina, Nicaragua and Hungary.

TOGETHER IN GHENT

To kick-start the networking – and to help participating researchers from developing countries forge links with one another and with eminent scientists in the North – a second workshop was held in autumn 2006.

IPBO

The Institute of Plant Biotechnology for Developing Counties (IPBO) was founded by Marc van Montagu (TWAS Associate Fellow 2001) in Ghent, Belgium, in 2000, with the support from the University of Ghent, the S.M. Sehgal Foundation and the Flemish government.

Its mission is to assist capacity building in developing-country agricultural systems at the individual, institutional and societal levels. It aims to achieve this by providing training and education in enabling technologies, international regulations and intellectual property rights. IPBO also conducts world-class research in plant biotechnology oriented to the needs of developing nations. To date, it has provided training for some 35 PhD students and some 50 postdoctoral researchers from more than 20 developing countries. Frequently, this research and training is carried out in collaboration with scientists at the Department of Plant Systems Biology (PSB) at the Flemish Interuniversity Institute of Plant Biotechnology (VIB). IPBO also promotes the transfer of suitable technologies to developing countries.

For additional information on IPBO, see: www.ipbo.ugent.be.

For additional information on PSB, see: www.psb.ugent.be.

Organized by the Institute of Plant Biotechnology for Developing Counties (IPBO) (see box above), the workshop, 'Increasing Tolerance to Abiotic Stress in Plants: Drought Stress', took place in Ghent, Belgium, on 30-31 October 2006, with support from the regional Flemish government. Eleven scientists from eight collaborating institutions attended.

In his introductory remarks at the workshop, Marc van Montagu, director of IPBO, said: "Drought stress is highly visible to the public, but agronomists have said that molecular biologists cannot solve the problem because there are too many genes involved. It is our responsibility to try and prove them wrong."

Subsequent plenary presentations by eminent scientists from Belgium, France and Italy focused on such issues as how the architecture of plant roots affects drought tolerance and how the levels of various plant hormones vary in response to drought stress.

Other presentations provided overviews of both conventional and biotechnological approaches to breeding for drought tolerance – demonstrating that

biotechnology may, in fact, be able to tackle drought stress and that agronomists could be proved wrong.

A common feature of the five selected projects, details of which were presented to participants on the second day of the workshop (see boxes, pp. 29-33), is that many potential drought-tolerance-inducing genes have already been identified and are in the process of being transferred to crop plants – and that many more await discovery. It is also the aim of several of the supported projects to identify a series of new genes, often from salt- or drought-tolerant plants that have been little studied to date.

The workshop concluded with a discussion of the challenges facing scientists working in plant biotechnology in developing countries and what organizations such as TWAS, ICGEB and IPBO could do to help.

Among the issues raised were:

- The obstacles created by limited access to equipment and information.
- The fact that national funding agencies often have unrealistic expectations for publications, patents and spin off companies, which raises unnecessary competition between fundamental and applied research.
- The challenges relating to intellectual property, which are important for applied research, especially where there is pressure to file patent applications or to consider start-up companies.

GM crops are showing an annual growth rate of more than 10 percent in both developed and developing countries.

Participants also discussed the possibility of sending young postdoctoral scientists from the Department of Plant Systems Biology in Ghent (or other laboratories interested in participating in such a programme) to laboratories in the developing countries to build 'hands-on' expertise. Such a scheme would be similar to the ICSU-TWAS-UNESCO-UNU/IAS Visiting Scientist Programme (see *www.twas.org/Exchange.html*), but would involve younger scientists.

"The practical application of all molecular tools is to breed new crop varieties and this must be promoted in developing countries," concluded van Montagu. "Molecular biologists, therefore, must be aware of the commercial and legal aspects of their research. Our ultimate goal must be to stimulate entrepreneurship based on research. It is not enough to be just a good researcher," he added. "For countries to develop, they need their own commercial enterprises."

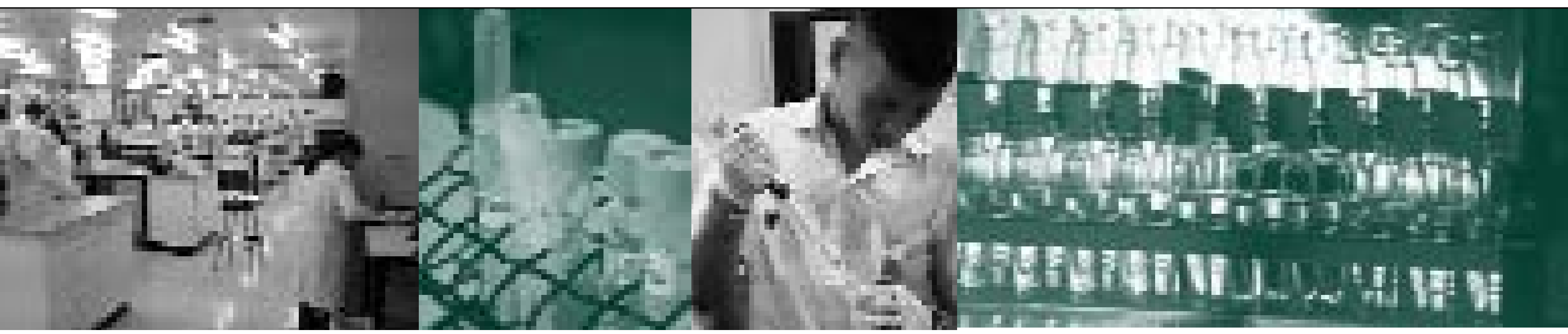
It is hoped that the funds made available to the five selected research groups in the Joint TWAS-ICGEB Programme on Tolerance to Abiotic Stress in Plants will not only successfully identify potentially useful genes, transfer them to crop plant species and demonstrate that they work, but also pave the way for the commercialization of new stress-tolerant varieties, helping to achieve a rainbow of revolutions marked by hues of blue and deep green. ■

ICGEB

Founded in 1987 within the framework of the United Nations system, the International Centre for Genetic Engineering and Biotechnology (ICGEB) is an international organization with 54 member countries and 71 signatory countries. It is organized in two components – one in Trieste, Italy, and the other in New Delhi, India. It also maintains a network of 37 affiliated centres.
ICGEB's mandate is to provide a centre of excellence in research and training with special attention to the needs of developing countries and countries in transition. ICGEB also plays an important role in promoting the applications and the sustainable use of biotechnologies and cooperates with other prominent international organizations on programmes concerning the protection of biodiversity, biosafety and risk assessment concerning the release of genetically modified organisms.
For additional information, see: www.icgeb.org.

BIOTECHNOLOGY: PROSPECTS AND CHALLENGES

OVER THE PAST 10 YEARS, FARIDA SHAH (TWAS FELLOW 2002) HAS BEEN A DRIVING FORCE IN THE ESTABLISHMENT OF COMMERCIAL BIOTECHNOLOGY ENTERPRISES IN HER HOME COUNTRY OF MALAYSIA. HERE SHE PROVIDES AN OVERVIEW OF SUSTAINABLE DEVELOPMENT OPPORTUNITIES PROVIDED BY BIOTECHNOLOGY AND OUTLINES WHAT IS REQUIRED FOR DEVELOPING COUNTRIES TO REPLICATE HER SUCCESS.



Biotechnology is defined as the use of living organisms or parts of organisms to create products, processes and services.

Three categories of biotechnology have been defined: 'Green Biotechnology', which concerns the biotechnology of plants; 'Red Biotechnology', related to medical and healthcare applications; and 'White Biotechnology' aimed at industrial uses. The development and application of biotechnology in each of these three categories have been touted as catalysts and engines of growth for many countries, including developing countries.

Biotechnology can be used to create wealth. In fact, it has been identified as a major avenue for the socio-economic advancement of developing countries. The scope, scale and practice of biotechnology research and development currently being carried out in many developing countries present a range of entrepreneurial opportunities for enhancing technological progress and ultimately a nation's economic and social wealth.

The development of biotechnology as an industry requires complex multidisciplinary and transdisciplinary efforts, including collaboration between scientists working in such fields as chemistry, microbiology, molecular biology, pharmacology, physiology, genomics and proteomics. Non-science sectors, such as sales and marketing, also need to be involved.

To develop and commercialize a biotech product, therefore, requires a synergistic strategy that brings together each of these components. In much of the developing world, where research is carried out mainly in the public sector, there is also a need to forge strategic alliances between the public and private sectors.

GREEN BIOTECHNOLOGY

One area with enormous potential for biotechnological applications in developing countries is agriculture. Agricultural biotechnology can influence the development of national strategies that minimize environmental, health and social risks in developing countries while addressing the economic needs of resource-poor farmers and the nutritional needs of those living in poverty.

World population, which currently totals more than 6 billion, is expected to increase at a rate of 70 million people a year, reaching 7.5 billion within the next 20 years. Most of this increase will occur in developing countries.

Such a large rise in population will have severe impacts on existing land and water resources. Indeed, feeding these additional people will require farmers to produce 40 percent more cereals, 30 percent more root and tuber crops, and 60 percent more meat. With little or no extra land available either for crops or large farm animals, the challenge is to increase yields and livestock production from land currently being used for agriculture and grazing.

So how can biotechnology, especially ‘green’ biotechnology, meet the needs of the poor?

As with conventional plant breeding, the challenge of green biotechnology is to shift the focus of research towards the needs of poor farmers and consumers in developing countries.

Modern plant biotechnology encompasses three major areas; tissue culture, marker-assisted breeding and genetic modification. Among these, the use of low-risk and low-cost biotechnology techniques such as micropropagation of disease-free plants using tissue culture has already proved beneficial. Such techniques have enabled small landholders in Argentina, India, Morocco and Uganda to increase crop yields on a sustainable basis.

For example, in Kenya, the mass production of disease-free banana plantlets through tissue culture has helped raise yields, making farm household incomes more secure. Indeed, healthier banana crops have helped raise the net income of participating farmers by 35 percent. The subsequent demand for disease-free plantlets, moreover, has led to the establishment of local biotech companies dedicated to producing planting material.

Another application of green biotechnology is the production of

BIOTECH IN MALAYSIA: THE MELAKA EXPERIENCE

Traditionally, research and development in Malaysia has largely been funded by the federal government and carried out in public research institutions. However, in recent years, there has been a debate on how best to commercialize research and development output developed through public funds.

At the same time, Melaka, a small state in southwest Malaysia, was seeking new sources of wealth creation and was eager to improve equality between the state's different races and ethnic groups. The answer was to create the Melaka Biotechnology Division (MBD), the Melaka Institute of Biotechnology and Melaka Biotech Holdings, which were established in 2003. In 2005, MBD was upgraded to become the Melaka Biotechnology Corporation (MBC).

The aim of MBC is to implement a seamless continuum of research-development-commercialization enterprises in biotechnology in order to advance science and technology and provide socio-economic benefits. To achieve this, two companies were created in 2005: Invitrotech Sdn Bhd, which is involved in the micro-propagation of herbal, aromatic, ornamental and other crops, and Tropical Bioessence Sdn Bhd, which extracts essential oils from aromatic plants for use in cosmetics and as flavourings and additives in various foods.

The business plans of the two young companies were developed in consultation with local farmers and the rural population, who will supply the raw materials. By the end of 2007, 50 farmers are expected to be under contract, selling materials and generating a combined annual income of US$400,000. This input of money into the state of Melaka should go some way towards achieving the regional government's aim of improving the income of members of different races and ethnic groups.

The MBC model for technology commercialization, industrial development, entrepreneurship development and rural development is now being studied with the view to replicating it in such countries as Oman and Yemen.

genetically modified (GM) crops. Despite the contentious nature of GM technology, in 2004, nearly US$5 billion-worth of GM crops entered the market. Today, GM seeds account for some 16 percent of the US$30 billion global seed market.

The first GM crops were planted 10 years ago. Even so, proponents contend that two fundamental forces – humans, who have engaged in several thousand years of selection, and nature, which has been responsible for developing today's crops from wild ancestors – represent a long-standing form of 'natural genetic modification'.

From this perspective, today's scientists have merely added a new tool to the toolkit. Indeed, the potential benefits provided by GM technology, including reduced dependence on expensive chemical fertilizers and the development of biologically based clean technologies, such as renewable energies from crops, can provide enhanced market potential for developing world economies.

These advances, however, need to be carried out in an open and transparent way and with proper scientific and legal guidelines in place. Several developing countries have adopted such measures. Many more are in the process of drafting biosafety guidelines.

However, the lack of facilities and professional skills in biotechnology limits research and development initiatives in developing countries and, in particular, in the least developed countries (LDCs). This lack of scientific capacity restricts the full participation of such countries in national and regional sustainable development ventures.

Success in the biotechnology sector, therefore, depends on nurturing an environment for science and innovation that offers competitive access to laboratories and human resources and that provides opportunities for acquiring adequate funding from investors, including venture capitalists. Well-structured government or regional policies that enable biotechnology to develop as an industry are equally important.

TARGET AREAS

The biotechnology business is already booming in many countries in the North, led by the United States. Entering such a crowded market requires specific innovative products – or targeting potential niche markets. Competing in this latter area is where developing countries can succeed.

Agricultural biotechnology businesses should be developed bearing in mind the principle 'from labs to farms to factories'. This means applications of biotechnology must be developed in an integrated fashion to ensure the continuous supply of raw materials to satisfy market demand.

There are the many tropical diseases that cause untold misery and strife in developing countries. Major pharmaceutical companies in the North often neglect such diseases because anticipated returns on investments are too small. However, there is a human need – and likely an untapped market – for simple diagnostic assays for such viral diseases as dengue and Japanese encephalitis.

Developing countries can also harness their indigenous biodiversity, including their human diversity. One area worthy of consideration is applying traditional medicinal knowledge to the development of 'nutraceuticals', or dietary supplements, and 'functional food'. The global market in herbal products alone currently exceeds US$22 billion. The World Bank projects that this market will grow to US$55 billion by 2008.

The development of nutraceuticals and 'cosmeceuticals' – cosmetic products with proven beneficial effects – based on the application of traditional knowledge has the potential to become an important driver for the development of medicinal and herbal industries in many developing countries.

Another equally important area is the conversion of 'waste to wealth' based on the production of energy from industrial and agricultural by-products. Such biotechnological applications often rely on the selection of bacterial strains that are able to break down waste products into the desired components (alcohol or methane, for example). Building such biotech-based businesses involves a combination of factors – not only strong scientific research and development, but also entrepreneurship, intellectual property rights regimes, funds to finance technology transfer operations, business planning and strategic partnerships.

CHALLENGES

Among the challenges facing the development of biotechnology-based industries in developing countries, are:

• *Financing*. Venture capitalists are few and far between in developing countries and banks are risk-averse, often lacking a clear understanding of the potential of the biotechnology industry.

• *Capacity building*. There is a need to develop a critical mass of knowledge workers and to nurture an entrepreneurial environment that can take full advantage of their skills. Skill sets must include management know-how for each stage of the technology transfer process, a deep understanding of intellectual property rights issues such as the filing and safeguarding of patents, and an ability to navigate such business matters as personnel management, sales and marketing.

• *Training of entrepreneurial scientists*. Developing countries need more entrepreneurial scientists with research and management skills, including experience in marketing and knowledge of intellectual property rights, as well as an understanding of scientific regulatory and ethical issues.

• *Defining of markets*. Developing countries must acknowledge market realities and aim for 'niche markets'.

• *Lack of harmonization of policies*. Government policies must be updated to produce an environment that encourages innovation and technology transfer.

• *Curbing government bureaucracy*. Too often, government red tape has meant delayed decisions, lost opportunities and wasted expenditure.

Despite these challenges, there are several opportunities for biotechnology to grow in developing countries. These include:

• *Translation of scientific knowledge into commercial businesses*. Services should be created encouraging the utilization of research in commercial situations. One such example could be the multiplication of improved seeds for sale to farmers.

• *Exploiting strategic advantages such as biodiversity.* Indigenous medicinal and aromatic plants can be developed into pharmaceutical, nutraceutical and cosmeceutical products.

• *Developing genetic modification technology*. Crops with higher yields and improved qualities can be developed.
• *Creating auxiliary services*. Diagnostic assays and screening protocols can be devised for diseases, pollutants and other contaminants. Through the use of genetic fingerprinting, for example, quality control can be applied to the export of products derived from medicinal plants, ensuring that the components are those that are desired.

STRATEGIES

Strategies for developing industrial applications of biotechnology, therefore, should:
• *Create enterprises*. Private companies are essential for integrating different sources of knowledge in the health and agricultural biotechnology sectors and turning them into products and services. In addition, there is a need to create technology transfer units and university-based investment funds with access to specialized government-based or private venture capitalists.
• *Establish and promote close links*. There must be close interplay between the three main players: industry, government and the research community. By promoting linkages between these components, existing strengths can be tapped in disparate fields. International connections can also be maintained to broaden the net in the search for business opportunities.
• *Tackle intellectual property issues and take advantage of local biodiversity, indigenous knowledge and science-based innovations*. Patent legislation has played an influential role in private-sector development. Strong scientific capacity, which is fundamental to the growth of biotechnology, must be tied into this process. Allowing researchers to keep the rights to their discoveries and inventions will provide them with added incentives and will promote entrepreneurial activity.
• *Seek involvement in key national economic development programmes*. The most prolific and dedicated scientists should be given incentives to work on flagship national economic development programmes and projects, a strategy practiced by Brazil, Cuba and South Africa. Such initiatives can also help prevent brain drain and encourage brain gain by promoting open and transparent funding opportunities.
• *Leverage large population bases*. The growing middle-classes of such countries as China and India are increasingly providing a lucrative market for products and services that can help South-based biotechnology companies compete against companies in the North.
• *Maintain long-term vision*. Governments must formulate coherent regulatory and enabling policies that meet international standards and actively foster biotech-based entrepreneurship.

These approaches are vital for developing countries to meet the demands of food security and to develop other commercial enterprises that can lead to socio-economic development.

As former US President Jimmy Carter has said: "Responsible biotechnology is not the enemy. Starvation is. Without adequate food supplies at affordable prices, we cannot expect world health or peace." ■

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SCIENCE IN SAUDIA ARABIA

SALEH ABDULRAHMAN AL-ATHEL (TWAS FELLOW 1994), PRESIDENT OF KING ABDULAZIZ CITY OF SCIENCE AND TECHNOLOGY (KACST), EXAMINES THE STATE OF SCIENCE IN SAUDI ARABIA. HE NOT ONLY EXPLORES THE NATION'S CURRENT POLICIES AND PROGRAMMES BUT ALSO ANALYSES THE INTRICATE RELATIONSHIP BETWEEN SCIENCE AND RELIGION.

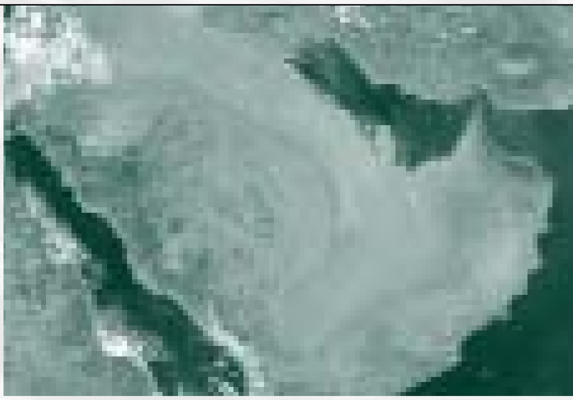
For Al-Athel, the dynamics between science and society in deeply religious Saudi Arabia are not that much different from other nations where religion is at the forefront of guiding cultural values and shaping behavioural norms.

Mention Saudi Arabia and two things come to mind: Islam (it is home to two sacred shrines, the Ka'abah in Mecca, and Al-Masjid al-Nabawi, the Mosque of the Prophet, in Medina) and oil (it has the world's largest reserves totalling 265 billion barrels).

While it's true that both are central to the nation's identity, it's also important to note that other critical factors come into play when seeking to understand the forces that drive the nation. One of these factors is Saudi Arabia's increasing interest in building a knowledge-based society by strengthening its indigenous scientific and technological capacity.

Saudi Arabia covers 2.25 million square kilometres. That's an area nearly four times the size of France. Unlike many nations in the region, Saudi Arabia has never been colonized. Indeed it is one of the world's youngest kingdoms. King Abdulaziz Al-Saud established the modern Kingdom of Saudi Arabia in 1932, after successfully melding together a group of fiercely independent desert tribes and small kingdoms. Since then, the Kingdom has transformed itself from a desert nation into a modern, sophisticated state, emerging as a major player on the international stage.

Saudi Arabia accounts for a quarter of the world's known oil reserves. Its rapidly growing,



youthful population (nearly 40 percent of its citizens are less than 15 years of age) currently totals nearly 24 million. And while many outsiders view Saudi Arabia as an insular nation, it is important to note that nearly 40 percent of the people living in Saudi Arabia were born in other nations, primarily other Arab nations. For example, over the past 25 years, it is estimated that 25 percent of the population of Egypt, at some point during

their adult lives, has travelled to Saudi Arabia in search of employment. With an average annual household income of more than US$13,000 (slightly higher than Russia's and double that of China), Saudi Arabia is among the wealthiest developing nations.

VALUES AND PURPOSE

Critics contend that Islam, particularly fundamentalist Islamic faith, has never come to terms with modern science. But their arguments are based largely on the conflict that has existed between religion and science in the Western world.

The truth is that, historically, Islam embraced science. The Qur'an (the words of God), and Hadiths (the collection of narrations of the prophet Mohamed) call on believers "to seek knowledge at all time, to investigate nature and to use reason in all aspects of life." The prophet Mohamed asked plaintively: "How can the knowledgeable and the non-knowledgeable be equal?" And the Hadiths proclaimed: "The search for knowledge is a religious duty for men and women."

These principles – religious tenets, if you will – spurred unrivalled accomplishments during the so-called golden age of science in Islam, which remained in place from the 8th to the 13th centuries. The gallery of eminent scientists from the Islamic world is long on accomplishment but short on notoriety even among those living within the region. Al-Kawarizimi (mathematics), Al-Biruni (astronomy), Ibn al-Haytham (optics), Ibn Rushed (medicine), Japir Ibn Hayyan (chemistry) and Ibn Sina (philosophy), and Ibn Khaldoon (social science and history) all made fundamental contributions to global knowledge at a time when Europe had plunged into chaos and ignorance following the collapse of the Roman empire.

It is fair to say that Islamic intellectuals and scientists provided the bridge between the glory of Rome and the splendor of the Renaissance, and that Europe would not be the Europe that we know today without the assistance that it received from the Islamic scholars and scientists during Europe's early Middle Ages.

Yet, for the past 300 to 400 years, it has been the West that has propelled scientific progress forward, first by drawing on the intellectual capacity of the Islamic world and then by building its own framework for thought and action anchored by the ideals of the Renaissance and the notions of progress inherent in the scientific and industrial revolutions that took place between the 15th and 19th centuries.

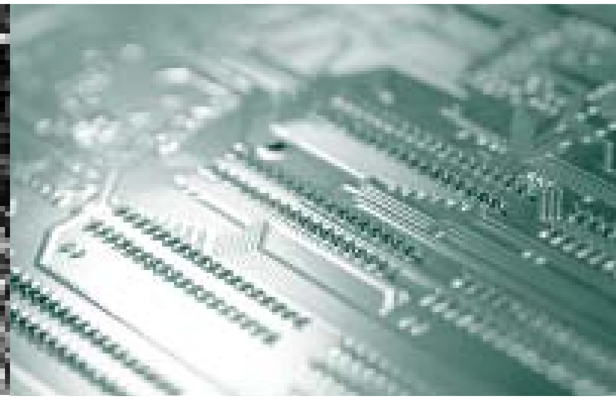
REVITALIZING SCIENCE

Arab nations failed to keep pace and, in fact, largely ignored what was happening in Europe. In the case of Saudi Arabia, the first national stirrings of interest in science did not occur until 1954 when a national Ministry of Education was created. Three years later, Saudi Arabia launched its first university – King Saud University.

However, it was not until 1970 that a consensus emerged for a national development plan that acknowledged the importance of science and technology in supporting societal well-being. In 1977, Saudi Arabia created the King Abdulaziz City of Science and Technology (KACST).

Operating within the prime minister's office, KACST's broad mandate includes devising and implementing national policies for science and technology, awarding grants for applied scientific research, fostering international cooperation and promoting public understanding of science and technology. It also oversees Saudi Arabia's efforts to advance new information and communication technologies and to devise regulatory frameworks for the successful awarding of patents.

In addition, KACST manages the nation's preeminent institutes for research and development, most notably in a wide range of fields that includes advanced materials, astronomy, biotechnology, computers, electronics, the environment, geophysics, petroleum and petrochemicals, and water treatment and desalination.



While science and technology in Saudi Arabia have enjoyed strong and growing support, especially from the government over the past several decades, it's also true that the nation's recent efforts to promote science and technology are moving ahead from a limited foundation.

Thus much remains to be done to create both a scientific and technological infrastructure and a level of scientific capacity that are commensurate with the nation's size and wealth. Even today, the nation spends just 0.25 percent of its gross domestic product (GDP) on research and development compared, for example, to 1.1 percent in China, 3 percent in Korea and 4.6 percent in Sweden.

Yet, for those who care to look, progress in science and technology is visible on a number of fronts.

Over the past decade, for example, the number of colleges in Saudi Arabia devoted to science and engineering has more than doubled from 33 to 74. Likewise the number of students seeking degrees in science and technology has risen from some 39,000 to 76,000 (in 1975, the number was less than 6,000). Today, Saudi Arabia has some 100 research institutes and centres – 90 percent of which are associated with publicly funded universities or government agencies. With roughly 730 researchers per 1 million population, Saudi Arabia's percentage of researchers is twice that of the average of developing countries, a figure that is expected to increase as spending for scientific research rises in the future.

THE ROAD AHEAD

The National Science and Technology Policy, approved by the government in 2002, is designed to build the capacity of individual scientists and to provide them with the skills that they need to pursue productive careers. This, in turn, requires the upgrading of the teaching curriculum and classroom and laboratory facilities.

The Saudi government has increasingly recognized not only the importance of science and technology but also of innovation. The goal is to put science to work to enhance competitiveness and prosperity and ultimately to lay the groundwork for a transition to a knowledge-based economy, one that is less reliant on the extraction and exploration of oil and is more diversified than today's economy.

The effort will take place over a broad range of fronts. First, there will be a concerted investment in new information and communications technologies.

Today, nearly 60 percent of the population owns cell phones. We hope to attain 100 percent cell phone use among the adult population over the next decade. Today, approximately 13 percent of the population has access to the internet. We hope to increase this figure to 30 percent during the next decade. In addition, the government plans to introduce an array of e-government and telemedicine services over the next few years.

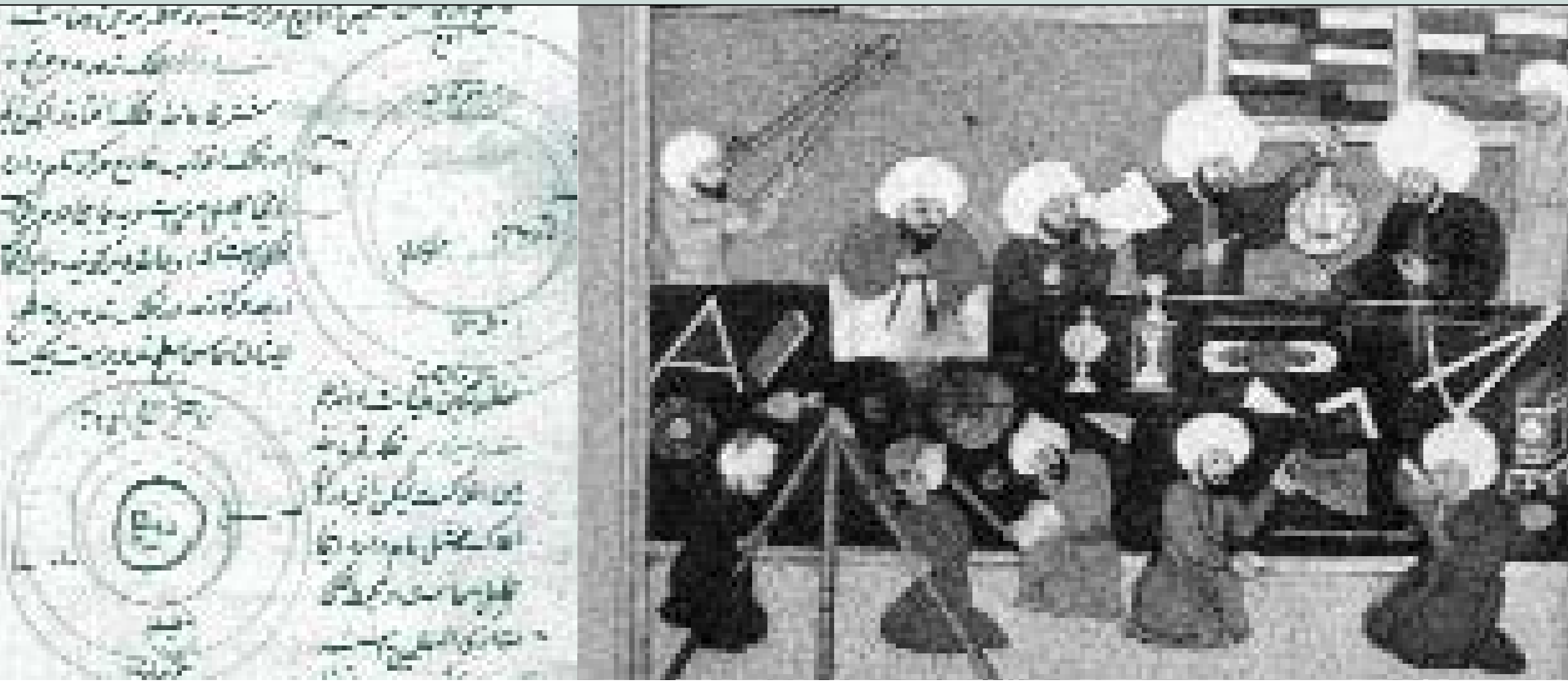
WOMEN AND SCIENCE

The position of women in Islamic society in general and in Saudi Arabian society in particular is a complex and frequently misunderstood issue. It is certainly true that Muslim and Western views of the role of women show sharp cultural differences but the stereotype of Muslim women, as uneducated, with no rights and with no opportunities, is a caricature born of ignorance or malevolence.

Although women in Saudi Arabia have a pre-eminent role within the family, it would be a mistake to think that the role of women in Saudi Arabian society is confined to home-making. Over the past four decades, women in Saudi Arabia have made great strides. They own businesses and property, and they work as bankers and doctors. And while they have come a long way, our society is working towards further empowering them in line with our traditions and culture.

The development of Saudi Arabia has brought with it increasing opportunities for women in both education and employment. In 1960, the government of Saudi Arabia introduced a national education programme for girls. By the mid-1970s, about half of all Saudi Arabian girls were attending school. Five years later, education was available to all Saudi girls.

Saudi women now represent more than half of the student body not only in primary and secondary schools but also in universities. Indeed the number of female students in some fields of study, such as environmental science and medicine, now exceed by far the number of males. In May, the government declared that the nation's local colleges would be transformed into universities and that the courses offered at these newly instituted universities would be expanded to ensure that women would have a greater number of courses to choose from closer to their homes. Unlike just a few years ago, today, the work and accomplishments of women are frequently discussed in newspapers and magazines and on television. These attitudes and perceptions – all taking place within the context of Saudi Arabia's traditional religious values and culture – are having a cumulative impact on Saudi society that is likely to continue in the years ahead.



At the same time, the government intends to liberalize its rules and regulations for foreign trade and to reform its corporate tax laws to provide incentives to private firms, encouraging them to invest in research and development. It also plans to launch a programme to privatize services that have been under the administrative jurisdiction of the government, including the nation's aviation industry and ports.

While science and technology have made important strides in Saudi Arabia over the past several decades, it is nevertheless true that the government has funded virtually all of the research and that the private sector has largely failed to invest in research and development, choosing instead to import scientific skills and technological products and services from abroad.

Recent decisions by ARAMCO and several other large corporations suggest that this may soon change. Nevertheless, it's also true that researchers in Saudi Arabia have tended to concentrate their studies on a select number of fields, most notably agricultural engineering, water management and medicine.

On the up side, the nation has witnessed an encouraging increase in the number of papers published in reputable journals. On the down side, little of the science done in Saudi Arabia has led to patents and even less has found its way into products and services that have been successfully marketed.

As a result, Saudi Arabia must not only continue to build its scientific capacity on the supply-side through additional investments in capacity building but it must also seek to orient its research towards addressing societal problems by strengthening the demand-side.

That means spurring additional improvements in education, especially higher education; nurturing and rewarding entrepreneurship; boosting the development of knowledge-based products and services; and encouraging the creation of institutional networks; and forging stronger ties with international institutions and businesses that can serve as both a source of cooperation and competition.

In short, Saudi culture should be transformed in ways that encourage risk-taking by rewarding success and not punishing failure too harshly.

Saudi Arabia's new science and technology policy specifically calls for increasing expenditures for research and development to 1.6 percent of GDP by 2020. It emphasizes the need to promote human resource development and job mobility by strengthening classroom education and building centres of scientific excellence, business incubators and technology parks. It seeks to liberalize the nation's scientific enterprise through new laws that promote research and innovation and encourage greater international scientific exchange. And it targets such key areas of cutting-edge scientific research as advanced materials, biotechnology and information and communication technologies. Yet it also warns against neglecting such traditional fields of concern as water management and petrochemicals.

The agenda is based on a simple yet challenging concept: sustainable innovation, based on a strong foundation of science and technology, is the only way for a nation to secure a place at the table in today's world of global competition and, as a result, the only way to build a prosperous and peaceful future for its people.

ISLAM AND SCIENCE

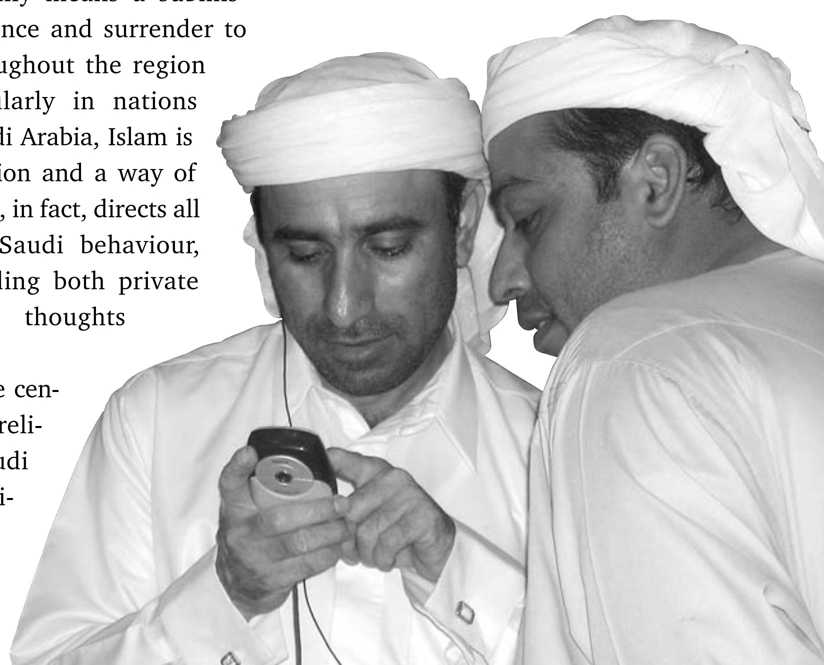
Science and technology are based on universal principles. After all, a law of nature is no less true in Sweden or Switzerland than it is in Saudi Arabia. Likewise, a new technology that allows for the more efficient extraction of oil from beneath the seabed of the North Sea will serve the same purpose in the Arabian Gulf.

Yet, to succeed within a national context and to play a central role within a nation's plans for economic development, proponents of science and technology develop policies that must be attentive and ultimately conform to a nation's cultural values. That is no less true of Saudi Arabia than it is of the United States.

In Saudi Arabia, this means a willingness to adhere to Islam, which literally means a submission, obedience and surrender to Allah. Throughout the region and particularly in nations such as Saudi Arabia, Islam is both a religion and a way of life. Religion, in fact, directs all aspects of Saudi behaviour, strictly guiding both private and public thoughts and actions.

Given the central role of religion in Saudi society, science cannot – and will not – be perceived as a secular activity, and thus cannot – and will not – be exempt from the fundamental Islamic principles that pilot society. Islam, simply put, governs all aspects of daily life: not just science but economics, politics, and social laws and customs.

In this context, the Shari'ah, the body of Islamic law, provides the sole source of guidance for how Muslims should behave. "O ye who believe," the Shari'ah says, "obey Allah, and obey the Messenger and those charged with authority among you. If you differ in anything among yourselves, refer to Allah and His Messenger, if you believe in Allah and the last day: that is best, and most suitable for final determination."



The primary sources of the Shari'ah – and thus Islamic jurisprudence – are the Qur'an, the direct words of God, and the Sunnah, the prophet Mohamed's words and actions. A secondary source of the Shari'ah is *Ijtihad*, which constitutes both a consensus view of Islamic scholars and the opinion of individual Islamic scholars. *Ijitihad* seeks to interpret the primary sources of the Shari'ah as part of a larger effort to adapt the principles and rules of the Shari'ah to the evolving needs of civilization.

An Islamic Jurisprudence Council *(Fiqh)*, established in 1398 and consisting of a group of eminent Islamic jurists, examines contemporary issues facing Muslims within the context of the Shari'ah. The jurists, whose ultimate goal is to demonstrate the supremacy of Islamic laws over human-made laws, is assigned the task of devising solutions to contemporary concerns in ways that do not contradict the Shari'ah.

The Shari'ah itself provides a hierarchical legal classification of behaviour and action, citing those that are forbidden, required, discouraged, permitted and recommended. Under Shari'ah, necessities take precedence over needs and needs take precedence over wants. The Shari'ah also places a premium on minimizing harm. Islamic law, for example, claims that preventing harm should take precedence over supplying benefits, that lesser harm should be endured to prevent greater public harm, and that individual harm should be tolerated to prevent public harm.

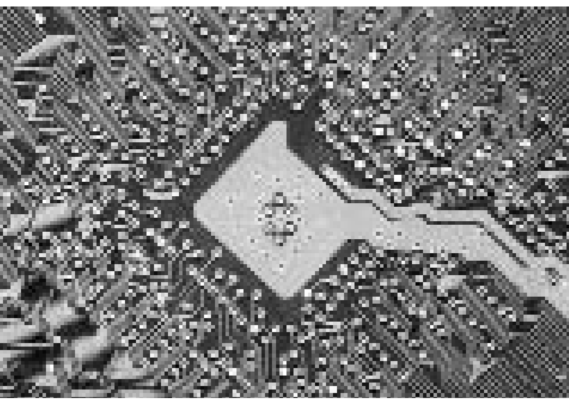
For many Muslims, the Qur'an and science share a common desire to understand and ultimately to live in harmony with nature, which for Muslims is God's and only God's domain. Some Muslims quote verses from the Qur'an demonstrating that God encour-

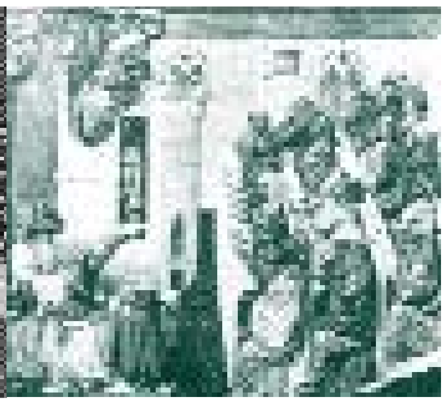
KACSTING FORWARD

King Abdulaziz City of Science and Technology (KACST), Saudi Arabia's main science and technology agency and lead organization for the implementation of the National Science and Technology Policy, is an umbrella organization involved in a wide range of activities. For example, it is the nation's largest funding agency for research in universities, research centres and hospitals. KACST also manages the nation's pre-eminent research institutes in fields ranging from aerospace to energy to information technologies and to natural resources and the environment. These institutes employ some 1,500 people, including 1,000 scientists with advanced degrees. In addition, KACST serves as the nation's equivalent to a ministry of science and technology, providing advice to the government and working with other government ministries such as finance and foreign affairs, to help ensure that science and technology issues are incorporated into the nation's overall development and diplomatic policies and programmes. For additional information about KACST, see www.kacst.edu.sa/eng.

ages people – Muslims and non-Muslims alike – to engage in scientific studies designed to prove the existence of God to nonbelievers. Some Muslims have also sought to present events described in the Qur'an as evidence that contemporary scientific discoveries were first revealed more than 1,500 years ago.

Islam and science, contrary to the views of critics, are not incompatible. In fact, they can be mutually re-enforcing. History tells us so; and so do efforts by predominantly Islamic countries to address some of the most scientifically contentious issues of our time.





In Saudi Arabia, for example, we have decided that human cloning is unacceptable (a violation of our strict belief that God should be the sole source of human creation), but that animal cloning is not. Moreover, we are currently debating whether our scientists should be able to engage in research cloning. Genetic engineering, designed to improve agricultural productivity and combat disease, is also acceptable providing, of course, ample attention is paid to biosafety. Genetic testing, under proper rules and regulations, is also allowed and indeed recommended except in the case of the offspring of married women who are considered part of the community. No amount of genetic testing, Islamic law maintains, will be able to save a community, which is a decision that rests in God's, not man's, purview.

The legality – and thus the ethics – of stem cell research are also being debated. Currently, adult stem cell research is acceptable under the Shari'ah while the legitimacy of embryonic stem cell research depends on the source of the cells. Extra fertilized eggs created for other purposes can be used; cloned eggs created exclusively for research cannot, a situation similar to that in many non-Islamic countries.

My point in raising these issues is to illustrate that the same contentious debates currently taking place elsewhere, particularly in the United States and Europe, focusing on such cutting-edge scientific fields as stem cell research and genetic engineering, are also taking place in Saudi Arabia and other Islamic countries. Deeply held religious beliefs in countries like Saudi Arabia have not hindered these debates. Indeed the ethical and moral principles that are at the heart of Islam have served a fundamental role in determining the course of action that is acceptable.

Religion, in fact, has provided a necessary moral and ethical framework for investigations that could potentially redefine the meaning of life. Instead of standing in opposition to one another, both the debate and the outcome often find science and religion working as one, seeking to reinforce common principles and goals that benefit both individuals and the larger society.

Science may not be viewed as secular in Saudi Arabia but it certainly has an impact on the everyday lives of people, and that impact is likely to grow in the years ahead. ■

Saleh Abdulrahman Al-Athel
(TWAS Fellow 1994)
president
King Abdulaziz City of Science and Technology (KACST)
Saudi Arabia

PEOPLE, PLACES, EVENTS

KING'S AWARD

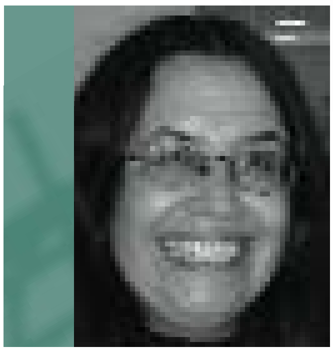
• **Mudumbai S. Narasimhan** (TWAS Fellow 1988) has been awarded the 2006 King Faisal International Prize. The prize, named after a former king of Saudi Arabia, carries a US$200,000 cash award. Narasimhan, an expert in algebraic and differential geometry, was the head of the mathematics group of the Abdus Salam International Centre for Theoretical Physics (ICTP) before retiring in January 1999. In 1987, he won the TWAS Award in mathematics. This latest award was given in recognition of his path-breaking research in strengthening the links between mathematics and physics. Narasimhan shares the prize with Britain's Simon Kirwan Donaldson, president of the Institute of Mathematical Sciences and professor of mathematics at Imperial College, London. The awards ceremony took place in February 2006 in Riyadh, Saudi Arabia.

Mudumbai S. Narasimhan

NATIONAL HONOUR

• **Patricia Berjak** (TWAS Fellow 2004), University of KwaZulu-Natal, South Africa, has been awarded the Order of Mapungubwe: Silver, South Africa's highest honour for excellence and achievement. The award, named after an African nation that existed a thousand years ago in what is now the northern part of South Africa's Limpopo province, was launched in 2002. Berjak is being recognized for her "excellent achievements in and contribution to the understanding of seed science." The award was presented by South Africa's President Thabo Mbeki at a special ceremony held in Pretoria in September 2006.

Patricia Berjak



Eugenia del Pino Veintimilla

ANOTHER HONOUR

• Following her award of the Eugenio Espejo Medal from the city of Quito, Ecuador (*TWAS Newsletter* vol. 17, 4, page 49), **Eugenia del Pino Veintimilla** (TWAS Fellow 1989), professor of biological sciences at the *Pontificia Universidad Católica del Ecuador*, has been elected a fellow of the American Academy of Arts and Sciences. del Pino shares the honour with such notable figures as former US presidents Bill Clinton and George W. Bush. Founded in 1780, the American Academy of Arts and Sciences is an independent research centre that conducts multidisciplinary studies of complex and emerging problems. Current research focuses on such issues as science and global security, social policy and education. Members, now totalling some 4,600, receive recognition in five categories: mathematics and physical sciences; biological sciences; social sciences; humanities and the arts; and public affairs, business and administration. del Pino was inducted into the academy during a ceremony held in Cambridge, Massachusetts, USA, in October 2006.

SWAMINATHAN AWARD

• **Gurdev Singh Khush** (TWAS Fellow 1989), a rice breeder from the International Rice Research Institute (IRRI), the Philippines, and currently adjunct professor at the University of California, Davis, USA, was awarded the Swaminathan Award for Leadership in Agriculture by the Prime Minister of India, Manmohan Singh, during the International Rice Congress 2006 held in New

Gurdev Singh Khush

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Delhi. Khush has been the driving force behind the development of more than 300 high yielding rice varieties, including several that played significant role in the Green Revolution of the 1960s.

TWO HONOURS

• **Harold Ramkissoon** (TWAS Fellow 2003), professor of applied mathematics, University of the West Indies, St. Augustine, Trinidad, has been elected Foreign Corresponding member of the Venezuelan *Academia de Ciencias, Fisicas, Matematicas e Naturales*, becoming the first Caribbean scientist to be so honoured. His election was based on his meritorious scientific and professional work, including his roles


Harold Ramkissoon

as president of the Caribbean Scientific Union and as a board member for the United Nations Educational, Scientific and Cultural Organization's (UNESCO) International Basic Sciences programme. Ramkissoon has also been honoured with the CARICOM (Caribbean Community and Common Market) Science Award for his outstanding achievements in mathematics. He was presented that award, which carries a US$5,000 cash prize, during a special ceremony in May 2006


Mohammed Musa Shabat

attended by the Prime Minister of Grenada, Keith Mitchell.

OPTICS AWARD

• **Mohammed Musa Shabat** (TWAS Fellow 2004) has been presented with the ICO (International Commission for Optics) Galileo Galilei Award for his work on opto-electronics, nonlinear optics and optical sensors. A condition of the award is that the high-level research must have been carried out "under comparatively unfavorable circumstances". Shabat, TWAS' only member from the Palestine Autonomous Territories, conducted much of his ground-breaking research at the Islamic University located in Palestine's Gaza Strip. He is currently on sabbatical at the Max Planck Institute for the Physics of Complex Systems, Dresden, Germany.

MALAYSIAN SCIENCE PROGRAMMES

• The Academy of Sciences Malaysia is inviting nominations for the Mahathir Science Award, worth US$28,000. This award is given to researchers who have made internationally recognized breakthroughs in the fields of tropical agriculture, tropical architecture and engineering, tropical medicine and tropical natural resources. Additional information concerning the award and nomination procedures is available at: *www.akademisains.gov.my*.

In addition, the Malaysian government, through its Ministry of Science and Technology, has launched the National Brain Gain Programme, with the objective of harnessing talented Malaysian nationals working abroad and other foreign talents. "The aim is to involve these people in collaborative research and development projects and to enhance worldwide networking in research and development," says Samsudin Tugiman, executive director, Academy of Sciences Malaysia. Additional information is available at: *bgm.mosti.gov.my*.


Luis Felipe Hartmann

IN MEMORIAM

• **Luis Felipe Hartmann** (TWAS Fellow 1987) died on 30 October 2006, aged 84. Hartman, former rector of the *Universidad Santo Tomás*, La Paz, Bolivia, was an expert in diabetes, thyroid function and chromosome defects. Among his other achievements was the creation of the Foundation for Scientific and Human Development in his native Bolivia.

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 800 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 Ministry of Foreign Affairs of Italy.

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.

TWAS was instrumental in the establishment, in 1988, of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of 150 scientific organizations in developing countries, whose goal is to assist in building political and scientific leadership for science-based economic development in the South and to promote sustainable development through broad-based partnerships in science and technology.

www.twnso.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 94 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 64 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

WANT TO KNOW MORE?

TWAS and its affiliated organizations offer scientists in the South a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS website:
www.twas.org

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes:
www.twas.org/Exchange.html
TWOWS offers postgraduate fellowships to women from least developed countries (LDCs) and other countries in sub-Saharan Africa:
www.twows.org/postgrad.html

GRANTS

Are you a scientist seeking funding for your research project? Then take a look at the TWAS Research Grants scheme:
www.twas.org/mtm/RG_form.html
Is your institution seeking funds to collaborate with a research institute in another country in the South? The TWNSO grants programme may be able to provide support:
www.twnso.org/grants.html

EQUIPMENT

But that's not all TWAS has to offer. For instance, do you need a minor spare part for your laboratory equipment – no big deal, really – but you just can't get it anywhere locally? TWAS can help:
www.twas.org/mtm/SP_form.html

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Check out the Visiting Scientist Programme:
www.twas.org/hg/vis_sci.html

CONFERENCES

Are you organizing a scientific conference and would like to involve young scientists from the region? You may find the help you need here:
www.twas.org/mtm/SM_form.html