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NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

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AS TWAS APPROACHES ITS 25TH ANNIVERSARY, WHICH WILL TAKE PLACE IN 2008, WE HAVE A GREAT DEAL TO CELEBRATE. OVER THE PAST QUARTER CENTURY, THE ACADEMY HAS EMERGED AS ONE OF THE WORLD'S PRE-EMINENT INSTITUTIONS FOR HONOURING SCIENTIFIC ACCOMPLISHMENT AND FOR BUILDING SCIENTIFIC CAPACITY IN THE DEVELOPING WORLD. TWAS'S STATUS IN THE INTERNATIONAL SCIENTIFIC COMMUNITY SHOULD SERVE AS AN ENORMOUS SOURCE OF PRIDE FOR ALL ACADEMY MEMBERS AND FOR ALL THOSE WHO HAVE SUPPORTED THE ACADEMY OVER THE YEARS.

Northern Exposure, Southern Light

The cornerstone of TWAS's efforts has been the election of eminent scientists to the Academy and the promotion of science and technology (S&T) throughout the developing world. We have also been an important focal point for the promotion of women in science in the South. In 1983, at the first meeting of TWAS, the number of founding members stood at 42. Today the Academy's membership totals 841. Through persistence and hard work, we have forged an enviable network comprised of some of the most talented scientists in the world. Our membership profile – about 85 percent of our members come from developing countries – does indeed make TWAS a unique organization.

Beyond its esteemed membership, the Academy has also earned a reputation as one of the most effective organizations for building scientific capacity in the South.

TWAS's research grants rank among the most sought-after grants in the South; our fellowships programme for postgraduate and postdoctoral students, sponsored in partnership with the governments of Brazil, China, India and Pakistan, is one of the largest South-South fellowships programmes in the world (some 250 grants are offered each year); our grants programme for scientific institutions in scientifically lagging countries provides up to US$30,000 a year for three years to research groups working under trying conditions in less privileged countries; and our associateships programme, a joint enterprise carried out with more than 100 centres of scientific excellence across the developing world, enables researchers from the South to exchange ideas and participate in projects of mutual interest over extended periods.

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ICTP Campus, Strada Costiera 11
34014 Trieste, Italy
tel: +39 040 2240327
fax: +39 040 224559
email: info@twas.org
website: www.twas.org

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All in all, TWAS has devised a comprehensive framework for scientific capacity building that has earned the Academy a well-deserved reputation in global science and that has often served as a model for others.

Efforts to build scientific capacity and nurture South-South scientific exchange have been at the heart of TWAS's agenda since its inception. These efforts will continue to be central to the Academy's agenda in the years ahead. With the growing scientific capabilities of a number of developing countries, TWAS is increasingly convinced that initiatives for South-South cooperation will become even stronger in the future, serving as the centrepiece of a global campaign to advance the goals of science-based development throughout the developing world. With TWAS's encouragement and support, an important trend has emerged in recent years: South-South cooperation. More than ever, the relatively more developed developing countries are sharing responsibility for building S&T capacity in less developed countries.

Changes in S&T in the South, together with the rise of global challenges ranging from climate change to species loss, are altering the traditional relationship between scientific and technological communities in the North and South. As the Nobel Laureate (Medicine 1975) David Baltimore, president of the American Association for the Advancement of Science (AAAS), notes in the article that follows, global challenges "are taking place in the context of a world that is becoming increasingly interdependent."

As Baltimore also notes, AAAS and many other international scientific institutions in the North are eager to work together with organizations such as TWAS to help build global scientific capacity and devise effective strategies for drawing on scientific expertise in both the developed and developing world to address the critical issues of our day.

TWAS welcomes the increasing eagerness of scientific institutions in the North to join their counterparts in the South in such a noble cause. The Academy has partnered with institutions in the developed world from its earliest days. The Italian government has generously provided the core funding for TWAS since its inception and the Canadian International Development Agency (CIDA) awarded the Academy its first programmatic grant in the late 1980s. Through the years, we have worked closely with a host of institutions in the developed world, including the Millennium Science Initiative (MSI), headquartered at the Princeton Institute for Advanced Study, and Harvard University's Kennedy School of Sustainability Science Program.

In today's world, TWAS envisions – in fact, embraces – expanding opportunities to strengthen North-South ties for the mutual benefit of both the developed and developing world. Indeed international scientific ties could prove to be more fruitful than ever before.

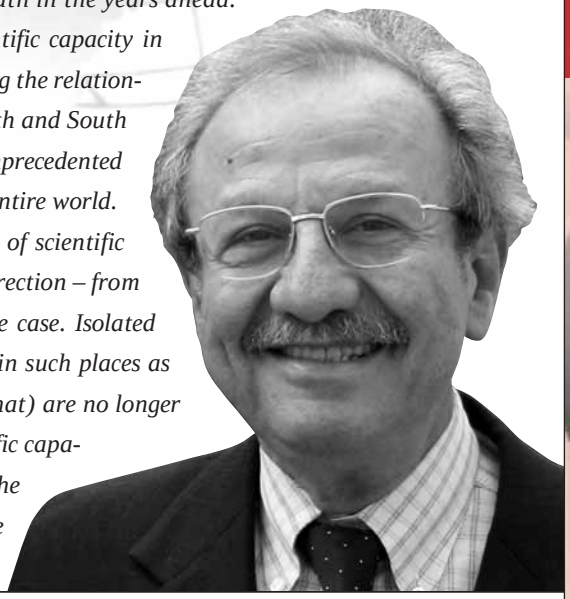
The global nature of today's problems requires a global strategy for success, not only on the diplomatic front but also on the scientific front. For example, it is inconceivable that the daunting challenges posed by climate change can be met without the full and active participation of scientists from the developing world.

Indeed, the involvement of scientists from the developing world is essential for addressing virtually all of the critical issues that the world now faces – energy and food insecurity, the spread of infectious diseases, the loss of biodiversity, desertification and dwindling supplies of safe drinking water. If scientists from the developing world are disengaged from global efforts to create solutions for these and other problems, the problems cannot be solved.

The good news is that governments and funding agencies in the developed and developing world have increasingly recognized the irreplaceable value of national and global scientific capacity – a hopeful trend in our troubled world.

Growing recognition of the value of science has prompted an increasing number of developing countries to invest a greater proportion of their national income in science and technology. The media has highlighted the success of Brazil, China and India, where investments in science and technology have passed the critical threshold of 1 percent of gross domestic product (GDP). But rising government support for science is also taking place in other developing countries – Chile, Mexico, Malaysia, South Africa and Vietnam, to name just a few.

This trend is significant for several reasons. It means that certain developing nations are now better able to address their economic development challenges; that a growing number of developing countries can serve as models for others; that opportunities for South-South cooperation are increasing; and that the global community can target funds to those nations that have yet to build an adequate scientific base. All of this bodes well for expanding scientific capacity at an accelerated pace across the South in the years ahead.



It is important to note that growing scientific capacity in the developing world is fundamentally changing the relationship between scientific communities in the North and South – and that such change is taking place at an unprecedented pace, carrying important implications for the entire world.

Just a decade or two ago, the global flow of scientific information and expertise took place in one direction – from the North to the South. That is no longer the case. Isolated examples of rapid scientific capacity building in such places as South Korea and Taiwan (and Japan before that) are no longer isolated. Brazil's success in applying its scientific capabilities to the development of biofuels and the manufacture of small-sized corporate jets; the

growing prowess of China's researchers in examining and addressing issues of climate change, energy efficiency, seismology and other concerns; and India's global presence in information technologies and the development of pharmaceuticals represent the most publicized examples of a trend that is rapidly taking hold in a growing number of nations across the developing world.

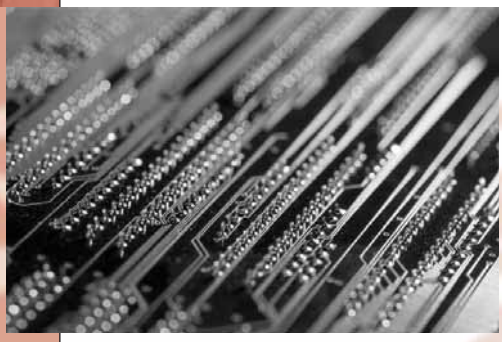
Fortunately, this is not a zero-sum game. As science rises in the South, it has not diminished in the North. That, in turn, should please everyone because it means that more bright minds are applying their knowledge to today's critical issues.

When TWAS began its efforts on behalf of science in the South nearly 25 years ago, its primary goal was to build scientific capacity across the developing world. There was no need to be selective. The need was everywhere.

In some regards, nothing has changed for the Academy. Scientific capacity building in the developing world remains the Academy's number-one goal.

Yet, in other regards, everything has changed. That's because growing scientific capabilities in the South have set the stage for the creation of truly equitable partnerships in global science. And this in turn has changed and expanded South-South scientific cooperation. The aim is to share responsibility for S&T capacity building with true cooperation, not aid.

Completing the journey from a junior to full member of the cast will require additional investments by governments across the developing world and a strengthened commitment to South-South scientific cooperation and exchange. The responsibility for making this happen lies largely with the developing countries themselves. Their future, at last, is in their own hands, providing that global and domestic challenges don't sabotage the national progress now underway.



But current trends in global science will also require a change in thinking and strategy on the part of our colleagues and friends in the North, and a willingness on their part to accept their Southern counterparts as equal partners both in global efforts to explore the frontiers of science and to effectively apply scientific knowledge to the difficult global challenges that lie ahead. It is in the North's broader interests, both within and beyond the scientific community, to welcome this development. Such trends, after all, provide the best chance we have to address the world's most critical issues.

Exposure to Northern science has played an enormous role in building scientific capacity in the developing world over the past quarter-century. Now, however, may be the time for scientists in the South to gain star billing in the world of science, sharing the global spotlight as equals with their Northern colleagues. ■

Jacob Palis
TWAS President
Rio de Janeiro, Brazil

AAAS LOOKS SOUTH

THE WORLD IS FACING MAJOR CHALLENGES THAT THREATEN LONG-TERM SOCIETAL STABILITY AND DEVELOPMENT. INTERNATIONAL COOPERATION IN SCIENCE IS KEY TO MEETING THE CHALLENGES THAT ARE BEFORE US, SAYS NOBEL LAUREATE DAVID BALTIMORE, PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS).

David Baltimore

More than 40 percent of the people in sub-Saharan Africa live on less than US$1 a day. Only half of the population in the developing world has access to improved sanitation. Childhood and maternal malnutrition continues to be the major contributor to global mortality. Global and regional climate changes are shifting growing seasons, affecting water supplies and increasing the threat of flooding in coastal regions.

All of these changes – and more – are taking place in the context of a world that is becoming increasingly interdependent.

While scientists and engineers are not miracle-workers, science and technology can provide innovative and practical solutions – some as simple as the chlorination of water supplies – capable of ameliorating pressing human concerns. There never has been a better or more urgent time for scientific cooperation on global issues such as disease, poverty, environmental degradation and climate change.

That was the message at the 2007 Annual Meeting of the American Association for the Advancement of Science (AAAS) in San Francisco, California, where the major theme was Science and Technology for Sustainable Well-Being. As Mohamed Hassan, executive director of TWAS, noted in his plenary address, we are at a moment in history that "presents us with unprecedented opportunities to make the world a better place, in part, by turning to science, technology and innovation to promote sustainable well-being."

Whether seeking to improve healthcare for HIV patients in Africa, create vaccines against the potentially devastating avian influenza strains in Asia, promote sustainable use of forest resources in South America or tackle the diverse and global challenges posed by climate change, researchers increasingly depend on partnerships that merge the capabilities and resources of the developed world with the local knowledge and technical capabilities in the developing world. This is all taking place at a time of increasing growth of world-class science in countries in the South.

Following the broad-based discussions that took place at the 2007 annual meeting, AAAS is now seeking ways to encourage scientists and policy makers to collaborate to meet important global challenges of sustainable development. One important tool is the online sustainability science forum hosted by AAAS's Center for Science, Innovation and Sustainability (sustainabilityscience.org). The forum serves as an information hub for a global network of scholars, scientists, government officials and others interested in bringing science and innovation to bear on some of these sustainable development challenges. We are glad that TWAS is an integral part of this effort.

AAAS

ADVANCING SCIENCE, SERVING SOCIETY

Rapid communication and travel have made the world smaller, changing the face of international science. There are more international research teams, the percentage of U.S. science articles with international contributors has more than doubled since 1998, and some developing countries, such as China and India, are investing heavily in research and development. Around the world, there is an increasing recognition that science is necessary for innovation, and innovation is necessary for economic prosperity

AAAS has long strived to provide a forum for discussion of important global issues through our journal *Science*, a premier vehicle for getting new data and new ideas on such topics as climate change out to the general scientific community and beyond. The journal has seen a steady increase in the number of accepted papers from scientists outside the United States (from just over 20 percent in 1992 to more than 40 percent in 2005).

AAAS has also been reaching out in other ways to encourage global scientific partnerships and cooperation. For example, we have initiated promising new cooperative relationships with government officials and scientists in China, Croatia, Panama and Vietnam. We have helped organize conferences in Kuwait on the role of women in Arab science and in Japan on sustainability. AAAS Science & Technology Policy Fellows, PhD-level scientists who devote a year or two to public service, have used their skills abroad to participate in such projects as the creation of an Iraqi Virtual Science Library and the rapid distribution of water purification packets in the aftermath of the Indian Ocean tsunami of 2004.

However, for international science partnerships to succeed, there must be a determined effort to nurture science capacity in nations that have been largely left behind in the push for technological innovation. TWAS has identified 79 countries, many of them in sub-Saharan Africa and the Middle East, that have very limited capacity in every field of science and technology. They have poor teaching facilities and substandard laboratories. Many of their most promising young scientists leave to work elsewhere, depriving their home countries of technical know-how that could help reduce the disparities between the "haves" and "have-nots".

We must ensure that no nation lags behind because it lacks enough talented scientists and engineers in its workforce. To help build science capacity in developing nations and foster the free exchange of ideas at the heart of the scientific enterprise, AAAS has been a strong advocate for easing post-9/11 visa restrictions on foreign scientists and students who want to come to the United States for study, research and work. We have also begun a pilot programme to link researchers in the developed world to students in emerging and developing nations (http://sustsci.aaas.org/edev/edev_survey.html).

At our 2008 Annual Meeting to be held in Boston, 14-18 February 2008, we will emphasize the importance of the global aspects of science in a rapidly changing and interconnected world. The meeting theme, "Science and Technology from a Global Perspective", stresses the power of science and technology, along with education, to assist developing nations and spur knowledge-driven transformations across a host of fields. We welcome the broadest possible participation in the meeting by scientists from around the world. The challenges we face are global, and so are the opportunities. ■

David Baltimore
(Nobel Prize in Medicine 1975)
President AAAS
Washington, D.C., USA

TRIESTE SCIENCE PRIZE WINNERS 2007

AN EMINENT MEXICAN BIOLOGIST, WHOSE RESEARCH HELPED TO SPUR THE CREATION OF THE FIRST GENETICALLY MODIFIED PLANTS, AND AN INTERNATIONALLY RENOWNED INDIAN CHEMIST, WHOSE INNOVATIVE LABORATORY TECHNIQUES HAVE LED TO THE SYNTHESIS OF MORE THAN 50 NATURAL PRODUCTS, HAVE BEEN AWARDED THE TRIESTE SCIENCE PRIZE FOR 2007. THE PRIZE, ADMINISTERED BY TWAS AND FUNDED BY ILLYCAFFÈ, PROVIDES INTERNATIONAL RECOGNITION TO OUTSTANDING SCIENTISTS LIVING AND WORKING IN THE DEVELOPING WORLD. WINNERS SHARE A US$100,000 CASH AWARD.

Goverdhan Mehta, CSIR Bhatnagan fellow and honorary professor at the Department of Organic Chemistry at the Indian Institute of Science in Bangalore, and distinguished research professor at the University of Hyderabad in India, is a world-renowned chemist who has made breakthrough contributions in a variety of fields related to organic synthesis.

His wide-ranging interests include the synthesis of biologically significant and architecturally challenging natural products; the design of novel molecules; the study of stereoelectronic effects; and super molecular chemistry. His synthesis techniques have been widely praised for their elegance and originality. Otteliones A and B, currently being tested for their anti-tumor activity, are among the 50 complex and biologically active natural products that Mehta and his group have synthesized.

Mehta's work has led to patents for hybrid drugs for the treatment of cancer that combine the drugs' conventional cytotoxic action with the ability to 'switch on' the drugs in the desired location using light as a stimulus. He and his group have also synthesized carbon compounds that may have potential applications in nanotechnology devices.

Beyond the laboratory, Mehta has made significant contributions to science education and science policy in India and abroad. He is currently president of the International Council for Science (ICSU) in Paris, France, and a member of the Scientific Advisory Committee to the Prime Minister of India.

Luis Rafael Herrera-Estrella, director of the National Laboratory for Genomics of Biodiversity and professor

MORE ON TRIESTE SCIENCE PRIZE

The Trieste Science Prize, now in its third year, is designed to bring recognition and distinction to the developing world's most eminent scientists who have not yet been honoured by other international award schemes dedicated to showcasing scientific achievement. It is named after Trieste, a city in northeast Italy that has made fundamental contributions to the promotion of science in the developing world. The prize has received the high patronage of the president of Italy. It is given annually and rotates among the following fields: biological sciences and physics/astrophysics (2005); mathematics and medical sciences (2006); agricultural sciences and chemical sciences (2007); and earth and engineering sciences (2008). For additional information, see www.twas.org/honor/TSP info.html.

of plant genetic engineering at the Centre of Research and Advanced Studies in Irapuato, Mexico, helped to pioneer the field of plant molecular biology and genetic engineering. Plant transformation techniques developed by Herrera-Estrella and his colleagues have had a significant impact on the commercial production of genetically modified (transgenic) plants currently grown on more than 100 million hectares worldwide.

Herrera-Estrella's work has largely focused on crop species of economic importance to Latin America, including asparagus, maize and papaya. In addition, his analysis of the molecular mechanisms of toxins, produced by the disease-causing bacterium *Pseudomonas syringae* pv *phaseolicola*, has led to the development of transgenic beans resistant to the disease.

MORE ON ILLYCAFFÈ

illycaffè, based in Trieste, Italy, produces and markets a unique blend of espresso coffee in 140 countries around the world. The company fosters long-term collaborations with the world's best Arabica coffee growers – in Brazil, Central America, India and Africa – providing know-how and technology and offering above-market prices. More than 5 million illycaffè espressos are served each day in some 50,000 of the world's finest restaurants and coffee bars. For additional information, see www.illy.com.

Herrera-Estrella has recently turned his attention to understanding the molecular mechanisms that make it possible for plants to tolerate toxic concentrations of aluminum and, more generally, that enable plants to adapt to nutrient-deficient soils. This is critically important in Latin America, where some 500 million hectares of farmland are deficient in phosphorus, an essential nutrient for healthy plant growth and crop production.

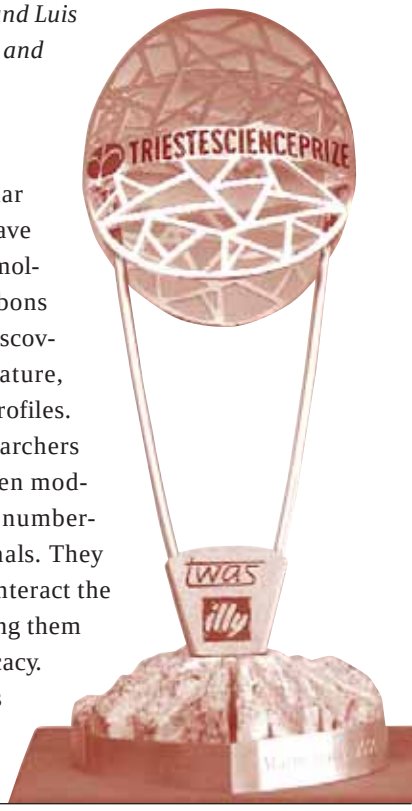
"Trieste Science Prize winners," says Jacob Palis, president of TWAS, "put a spotlight on the enormous impact that scientists from the developing world are making to international science. Their efforts are not only helping their nations to advance but are also making our global community a better place."

"illycaffè," says Andrea Illy, the company's president and chief executive officer, "is pleased to honour scientists who are making significant contributions to society. The Trieste Science Prize symbolizes excellence, an enduring value that drives success in all fields of endeavour–as we at illycaffè know very well." ■

THE AWARDS CEREMONY FOR THE TRIESTE SCIENCE PRIZE TOOK PLACE IN THE POLITEAMA ROSSETTI THEATRE IN TRIESTE ON 19 MAY 2007 AS PART OF THE FIRST-EVER FEST, *FIERA DELL'EDITORIA SCIENTIFICA TRIESTE* (INTERNATIONAL SCIENCE MEDIA FAIR). OFFICIALS IN TRIESTE HOPE TO MAKE FEST A YEARLY EVENT AND TO HAVE THE ANNUAL CEREMONY OF THE TRIESTE SCIENCE PRIZE AS AN ONGOING PART OF THE FESTIVITIES.

PRIZE WINNERS TALK SHOP

During their visit to Trieste, the editor of the TWAS Newsletter had an opportunity to sit down and speak to the two winners of the 2007 Trieste Science Prize, Goverdhan Mehta, Bhatnagar fellow and honorary professor of organic chemistry at the Indian Institute of Science in Bangalore, and Luis Rafael Herrera-Estrella, professor of plant genetic engineering at the Centre of Research and Advanced Studies in Irapuato, Mexico. Excerpts of the interviews follow.



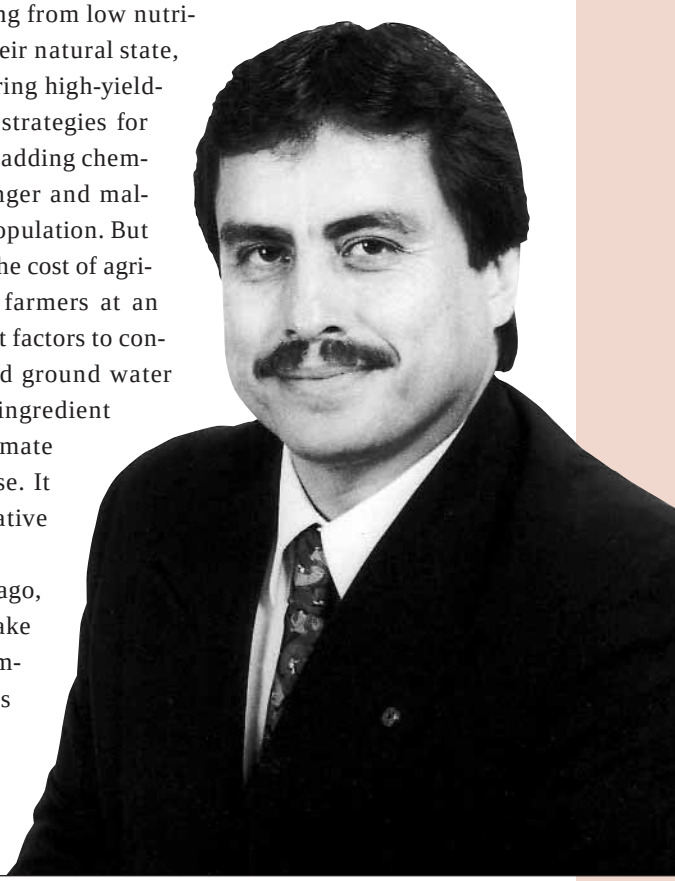
What is the nature of your research? What makes it unique?

Mehta: My research has focused largely on the creation of new and diverse molecular architecture. Like many of my colleagues working in the field of organic chemistry, I have devoted a good deal of time to the design of carbon-based structures (that is, organic molecules). The public knows about carbon-derived structures largely through hydrocarbons present in fossil fuels. But organic molecules have also proved invaluable in drug discovery. Almost all drugs are based on organic molecules. Many have been inspired by nature, which makes a vast array of organic molecules that exhibit interesting bioactivity profiles. Nature, in fact, provides a repository – a library, if you will – of molecules that researchers can explore for the purposes of replication, and, when possible, amplification and even modifications of their drug-related attributes. The approach works like this: molecules, numbering in the hundreds of thousands, are isolated from microorganisms, plants or animals. They are then characterized and examined to identify compounds with the potential to counteract the effects of human ailments and diseases. Synthetic chemists pick up these leads, preparing them in the laboratory. They also carry out modifications to enhance their therapeutic efficacy.

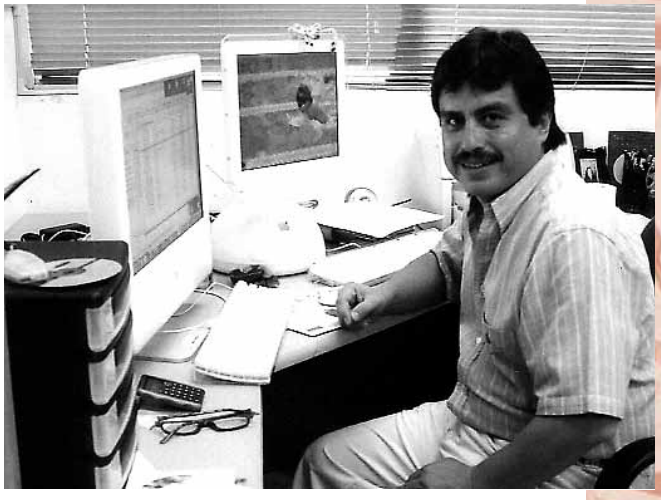
The study of natural products was – and remains – one of the primary strategies that scientists use to advance pharmaceutical research. Until recently, it was the main

strategy other than classical trial-and-error approaches. With the advent of molecular biology and, more specifically, with the unraveling of the human genome, scientists now have powerful new tools to conduct research in drug discovery. Every human disease is associated with a certain portion of the genome. The genome sequence, in fact, provides a biological roadmap that tells us which proteins are linked to which diseases. Once such an identification has been made, which is no easy task, the challenge is to inhibit or 'lock out' disease-inducing proteins or even 'switch off' the pathways leading to them. Such advanced scientific knowledge creates the potential both to uncover and create molecules to treat, for example, bacterial diseases, cancers and HIV/AIDS. My research aims to synthesize molecules that exhibit promising profiles against such disorders. What I do is not very unique. But it does advance knowledge about the art and craft of making new and useful molecules.

Herrera-Estrella: My research focuses on understanding the genetic mechanisms by which plants survive – and indeed thrive – in soils suffering from low nutrient levels. There are not many places with soils that, in their natural state, have sufficiently high levels of nutrients capable of nurturing high-yielding food crops. As a result, scientists have investigated strategies for boosting soil nutrient levels in a variety of ways, including adding chemical fertilizers. The latter effort has helped to reduce hunger and malnutrition in poor countries and to feed a growing global population. But it has come at a price. Fertilizers are expensive and add to the cost of agricultural production. That places poor people and poor farmers at an economic disadvantage. But there are even more important factors to consider. Pesticide-laced runoff has polluted both surface and ground water across the globe. Moreover, phosphate, which is a prime ingredient in many fertilizers, is a finite resource that soil experts estimate could be depleted within 50 years at current levels of use. It therefore makes sense for scientists to develop alternative strategies for helping to reduce the use of fertilizers.



From the very outset of biotechnology several decades ago, scientists hoped to engineer plants in ways that would make them more hardy and productive without resorting to chemical interventions. But the science, not surprisingly, was difficult. As a consequence, research in the 1970s and 1980s focused mainly on microbes because of their relative simplicity. The laboratory I worked in as a graduate

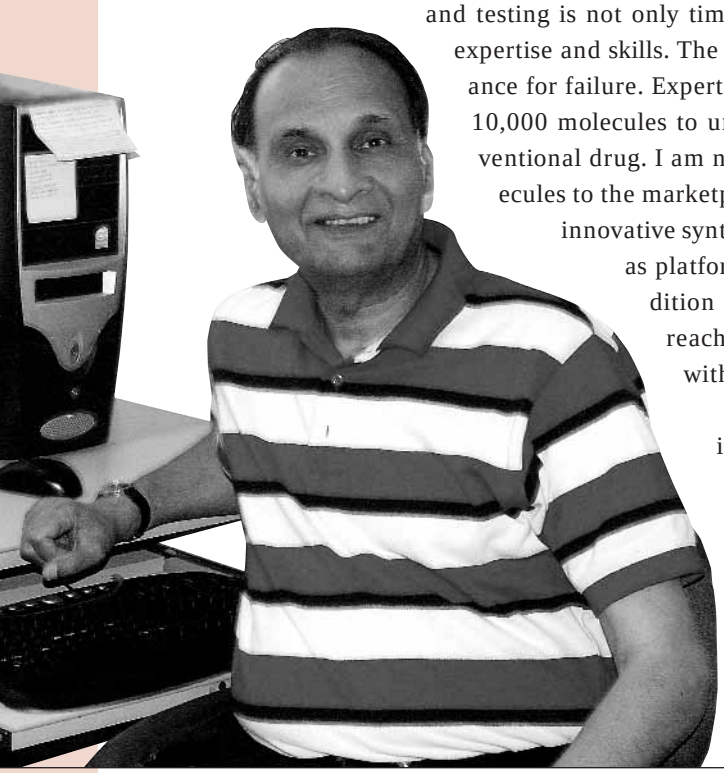


student in the mid 1980s, under the tutelage of professors Marc Van Montagu (TWAS Associate Fellow 2001) and Jeff Schell in Belgium, was the world's first laboratory to transfer the DNA of a soil bacterium (*Agrobacterium*) to plant chromosomes. Our research made it possible to introduce foreign protein into existing plant organisms. In effect, we produced the first genetically engineered plants.

Our research focused exclusively on tobacco. Tobacco possesses a property that is rare among plants: a single cell can be induced to develop into a normal tobacco plant. Because it is relatively easy to regulate and modify single cells, and because, in the case of tobacco, these cells can be transformed into a complete plant, tobacco is often the plant of choice among researchers. Only after I decided to return to Mexico in 1986 did I turn my attention to other plants – beans, chili peppers, husk tomatoes, sorghum, tropical maize and papaya – that are important to food production and food security in developing countries, particularly in Central and South America.

What are the current research challenges that you face?

Mehta: There is often a 10- to 15-year time lag between the identification of a molecule that has the potential to develop into a drug and the actual commercialization of a drug. The screening and testing is not only time-consuming and expensive, it also requires diverse expertise and skills. The process is not easy and requires a great deal of tolerance for failure. Experts estimate that scientists must investigate more than 10,000 molecules to uncover just one with the potential to become a conventional drug. I am not directly involved in efforts to bring potential molecules to the marketplace as drugs. My research is more basic. I try to take innovative synthetic routes to make natural molecules that can serve as platforms for 'diversity creation', which is a necessary condition for drug development research. Once this stage is reached, I pass the work to others who take it forward with their eyes set on the pharmaceutical marketplace.



Another aspect of my research is devoted to exploring and manipulating the architecture of molecules – a process that can only be 'seen' by using advanced spectroscopic and nuclear magnetic resonance techniques. Such efforts to design organic molecules are not only scientifically challenging; they also have extraordinary artistic and aesthetic appeal. I first conceptualize the shape of familiar objects, for example, a football, a bowl or a ladder – much

as geometricians create their own symbolic forms and shapes. I then try to build the molecular equivalents of what I have seen in my mind's eye. The construction can take the form of chemical expressions, carrying the elegance that mathematicians find in formulae and proofs. What's created may be of no obvious or immediate use. But it is eminently pleasing to me and others who have invested a life's work in creating diverse molecular architecture. What we can't yet see, we can create with our imagination at a molecular level. It is often a thing of beauty.

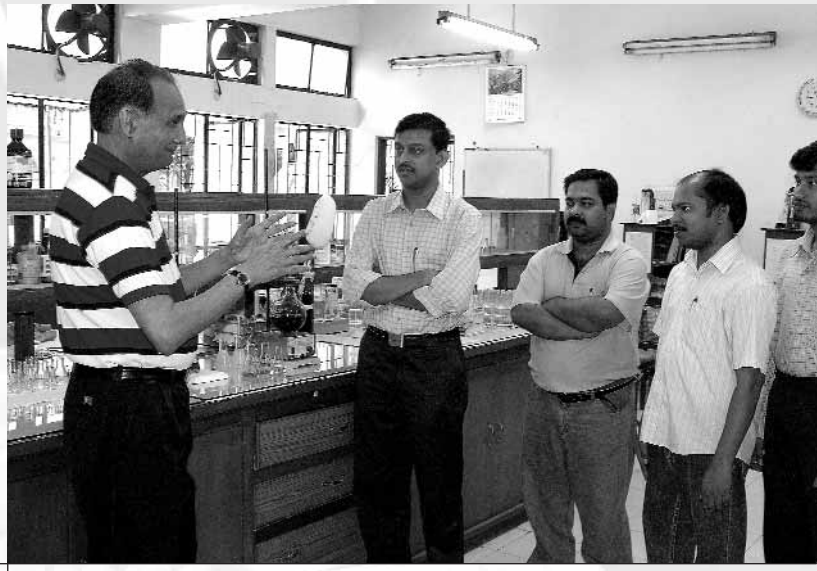
Herrera-Estrella: I don't seek to replicate molecular architecture at the basic scale that professor Mehta just described. But I do seek to genetically engineer plants to make them more hardy and productive. There are two basic avenues of research I have pursued since I returned to Mexico. First, I have studied plant biology with the goal of transferring genes from other organisms into plant cells. The usual intent is to enable the engineered plants to absorb nutrients more efficiently. In this effort, my laboratory colleagues and I have studied broccoli and cauliflower, two food plants that grow well in low-nutrient soils. In broad terms, we seek to dissect the biological mechanisms that give these plants such an enviable trait and then to apply this knowledge – as well as our technical skills in genetic engineering – to produce plants with more efficient rates of nutrient uptake. Second, with the help of recent breakthroughs in genetics, we try to determine the regions of the DNA in plants where protein functions are expressed. Such knowledge, based on our growing expertise in genomics and genome mapping facilities, has enabled us to conduct new experiments that were not possible a few years ago. These experiments not only enhance basic scientific knowledge but also lead to strategies that allow plants to trigger reactions only when an external danger is present. Such a targeted approach is not much different than that outlined by professor Mehta in his description of efforts to identify drugs that are able to fight human diseases. In plants, however, we are dealing with the use of insecticides, for example, that would only be activated when a plant is attacked by a particular insect. Such a strategy would obviously reduce the amount of chemicals needed to protect a plant from the ravages of pests. This would be good not only for crop productivity but also for the environment.

What is the current state of science in your country, particularly when compared to the state of science when you began your career?

Mehta: There has been a sea change in science in India during the course of my career. Funding has increased enormously and facilities have improved markedly, especially over the past decade. When I first began my research in the 1960s, there was virtually no ready access to equipment in my field (or in any other field, for that matter) to carry out competitive level research in India. Reagents and chemicals, so critical for the kind of research I do, were not available and foreign exchange restrictions and import controls made it difficult and time-con-

suming to purchase them from abroad. Under these circumstances, I had no choice but to ship my samples to colleagues in other countries who would make spectroscopic measurements and send me the results. This was very time-consuming and frustrating. I sometimes feel that I should be launching my research career now when things are so much better. But, I don't have much to regret. I'm glad things are easier now. But I sometimes think the difficulties faced by my generation of scientists forced us to be more innovative and enterprising.

Herrera-Estrella: For the most part, conditions for scientists in Mexico have essentially held steady since I began my career in the mid 1980s. There have been some fluctuations in spending levels but overall the level of funding has remained about the same. In 1986, Mexico spent about 0.3 percent of its gross domestic product on research and development; in 2006, the figure was 0.36 percent. The nation's economy has grown though. So that means there is more money. There has also been a slight increase in the number of scientists. Surveys show that there are currently about 30,000 scientists actively publishing in peer-reviewed international journals. This upward trend is indeed welcome. But we should not forget that the figure remains extremely low for a country with 100 million people. My institution has been extremely fortunate to have received generous and consistent support from the government. We have enjoyed a privileged position under difficult conditions. In 2004, we received a US$14 million grant from the government to launch a new genomics institute dedicated to studying Mexico's unique biodiversity. Mexico ranks among the top five countries in terms of biodiversity and its status as a 'biodiversity hotspot' represents a huge scientific opportunity that could have enormous economic impacts extending well beyond the scientific community. Our job is to sequence the genomes of Mexico's plants and microbes to determine whether some of their genes could ultimately find commercial applications. The project began three years ago and the first new laboratory building should be ready for occupancy by the end of this year. In the interim, we have begun sequencing several plants, including agave (used in the production of tequila) and chili peppers. We have also sequenced a desert microbe that has survived for 8 million years to try to determine the biological mechanisms that have allowed it to exist in such an arid environment. Although the government has generously supported our research, there is a dark side to our efforts to create a world-class laboratory. Nearly a quarter century after the discovery of transgenic plants, the potential impact of this technology has been severely impaired by controversies fuelled by environmental groups that, without any scientific basis, have claimed that transgenic plants are dangerous to human health and the environment. In Mexico, an internationally orchestrated campaign has lead the government to impose a nationwide moratorium that extends not just to the commercialization of transgenic plants but also to experimental field testing for techniques developed in our country. This represents a serious impediment to Mexico's efforts to join the ranks of Brazil, China and India as a scientifically proficient



developing country. Ultimately, it handicaps national efforts to ensure adequate supplies of food commodities both for domestic consumption and foreign export.

Who inspired you to become a scientist?

Mehta: I had two major influences. First, my parents (my mother was a housewife and my father a senior government officer) always wanted me be to a scientist. To this day, I still don't know why they had such strong feelings about my career choice. I do believe, however, that they believed science to be an honourable profession that brought out a person's best instincts. Second, I had excellent early education and sound mentoring at the university and research level. I was taught by teachers who not only made learning exciting but also instilled a sense of values and dedication. The significance that my teachers and parents placed on education is part of a great Indian tradition – a tradition that has recently begun to pay significant economic dividends for my nation.

Herrera-Estrella: Since I was a child, I've been interested in discovery and during my adolescence and teenage years I dreamed of becoming an inventor. That dream only began to be transformed into reality after I entered university. There I took a course in molecular biology during my freshman year. The teacher did a wonderful job explaining how research was done and how knowledge could be applied to address critical societal needs. I've been hooked ever since and I don't expect the sense of wonder is something that will ever leave me.

How did you learn about winning the Trieste Science Prize and what does the prize mean to you?

Mehta: I was at an executive board meeting of the International Council for Science (ICSU) in Rome, Italy, where I currently serve as president, when I received a phone call from Mohamed Hassan, TWAS's executive director. I had known about the Trieste Science Prize from the press articles and was aware of the previous winners from India (T.V. Ramakrishnan who won the prize in physics and C.S. Seshadri who won the prize in mathematics). But I was nevertheless completely surprised by the news. The award brought me a feeling of great satisfaction at being recognized by peers and honoured by a leading professional body like TWAS. However, I must say that I derive equal – if not greater – satisfaction and joy from doing research, especially when a project is going well. It is the reason that led me to become a scientist in the first place and it is the reason that drives me in my work today.

Herrera-Estrella: I too had heard of the prize and I was also completely surprised when I received an early morning call from Mohamed Hassan telling me that I had won. It is indeed a

great honour to receive the Trieste Science Prize, and it is as much a tribute to my research team as it is to me. In Mexico, you often don't receive public recognition for your work until you are recognized abroad. The prize brings attention to my research and lets policy makers in Mexico know that I am doing world-class research. As a result, it likely means that I will be listened to more carefully when I speak in public about the importance of science to the nation's economic and social well being. My hope is that it will help make me a more effective spokesperson for science and that this, in turn, will help gain greater support for Mexico's scientific community.

What does the future hold for your work?

Mehta: I have recently devoted much of my research to issues related to neurodegenerative disorders. Little is understood about this age-related phenomena. Yet, it is likely to become increasingly important in the future as the world's population grows older. There is indisputable medical evidence that neuron connectivity grows weaker – and, in some cases, is lost – as people age. There is hope that new medicines could slow and perhaps reverse this process and that studies involving organic synthesis could help provide a platform for understanding the process of degeneration, and, more importantly, for doing something about it. Success won't be easy. But we have started working on the synthesis of natural products that exhibit neurotrophic activity and create 'diversity' around them for possible therapeutical development.

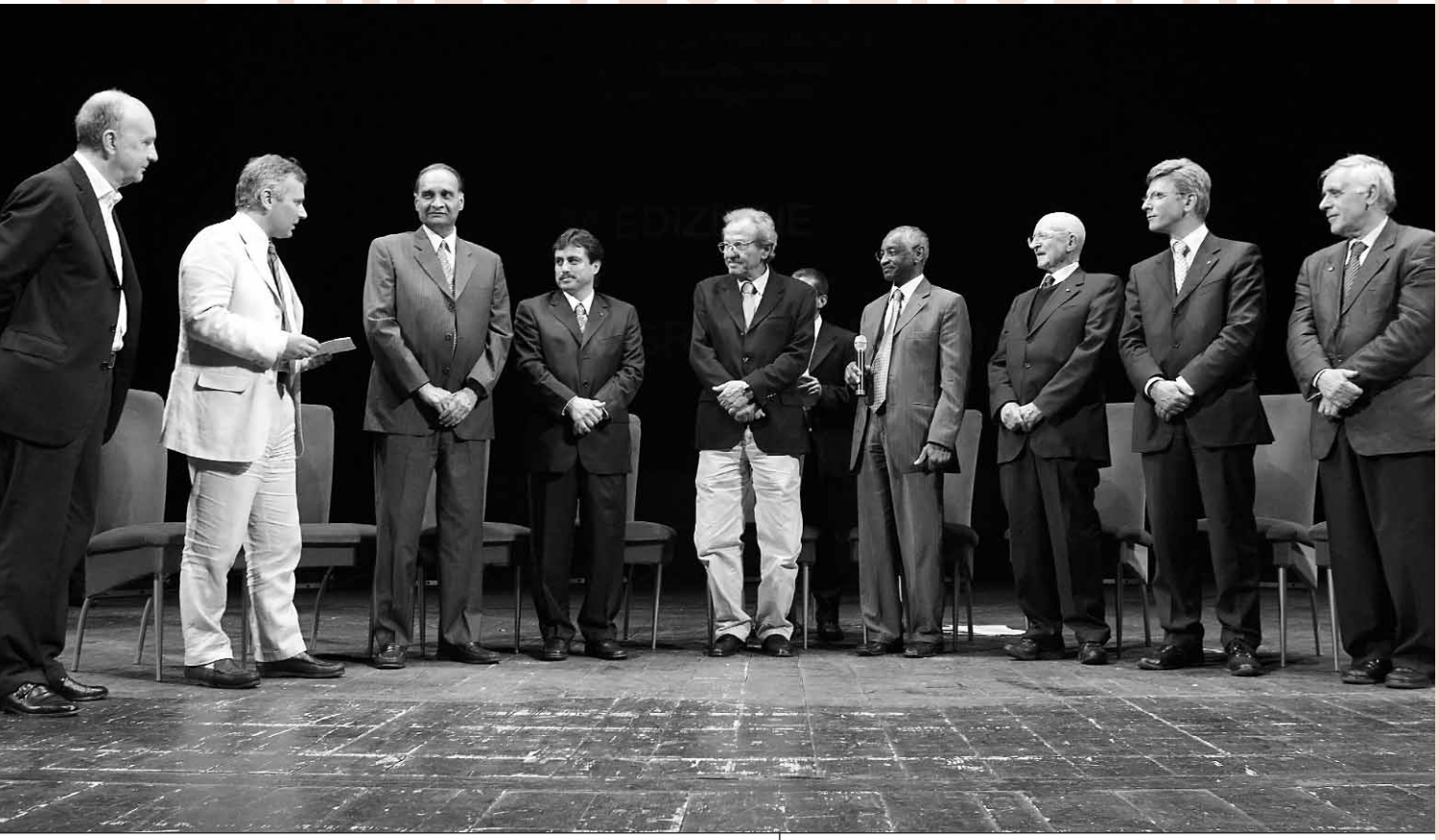
I also hope to spend time helping to reinvigorate interest in chemistry among young people not just in India but also around the world. India is doing well in some aspects related to chemistry, especially when it comes to drug-related process research and development. It has, for example, taken a lead role in developing and distributing generic HIV/AIDS drugs that cost 100 times less than similar drugs produced by international pharmaceutical firms in the developed world. This effort has had a profound impact on the treatment of HIV/AIDS in the developing world and has given both life and hope to millions of HIV-infected persons who had neither. However, we in India have to go a long way to become a major force in the world of chemical research.

There are some troubling developments in the field. Most notably, a global decline in enrollment in chemistry. India is no exception to what is happening. At a time when chemistry's importance to public health and well being, the environment and energy has never been greater, we are finding fewer and fewer takers on the subject. As a chemist I feel we have an obligation to try and help reverse these ominous trends.

Herrera-Estrella: I hope to deepen my research by continuing to analyse plant genomes that could be useful in increasing the efficiency of phosphorous

uptake and thus limiting the amount of fertilizers necessary to grow high-yielding food crops. I also hope the same techniques can be successfully used to create food crops that are more resistant to drought. We have witnessed a remarkable increase in crop yields over the past half-century, thanks largely to the impact of the Green Revolution and its emphasis on the creation of new varieties of maize, rice and wheat through conventional plant breeding. But the impact of the Green Revolution in terms of increasing plant yields has been slowing for some time. At the same time, global population, especially in the developing world, continues to rise. Consequently, the ability to feed the world's population may well depend on advances in our understanding of the plant genome and plant genetics, and on our ability to engineer new plant varieties that can meet the environmental and climatic challenges that farmers are likely to face in the future. Scientists working in these areas face two major challenges: one is scientific – that is, to continue to conduct the research that is necessary to make advances in the field. The other is to convince the public that the work of scientists is not only safe but also necessary, and that good, not harm, can come from these efforts. These are the two areas in which I have concentrated in the past and these are the two areas that I plan to concentrate on in the future, hopefully with increasingly positive results, thanks, in some measure, to the boost in recognition that I have received by winning the Trieste Science Prize. ■

TRIESTESCIENCEPRIZE



EYES ON TRIESTE

ON 10-12 MAY 2007, THE INTERNATIONAL SCIENTIFIC AND EDUCATIONAL ORGANIZATIONS IN TRIESTE HOSTED A WORLD FORUM ON EDUCATION, RESEARCH AND INNOVATION: NEW PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT. THE MEETING WAS HELD UNDER THE AUSPICES OF THE G8 AND THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND EDUCATIONAL ORGANIZATION (UNESCO).

For a few warm, sunny days in mid May, the eyes of the international science and economic development communities were focused on Trieste. The reason? The G8-UNESCO World Forum on 'Education, Research and Innovation: New Partnership for Sustainable Development'.

The event, attended by ministers of science and technology from developing countries, directors of international organizations and representatives of private companies with an interest in science and technology, examined the 'knowledge triangle' of education, research and innovation. The Abdus Salam International Centre for Theoretical Physics (ICTP) led Trieste's international scientific institutions in organizing the event. Romano Prodi, Prime Minister of Italy, and Koïchiro Matsuura, director general of UNESCO, spoke at the opening session.

KNOWLEGE AND INNOVATION

In his opening comments, Koïchiro Matsuura expressed his hope that the forum would focus on ways that "knowledge and innovation could spur sustainable economic development, especially in developing countries". Matsuura praised the work of the scientific research and education institutions in Trieste, especially the role that TWAS has played – and continues to play – in promoting science, technology and innovation as key components for sustainable development in the South.

In his opening address, Italian Prime Minister Romano Prodi reaffirmed his belief that research and innovation are essential for sustainable economic development.

"Politicians require, as never before, support from science and research," said Prodi. "Choices and decisions in critical sectors – the environment, health, food security and biotechnology, for example – need to be supported by information based on rigorous scientific, economic and social analysis.

"This will lead to a new role for academia," he continued, "which, though maintaining its intellectual and ethical independence, cannot work in isolation."

Despite this, interactions between science and politics, even in Europe where the issue is regularly debated, remain abstract, noted Prodi. He then praised the forum for dedicating one session to Africa, adding that both his

government and the scientific institutions in Trieste would vigorously assist Africa's efforts to promote science-based development.

SESSIONS AND SPEAKERS

The forum evolved around a series of 10 themes:

- University research institutions and industry.
- Education in the knowledge-based society.
- The global environment.
- Innovation and society.
- Health.
- Energy.
- Research and innovation.
- Knowledge and sustainable development.
- Science, technology and innovation: Perspectives for Africa.
- Knowledge for sustainable development: The Future.

When discussing the global innovation society, all delegates stressed the importance of education.

"It is better to have a slightly lower gross national product than to save money on education," advised Zhang Xinsheng, China's vice minister of education and chair of UNESCO's executive board.

Such sentiments were tempered, however, by the contention that as soon as developing countries train talented young scientists, they leave for employment in the North.

"Every year, more than a million Chinese students go abroad," countered Xinsheng. "Now, however, more are returning. We are also beginning to attract foreign students to China. This is the result of more than two decades of effort."

Tanzania is one country that has invested in education. However, of the 48,000 graduates each year, some 50 percent remain either unemployed or underemployed. Against this background, a Tanzanian government official contended that when private companies invest in Tanzania, they bring their own people for the top jobs. "How can we partner with organizations and private companies in the North to avoid this scenario?" he queried.

Politicians require support from science and research.

In response, Furio Honsell, rector of the University of Udine, Italy, advised governments not to rely on foreign investments but to support local entrepreneurs.

Stefano Fantoni, director of the International School for Advanced Studies (SISSA) in Trieste, agreed, saying: "Universities in developing countries should promote entrepreneurship and develop spin-off companies. Once an idea has been shown to work," he added, "other investors will come on board."

Bruno Lanvin, an advisor to the World Bank, agreed that education and innovation were key components in

any poverty reduction strategy. He also explained that the World Bank was involved in information and communication technologies (ICTs) because it believes these technologies have a crucial role to play in national development and poverty reduction.

"Innovation is required at every step of the development and commercialization chain," he explained. "In the global information economy, the winners will be 'permanent innovators' and 'continuous learners'." Lanvin predicted that "all economies will become knowledge economies, putting human resources – that is, brains – at the centre of competition and development." The implications of this are that governments must develop policies to promote innovation largely by supporting education and strengthening information technology infrastructures.

All economies will become knowledge economies.

Similar sentiments were expressed during the session on 'sustainable development and health'.

"The greatest need is to improve the capacity to deliver existing healthcare practices and technologies," said Giorgio Tamburlini, scientific director, Institute of Child Health at the Burlo Garofolo hospital in Trieste. "Human capital is at the heart of sustainable development," he observed.

But it is not just developing countries that are failing to innovate, explained Janez Potocnik, commissioner for science and research, European Commission, Brussels, Belgium. European countries, too, are failing to convert knowledge into commercial products at a pace comparable to that of the United States and other leading innovation economies.

"For this reason, Potocnik said, "we have established a European Institute of Technology that we hope will bring the three parts of the knowledge triangle together: businesses, researchers and students."

The European Commission (EC) adopted a proposal to create a European Institute of Technology (EIT) in February 2006. The aim is to replicate the example of the US-based Massachusetts Institute of Technology (MIT), which has successfully combined world-class education, research, and innovation in ways that benefit both the

institution and society. This June, the EC agreed that the EIT should launch two or three knowledge and innovation communities based on a network of pre-existing universities. These networks will address such EU priority issues as renewable energy and climate change.

Atta-ur-Rahman (TWAS Fellow 1984), federal minister, Higher Education Commission, Pakistan, also cited the example of MIT in his presentation. "MIT has had a huge impact," he said. "Its graduates have founded some 4,000 companies that, collectively, are equivalent to the world's 24th largest company."

was a special session dedicated to 'Science, Technology and Innovation: Perspectives for Africa'.

The session was chaired by TWAS executive director, Mohamed Hassan, who, in his introductory remarks, highlighted the depth of the poverty that still afflicts Africa. For example, 30 million African children go to bed hungry each night, more than 70 percent of Africans do not have access to reliable sources of energy, and more than 40 percent lack access to safe drinking water.

Hassan noted, however, that there have been some positive developments over the past few years, especially

He went on to explain Pakistan's policies in recruiting and rewarding its brightest scientists, who may receive up to three times the salary of a federal minister. Young dynamic researchers are also rewarded for their productivity and may earn more than established professors. Such policies are designed to help Pakistan reverse a critical problem facing many developing countries: the brain drain. Africa, for example, has lost some 60,000 professionals in the past five years. Pakistan has also built course modules on innovation and entrepreneurship into its university curricula. "My message to other developing countries is to stop looking to others to help you because other countries are mainly interested in helping themselves," concluded Rahman.

FOCUS ON AFRICA

Organizers of the G8-UNESCO Forum agreed that emphasis should be placed on Africa during the course of their discussion. The main manifestation of this focus in efforts to put science, technology and innovation at the centre of the development agenda. "Among these are the creation of a national science foundation in Nigeria with a US$5 billion endowment fund; an increase in Rwanda's science and technology budget to 1.6 percent of its GDP, and South Africa's recent doubling of its science and technology budget."

"The problem of brain drain persists," Hassan acknowledged. "The only way to prevent it is to provide facilities and incentives for scientists to stay at home or to convert the 'drain' into 'gain' or, at least, 'circulation' by encouraging scientists who have left to interact with colleagues in their native countries."

Armando Sanguini, Italy's director general for sub-Saharan Africa, observed that Italy would assume the presidency of the G8 in 2009. He hoped that the session on Africa, by highlighting practical programmes and solutions for the continent, would prove a useful start to Italy's intended emphasis on Africa in two years' time.

"Such initiatives are being developed by African scientists and politicians," noted Nagia Essayed, commissioner for human resources, science and technology, African Union (AU), Addis Ababa, Ethiopia. "The AU's 53 member states have agreed to raise their science and technology budgets to at least 1 percent of their GDP by 2010," she announced. "In addition, AU members will focus on South-South cooperation, improve institutions of higher education and establish a pan-African intellectual property organization. We are also devising an African science and technology policy framework to assist in the design of new national policies," she added.

Hany Helal, minister of higher education and scientific research, Egypt, echoed Atta-ur-Rahman's words, when he said: "The fundamental rule is that no one will help you unless you help yourself first."

He outlined his ministry's support for scientific research, which has been labeled the '4 Ps concept': publication, patents, prototypes, and products. Egypt also intends to increase its international cooperation in science, said Helal, starting with key partners in Germany and Japan. This will be assisted by increasing Egypt's own investment in science and technology, especially through the creation of a National Science Foundation (only the third in Africa, after South Africa and Nigeria) with an initial annual budget of US$160 million.

"What Egypt would like to see come out of this G8-UNESCO Forum," Helal said, "is a global alliance for technology and education serving as a funding mechanism to support the knowledge triangle of education, research and innovation."

"We must move from talk to action and confront the real and urgent challenges of development for our people," said Noah Wekesa, minister of science and technology, Kenya. "For the next three years, Kenya will chair the African Council of Ministers of Science and Technology," he noted. "I personally look forward to implementing Africa's Science and Technology Consolidated Action Plan and exploring other innovative avenues and initiatives for the benefit of the people of Africa."

Romain Murenzi, minister of science, technology and scientific research, Rwanda, described how Rwanda has almost achieved universal primary education. The aim, he said, is to continue this trend through to secondary schools. "If a nation builds its human capacity, it will 'make it'," claimed Murenzi. "And I believe Rwanda is on its way to making it."

Although the Democratic Republic of the Congo is the third largest country in Africa, it is also one of the poorest. "We are emerging from 30 years of civil strife," explained the Congo's minister of scientific research and technology, Sylvanus M. Bonane. "The war has killed some four million people, including 2,000 scientists. The country is in urgent need of sustainable development strategies, especially to protect our forests and their huge biodiversity."

Bonane noted that although his country's science and technology budget was currently just 0.16 percent of its GDP, there were plans – similar to those of Rwanda – to increase this to 3 or even 4 percent over the next 15 years.

"I take the opportunity of this forum to ask UNESCO to establish programmes with countries such as ours to help train scientists and rebuild and reform our scientific infrastructure," Bonane added.

Concluding the special session on Africa, Patrizia Sentinelli, Italian deputy minister of foreign affairs, said that the world should not consider Africa as just a 'taker' of science and technology and that Africa itself should aggressively pursue strategies that conform to its own research priorities. Nevertheless, she added, the international community must assist it in these efforts.

"The promise that AU countries have made to increase their science and technology spending is an important sign of renewal on the continent," said Sentinelli. "Science and technology must be at the heart of strategies to eradicate poverty.

"Africa still faces many challenges," she continued, "such as access to safe drinking water, the rights of women and development of renewable energy systems. We therefore need a new strategy of collaboration between Africa and Europe, especially in science and technology, if we want to attain the Millennium Development Goals."

Summing up the session, Hassan noted that, although there are an increasing number of North-South initiatives in scientific collaboration and although some developing countries were making great advances in science and technology – both in terms of investment and results – some developing nations are being left behind.

"The chances of success have rarely been brighter," concluded Hassan, "and the consequences of neglect and indifference have rarely been more troubling. The international science community should seize this moment. If we don't, it could well fade into history as a lost opportunity that scientists and citizens can ill-afford to lose."

WHERE TO NEXT?

In his keynote summary, David King, science advisor to the UK government, reminded participants that: "At the start of the 20th century, there were one billion people on the planet and life expectancy was about 45 years. Now there are more than six billion people and average life expectancy is about 70 years. By 2050 – in just 43 years' time – we will reach nine billion people. The challenge is to meet the requirements of all those nine billion people. Can we make the cultural changes that will be necessary?"

No one will help you unless you help yourself first.

These additional three billion people will put added pressure on our natural resources, observed King, the effects of which will be felt most severely in Africa, the region that has the least capacity to deal with it.

Despite these gloomy predictions, King said he remains optimistic that nations will develop the technologies and political processes required to face such challenges.

"We have to be dreamers and we have to try to realize our dreams for the sustainable future of the world," said European Commissioner Potocnik. "All other options are unsustainable."

The forum was closed by ICTP director K.R. Sreenivasan requesting comments to be submitted to ICTP so that he could respond to Prime Minister Prodi's request to take a series of action points to the G8 summit to be held in Heiligendamm, Germany, in June.

The communiqué was prepared and submitted to Prodi. Among its key recommendations are:

- G8 countries should take the lead for a new partnership with the developing world based on a framework that connects knowledge and sustainable development.
- Sustainability requires the strengthening of education and research institutions as well as networks. The G8 countries should support the establishment and networking of centres of excellence for sustainable development for the purposes of integrating education, scientific knowledge and innovation for sustainable development.
- G8 countries should take advantage of Italy's 40 years of experience in fostering science in developing countries through the international institutions located in Trieste.
- G8 countries should consider diverting a portion of their public research and development expenditures to a 'Sustainability Innovation Initiative Fund'.

We have to be dreamers and we have to try to realize our dreams.

Although no formal outcome was expected from the forum, these recommendations to the leaders of the world's strongest and richest countries will hopefully lead to the G8 nations honouring the pledges for support to Africa made during the previous summit in Gleaneagles, United Kingdom, in 2005.

Apart from discussions that took place during the plenary sessions, the forum allowed ministers, heads of international organizations, leaders of private companies – not to mention students and scientists – to meet 'behind the scenes'.

The document submitted to the G8 by the Italian delegation is the most concrete outcome of the forum. But networking opportunities, nurtured by conversations flowing from all 'points on the knowledge triangle' may ultimately prove to be the forum's greatest legacy. ■

AFRICAN ACADEMIES CALL ON G8

THIS SPRING, THE NETWORK OF AFRICAN SCIENCE ACADEMIES (NASAC), REPRESENTED BY MOHAMED H.A. HASSAN, PRESIDENT OF THE AFRICAN ACADEMY OF SCIENCES AND EXECUTIVE DIRECTOR OF TWAS, PRESENTED A STATEMENT TO ANGELA MERKEL, CHANCELLOR OF GERMANY AND CURRENT HEAD OF THE G8, A GROUP OF THE WORLD'S RICHEST COUNTRIES, OUTLINING NASAC'S CONCERNS ON SUCH CRITICAL ISSUES AS SUSTAINABILITY, ENERGY EFFICIENCY AND CLIMATE CHANGE.

The statement, delivered in Berlin on 15 May, also urged G8 member countries to fulfill their promise to provide US$5 billion for reforming Africa's universities and an additional US$3 billion for the building of scientific centres of excellence in Africa.

The NASAC statement was one of three presented by representatives of science academies to Chancellor Merkel as a run-up to the 2007 G8 Summit, which was held in Heiligendamm, Germany, 6-8 June. The other two statements, prepared by science academies from the G8 + 5 countries (Brazil, China, India, Mexico and South Africa), focused on energy efficiency and climate change mitigation. All of the statements, including the one issued by NASAC, urged the G8 to work more closely with science academies to address these critical global concerns.

What follows is the full text of the NASAC statement. For the texts of the academy statements on energy efficiency and climate change, see http://www.interacademies.net/ or contact iap@twas.org.

JOINT STATEMENT BY THE NETWORK OF AFRICAN SCIENCE ACADEMIES (NASAC) TO THE G8 ON SUSTAINABILITY, ENERGY EFFICIENCY AND CLIMATE CHANGE

We, the members of the Network of African Science Academies (NASAC), submit the following statement on sustainability, energy efficiency and climate change to the leaders of the G8 countries. The goal of this statement is to convey information and spur action on the occasion of the G8 Summit in Heiligendamm, Germany, in June 2007.

A consensus, based on current evidence, now exists within the global scientific community that human activities are the main source of climate change and that the burning of fossil fuels is largely responsible for driving this change.

The Intergovernmental Panel on Climate Change (IPCC) reached this conclusion with "90 percent certainty" in its Fourth Assessment issued earlier this year. The IPCC should be congratulated for the contribution it has made to public understanding of the nexus that exists between energy, climate and sustainability.

Although we recognize that this nexus poses daunting challenges for the developed world, we firmly believe that these challenges are even more daunting for the most impoverished, science-poor regions of the developing world, especially in Africa. These poor regions not only lack the resources to cope and adapt, but they also do not have adequate capacity in science and technology to successfully address the challenges of the future.

We refer to NASAC's joint statement to the African Heads of State on "Building science, technology and innovative capacities in Africa" presented at the African Union (AU) Summit in January 2007.

We are encouraged by several recent events that indicate African leaders are increasingly recognizing the important role that science, technology and innovation can play in larger efforts to promote sustainable well-being. We draw attention to the commitment made by Africa's Heads of State and Government at the AU Summit to increase investment in science and technology to at least 1 percent of each nation's yearly gross domestic product and their decision to declare 2007 the year of "Science and Innovation for Africa." We acknowledge, however, that Africa will need help from the developed world if it is to successfully address the challenges it faces and we are convinced of the vital roles that the G8 governments and the international scientific community can play in the promotion of science, technology and innovation in Africa. NASAC, moreover, appreciates the G8's decision to focus its 2007 Summit on "Growth and Responsibility" and to include Africa in its discussions.

We therefore make the following recommendations to the leaders of the G8 + 5 countries:

1. That the G8 governments support and encourage recent efforts by the governments of Africa to increase national investment in science and technology. Such support should be largely directed to assist in the revitalization of Africa's universities and research institutes and to help create centres of excellence. The goal should be to build at least one research intensive university in each of the major regions of Africa.

In particular, the G8 should implement the recommendations of the 2005 report on Africa, endorsed at the G8 Summit at Gleneagles, Scotland, in July 2005, which calls on G8 countries to provide US$5 billion to help rebuild Africa's universities and US$3 billion to help establish centres of scientific excellence in Africa.

2. That the private sector, both in the G8 countries and in African countries, assumes its role and responsibility, in partnership with government, to establish research-intensive universities, through its financial and in-kind support of talented individuals, infrastructure, research and innovation.

3. That the G8 governments and national academies of science in G8 countries support efforts and lend their expertise to improve the ability of the African scientific community, particularly through its academies of science, to provide effective advice to governments on a range of issues, including sustainability, energy efficiency and climate change. We are committed to pursuing pro-

ductive partnerships that will increase our capacities to provide credible evidence-based advice on S&T-based issues of both regional and global significance. We believe that together we are well positioned to assist in transforming Africa via science, technology and innovation into a continent of peace, plenty and stability.

4. That the G8 governments work in close consultation with the AU to develop a common agenda designed to advance the goals embodied in the AU's year of "Science and Innovation for Africa." We urge the G8 to establish a G8-AU fund for the advancement of appropriate and advanced technologies related to climate change, energy, information connectivity and water. The fund would be invested in joint G8-AU projects designed to help Africa meet its growing energy needs without placing additional stress on the global climate or on food security.

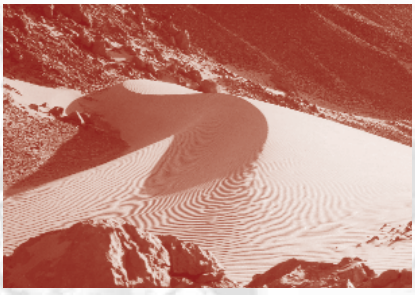
5. That the G8 governments assist the AU and its constituent medical institutions to deal with the challenges of infectious diseases through prevention and treatment, educational programmes, fostering the rights of women and children, developing effective means of treating HIV/AIDS, malaria and tuberculosis, and assisting in the improvement of health systems, particularly in rural areas.

6. That the G8 governments provide financial, scientific and technical support for the efforts of the African scientific community, including NASAC and the Association of African Universities (AAU), to work with the academies of science, engineering and medicine in G8 countries, to promote international cooperation in science and technology for the purposes of advancing the Millennium Development Goals (MDGs) in Africa. ■

NASAC members: *the African Academy of Sciences, Cameroon Academy of Sciences, Ghana Academy of Arts and Sciences, Kenya National Academy of Sciences, Madagascar National Academy of Arts, Letters, and Sciences, Nigerian Academy of Science, Académie des Sciences et Techniques du Sénégal, Academy of Science of South Africa, Sudan National Academy of Sciences, Tanzania Academy of Sciences, Uganda National Academy of Sciences, Zambia Academy of Sciences and Zimbabwe Academy of Sciences.*

DRY
LIVING LIFE WITHOUT WATER

UP TO A BILLION PEOPLE LIVE IN THE DRYLANDS OF THE DEVELOPING WORLD. THEY ARE INVARIABLY AMONG THE WORLD'S POOREST AND ISOLATED PEOPLE. MANY BELONG TO SOME OF THE WORLD'S OLDEST CULTURES, STRUGGLING TO COME TO TERMS WITH MODERNITY.



What follows are three stories – from Kenya, India and Chile – examining what life is like on lands that are dry. It offers insights into how people, especially poor people, successfully adapt to rain-poor environments. The text, which was published earlier this year in Environment *magazine (January/February 2007), is drawn from material that first appeared in* Dry: Life Without Water *(Harvard University Press, 2006).*

Two decades ago, the problems of dry countries in the developing world began to rise up the global agenda, culminating in the United Nations designating 2006 as the Year of the Desert.

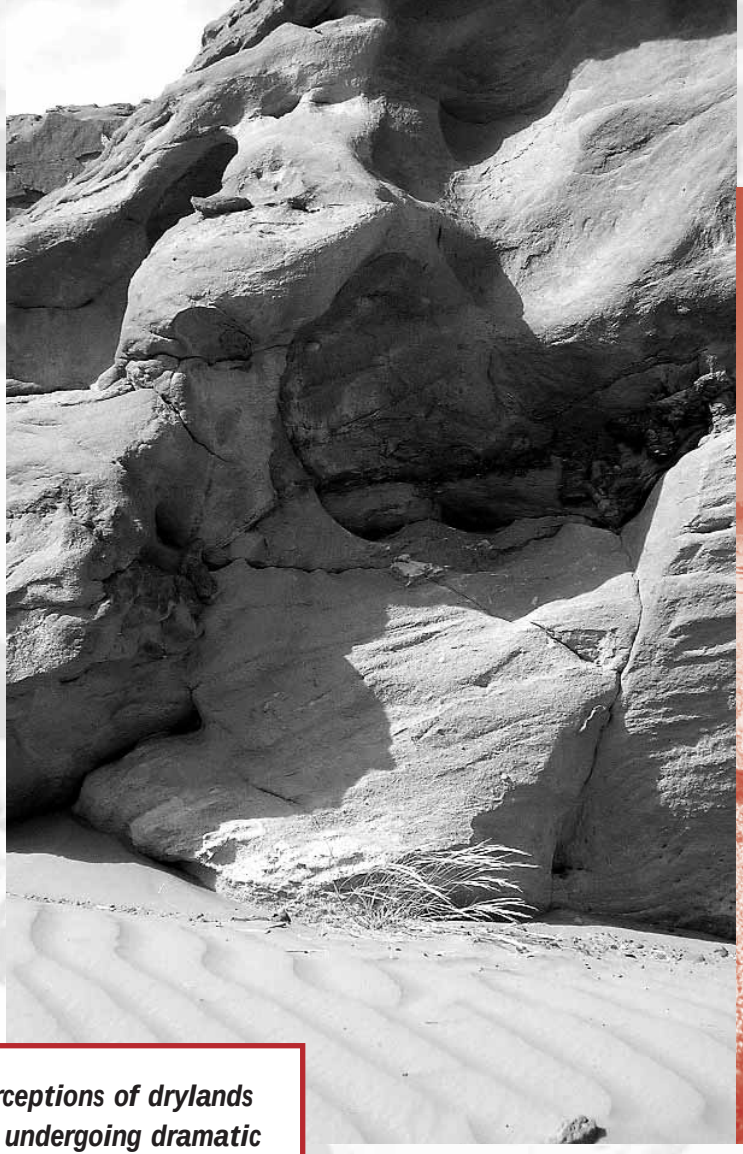
For many years, scientists and public officials assumed that the spread of deserts was largely due to poor management practices and population growth.

The solution to halting desertification was to grow more trees or build earthen dams; everything, it seems, except listen to the needs of people.

This has now changed and today there is broad agreement that people, far from being a source of the problem, are integral to the solution. International organizations and national governments agree that the best policies are those that allow people to adapt to their dry environments.

There is less enthusiasm for activities that try to change the environment into something incompatible with nature.

This is why an understanding of the knowledge, skills, and aspirations of the people who live in dry environments is so crucial. Their history and experience are invaluable to global efforts designed to protect and conserve drylands. The United Nations Convention to Combat Desertification explicitly states that little progress will be made without the active involvement of local populations.



Perceptions of the world's drylands are undergoing dramatic change. Once thought to be barren and lifeless, these environments are in fact teeming with life. Once perceived as places inhabited by resilient but unschooled people, they are rich in indigenous knowledge from which we can all learn.

A closer look at three communities will reveal that, contrary to the technology driven policies of the past, which sought to transform the desert into a temperate, water-full environment that nature did not intend it to be, solutions for improving the quality of life in drylands lie largely with the people who live there. Whether it's examining the ways in which the Maasai have meticulously used the wetlands found within their desert environment to maintain their pastoral way of life; efforts by villagers in India's bone-dry Alwar district in western India to create an agricultural oasis through the construction of small dams along the area's rivulets; or the draping of volleyball-like nets on mountaintops to catch fog droplets coming in from the sea at Chungungo, Chile, an isolated coastal village just south of the Atacama desert, this much we know: Local ingenuity and persistence often make the difference. Moreover, solutions, once rendered, mark the beginning, not the end, of the story because it is not just a question of finding answers to problems but also summoning the determination to continue to manage the challenge once solutions are found.

Perceptions of drylands are undergoing dramatic change.

MAASAI IN KENYA

The nomadic pastoralists known as the Maasai – the indigenous people of Kenya's Rift Valley and parts of northern and central Tanzania – inhabit some of the driest land on earth. In Kenya, this includes the open, semi-arid plateaus of the Kajiado and Narok districts in the south, and in Tanzania, the Ngorongoro and Simanjiro regions to the north.

Much of Kenya is dry, but there is abundant water in the south for those who know where to look. Strangely for an arid land, wetlands cover nearly 10 percent of the region. These include fresh and saline swamps, shallow lakes, margins of deep lakes, dams, fish ponds, marshes, mudflats and floodplain grasslands, and springs and streams that are the Maasai's primary sources of water.

Ancient Callings

For the Maasai, wetlands are a source of water of last resort. They have learned over centuries to rely on the wetlands only when the rains fail or are irregular.

The Maasai are one of the world's last communities to maintain a lifestyle that predates the birth of agriculture 10,000 years ago. They migrate through and sojourn in some of the world's most extreme terrains seeking water, not just for themselves, but also for the tens of thousands of cows, sheep, and goats they rely on for meat, blood, and milk. Cattle, in fact, support 80 to 90 percent of the Maasai, who have become highly skilled

over the generations in finding sources of water for their herds and flocks – including 180,000 head of cattle.

The importance of water to their culture means that Maasai believe water to be a public (or at least a community) resource as well as a fundamental right that cannot be denied. In Maasai culture, there is no hierarchy of access to water.

In practice, this means that someone in a leadership position has no more water privileges than a lower-ranked Maasai community member. The Maasai regard it as everyone's duty to keep water clean, and this is taught to children.

Nathan Gichuki and Jane Macharia of the National Museums of Kenya are among the world's leading authorities on the Maasai. The pair has conducted extensive studies in Maasai water management, finding that a conservation ethic runs deep in Maasai communities and that it is derived from their culture and beliefs.

For example, permanent springs, swamps, and marshes are seen by the Maasai as sacred sites. Access to such sites is permitted only during ceremonies and rites. Other customs and beliefs forbid any drainage of the wetland or the indiscriminate harvesting of plants. Community members who fail to respect these arrangements are punished, says Jeremy Lind, a researcher at King's College in London. "Punishment may take the form of a fine, or a curse." The Maasai believe in the concept of God, whom they call Enkai and whom they regard as the provider and regulator of water, which they call Enkare. They also believe that God uses water to reward or punish the community. "More rain means Enkai is happy with the community and a lack of it means that Enkai is annoyed," says Partalala Ole Kamuaro, a member of one of Kenya's Maasai communities.

If, for example, the rains fail, a sacrifice has to be offered.

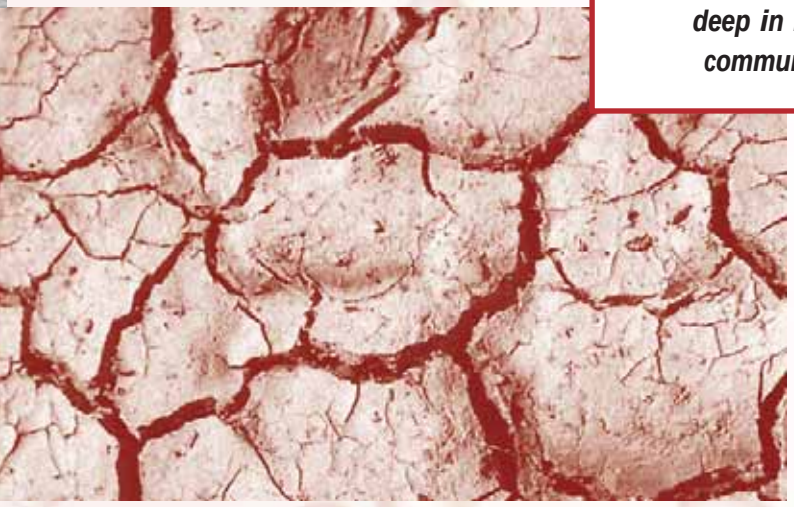
Maasai communities divide themselves into groups called enkutotos. Enkutotos are defined by a set number of families living within a given area and who share pastures for their animals, water and other resources. Before a new family is allowed into an enkutoto, a meeting is held to obtain consensus from other members, who will also decide the location of the new boma, or house. No house can be built near a water source or in an area where surface water can flow into a water source. Such meetings also set limits to the number of houses allowed in an enkutoto, which is a way of regulating household and other uses of water and other natural resources.

Other aspects of Maasai conservation include the Maasai practice of moving between different wetlands so that the land can recover after it has been used for some time. Maasai also try to diversify their livestock to include cattle, donkeys, goats and sheep so that no single breed of animal dominates. In areas where water is particularly scarce, rivers and streams are divided into zones that can only be used by people, sheep or cattle – but not all three.

Clash with Colonialism

The history of property rights in the Maasai lands helps illustrate how the legacy of colonialism in Africa still haunts conservation today. During colonial rule, the British were encouraged to immigrate to Kenya in an effort to develop commercial farms. The state later imposed formal property rules that subordinated Maasai interests to those of the new settlers.

Conservation ethics run deep in Maasai communities.



Under the Maasai treaties of 1904 and 1911, a number of British farmers appropriated Maasai lands because these were deemed "unoccupied" by the colonial powers. The Kenya Land Commission, the colonial-era institution governing these acts, created what were called "native reserves" and developed new grazing schemes and systems for managing land. The net result of these changes was an agricultural system that had little relevance to Maasai needs and that took no account of existing Maasai methods or the centuries of Maasai knowledge.

In the 1950s and 1960s, as Kenya's independence from British rule approached, the Maasai began to demand their lands back. In response, the colonial government recommended that land on which the Maasai lived and worked should be divided up – effectively privatized. The government also laid the foundation for a land adjudication and registration program.

Following independence in 1963, a new law, the 1970 Group Representative Act, created exclusive land ownership and rights among groups of Maasai living in identifiable areas. A land title was issued to each group, formalizing its collective rights to the land.

These group ranches, as they are known today, were intended to guarantee protection for the Maasai from further encroachment and appropriation. But this is not what happened in practice. Far from restoring Maasai control, the land was systematically taken by British farmers and others in authority, and over time the Maasai lost access and control over much of it. The Maasai, as a result, had to move and therefore adapt their pastoralist traditions to new environments.

In the early 1980s, Kenya's then-President Daniel arap Moi began calling for the group ranches to be further subdivided.

While some of the Maasai were attracted to the idea of individual ownership, for others it meant a reduction in their ability to roam and obtain water and pasture for their livestock. The post-Moi era has not led to improvements, and the Maasai today continue to face insecurity over their lands.

Modernization

Kenya is developing economically at a rapid pace. Modernization means that wetlands, for example, are now a prime economic target as a source of rich forage for livestock and as a store of fertile soil for agriculture on a commercial scale, which the government is keen to promote.

Some in government contend that a nomadic pastoral system like that of the Maasai is unsustainable and needs to be complemented, if not eventually replaced, with modern agriculture. Moreover, they believe that not all aspects of Maasai practice are environmentally friendly.

Indeed, they contend that some of these practices are having the effect of degrading Maasai lands.

Livestock, for example, is claimed to be among the biggest threats. In many areas, large flocks of sheep and goats and large herds of cattle use the same route to a watering point all year round, which, critics say, is weakening the soils. As a consequence, some wetlands are silting up into muddy pools. Organic matter, dung, and urine deposited into a wetland as cattle drink are affecting aquatic life and changing plant types. Another threat comes from modernization in farming.

Not all Maasai are pastoralists; some are small-scale farmers. These Maasai farmers are now using fertilizers and pesticides, which destroy wetland wildlife and make the water for their livestock toxic.

Others, however, see a different picture.

For example, staff at the Drylands Program of the London-based International Institute for Environment and Development (IIED), believe that the accusations are unjust. They argue that Maasai pastoralists should not be singled out for blame for environmental degradation, whose causes are complex. They point out that Maasai communities are often unable to present their case to the authorities effectively, in part because they lack access to the top levels of power. IIED staff also point out that many policies that affect the Maasai, particularly relating to changes in land laws, are largely driven by a set of values reflecting developed-country concepts of how to raise standards of living.

Africa is changing and this change is affecting communities.

There has been some acknowledgement of this view from the current government headed by President Mwai Kibaki. Despite the push toward commercial-scale agriculture, pastoralism remains an important part of Kenya's economy. Half of the country's entire livestock population occupies areas used by pastoralists, and these regions also generate 80 percent of the country's ecotourism revenues.

Indeed, the importance of pastoral livelihoods is recognized in Kenya's most recent economic recovery plan, which also acknowledges that loss of land is an important reason for some of the problems faced by the Maasai.

Recognition of traditional Maasai expertise is one thing, but the Maasai are also being encouraged to recognize merit in some non-Maasai methods of water conservation. The International Water Management Institute, for example, has been helping the Narok Maasai to build small dams in the Mara River basin. One

expert, Malesu Miambo, regional coordinator of the World Agroforestry Centre, says that the Maasai are not averse to modernization where the benefits are clear.

The Maasai are an independent and resilient people battling the tide of modernization.

Their desire, at base, is to roam Kenya in search of the surge and gush of springs for their herds.

At the same time, all of Africa is changing and this change is affecting the Maasai as it is other communities. The paradox is that with two of the world's longest rivers – the Nile and the Congo – the continent theoretically has plentiful water; it is just that some communities have better access to it than others.

There is a powerful incentive to keep wetlands and their regulating effect on the greater environment in good shape.

Appropriate policies and development interventions that can conserve the best of the Maasai ways while at the same time introduce them to effective alternatives have the best chance of succeeding.

RAJASTHAN IN INDIA

Most of Rajasthan, a large state in western India, is a desolate and devastated landscape. But in the semi-arid reaches of the Alwar district, a new oasis has been taking shape for some years. In a slow and steady transformation, a group of local farmers in 750 villages has managed to defy the worst droughts in recent memory simply by reinstating their lost tradition of water harvesting and reforesting the area.

Alwar is a part of the ancient Aravalli mountain range that extends through the part of the Thar Desert lying in Rajasthan right up to New Delhi. It is among India's driest and hottest regions, with an annual rainfall of less than 450 millimetres, the bulk of that falling during the brief monsoon season. Many of the villages here were resigned to suffering their way through the searing droughts of the region.

Inspired by Tradition

In 1986, led by young government employee Rajendra Singh, the non-profit organization Tarun Bharat Sangh (or TBS, translated as Young India Association) worked with villagers to begin building water-harvesting structures inspired by traditional methods of Rajasthan's indigenous Minhas peoples, who have mastered the art of collecting whatever little rain that falls on their lands and carefully using it throughout the year.

Since that year, TBS has built more than 1,000 water-harvesting structures in the region with little financial support from the Indian government. The technique is simple: At a point upstream of the area's main water source, a tiny, semicircular dam is built to collect water from rainwater-fed rivulets in the area.

The water that collects behind the dam soaks into a shallow pit, which will then seep into the ground to recharge the reservoir of water serving the area. This system, locally known as a johad, is used in conjunction with good forest conservation practices to keep the soil nutritious and capable of retaining moisture. The result is replenished groundwater and a raised water table – even in bone-dry Rajasthan.

The five small rivers of Alwar – the Bhagani-Teldehe, Arvari, Jhajwali, Sarasa and Ruparel – are all within the catchment of the Yamuna River, which in turn flows through Delhi and is itself the largest tributary of the Ganges. Before Singh came, they had nearly dried up. Now they flow year-round. The Centre for Science and Environment (CSE) in New Delhi describes the TBS story as a spectacular victory, and the first time Indian rivers have ever regenerated successfully.

Although the locals have shouldered more than three-quarters of the costs, it has been worthwhile: A study carried out by CSE found that the return on investment in these traditional water-harvesting structures was an astonishing 400 percent.

In Alwar, the main livelihood is a combination of rain-fed cultivation and animal husbandry. Johads are

the traditional method of water conservation in the area, trapping water where it falls during the brief rainy months in the ponds or in dammed rivulets. They are doubly beneficial, as they not only recharge much-needed groundwater but also provide surface water.

A johad will be built at a spot likely to catch the most rainwater. The tanks and other parts of the system require regular cleaning to remove any silt arriving with the water. Too much silt will choke their storage capacity, which is why the slopes or catchments surrounding them must be heavily forested to prevent soil erosion.

Forests also serve as sponges, retaining water after heavy rains then slowly releasing it over time.

Dammed and Blessed

The simple workability of the idea can be seen in the village of Nimbi. By the mid-1990s, the area had been in the grip of famine for nearly a century. Many in Nimbi's communities had long since given up on agriculture and turned to making illicit liquor or had migrated to the cities in search of a livelihood.

Indigenous peoples have mastered the art of collecting whatever little rain falls on their lands.

In 1994, with TBS's help, the people of Nimbi built two mud and cement dams in their village, at a cost of about US$12,000.

The first pond that formed in Nimbi after the first rains has never dried up.

And today, there is a belt of intensive vegetable cultivation in the village that is 3 kilometres long – and watered with not a single drop of irrigation.

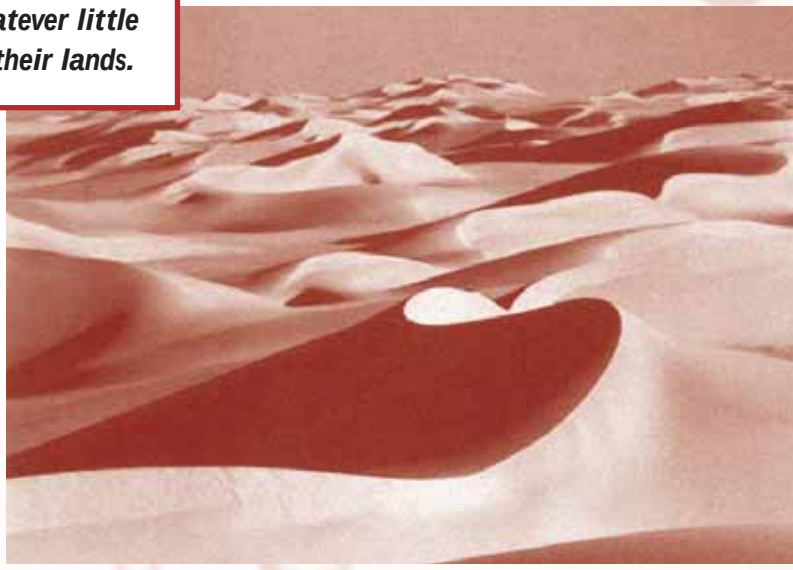
How this has come about is that the land is saturated, and water can be accessed at depths of less than a metre. The villagers have dug trenches and sown the seeds for melon, watermelon, bitter gourd, and cucumber. This year, the revenue generated by this village from agriculture alone was $750,000 – and it was the third consecutive year of drought in the area.

But Nimbi is only one indicator that a working network of johads is essential in this arid place. Past mistakes, too, point to the necessity for a sustainable solution. In the years following India's independence from Britain in 1947, many villagers in Rajasthan were overly dependent on the state for their irrigation needs. The state-constructed irrigation systems did not take into account knowledge and experience of local people.

People began failing to clean out the johads and left them in a state of disrepair.

At the same time, the neighbouring hills were stripped of forest cover, which triggered soil erosion that, in its turn, choked the johads further. This is one of the main points Singh and TBS make: Stripping the slopes of trees in the region will make water a very scarce commodity.

In the decades preceding the 1990s, drinking water became heavily depleted and cattle died in large numbers because vegetation in the area had long since withered. Villagers lost confidence in themselves and in the government agencies that were ostensibly there to help. There was a wholesale exodus to the cities in search of work – and the minority who remained faced starvation and struggle.



Alwar became what is called in government records a "dark zone" – an area with little potable water. A short time after TBS began its turnaround in 1994, the government reclassified Alwar as a "white zone," and the seasonal and usually dry rivers flowed steadily.

High Hopes

Agriculture began to thrive with the water's return. Moreover, local villagers, mindful of the essential role of their catchment forests, enthusiastically protected them. Trees regenerated over large tracts of land – and with that came the slow revival of some wild animal populations.

A decade later, two villages in the Bhaonta-Kolyala region have begun to protect their forests, a 12.5-square kilometre expanse called the Bhairon Dev Lok Van Abhayaranya. The name was suggested by TBS to honour the successful conservation work of these dedicated local communities: Lok van abhayaranya translates as "people's sanctuary." Recently, locally endangered wild herbivores, like the nilgai (also called the blue bull), and India's largest deer, the sambar, have bounced back. A migrating tiger has also been spotted in the regenerating forests, and villagers report occasional sightings of at least two leopards in the sanctuary. The villagers seem to bear the leopards no ill will even though there are stories of them stealing goats.

This level of tolerance might seem remarkable, but Swati Shrestha of Jawaharlal Nehru University in New Delhi has revealed intriguing reasons for it. Shrestha, who carried out a detailed study of the sanctuary for the environmental nonprofit organization Kalpavriksh, reports that the presence of carnivores is actually welcomed by villagers in the area: They believe that the disappearance of big cats from the forest decades ago effectively led to deforestation. The presence of tigers and leopards, the villagers maintain, will inhibit people from going into the forest unless absolutely necessary and thus leave it intact as their bulwark against drought.

According to Singh, the villagers have displayed a high level of awareness, sense of ownership, and responsibility in restoring their natural resources. Today, villagers who might have been busy hacking down trees present ideas on how to save their forests. They have devised a set of 11 rules to deter each other from felling trees and wasting water.

A total of 1,058 villages have now built johads or performed other water conservation work. Of these, 90 have been made drought-proof. This means that even if these villages receive less than 80 millimetres of rain a year, they will face none of the hardships of drought. The key is that they continue planting species of trees and crops that do not require too much water.

TBS believes in the spirit of one-to-one communication, and many villagers, having taken care of their own fields, are following Rajendra Singh's example.

They are setting out on foot from village to village, inspiring others to help themselves by creating their own watershed constructions.

COASTAL DESERT IN CHILE

The Atacama Desert, a narrow strip of desert in the north of Chile, is among the driest places on Earth. Trapped between the snow-capped Andes to the east and the Southern Pacific ocean to the west, much of the Atacama is a barren and seldom changing landscape. In

many areas people say that it has never rained – or at least not often enough to get wet.

Despite this, nearly one million people live here. Fishing and small-scale mining provide the main means for survival.

Most of the desert's inhabitants squeeze into a handful of coastal cities, surviving thanks to water piped down from the mountains or extracted from groundwater reserves.

In the Atacama's many smaller villages, the municipal authorities consider it too expensive to have water piped directly to homes. This means that people have no choice but to drink water trucked across the desert from distant rivers.

This makes water precious – and pricey.

For many, daily bathing and washing is out of the question. The few litres a day that most can afford is barely enough even for drinking.

Reservoir in the Sky

High on the hilltops that flank the northern Chilean coast lies a solution to the villagers' plight. It is a thick, moist fog that blows in from the sea – a misty reservoir in the sky. Most urban dwellers regard fog as a nuisance and associate it with cold, dark nights and pollution. However, in the Atacama, the camanchaca, or creeping fog, has always been considered as something of a life-giver thanks to the many species of plants that grow in places where you wouldn't expect them. These species are known as lomas and range from cactuses to ferns.

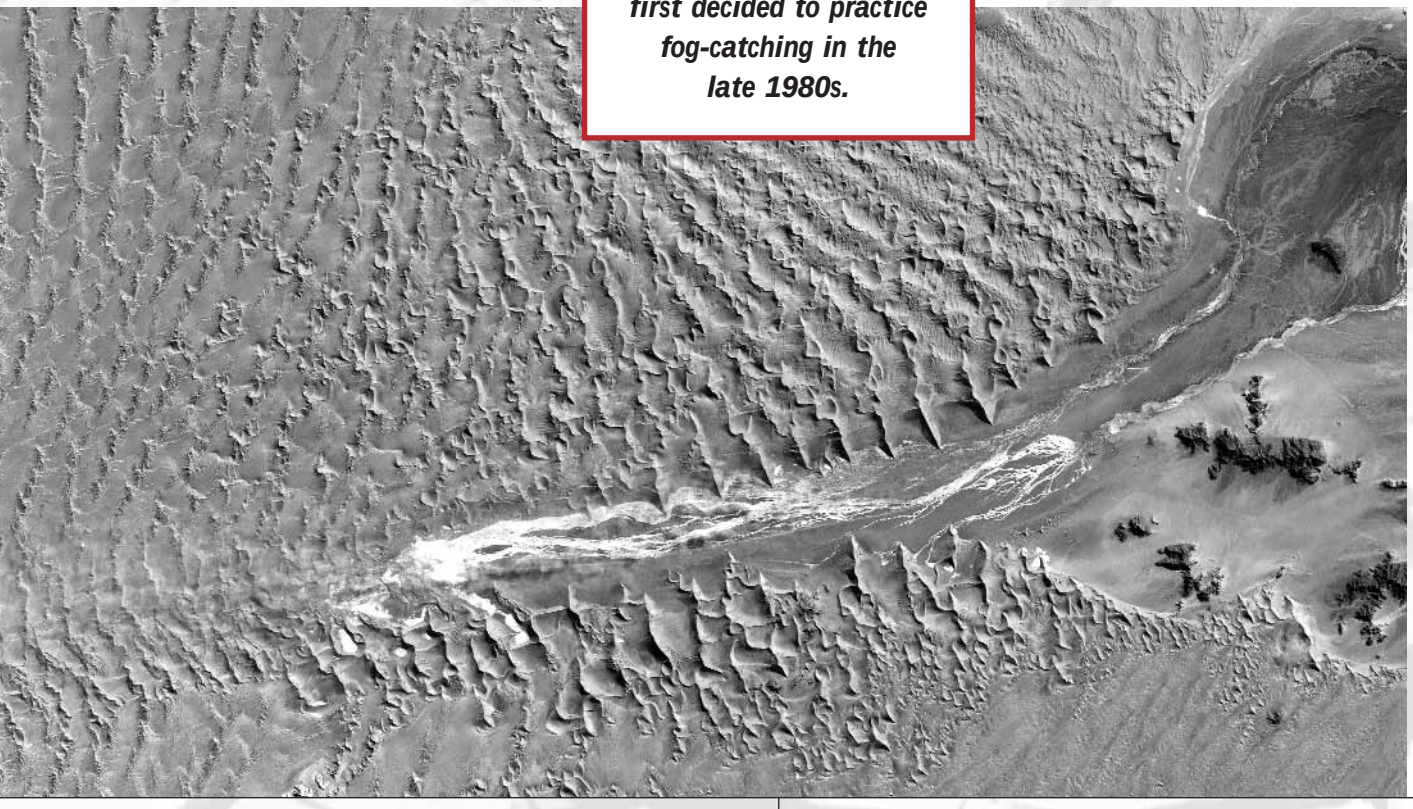
For centuries, the people of the Atacama have noticed how these plants collect the tiny water droplets from the fog. But it was not until the 1960s that scientists started to work systematically on a way to tap this water source. After years of research, Chilean scientists came up with one potential solution – "fog catchers," large, volleyball-style nets that stand upright on the hilltops, ready to intercept passing fog clouds.

Several metres of fine synthetic mesh made from polypropylene are stretched between two posts on the mountainside.

As the wind drives tiny droplets of water through the net, about half get trapped on the net's fibres. More wind drives through more fog droplets, and the small droplets join to make larger ones.

This process must be repeated again and again to form a visible

Chilean researchers first decided to practice fog-catching in the late 1980s.



drop of water – fog droplets are so small that 40 million need to join up to form a drop the size of a match head. But eventually the droplet gets so heavy that gravity pulls it down and it runs down the net, dragging other smaller droplets with it. Gutters collect the water and a network of pipes channel it to villagers.

The amount of water collected is modest – between about 5 and 14 litres per day per square metre of net. But for communities that have few other choices, it can be the difference between life and death. In theory, the water that these anchored sails can harvest is almost limitless: Clouds bring an essentially unlimited amount of water. This means that in principle, the quantity of nets is the only obstacle to more water for communities.

People's Science

Chilean researchers first decided to put fog-catching theory into practice in the late 1980s. They chose an isolated coastal village called Chungungo. Located south of the Atacama in the semi-arid province of Coquimbo, the village sits on the edge of the *desierto florido*, the spectacular "flowering desert" where wildflower plants burst into life after the heavy rainfall that occurs once every few years.

Before the fog-catching initiative, most of Chungungo's 300 inhabitants eked out a living from fishing (mainly shellfish) in the cold coastal waters. Surrounded by seawater they could not drink, and with only 100 millimetres of rainfall a year, each villager survived on 14 litres of water a day trucked in from a river 20 kilometres away and from the nearest city, La Serena, 60 kilometres to the south.

Funded by Canada's International Development Research Centre (IDRC), a team of scientists from Santiago's Catholic University together with Corporación Nacional Forestal (CONAF, Chile's national forestry association), put 100 fog catchers on the hills above the village, ready to catch oncoming fog clouds.

Fog catching's simplicity is matched by its economy. The fog catchers cost just US$1,000. The net itself is the cheapest part, accounting for about one-twentieth of the overall cost.

The results were impressive. On average, the fog catchers harvested 11,000 litres of water per day –

more than double the village's water needs. And, once chlorine was added and the water was boiled, it was safe to drink.

Local people had enough water to grow vegetables and to keep a few chickens or ducks. And they could install flush toilets, improving hygiene levels and health.

One resident who remembers how the fog catchers changed peoples' lives is Patricio Piñones, a water and sanitation engineer, who sat on the village's Rural Water Committee from 1992 to 2001. The fog catchers, he says, had a massive impact on people's quality of life. "To plan ahead, you need a permanent and stable source of water," he says. "The fog catchers gave us the freedom to think about the future.

And for the first time people could work in something other than fishing – they had other alternatives, such as growing vegetables to eat or to sell." The population also swelled as people who had left for other towns returned home.

Pilar Cereceda, a geographer from Santiago's Catholic University, led the first pilot project, and the memories of its revolutionary impact remain fresh in her mind. "Before, women had to wait hours for the water truck to arrive. It never came at the same time each day, so they could not get on with other things until it turned up," Cereceda explains. "But once the more constant and predictable water supply from the fog catchers was established, they felt they had much more time" as the water from the fog catchers was carried through pipes straight to their homes, removing the need to lug barrels of truck-delivered water.

Novelty Drink

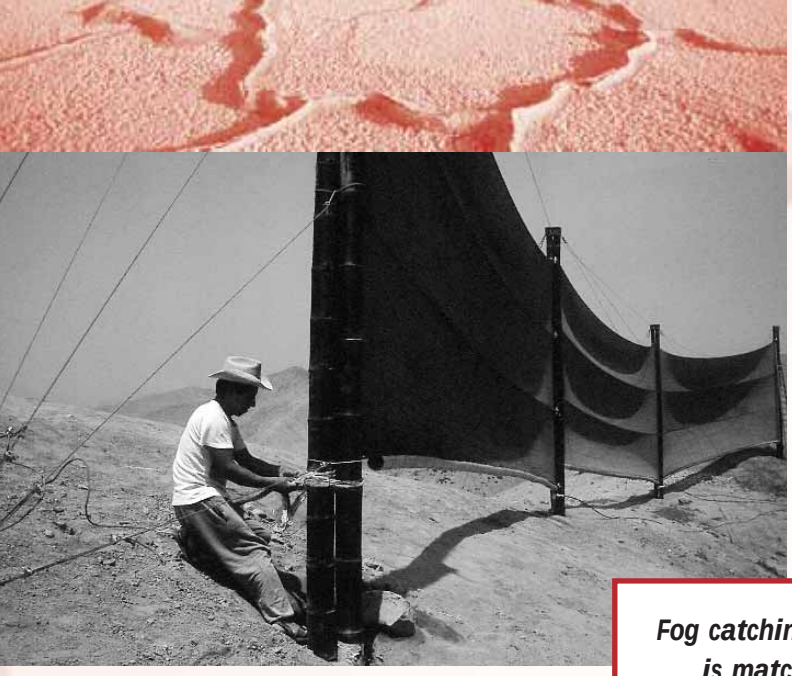
Most of the villagers were proud of their novel way of getting a drink. They set up a local committee to maintain the fog-catching equipment. The project attracted considerable media attention in Chile and from overseas. Film crews flocked to the village, and Chungungo enjoyed its moment of fame.

Chungungo's fog catchers worked well for about seven years. But maintenance was neglected and the frayed nets stopped working. Then villagers started removing the nets, using them instead as sunshades or windbreaks. By 2000, water trucks had started rolling into the village once again.

A return visit to the Chungungo hills will reveal that the fog catchers have disappeared.

This is not because they failed to work, but because the local authorities failed to maintain them. Fog catchers are simple to build and run and last at least a decade, but they must be maintained.

The nets need to remain tightly stretched between the poles to ensure that water flows into gutters; torn



Fog catching's simplicity is matched by its economy.

nets need to be repaired; and gutters and pipes must be kept free of blockage. If this is not done, the system can fall relatively quickly into disrepair, which is what happened in Chungungo.

For Pilar Cereceda, responsibility for failure rests squarely with the authorities.

"They could have done so much more to ensure the sustainability of the project," she says. For example, they could have charged entrance fees to film crews or to the many tourists who made special trips to Chungungo to see with their own eyes the large black sails of the fog catchers lining the hilltops. But authorities did not do anything to exploit the income-generating potential of the fog catchers.

Piñones, who still lives in Chungungo, says he would rather blame himself and the village for the fog catchers' failure, instead of the scientists or authorities.

Important lessons were learned, he says, and these will be applied in the next generation of fog catchers.

"It was a good project," he says, "in fact at one point there was too much water – 4-to-5 times as much as we needed. There were not enough tanks to store the water in." But he says it failed for essentially two reasons: strong winds damaged the nets and there was a lack of money to fix or maintain them. The people in the village had excellent relations with the scientists and appreciated their expertise and advice. "They came to the village to show how to use water wisely and how to cultivate plants. Local people were involved. We just didn't have the capacity to maintain the fog catchers," Piñones says.

Learning from Failure

Given what they learned from this experience, Chile's scientists are now designing schemes that give local users incentives to maintain the fog catchers.

In three projects across northern Chile, scientists from three institutions – the Bolivariana University in Iquique, Santiago's Catholic University and CONAF – are building fog catchers with local residents at the helm. It is a simple process.

Three people can build a fog catcher in one day. An important aim is to make sure that the residents will not need to rely on outside experts to maintain them once the scientists go home.

Researchers have also discovered that an effective way of encouraging self-reliance is to give the residents a financial incentive to maintain the fog catchers.

In the Atacaman village of Taltal, for example, scientists from the Catholic University of the North in Antofagasta plan to install fog catchers to supply water to a hydroponics system. Hydroponics involves growing plants in nutrient-rich water rather than soil to produce vegetables, which can be sold. They hope that if people can make money from this – and so start to depend on the fog catchers for their livelihood – they will keep the fog catchers in good condition.

Elsewhere in Chile, fog catchers are now being put to quite a different use. In Fray Jorge, one of Chile's less-visited national parks found in the semi-arid belt between the Atacama and the capital city Santiago, 99 percent of the park consists of bushes and scrubby vegetation. But the uppermost reaches of the hills are thick with clouds and trees. The moist air sustains the forest, which is packed with plants such as mosses and ferns that thrive in damp atmosphere.

The trees themselves are natural fog catchers – their branches and leaves trap fog droplets in precisely the way the fog catchers' nets do. As a result, precipitation in the Fray Jorge forest is 1,000 millimetres per year, 85 percent of which is derived from fog. Much of this extraordinary forest was destroyed in the early 20th century, before it was designated a national park. Today, only 100 hectares remain.

Now, CONAF is using fog catchers to help bring the forest back to life. They have put up 10 fog catchers and

have used the water harvested to irrigate five hectares of land that have been replanted with three species of tree – olivillo (*Aextoxicon punctatum*), winter's bark (*Drimys winteri*) and petrillo (*Myrceugenia correifolia*).

"There is a wonderful sustainability about this system," explains CONAF regional director Waldo Canto. "After about four years, when the trees reach a height of 1.5 metres, they have enough leaves and branches to start harvesting their own water. This means that the fog catchers can be used to irrigate other areas." The system has been so successful that CONAF hopes to plant 20 to 30 more hectares of forest this way.

The forestry association is also using fog catchers to provide water for goats that graze the foggy hilltops near a village in the region of Coquimbo. CONAF planted bushes up on the hills, but villagers who live down below were unable to graze their livestock without water for their animals. Now, two fog catchers together provide more than 140 litres of water a day – enough water for 50 goats.

Canto estimates that, as a result, villagers' incomes have risen by almost one-third.

These different projects reveal the versatility of fog catchers, he says. "In the case of the forest of Fray Jorge, the contribution of fog catchers is to science; in Chungungo, it is for the health of the people; in this case, it is for livestock and the economic well-being of the people." And there are many other, as-yet untapped ways in which this technology could be used to sprinkle life into Chile's arid zones, Canto says. For example, many spectacular beaches along Chile's 4,000 kilometre-long coastline are empty of tourists – simply because there is no drinking water. Fog catchers could be the answer. They could also provide a cost-effective way to provide water to enable the mining of mineral deposits that have not yet been exploited.

The most successful initiatives took their cue from listening hard to people.

It is not just the Chileans who have recognized this potential. Fog catchers have popped up in many of the world's dry spots, including the Canary Islands, Namibia, Nepal, and Peru, helping to increase vital water supplies for people, plants, and animals. Economic welfare, environmental vitality, community health and cultural values have all benefited as a result.

DRY RULES

What lessons can be learned from these and other cases? And how might these lessons be applied elsewhere? Several common themes have been identified that may seem simple at first but could serve as valuable signposts for charting success:

- *Money inside and out*. All initiatives attempting to improve the local environment as well as the quality of life of those who depend on natural resources cost money. Of the projects featured above, those that were funded mostly (or entirely) from outside sources, like the fog-catching initiative in Chile, succeeded for a shorter time than projects that were funded through local means, like the management of water harvesting in Rajasthan, India.

- *Tradition and modernity.* Many of the communities featured above follow traditional ways of life often thousands of years in the making. They now face profound changes. In many cases (such as with Kenya's Maasai), they need to decide how best to respond to the forces of modernization, particularly the advent of large-scale, commercial agriculture.

  Standing still is no longer an option. By doing nothing, communities run the risk of losing their traditions to modernity.
- *Knowledge old and new.* Modern science is very much an activity that rests on the shoulders of some of the giants of research from different periods in history and from different cultures. Some of the longer-lasting initiatives featured in Dry: Life Without Water are those that promote, revive, or build on knowledge or research from the past. By contrast, the essays from India and Kenya are examples of the harm that can be done when traditional expertise (in water harvesting and wetland conservation) is neglected. Much international development these days is more about listening to what people need and less about telling them what to do.

  Of all the essays in this article and in the book, some of the most successful initiatives are those that took their cue from listening hard to the people the projects were designed to assist.
- *Involvement and initiative.* Community involvement is a mark of many of the essays, but in a few cases, it is individual (and often inspiring) leadership that has made all the difference as it did in India.
- *Success and failure.* Not every story of dryland adaptation is a story of unambiguous success; nor does each have a happy ending. For example, investigations show that the giant nets intended to trap fog and convert it into usable water for the people of Chile's Atacama Desert did not survive the departure of the scientists who had designed them. The financing had run out, and local people were unable to maintain the nets without the help of experts.
- *Serendipity counts.* Serendipity often plays an important (although unacknowledged) role in research and development.

Money, knowledge, initiative, and luck are essential ingredients for a successful life anywhere in the world, but perhaps more so in dryland environments than elsewhere. ■

The following people contributed to this article:

***Daniel Schaffer**, TWAS public information officer*

***Ehsan Masood**, freelance journalist, London, UK*

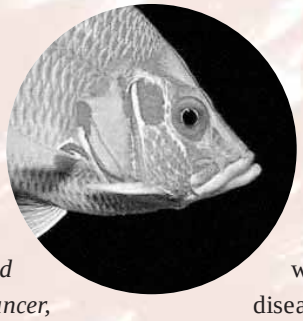
***Yvonne Ndege**, BBC television journalist*

***Pallava Bagla**, chief South Asia correspondent,* Science

***Katie Mantell**, freelance writer, former editor, Science Development Network (SciDev.Net).*

HEAVY METAL ACTION

TWAS IS CURRENTLY SUPPORTING NINE RESEARCH UNITS IN LEAST DEVELOPED COUNTRIES THAT ARE CARRYING OUT EXCELLENT RESEARCH UNDER DIFFICULT CONDITIONS. PATRICK EDORH, HEAD OF THE TOXICOLOGY OF ENVIRONMENT UNIT AT THE UNIVERSITY OF ABOMEY-CALAVI, BENIN, HAS RECEIVED FUNDING FROM TWAS SINCE 2006 TO CONDUCT RESEARCH INTO HEAVY METALS IN AQUATIC ENVIRONMENTS AND MARINE PRODUCTS.

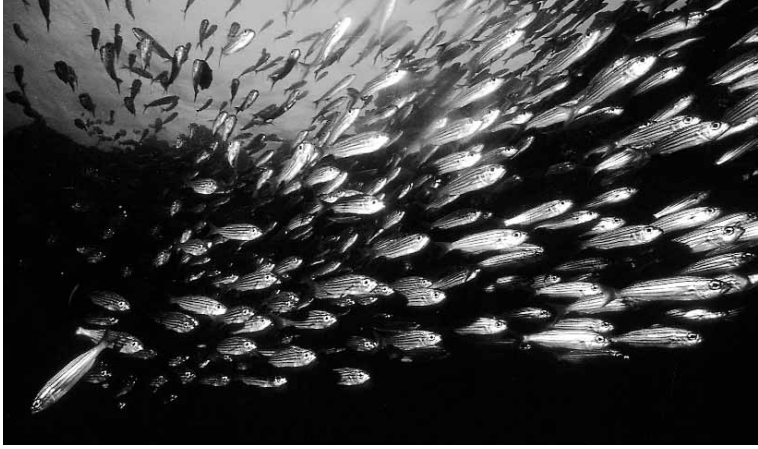


Heavy metals, including cadmium, lead and mercury, are used in many industrial and agricultural applications. However, they are increasingly becoming a source of concern due to their harmful effects on the environment and human health. Even trace amounts of such metals can accumulate in the food chain, eventually causing diseases such as cancer, leukaemia and lymphoma. Under the TWAS Grants for Research Units in Least Developed Countries (LDCs) programme, Patrick Edorh, head of the Toxicology of the Environment Unit, University of Abomey-Calavi, Benin, is carrying out an environmental study of heavy metals in aquatic environments, including continental waters, and products derived from the sea. He is also examining the effects of heavy metals on people's health.

Problems associated with heavy metal contamination first came to light in such industrially advanced countries as Sweden and Japan in the 1960s and 1970s, most notably through incidents of mercury and cadmium pollution.

During the first half of the 1900s, for example, a chemical plant dumped an estimated 27 tonnes of mercury into Japan's Minamata Bay. By the later 1950s, local people, who relied on seafood harvested from the bay as a major part of their diet, were diagnosed with a neurodegenerative disease. Soon thereafter, the cause was identified as mercury poisoning and the disease has since become known as Minamata disease.

Despite the comparatively low level of industrial activity in developing countries, less developed regions such as Africa are increasingly becoming exposed to the unwanted ecological effects of heavy metals. That is because heavy metals can be transported through the atmosphere and by ocean currents from sources further afield and because many African countries lack adequate and properly planned industrial zones, as well as systems for the controlled disposal or processing of industrial effluents. In addition, many African cities have yet to devise environmental policies that take into consideration the need to improve and expand their



infrastructure in the face of their rising populations. The situation is exacerbated in coastal areas by such activities as the unloading of fertilizers, oil and fuel, which can create spillages that directly pollute the waters.

Such challenges have prompted a growing awareness in Africa of the need for the rational management of heavy metals.

"Unfortunately, environmental and health data concerning Africa on the threats created by heavy metals are rare and scattered," says Patrick Edorh, head of the Toxicology of the Environment Unit at the University of Abomey-Calavi, Benin, a recipient of a TWAS Grant for Research Units in Least Developed Countries (LDCs).

"This creates the rationale for precise studies of the prevalence of heavy metals in Africa's ecosystems, including the aquatic environment," adds Edorh, who is using his grant to carry out an environmental study of heavy metals in the marine environment, interior waters and marine products.

Less developed regions are increasingly becoming exposed to the effects of heavy metals.

Benin, sandwiched between Nigeria and Togo, has some 120 kilometres of coastline along West Africa's Gulf of Guinea. As an LDC, industry is limited, although some offshore oil and gas exploration is being carried out. The sea is also a primary source of food for coastal residents and a primary source of income for local fishermen.

Edorh describes heavy metal pollution as "a reality in many African countries" and notes that many nations, including Benin, have not conducted systematic studies to estimate the effect of the phenomenon. Neither have they made any assessments of the potential pollutants that characterize their ecosystems. Surveys detailing the accumulation and movement of these pollutants in aquatic ecosystems and evaluations of the impact of heavy metals on the environment and public health are also lacking.

"There is an urgent need for national and regional activities in Africa to address this absence of data by mapping heavy metal pollution and by analyzing how these elements move through marine and terrestrial ecosystems," notes Edorh. "For this reason, we will be sampling sea water and marine sediments as well as herbivorous and carnivorous fish, shrimps and cuttlefish.

"It is also necessary to identify the sources and the quantity of heavy metals dumped in the continent's aquatic ecosystems," continues Edorh, "and to take measures to prevent this pollution." Such measures are likely to include new rules and regula-

PROGRAMME EXPANDED

The TWAS Grants for Research Units in Least Developed Countries (LDCs) programme, which has been operating since 2003, currently supports nine units.

The programme has recently been expanded and made available to research units not only in the 50 LDCs, but to units in some 79 countries identified by TWAS as lagging in their science and technology capacity. For additional information, including a full list of the 79 eligible countries, see www.twas.org/mtm/research_units.html.

tions; more efficient production processes that lessen the emission of metals in waste; and public education and awareness campaigns.

"Our study will focus on Benin in the first year of the grant and expand to cover Nigeria and Togo in the second year," says Edorh. "We already know that the major sources of pollution are port facilities, phosphorous and oil industrial plants as well as emissions from second-hand engines imported from Europe – engines still requiring that lead be added to the petrol.

The study will create an inventory of the different heavy metals in the aquatic environment. It will also locate the sources of these pollutants and attempt to model their evolution.

"A thorough review of the literature and other documentation on problems relating to heavy metals carried out by scientists from other parts of the world is another important part of this study," says Edorh.

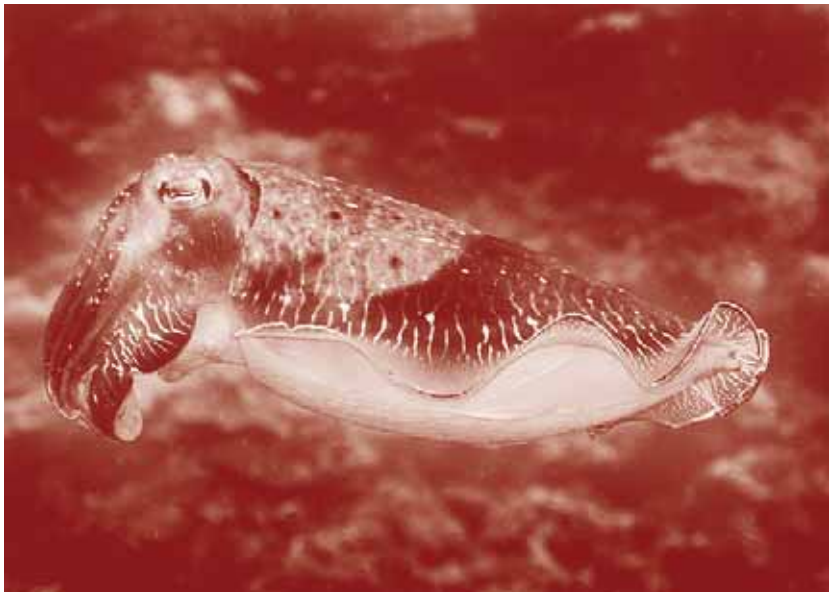
This will be achieved using facilities at the University of Abomey-Calavi, the University of Lomé in Togo and the University of Bordeaux II in France. In addition, the libraries of such national organizations as the Laboratory of Biogeography and Environmental Appraisal, the Laboratory of Modelling and Applied Hydrodynamics, the Centre of Documentation of the Regional Institute of Public Health, the National Institute of Statistical and Economic Analysis and the Ministry of Environment of Habitat and Urbanization will be consulted.

"Reviewing the literature confirms that heavy metals enter aquatic environments from many different sources, both natural and anthropogenic," says Edorh. "Among the most important natural sources are volcanic activity and forest fires that release metals previously bound up in the soil. However, we know that anthropogenic sources created by mining, heavy industries, urban effluents and leaching from solid waste dumps contribute much more to the presence of heavy metals in the environment," he says.

The effects of heavy metal pollutants vary considerably and depend on both the element and the level of concentration.

"Heavy metals such as cadmium, lead and mercury – as well as lighter metals such as aluminium – are harmful to many living beings even at low concentrations," explains Edorh. "Mercury, for example, causes ailments such as chronic fatigue syndrome and Miramata disease; lead has neurological effects; and cadmium can lead to anaemia and kidney problems."

Several major studies, Edorh points out, have shown that these adverse impacts often occur more frequently in aquatic organisms because the heavy elements are ingested by tiny plankton and levels increase during each step of the food chain – a process known as bioaccumulation. The pollution of aquatic systems by heavy



metals, therefore, can have both direct and chronic effects on aquatic life. At the top of the food chain – especially in the coastal area of west Africa where seafood is a major part of the diet – bio-accumulation has direct consequences for the local population.

The effect of heavy metal pollution on the environment and the local population also means that the economy – including such sectors as fishing and tourism – can also be affected. Edorh plans, therefore, to collect not only biochemical data on industrial and non-industrial emissions and the distribution of heavy metals in the environment, but also biochemical and socio-economic surveys of the people that eat seafood.

Environmental and health data on the threats created by heavy metals are rare in Africa.

This part of the project is scheduled for the third year of the grant and will be assisted by the purchase of a thermal cycler that will help the laboratory to carry out genetic analyses in search of defects caused by heavy metals.

"The aim is to use statistical analyses to try and link the biochemical data to socio-economic data," explains Edorh. "If we can do this, we will have developed a strong argument for implementing controls on the emissions of heavy metals in the region.

"Our research unit in Benin is highly qualified," says Edorh, "and with some new equipment, such as a portable photometer purchased with funds provided by the TWAS grant, we will be able to detect cadmium and lead in many of our samples. To analyse the concentrations of other heavy metals, we intend to work with such partners as the Laboratory of Toxicology and Applied Hygiene, Bordeaux, France."

In developed countries, several models have been developed to help combat environmental pollution.

"Our efforts to find sustainable solutions to the problem of heavy metals in west Africa will only be fruitful if, in addition to a deep knowledge of pollution dynamics, we can develop similar operational tools, such as mathematical models, that will allow us to follow the evolution of heavy metal pollutants in the environment and predict their movements," says Edorh. "Such models are currently non-existent for our region and a central part of this project will be to develop such tools. This requires detailed understanding – gleaned from a massive input of data – of the mechanisms of accumulation and transportation of heavy metal pollutants in the environment and their spatial and temporal movements.

"Thanks to the TWAS grant, the study will be conducted over a three-year period," says Edorh. "At the end of this period, we expect to be able to affirm the state of heavy metal pollution in west African aquatic ecosystems and to have developed and tested a model to predict and simulate the dynamics of the different heavy metals. In addition, we hope to achieve our over-riding aim of promoting a concept of integrated management for natural resources and food security in the continent," he concludes. ■

MINISTER YUTHAVONG

• Yongyuth Yuthavong (TWAS Fellow 1991) has been appointed Thailand's Minister of Science and Technology. Yuthavong obtained his doctorate degree in organic chemistry in 1969 at the University of Oxford, UK. He subsequently taught and conducted research at Mahidol University, Thailand, where he was appointed professor of biochemistry in 1983. He also served as the first president of Thailand's National Science and Technology Development Agency (NSTDA) between 1992-1998 and led a group at the National Centre for Genetic Engineering and Biotechnology (BIOTEC) focusing on the development of new antimalarials. In 2006, Bangkok's *Nation* newspaper identified him as one of 35 most influential Thais of the past 35 years.

Yongyuth Yuthavong

RAJ PARODA

• Raj Paroda (TWAS Fellow 1997) has been appointed assistant director general of the International Centre for Agricultural Research in the Dry Areas (ICARDA). Located in Aleppo, Syria, ICARDA is part of the Consultative Group on International Agricultural Research (CGIAR). Ending a five-year term as regional coordinator of the Collaborative Research Programme for Sustainable

Raj Paroda

Agricultural Production in Central Asia and the Caucasus (CAC), ICARDA, in Tashkent, Uzbekistan, Paroda says, "It has been a very satisfying experience to live and work in a region which is full of challenges and opportunities, and a region known for its rich biodiversity and civilization." Under his leadership, CAC made significant contributions to genetic resource conservation, seed production, natural resource management and capacity building. Paroda will now oversee activities involving international cooperation at the ICARDA Aleppo centre.

NEW NAS MEMBERS

• The US National Academy of Sciences (NAS) has announced the election of 72 new members and 18 foreign associates. Three TWAS members were among those chosen. Katepalli R. Sreenivasan (TWAS Associate Fellow 1998) was elected as a member and Ronald F. Woodman (TWAS Fellow 1989) and Zhang Qifa (TWAS Fellow 2000) were elected as foreign associates. Sreenivasan who directs the Abdus Salam International Centre for Theoretical Physics (ICTP), is an experimental physicist who has made significant contributions to the fields of fluid dynamics and turbulence. Woodman, who directs the Jicamarca Radio Observatory, *Instituto Geofísico del Peru*, has made major contributions to radar probing of the upper atmosphere, combining radio science with ionospheric and atmospheric research. Zhang is a plant geneticist and molecular biologist who currently heads the National Key Laboratory of Crop Genetic Improvement at Huazhang Agricultural University in Wuhan, China. His work has included the systematic analysis of the genetic diversity of world barley. For a full listing of the newest members of NAS, see: www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=05012007.

Zhang Qifa

JAGADISH SHUKLA

• Jagadish Shukla (TWAS Associate Fellow 1995) has been awarded the 52nd International Meteorological Organization Prize by the World Meteorological Organization (WMO) Congress. The awards ceremony will take place at the 59th session of the Executive Council held in Geneva, Switzerland. Shukla, who has made significant contributions to the understanding of the predictability of weather and climate, including Asian monsoon dynamics, deforestation and desertification, is professor of climate dynamics at George Mason University, Virginia, USA, and

Jagadish Shukla

president of the Institute of Global Environment and Society. He obtained his BSc, MSc and PhD from Banaras Hindu University, India, and DSc from the Massachusetts Institute of Technology. Other honours include the Rossby Medal from the American Meteorological Society, the Walker Gold Medal from the Indian Meteorological Society and the Exceptional Scientific Achievement Medal from the US National Aeronautics and Space Administration (NASA).

C.R. RAO

• Calyampudi R. Rao (TWAS Founding Fellow) has received an honorary doctorate degree from the University of Rhode Island, USA. He is being honoured for influencing not only statisticians but also scientists worldwide in a number of fields. The award also recognizes his ongoing efforts to promote the use of statistics in national security, industry, business and economics. Rao holds 31 honorary doctorates granted by institutions in 18 countries. He is a US National Medal of Science laureate, Eberly Family Chair emeritus in statistics and director of the Center for Multivariate Analysis at Pennsylvania State University. From 1972 to 1976, Rao served as secretary and director of the Indian Statistical Institute. He has been honoured with the Emanuel and Carol Parzen Prize for Statistical Innovation, Padma Vibhushan, and the National Medal of Science, USA. He is honorary fellow of seven institutes, associations and societies.

ATTA-UR-RAHMAN

• Atta-ur-Rahman (TWAS Fellow 1985) has been made honorary life fellow of King's College, Cambridge University, UK, for his achievements in academic research. Atta-ur-Rahman is the first Pakistani scientist to become a fellow of King's College. He is also the first scientist from the Muslim world to win the UNESCO Science Prize. Atta-ur-Rahman obtained his PhD from Cambridge University in 1968 and later received an honourable DSc by the same institution. He now holds a federal ministerial post responsible for higher education in Pakistan and serves as adviser on science and technology to Pakistan's Prime Minister. He is also president of the Pakistan Academy of Sciences, coordinator general of the Committee on Science and Technological Cooperation (COMSTECH) in Islamabad, Pakistan, and director of the Husain Ebrahim Jamal (HEJ) Research Institute of Chemistry, Karachi, Pakistan.

Calyampudi R. Rao

Atta-ur-Rahman

IN MEMORIAM: PAULO C. CAMPOS

• Paulo C. Campos (TWAS Fellow 1988) died on 2 June 2007 in Manila, Philippines. He was 85. Campos was known for his work in nuclear medicine, covering such topics as insulin action, red cell studies and genetic factors in endemic goitre. He obtained his medicine degree from the University of the Philippines (UP) in 1946 and completed postgraduate studies at the Harvard and Johns Hopkins Schools of Medicine and the Oak Ridge Institute of Nuclear Medicine. He returned to the Philippines in the late 1950s to establish the country's first Nuclear Medicine Laboratory, Radioisotope Laboratory and Thyroid Clinic. Campos also founded the Medical Centre Manila, the De La Salle University-Dasmariñas and the Emilio Aguinaldo College in Manila. The Philippine Association for the Advancement of Science named him Outstanding Scientist (Gregorio Y. Zara Award) in 1969 and the National Academy of Science and Technology elected him as a member in 1978. Campos is survived by his wife and three children.

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 89 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.

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

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

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 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