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TWAS newsletter

THE NEWSLETTER OF THE THIRD WORLD ACADEMY OF SCIENCES

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Summit and Beyond

The number of people attending the World Summit for Sustainable Development (WSSD), some 65,000 in all, ensures that the event, scheduled to take place from 26 August to 4 September 2002, will draw extensive media coverage. Yet, for all the immediate attention that it receives, the full impact of the WSSD will ultimately be measured over time through the effectiveness and staying power of long-term capacity-building programmes that take place far away from the media spotlight.

The Third World Academy of Sciences (TWAS) has been an active participant in many of the activities leading up to the WSSD, including the preparatory meetings held in New York City and Bali, Indonesia. And it plans to be an active participant in the WSSD as well, especially at the 'science forum,' which will be held during the summit's first week. After all, TWAS has been at the centre of capacity building efforts in science and technology since its earliest days nearly two decades ago.

For these reasons, the Academy believes that it has a great deal to contribute to the WSSD – and, more importantly, to the activities likely to follow. That's because two of the prevailing bywords of the WSSD – capacity building and partnerships – have always been at the heart of TWAS activities and promise to be at the heart of WSSD-related activities too.

This special double-volume edition of the TWAS newsletter focuses on core Academy activities – TWAS award, research grant, fellowship, and professorship programmes, and Academy-sponsored conferences, meetings, and publications – that have been the hallmark of TWAS since its beginning. This edition also focuses on other Academy-related initiatives – for example, the production of a series of profiles examining best practices in the application of science and technology launched by TWAS's affiliated organization, the Third World Network of Scientific Organization (TWNSO); an advanced-degree programme for young women scientists in the developing world that is led by the Third World Organization for Women in Science (TWOWS), another organization closely associated with TWAS; and the work of the

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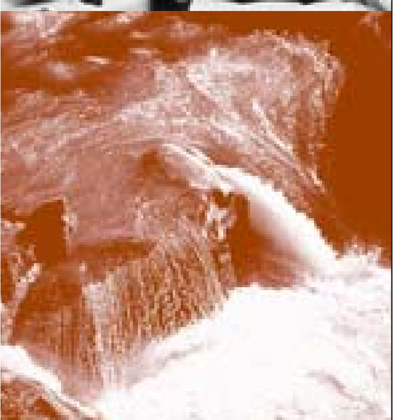
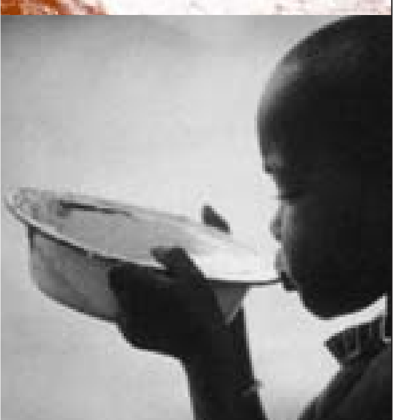


InterAcademy Panel (IAP), a network of 85 science academies from around the world dedicated to helping academies gain a stronger voice for science-related issues in their own countries.

TWNSO, TWOWS, and IAP are all located on the campus of the Abdus Salam International Centre for Theoretical Physics near Trieste, Italy, which has been home to TWAS since 1983. Together, these organizations, all of which have received generous funding from the Italian government, have come to form a unique institutional network dedicated to the advancement and applications of science in the developing world.

What follows is a series of articles highlighting the work of TWAS and its affiliated organizations, focusing largely on the organizations' long-standing commitment to capacity building for sustainable development. These articles highlight efforts that span the entire developing world – from the Caribbean to Cameroon and from China to Chile. And they deal with subject matter that ranges widely from biotechnology to climate change to fiber optics. We have chosen to explore these places and these issues by examining the work of scientists and scientific institutions that TWAS has helped along the way, hoping to show that our efforts have mattered by enabling people to acquire the skills and resources that they need to succeed.

We believe that two important insights, worthy of consideration at the WSSD, emerge from these stories. First, capacity building for sustainable development should be viewed as an investment that pays handsome dividends over time; and, second, the work that we have done and the modest contributions that we have made to science-based sustainable development could not have been accomplished without the close and continuous cooperation of our global, national, regional and local partners. We are proud to count the family of United Nation agencies among our closest allies and we are equally delighted to be working closely with a growing list of science ministries, academies, research institutions, universities and grassroots organizations seeking to move science to the forefront of sustainable development efforts throughout the developing world.

TWAS and its affiliated institutions wish the organizers of the WSSD much success in their endeavors. Equally important, we look forward to working with the countless institutions that will participate in the WSSD and will likely be involved in the planning and implementation of follow-up activities in the years ahead.

In short, we present the following account of initiatives by TWAS and its affiliated institutions as a series of snapshots detailing what we have been doing to promote the goals of science-based sustainable development that we all share. We hope that you find the stories intriguing, insightful and instructive.

BACK TO BASICS

THE CONCEPT OF SUSTAINABILITY MAY BE DIFFICULT TO DEFINE, BUT TWAS'S PRESIDENT, C.N.R. RAO, CONTENDS THAT ITS ADVANCEMENT DEPENDS ON SOME VERY BASIC PRINCIPLES: THE PROMOTION OF SCIENTIFIC LITERACY FOR ALL CITIZENS.

At its core, science deals with the unfettered human exploration of nature and the universe. Science also represents an informed attitude towards natural phenomena and even life itself. Like history, literature and economics, science is an important part of our knowledge base.

For these reasons, among others, science has increasingly become an essential part of our language and culture vying on a global scale with sports, music and popular art.

While most people commonly mistake the direct – and indirect – benefits derived from science, which now reach into every corner of our world, for science itself, we must also recognize the importance of science, as distinct from technology, in all human endeavours, including in the quest for sustainable development.

Without an awareness of our new science-based vocabulary, it is difficult for anyone to carry on an effective and engaging conversation in today's world. Think about how different a dialogue would be for individuals unaware of computer science, biotechnology, space exploration, and nuclear discovery and research. Not only does science inform the subject matter of our discussions but it helps to create the imagery and metaphors that give life to our language, perceptions and thought.

To address the critical issues and problems that are part of all of our everyday lives, every citizen of the world must have essential knowledge of science and a fundamental sense of what science is and how it operates. As a result, every country, however small or poor, must develop an appropriate and enduring scientific base of knowledge not only for citizens who pursue science as a career but for all citizens regardless of how they choose to earn their living.

Indeed while investments in scientific infrastructure and trained personnel depend primarily on a nation's long-term vision and goals, there is little doubt that every country must make adequate investments in science education to create an informed and vibrant citizenry. In fact, only through science-based education can people gain the self-confidence and self-esteem they need to succeed in the 21st century. This fact is especially true for the under-privileged who constitute a majority of the world's population.

That is why I believe that the most important component of scientific capacity building for sustainability relates to science-based education at primary and secondary school levels and to efforts designed to overcome adult illiteracy. Such initiatives should prove especially important for women because in most nations women shoulder primary responsibility for nurturing healthy families and sound societies as a whole.

The other critical aspect of capacity building for sustainability deals with the development of minimal (or should I say optimal) training of teachers, at all school levels, and the training of personnel involved in such critical national needs as health care, and resource, energy and information management – all of which have critical scientific components.

If all countries paid adequate attention and invested sufficient resources in such science-based capacity building efforts, the gaping inequalities currently existing between and within nations would more likely diminish. While economic inequalities would not be eliminated entirely, most human beings would begin to feel a sense of social equity – indeed of belonging – because the knowledge that they acquired and the language that they used would become comparable to others.

This is one of the primary strategies that we have at our disposal to effectively minimize global disparities, laying the foundation for a more peaceful and secure world in which the majority of the people develop a healthy and rational attitude towards their own life and the lives of their fellow human beings.

Because the concept of sustainable development requires judicious use of resources, a proper balance between production and consumption, long-term protection of the environment, and ready access to the global information-base, the ideal of sustainability can only begin to be realized when a majority of the world's population acquires sufficient knowledge and appreciation of both the complexity and promise of science-based development. It is in this realm that science education can contribute mightily to one of the most critical issues of our time.

Consequently, the importance of an adequate science education for all citizens should not be overshadowed by our preoccupation with what may appear to be more immediate social and economic problems – for example, poverty alleviation, public health and water management. All of these issues would be better served by scientifically literate citizens and a critical mass of well-trained scientists in all countries.

In the meantime, TWAS and other scientific institutions directly involved in scientific capacity building as a core responsibility, should determine what exactly we want to convey to our fellow citizens.

What is that core message about science that each person should receive? What are the rudimentary scientific concepts and skills they need to understand and appreciate to live comfortably in the world in which we live – and, equally important, to participate effectively in the decision making process? And what fundamental lessons of science should scientists be transmitting to the public, especially to children?

True, the agenda is an ambitious one. Yet that is why it is a challenge worthy of the high ideals and ambitious goals of the World Summit on Sustainable Development (WSSD) in Johannesburg. The time to start is now.

C.N.R. Rao
President
Third World Academy of Sciences
Trieste, Italy

PARTNERS

SCIENCE ON SUSTAINABILITY

FIVE INTERNATIONAL SCIENCE ORGANIZATIONS, INCLUDING TWAS, HAVE ISSUED A REPORT FOR THE JOHANNESBURG SUMMIT EXAMINING THE ROLE AND CONTRIBUTION OF THE SCIENTIFIC COMMUNITY ON ISSUES RELATED TO SUSTAINABLE DEVELOPMENT.

The transition towards sustainable development is inconceivable without science. That is the 'take-home' message of the 17-page report, the *Role and Contribution of the Scientific Community to Sustainable Development*, which was submitted last December to Kofi Annan, Secretary General of the United Nations. The report is one of nine "dialogue" papers that have been prepared for the upcoming World Summit for Sustainable Development (WSSD), which will take place in Johannesburg, South Africa, 26 August to 4 September 2002. Many observers view the summit as a global 'checkup' on the state of sustainability a decade after the Rio Earth Summit. The event is expected to draw more than 65,000 participants from around the world.

"We are delighted to be deeply involved in the WSSD," explains Thomas Rosswall, executive director of the International Council for Science (ICSU). "The summit itself," Rosswall adds, "is designed as a 10-year assessment of the significant advances that have been made – and the daunting challenges that remain – in devising an effective global strategy for sustainable development."

"While no one denies that science and technology are critical factors in economic development, the voice of scientists and technologists has often been muted in policy discussions. "This report," says Rosswall, "is intended to raise the level of participation of the S&T community in policy debates concerning applications of science and technology for sustainable economic growth."

The *Role and Contribution of the Scientific Community to Sustainable Development* was prepared under the direction of ICSU and the World Federation of Engineering Organizations (WFEO). The Third World Academy of Sciences (TWAS), the InterAcademy Panel for International Issues (IAP), both located in Trieste, Italy, and the International Social Science Council (ISSC), in Paris, were asked to join the effort, which is one element of a larger WSSD-related effort, led by ICSU, that is being funded by the David and Lucile Packard Foundation.

"Our report," notes Lee Yee Cheong, president of WFEO, "focuses on the themes found in Chapter 31 of Agenda 21, the framework for action agreed upon at the Rio Earth Summit in Brazil in 1992." Lee, who also serves as vice president of the Malaysian Academy of Sciences, adds that "the major themes of that chapter focus on the role of science and technology in development issues and the role that professional ethics should play in such efforts. Nevertheless," Lee continues, "the report has allowed us to examine a number

of broad-ranging issues that we think will be central to discussions that take place in Johannesburg."

"*The Role and Contribution of the Scientific Community to Sustainable Development*," observes Yves Quéré, co-chair of the IAP and foreign secretary of the French Academy of Sciences, "calls for a new contract between science and society in which S&T technology assume a key role in addressing issues related to social equity, poverty reduction and other primary social and economic concerns."

To advance such goals, Quéré notes, "scientists have an obligation to shape their research agendas to confront questions of basic human and societal needs." At the same time, "each nation has a responsibility to provide adequate funding, up-to-date research facilities and adequate career opportunities for its scientists."

No country can contribute to sustainable development unless it builds and maintains sufficient S&T capacity.

Specifically, the report calls on nations to:

• *Increase investments in science and technology and view such investments as fundamental aspects of their overall economic development strategies.* "Economists," notes Rosswall, "have consistently ranked investments in science and technology among the highest yielding investments that a nation can make. While developed countries consistently spend 2 to 3 percent of their annual gross domestic product (GDP) on science and technology, yearly levels of investment in developing countries have rarely exceeded 0.5 percent of GDP. This discrepancy in funding goes a long way in explaining the vast differences in economic and social well-being between the North and South."

• *Build and maintain scientific capacity to the point of establishing a critical mass of scientists.* As Mohamed Hassan, executive director of TWAS, notes, "no country can contribute to sustainable development unless it builds and maintains sufficient S&T capacity. The consistent levels of investments that Northern countries have made in developing their capacities in science and technology, in fact, help to explain their economic success."

Hassan also observes that "the sustained investments in science and technology recently made by countries such as Brazil, China, India and South Korea show that the surest path to economic growth lies in an unwavering commitment to scientific and technological capacity building."

While the least developed countries in the South are likely to find the experience of western European countries and the United States remote and difficult to emulate, developing countries that have successfully pursued science-based development could serve as models for others to follow. "South-South cooperation," Hassan notes, "may well be the key that opens the door to sustained science-based growth throughout the developing world."

• *Develop and share new and existing technologies that are directed towards sustainable production and consumption patterns.* "Sustainable development," says Lee, "must be linked to innovation. On the one hand, this requires greater investments in cutting-edge technologies that curb energy and other resource requirements in both production and consumption processes. On the other hand, applying new and existing technologies more effectively requires greater recognition of indigenous knowledge and the tailoring of technologies to fit local requirements."

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The science community must forge stronger partnerships with the social sciences and the private sector.

To reach these goals, Lee adds, "the science community must forge stronger partnerships with representatives from other fields of study, including the social sciences, as well as the private sector."

Ties with the former will help ensure that science-based strategies for development address the needs of people, while ties with the latter will help ensure ready access to capital and, at the same time, draw research agendas closer to everyday products and services.

• *Encourage the scientific community to participate in the decision-making process.* As noted in the report: "In an international arena increasingly defined by knowledge, in a global economy depending more and more on science and technology for its success, and in a world increasingly challenged by environmental and social problems that spill across political and social boundaries, scientists and engineers have an obligation to become more and more involved in sustainable development policy issues."

That means, as noted by Quéré, "the research findings of the scientific community must be presented in ways that can be understood both by policy makers and everyday citizens. It also means that the scientific community should be willing to engage in a continuous dialogue with the public on issues of mutual concern. Scientists must accept the fact that they do not have all the answers and the public must embrace science as one of the primary tools for solving society's most critical problems."

The *Role and Contribution of the Scientific Community to Sustainable Development* details the progress that has been made since the Rio Earth Summit in integrating science into the decision-making process. Specifically, the report cites the development of 'authoritative' scientific assessments – most notably, the series of reports issued by the Intergovernmental Panel on Climate Change (IPCC) – as among the most effective strategies for advising policy makers on critical social, environmental and economic issues. The *Role and Contribution of the Scientific Community to Sustainable Development* also highlights the increasing number of collaborative initiatives among international science institutions, including the preparation of the pre-Johannesburg document itself, as noteworthy steps that have helped to raise the presence of science in the policy arena.

"The global community has made significant strides in integrating science into the policy making process over the past 10 years," says Hassan. "Nevertheless we have fallen short in two critical areas: First, in finding ways to ensure that the fruits of science and technology are enjoyed by all people and, second, in communicating our knowledge and insights to a larger public."

"As a result," Hassan continues, "while science has experienced an unprecedented period of discovery over the past decade, the gap in social and economic well-being between the North and South has widened. At the same time, while the reach of science into every aspect of daily life expands across the globe, public skepticism about scientific research and its applications deepens."

"These are the critical issues that the scientific and technological community must address if it is to become a major player in discussions over the future of sustainable development," Hassan adds. "I know I speak for all of the institutions that have been involved in the preparation of this report when I say that our efforts are designed to help set the stage for a fruitful and productive dialogue at the WSSD in Johannesburg and to help shape the agenda of follow-up activities likely to take place in the years ahead." ■

For a copy of the full text of the report, see
Report of the Scientific and Technological Community to the World Summit on Sustainable Development *(WSSD)*
(Paris: ICSU Series on Science for Sustainable Development, No. 1, 2002)

STAYING POWER

MOROCCO-BORN MICROBIOLOGIST JAMAL IBIJBIJEN HAS USED HIS RESEARCH TRIPS TO BRAZIL TO LEARN NEW SCIENTIFIC TECHNIQUES FOR ENRICHING THE SOILS OF HIS NATIVE COUNTRY.

The Third World Academy of Sciences (TWAS) – United Nations Educational Scientific and Cultural Organization (UNESCO) Associate Membership Scheme, with additional funding from the OPEC Fund for International Development, seeks to build and sustain scientific capacity in a wide variety of fields by drawing on the growing strength of the South's leading research institutions. A cooperative venture between Morocco and Brazil offers a case in point.

The hallmark of the scheme, established in 1994, has been South-South cooperation.

The programme works like this: An institution in the South, recognized for its scientific excellence, selects a promising young scientist from another institution in the developing world to conduct research at its centre for several months. TWAS, with funds from UNESCO and the OPEC Fund for International Development, pays for the scientist's transportation to and from the institution. The Academy also provides a small stipend.

Meanwhile, the host institution, in addition to providing access to its research facilities, covers the cost of lodging and meals during the scientist's extended stay.

The exchange is subject to renewal helping to ensure that the cooperative venture can continue for several years. Currently, 87 centres of excellence from 21 different countries in the Third World participate in the programme.

What follows is a brief description of the experience of one recent Visiting Associate: Jamal Ibijbijen, professor of microbiology in the faculty of sciences at Moulay Ismail University, Meknes, Morocco.

Last year, Ibijbijen, who was educated in Morocco, France and Brazil, spent three months at the National Research Centre for Agrobiology (CNPAB/EMBRAPA) in Rio de Janeiro, Brazil.

Ibijbijen's visit enabled him to hone his skills in the science and art of plant mycorrhization and biological nitrogen fixation. At the same time, he established a wide range of close contacts with colleagues from South America that are likely to last a lifetime.

Ibijbijen plans to return to Brazil in 2003, under sponsorship from the same programme, to continue his research in soil microbiology and biochemistry. He is keen to enrich both his research capabilities and his

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nation's long-term strategies to improve plant yields in both agriculture and timber.

Such efforts, when multiplied by 40 grants each year, are helping to establish a broad network of individuals and institutions that is designed to lay a strong foundation for the promotion of science in the developing world. The ultimate goal is to build and sustain an intricate system for scientific research and development throughout the South based on the enduring principles of cooperation and information exchange.

Ibijbijen's collaboration with scientists in Brazil has helped him master the microbiological and biochemical techniques.

It doesn't matter if you are a farmer from Marrakech or Madras, chemical inputs are often a critical element of success," notes Jamal Ibijbijen, professor of biology in the faculty of sciences at Moulay Ismail University in Meknes, Morocco.

"Fertilizers," Ibijbijen adds, "are essential for initially boosting and then sustaining higher yields. And, at the beginning of the 21st century, if you are using fertilizers, you are in all probability using a heavy dose of chemicals."

The good news is that chemicals, when applied with scientific know-how and skill, enhance crop yields. As a result, they have become an important tool for combating global malnutrition and hunger. The bad news is that fertilizers inevitably have an adverse environmental impact on soil and water, endangering, over the long-term, both public health and the well-being of ecological systems.

Such chemicals also cost money – lots of it – which makes it more likely that only large-scale farmers, who can afford to purchase fertilizers, will reap the full benefits of their use.

As a consequence of all these factors, Ibijbijen contends that it is imperative that scientists develop environmentally friendly, inexpensive methods of improving soil fertility. That's where his association with the National Research Centre for Agrobiology (CNPAB/EMBRAPA) comes into play. The centre has emerged as one of the leading research institutions in the South in the development of biofertilizers as alternatives to chemical fertilizers.

"Biofertilizers," notes Segunda Urquiaga, a researcher at the CNPAB/EMBRAPA and one of Ibijbijen's chief collaborators, "are biological techniques designed to increase the robustness of plants without resorting to chemicals. The trick is to find biological mechanisms – for example, the nurturing of bacteria or fungi – that can actually improve the health of plants and their resistance to disease."

Nearly two-thirds of all nitrogen fixation in soils – a prime factor in determining a soil's fertility – takes place through biological nitrogen fixation. "Our job as researchers," says Urquiaga, "is to enhance such biological processes so that increased yields can be sustained without an excessive use of chemicals."

Those are exactly the fields that Ibijbijen is exploring in his research, which is targeted not only to the growth of agricultural plants but to the growth of shrubs and trees.

"Under natural conditions," he explains, "most plants form a symbiotic relationship with so-called 'arbuscular mycorrhizal' soil fungi. The plant offers the fungi, which live beneath the soil's surface, the nutrition that they need to survive. The fungi, meanwhile, aerate the soil, improve its texture and shield roots from water loss. This, in turn, promotes the uptake of nitrogen, phosphates and other micro-nutrients, leading to healthier, more vigorous plants that ultimately provide farmers with higher yields.

"The problem," says Ibijbijen, "is that in some soils (particularly poor soils), the population of mycorrhizal fungi is too low or the biological mechanisms under which they are operating are too inefficient to maximize the benefits of this mutually beneficial relationship." In a sense, researchers involved in such issues view themselves as 'soil marriage counselors' devising practical strategies to improve and strengthen the relationship in ways that enable both partners to work together harmoniously over the long term.

Ibijbijen's collaboration with fellow scientists at Brazil's CNPAB/EMBRAPA is intended to help him master the microbiological and biochemical techniques that lie at the heart of plant mycorrhization and biological nitrogen plant fixation processes. Such techniques require a host of skills.

"The first, and perhaps most important, step," Ibijbijen notes, "is to quantify – or, in scientific terms, to calibrate – the population of mycorrhizal fungi in the plant's roots. In effect, you cannot determine what to do until you know the level of fungi that exists naturally in the soil system that surrounds the plant."

For this step, scientists use a highly technical process known as chitin analysis that is based on a combination of microscopic observations and biochemical analyses. The process not only provides a 'fungi census' count but also projects what would be an optimal number of fungi for future plant health and growth.

"The technique has been utilized in Brazil to help improve biological nitrogen fixation among various plant species – for example, maize, wheat, soybean and sugarcane," says Urquiaga.

Ibijbijen, in turn, has learned how to apply this technique to plant species found in abundance in Morocco – for example, common beans (*Phaseolus vulgaris*) and other legumes; shrubs such as atriplex and bituminaria; and acacia and eucalyptus trees.

"The second step beyond chitin analysis," observes Ibijbijen, "is to 'infect' the plant with additional fungi and bacteria through a process known as inoculation."

"Here, we are still in the experimental stage," he adds, "and we won't be doing demonstrations in Morocco for some time. In fact, on my next visit to Brazil, scheduled to take place in 2003, I plan to learn how Brazilian scientists from CNPAB/EMBRAPA have moved their findings from

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the laboratory to the fields and from test tubes to the soil. That's where the research that I am doing will really pay off."

In the meantime, Ibijbijen will continue to pursue his analysis and publish his findings in professional journals, hoping to build a reputation in the field that will ultimately prove fruitful both for himself and for his native country.

His efforts are by no means relegated to the academic world. An estimated 70 percent of Morocco's arid soils are nutrient-poor and, due to a period of extended drought that began in the early 1990s (only one season in the past 10 has had adequate rainfall), the country has had to import nearly 50 percent of its foodstuffs each year over the past decade.

"We must devise solutions to the farming challenges we face that are both ecologically and economically sound," advises Ibijbijen, "and in light of recent trends in climate and weather we don't have much time to lose. Techniques associated with microbiology and biochemistry offer a proven area of success that we hope to tailor to our circumstances."

The TWAS-UNESCO Associate Membership Scheme programme, which also receives funding from the OPEC Fund for International Development, has helped him gain a strong foothold for eventually applying these techniques to benefit the soils and plants of Morocco.

As Urquiaga notes, with words that reflect the spirit and purpose of this South-South venture, "we at the CNPAB/EMBRAPA stand ready to work with Ibijbijen" as he continues to nurture a research agenda that is both grounded on good science and rooted to the needs of his nation and region. ■

For additional information about the TWAS-UNESCO Associate Membership Scheme, contact **Helen Grant**, *TWAS Secretariat c/o the Abdus Salam International Centre for Theoretical Physics (ICTP)34014 Trieste Italy; phone: + 39 040 2240387 fax: + 39 040 224559; e-mail: info@twas.org or visit www.twas.org*

About 70% of Morocco's soils are nutrient-poor; nearly 50% of foodstuffs have to be imported each year.

FELLOWS AND SYSTEMS

JUN ZHOU'S RESEARCH AGENDA HAS BEEN SHAPED, IN PART, BY HIS VISITS TO TRIESTE WHERE HE HAS BECOME A PRIME BENEFICIARY OF THE TRIESTE SYSTEM.

When people think of the Trieste System, they think of a small but vibrant network of international institutions dedicated to advancing science and technology in the developing world. Launched by Nobel Laureate Abdus Salam in 1964 with the establishment of the International Centre for Theoretical Physics (ICTP), the "system" now consists of a set of diverse organizations that includes the:

- *Third World Academy of Sciences (TWAS, founded in 1983).*
- *Third World Network of Scientific Organizations (TWNSO, founded in 1988)*
- *Third World Organization for Women in Science (TWOWS, founded in 1988)*
- *International Centre for Genetic Engineering and Biotechnology (ICGEB, founded in 1983).*
- *International Centre for Science and High Technology (ICS, founded in 1988).*
- *InterAcademy Panel for International Issues (IAP, founded in 1993; relocated to Trieste in 2000).*

All of these organizations, except for IAP, operate under the umbrella of the United Nations system and all, including IAP, receive generous funding from the Italian government.

Through its training and research activities and through a host of services that includes, for example, study fellowships, travel grants, diploma courses, awards, prizes, and a journals donation programme (recently expanded to an e-journals delivery service), the Trieste System offers Southern scientists the opportunity to keep pace with the latest developments in a wide range of disciplines. Long-running success in delivering such programmes and services has earned Trieste the title "City of Science."

But what is often overlooked by those who have examined the Trieste System is the fact that it not only provides help to the South's scientific communities but, equally important, that it serves as a nurturing place for individual researchers who can take advantage of the opportunities provided by Trieste's diverse scientific institutions. In this sense, Trieste is not just a city of science but a 'home away from home' for scientists, particularly scientists from the developing world.

Such has been the case for Jun Zhou, a physicist at Shandong University of Science and Technology, Taian, Shandong, China, who has participated in several Trieste-based research and training activities that have been instrumental in redirecting and advancing his career.

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In addition to his scholarly visits to the ICTP in Trieste, Zhou has received a TWAS research grant that has helped him to upgrade laboratory equipment so essential to his research. More recently, he has been appointed a fellow under the ICTP Training and Research in Italian Laboratories (TRIL) programme. This activity has allowed him to pursue his studies in Naples at the Institute of Cybernetics, which is part of the Italian National Research Council (CNR) .

Jun Zhou has pursued an unusual career path to arrive at his current position as professor and director of the Institute of Engineering Physics at Shandong University of Science and Technology, in Taian, Shandong, China, which is situated in the northeastern corridor of the nation about 450 kilometres south of Beijing.

His journey, in fact, has taken as many twists and turns as the recent history of China. As a teenage boy in the early 1970s, he was required to postpone his schooling to toil in the farm fields of rural China during the Cultural Revolution. As a young man in his early twenties, he was a member of China's post-Cultural Revolution class of 1977, competing with hundreds of thousands of his contemporaries (many of whom had been out of school for a decade) for a limited number of openings in China's newly unshackled university system.

As a young college-trained worker, with a bachelor's degree in physics (obtained in 1982), he began his career in industry-related research examining the critical everyday problems facing China's miners and mine operators (a position that he would hold for nearly 10 years).

One year after earning his doctorate in optics in 1996, he became a professor – the same year that his university was designated a full-fledged research institution, marking the successful conclusion to a campaign that had begun 20 years before.

"In many ways," Zhou notes, "my career path tracks the larger trends that characterize the recent history of China, including the increasing emphasis on education that has been a central part to the government's overall development policies for the past several decades."

Trieste is a 'home away from home' for scientists, particularly those from the developing world.

While the recent events in Zhou's career would not have been possible without the dramatic changes that have taken place within China, it is also fair to say that none of his good fortune would have been possible without the help provided by the Trieste System, particularly through the Abdus Salam International Centre for Theoretical Physics (ICTP) and TWAS.

"I did not know anything about ICTP until the autumn of 1997 when I learned about the Centre's winter college on optics from a flyer announcing the event posted on a wall outside my office. I applied and was lucky enough to be one of 80 researchers who was accepted. Participation in the course coincided with dramatic changes in my own career. These career changes, in turn, paralleled fundamental changes taking place at my university, which gained new status as a research university in 1999."

At the workshop, Zhou met several ICTP scientists, including Gallieno Denardo, head of the ICTP External Activities programme and the driving force behind the Centre's training programmes in the physics of optics, and Giuseppe Furlan, head of the Centre's Training and Research in Italian Laboratories (TRIL) programme. Both would prove instrumental in Zhou's future research endeavours.

Since then, Zhou has attended an ICTP workshop on thin film physics and a conference on microstructure and surface morphology evolution in thin films. He has also received a TWAS research grant for a project titled, "The nonlinear optical characteristics and optical switching effects of polymer waveguides." The TWAS grant laid the groundwork for investigations that have since earned Zhou two awards: third prize for contributions to scientific and technological progress from the Xinjiang Uygur autonomous regional government of China (1999) and second prize for scientific research from Shandong's provincial government of China (2001).

Zhou's most recent research has focused on polymer materials that can be easily fabricated into thin films. Such materials are proving valuable for both optical and electro-optical applications in the burgeoning field of telecommunications because of their ability to transmit light signals without a substantial loss of energy or significant distortion.

His basic research agenda, however, has been far removed from the real world of commercialization. For him, the challenge has been to try to determine the fundamental optical properties of various polymers and films that are subject to laser and electronic impulses.

"What I do is part theoretical and part experimental," Zhou explains. "For me, the issue is always one of knowledge – gaining a better understanding of the behaviour of polymers and films, and observing their behaviour under controlled laboratory conditions. I leave it to others to determine how this data and information may prove to be of use in the world of lasers and photonics that lie outside the laboratory."

Zhou's own world of pulse lasers, spectrometres, and analysers is defined by such unusual terms as nonlinear optical coefficients, optical qualities and propagation losses for channel waveguides. It is a world in which equipment plays an important role. "Without the proper equipment, it is impossible to conduct the right experiments to advance your research," notes Zhou.

And that's where TWAS's research grant programme has proven so critical. "I simply did not have the appropriate equipment to conduct sophisticated experiments in my laboratory. In fact, I was relying on my ties to the City University of Hong Kong to move my studies ahead. I visited the university several times between May 1999 to August 2000 to conduct experiments and then carried the data back to my office in Shandong for analysis. I was glad to have the opportunity to work there but I always knew having better equipment at home would be more convenient and efficient."

The equipment that he purchased with the TWAS research grant is quite basic. However, it is difficult to underestimate its value to his work. As Zhou notes: "It has allowed me to measure the absorption and refractive indexes of the polymer films that I had fabricated, providing more continuity and flexibility to my day-to-

[CONTINUED PAGE 16]

The Trieste System has proven to be invaluable for building scientific capacity in the South.

day research. It simply means that I have been able to learn more, and to learn it faster."

Such in-house activities have not prevented Zhou from continuing his collaborative work with the City University of Hong Kong. In fact, the university's high-powered pulse laser, which is far more expensive and sophisticated than the equipment in Zhou's laboratory, has enabled him to examine the nonlinear properties of polymers and films. That, in turn, has made it possible for him to push a portion of his research agenda to the cutting edge of inquiry, reflected by the fact that his research results have recently been published in international journals.

"In an unintended way," Zhou notes, "the TWAS research grant helped me to continue my collaboration with the City University of Hong Kong. That's because the research on linear measurements that I began in my own university – that was made possible by the equipment purchased with funds provided by TWAS – set the stage for the more advanced nonlinear research and measurements that I subsequently did in Hong Kong. In effect, City University of Hong Kong said to me: You're off to a promising start; please continue your work here – and so I did."

In late 2001, Zhou earned his stripes as a honorary member of the Trieste System when he arrived in Naples, Italy, to pursue even more advanced laser research on polymer films at the Institute of Cybernetics, part of the Italian National Research Council (CNR). His one-year fellowship was made possible by a grant from the ICTP Training and Research in Italian Laboratories (TRIL) programme.

"My work here in Italy represents a continuation of the research that I have been doing for the past four years or so – this time, however, with more advanced equipment than ever before."

Zhou is again engaged in a quest for knowledge: He fabricates different polymer films and then examines their optical and electronic properties. His ultimate goal is to try to determine which of the fabricated polymer films experiences the smallest loss of laser power and thus which films respond the fastest when subject to laser impulses and electronic fields.

"China," Zhou observes, "is committed to advancing its educational system as a primary strategy for creating a highly skilled workforce capable of succeeding in today's high-tech global environment. ICTP, TWAS and the rest of the Trieste System provide a valuable means for accelerating this process while simultaneously improving North-South cooperation in science and technology. The Trieste System has proven to be an essential framework for building scientific capacity in the South at both the individual and institutional level. My personal experience is living proof of its success." ■

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B.S. NGUBANE, SOUTH AFRICA'S MINISTER OF ARTS, CULTURE, SCIENCE AND TECHNOLOGY, TALKS ABOUT HIS NATION'S EFFORTS TO BUILD A FUTURE OF ECONOMIC WELL-BEING AND SOCIAL HARMONY THROUGH A SUSTAINED COMMITMENT TO SCIENCE AND TECHNOLOGY.

The peaceful transition of South Africa from an oppressive apartheid regime to a multiracial democratic society is truly one of the great success stories of the late 20th century.

Despite the enormous progress that has been made, however, the legacy of the past continues to cast deep shadows over the nation as it seeks to dramatically reform its institutions and invigorate its economy. As a result, much remains to be done to ensure a more secure and prosperous future.

SOUTH AFRICA'S SCIENCE-BASED FUTURE

In South Africa, poverty plagues both urban and rural areas. A deep 'white-black' divide, reflected in vast differences in income, education and living conditions, persists. Substandard housing and inadequate infrastructure burden vast segments of society. The public health system is woefully deficient and educational reform must continue to ensure improved career opportunities for its black youth. And South Africa, for so many decades isolated from the rest of the continent because of its racist policies, must work diligently to earn the trust of its neighbors.

What role should science and technology play in the ongoing efforts to address such critical issues? Here, South Africa's past ironically provides a foundation of flawed and twisted strengths that must be radically reconstructed, but not totally abandoned, if science and technology are to serve the needs of its democratic society in the years ahead.

In 1996, the South African Ministry of Arts, Culture, Science and Technology produced a 30-page White Paper on Science and Technology, *which outlined a 'national strategic vision' to advance science and technology 'for the purposes of addressing national needs.' The report sought to outline a comprehensive plan to put science to work on a host of social and economic problems by making better use of South Africa's human and natural resources. Specifically, the report called for applications of science and technology to increase the nation's economic competitiveness, to nurture sustainable development, and to achieve greater racial and gender equity. Spurring innovation by encouraging and rewarding the talents of its people served as the centrepiece of the report's conclusions.*

Baldwin Sipho Ngubane was reappointed Minister of Arts, Culture, Science and Technology in 1999 (he had held the same title from 1994-1996). Educated at St. Francis College, University of

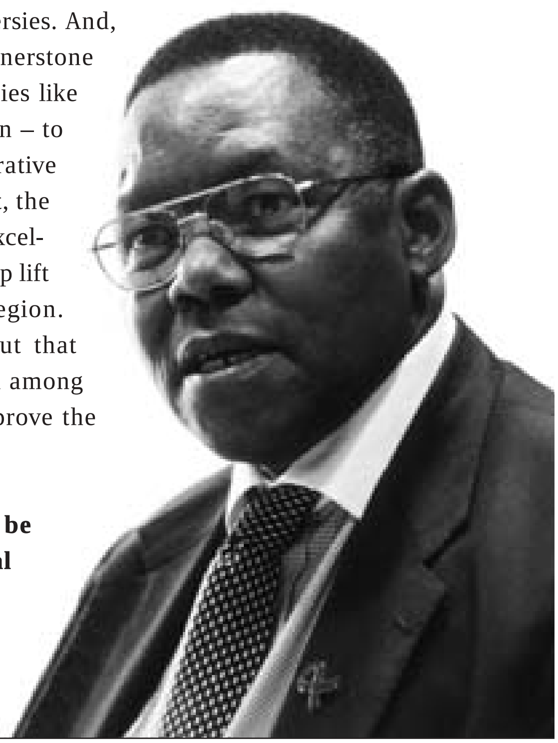
Witwatersrand, and Durban and Natal Medical Schools, Ngubane has spent the past decade examining the role that science and technology can play in helping both South Africa and the rest of the continent clear a path to sustainable economic development. In April 2002, the editor of the TWAS Newsletter *had an opportunity to discuss the current state of science and technology in South Africa and the progress that has been made in fulfilling the 'strategic vision' first presented in the* White Paper on Science and Technology *six years ago. Excerpts from the 45 minute interview follow.*

What have been South Africa's short-term goals for the promotion of science and technology? What steps have been taken to achieve these goals? What are the nation's long-term goals for science and technology and what do you think will be the key factors for success?

These are complex issues for which there are no easy answers. As outlined in the 1996 *White Paper on Science and Technology*, investment in human resources is a critical issue not just in South Africa but throughout the entire continent. That means investing in education at all levels from primary schools to postgraduate university study. It also means investing in research and training activities for both scientists and technicians throughout their careers. And it means fully utilizing the research facilities that were built during the era of apartheid in ways that tap the full potential of all South Africans – as well as upgrading and building new research facilities to ensure that our nation keeps pace with the rapid progress taking place in all fields of science. And, finally, it means promoting innovation in the public and private sectors through a variety of measures, including encouraging the international exchange of scientists and technologists, furnishing access to the most up-to-date scientific information, making available sufficient amounts of capital for investment, and establishing a system of reward that recognizes scientific creativity and cutting-edge technological know-how. But the fact is that African nations – even nations like ours that have reasonably strong scientific infrastructures – cannot attain progress on their own. We need help from other nations and international organizations. That is why we have placed such enormous value on the scientific research and training network in Trieste – the Abdus Salam International Centre for Theoretical Physics (ICTP), the Third World Academy of Sciences (TWAS), the International Centre for Genetic Engineering and Biotechnology (ICGEB), and other Trieste-based international organizations that are devoted to the promotion of science and technology in the developing world. For the same reason, we were delighted to host a meeting of Trieste's and South Africa's scientific communities in Cape Town, this March, that was attended by President Carlo Azeglio Ciampi of Italy and President Thabo Mbeki of South Africa. The meeting resulted in a memorandum of understanding that will undoubtedly lead to more wide-ranging cooperation between the two countries in the future. The European Union has also provided opportunities for South Africa's scientists to pursue research in world-class facilities abroad. However, it is the Trieste System's research and training programmes – its annual workshops, conferences, schools and seminars in physics, mathematics and increasingly other topics, including the physics of weather and climate, earthquake risk assessment, and ecological economics – that have been among the most useful capacity-building tools for our researchers, especially for our young researchers. In fact, we view our access to Trieste's training and research activities – access that was prohibited during the era of apartheid for moral and ethical reasons – as a significant contributing factor to our recent progress in science and technology.

How much integration would you like to see between South Africa's science and technology communities and the scientific and technological communities in the rest of Africa? What steps have you taken to move in that direction? What obstacles do you face in achieving even greater integration?

African nations with the highest levels of scientific and technological capacity, such as my own nation, must take the lead in promoting science and technology throughout the continent. Other nations – for example, Kenya, Nigeria, Senegal and Tanzania – could play similar roles in areas of science where they have achieved some success. The important principle to remember in forging these partnerships is that those taking the lead cannot impose their ideas on their neighbours. Rather, they must work with their neighbours to develop relationships that take advantage of national strengths in science and technology while remaining sensitive to the significant differences that exist among African nations due to variations, for example, in historical circumstances, economic wealth, natural resources, political structures and educational systems. The good news is that Southern countries, including those in Africa, have recently made significant strides in coordinating their efforts in science and technology and that regional cooperation is much more prevalent today than it was a decade or two ago. This positive trend is due, in some measure, to bilateral agreements and, in some measure, to the work of such groups as the Third World Network of Scientific Organizations (TWNSO), headquartered in Trieste, which has been one of the most effective proponents of South-South cooperation. Developments over the past several decades raise two important points. First, the best paths to South-South cooperation may often be cleared by such third-party intermediaries as TWNSO that can bring together scientists and scientific institutions from different countries without being burdened by history or sidetracked by present-day political controversies. And, second, regional leadership in science and technology has been a cornerstone of progress in other continents, most notably Europe, where countries like Germany and France have helped other nations – for instance, Spain – to upgrade their scientific expertise and infrastructure through cooperative research frameworks established by the European Union (EU). In fact, the scientific and technological frameworks adopted by the EU offer an excellent example of how partnerships among neighboring nations can help lift the scientific and technological capabilities of an entire region. Undoubtedly, vast differences exist between Europe and Africa, but that does not mean a strategy for scientific and technological cooperation among African nations, based on Africa's circumstances, could not help improve the state of science and technology throughout the entire continent.



South Africa's science and technology community continues to be dominated by whites. How do you hope to achieve greater racial balance both in the short- and long-term?

The government of South Africa is determined to achieve racial balance among its staff within all institutions, not just institutions focusing on science and technology. And we are determined to reach this goal sooner rather than later. Yet, it is also true that part of the dreadful legacy of apartheid is that all positions of responsibility were restricted to whites. If experience is a criteria one uses in hiring – and I think we would all agree it is a factor worthy of consideration – then the potential pool of black candidates for any given position can often be quite small. This problem has been compounded by vast imbalances in the dual 'black-white' educational systems that characterized South Africa in the past. The fact is that we cannot – and, in fact, should not – dismiss our existing people – not just for humane reasons but because they are part of our human resource base and should be able to continue to make valuable contributions to our overall efforts at promoting science and technology. What we can do, however, is to invest in our educational system to ensure that present and future generations of South Africans – black and white – are given ample opportunities to learn and excel. And that is what we have done in areas ranging from primary schools in villages and towns across the nation to master's and doctorate programmes in historically black institutions of higher education. It will take some time to see the full results of our efforts. But progress is apparent, for example in the ever-increasing number of blacks appointed to high-level management and administrative positions. Apartheid distorted life and work in South Africa for decades and its legacy cannot be erased over night. We believe that one of the best way to overcome this legacy and to create a brighter future is to ensure that appointments and financial rewards in the work place are based on the quality of one's work and accomplishments and not on the colour of one's skin. And one of the best ways to achieve this goal is to improve our national system of education and training from top to bottom, especially for our majority black population.

Could you describe the mandate of the New Partnership for African Development (NEPAD)? What role will South Africa play in this initiative? How do the goals and strategies of NEPAD differ from previous pan-African initiatives?

The New Partnership for African Development's (NEPAD) mandate is to find a 'holistic, comprehensive, integrated, strategic framework for the socio-economic development of Africa.' That is a large order. Other pan-African initiatives, which have been framed by lofty (some would say, bloated) rhetoric, have fallen far short of their goals. But I believe that NEPAD could lead to a different, more positive, outcome for several reasons. First, previous pan-African efforts failed to devote sufficient attention to the development of human resources. Second, these efforts did not give their full due to the critical role that science and technology plays in socio-economic development. Third, they often proved too insular, concentrating much of their resources and time on strictly national issues and not enough on global trends in economics, science and technology. NEPAD, in contrast, calls for strong partnerships with the Group of 8, the world's richest nations, and it seeks to encourage international private investments in Africa as well. It also focuses on regional partnerships that would enable African nations to help one another. There is no doubt that NEPAD is driven by Africa's leaders and that its agenda is based on Africa's needs. Nevertheless, NEPAD's most ardent proponents, which include the presidents of South Africa, Nigeria, Algeria, and Senegal, actively encourage both bilateral and multilateral partnerships within and beyond Africa. In fact, they envision these partnerships as critical elements of the overall strategy for success. Such a framework carries importance for two reasons: First, it is based on the notion that science and technology should be closely linked to economic development. And second, it views coordinated regional- and even continental-wide action as key elements in any effort for sustainable economic growth. If NEPAD succeeds it will be, in part, because of the emphasis it has placed on science and technology as a cooperative enterprise intricately connected to economic development issues.

What are your views of the World Summit on Sustainable Development (WSSD)? As the host country for this event, what do you hope this global event will accomplish?
South Africa is, of course, delighted to serve as the host nation for this event. Some 65,000 individuals from all corners of the earth and all walks of life are expected to attend. It will mark the largest global gathering since the UN Conference on Environment and Development (the Rio Earth Summit) held in Rio de Janeiro in 1992. In fact, the WSSD is designed, in part, to assess what has happened to our global environment and economy (for better or worse) since then. We in South Africa hope to take advantage of this opportunity to showcase the progress that has been made in South Africa since the peaceful end to apartheid in a wide variety of fields ranging from politics to education to science and technology. We plan to discuss our commitment to science-based sustainable development not just as an abstract concept but as a strategic instrument essential for shaping practical policies and programmes. But beyond these important goals, the WSSD will give the global community a unique chance to examine the linkages between poverty, environmental degradation, public health and education. We hear a great deal about the need for political and economic reform as prerequisites for sustainable economic growth. The dramatic changes that have taken place in South Africa since the demise of apartheid provide no better example of the importance of such linkages. Yet, our efforts – and like-minded efforts by many other developing countries over the past decade – to promote science and technology as critical elements in the South's overall economic development strategies also provide valuable lessons for a world endlessly searching for solutions – often without success – to some of its most critical and intractable problems. The challenges in overcoming poverty, disease and hopelessness are enormous. But I think we have recently made notable progress in our understanding of the long-range strategies that might work. Education, training, the promotion of science and technology, and bilateral and multilateral cooperative agreements all add up to a blueprint for reform that could have a lasting impact on the quality of life throughout the developing world and especially in Africa. As Kofi Annan recently noted, he hopes the WSSD can show the world 'what works.' That's a hope that the world fervently shares.

ANY GATHERING OF 65,000 PEOPLE – THE NUMBER OF PARTICIPANTS EXPECTED AT THE WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT (WSSD) IN JOHANNESBURG – IS BOUND TO GENERATE AN EXTRAORDINARY RANGE OF OPINIONS. TWAS HAS ASKED A CROSS-SECTION OF PEOPLE REPRESENTING THE ACADEMY'S BROAD COMMUNITY OF INSTITUTIONAL PARTNERS TO LEND THEIR VOICE TO THE DISCUSSION. THE QUESTION: WHAT ARE THE MAJOR CHALLENGES FACING THOSE WHO ADVOCATE SUSTAINABLE DEVELOPMENT? HERE'S A SAMPLING OF WHAT THEY HAD TO SAY.

VARYING VIEWS

TODAY'S FUTURE

The greatest challenge that human beings may ever face is being faced today: What future awaits today's youth as well as future generations in their efforts to create an equitable and dignified way of life for the estimated 9 billion people that will be living on earth by mid-century? The fact that this challenge often remains in the shadows of other, more immediate, concerns makes it no less compelling. This issue, moreover, relates directly to the sustainability of our present way of life – specifically, the means by which the nearly 4 billion people who now live in utmost poverty will attain more decent living standards, while we simultaneously put conditions in place to enable future generations to enjoy even better and more equitable living conditions. This is the challenge of sustainable development, a concept based on the constraints imposed by the geophysical, chemical and biological components of the environment, but one also strongly influenced by issues related to the social sciences. Moving sustainability forward requires virtually everyone's participation because everyone shares some responsibility for the environmental problems that affect us. Scientists have a critical role to play too. While societal considerations will supply the framework for building solutions for sustainable development, it will be impossible to pursue effective governmental and industrial actions and to monitor their effects without access to a solid and reliable base of scientific information. This will be particularly true for developing nations and their scientists. In this respect, the Third World Academy of Sciences (TWAS) may play a key role not only as a catalyst for action in scientific communities in the developing world, but also as a clearinghouse for information and expertise on issues that could help propel sustainable development throughout the South.

José Sarukhán
National Coordinator, CONABIO-National Commission for the Knowledge and Use of Biodiversity
Advisor to the President of Mexico, Mexico City, Mexico

WOMEN CENTRE STAGE

Environmental issues are a natural concern of women flowing directly from their family and household responsibilities. That is why I believe that women in general and women scientists in particular must hold centre stage at the World Summit on Sustainable Development (WSSD). Linkages between the environment, women and economic well-being are even more prominent today than they have been in the past. After all, polluted environments have led to food shortages and water degradation in a number of developing nations and that, in turn, has undermined the economic and social welfare of hundreds of millions of people. For all of these reasons, the WSSD must not focus solely on environmental issues, but must closely examine social issues as well, particularly to redress the gross inequalities between and within nations. Science and technology, which provide the tools for addressing problems of poverty, must also receive attention at WSSD. Here again, women must play a central role. By educating women in science and technology, you can help give them the tools that they need to tackle critical environmental problems. Such a strategy, in fact, may be the most direct way of promoting sustainability issues throughout the South.

Lydia Makhubu
Member, United Nations Secretary General Panel on the Summit for Sustainable Development
President, Third World Organization for Women in Science, Kwaluseni, Swaziland

CHILDREN, SCIENCE AND SUSTAINABILITY

The global environment is changing rapidly – and not for the better – as hundreds of new chemicals are being added to an already long list of environmental pollutants. Still more dangerous is the incursion of environmental estrogens and heavy metals since they directly affect human genetic material. Some people are more susceptible than others to these dangers, most notably children and the elderly. Because women worldwide are intimately involved in the rearing of children and caring of the elderly, they have expressed the most concern about these matters. The Third World Organization of Women in Science (TWOWS) should focus on these issues and, more importantly, devise programmatic initiatives to counter such risks. Additional funds for research on health and nutrition; childhood development; and public education and awareness should receive special attention. Risk assessment of environmental contaminants should serve as the focal points of such research projects. Data collected from such efforts should then be made freely available on the internet by TWOWS working together with the Third World Academy of Sciences (TWAS). I can think of no other initiative that would have a greater positive impact on the sustainable well-being of the global environment and the lives of millions of people in the developing world.

Kaiser Jamil
Vice-President, TWOWS
Emeritus Scientist, Genetic Toxicology, Mahavir Hospital and Research Center, Secunderabad, India

ACADEMIES AND SUSTAINABILITY

The Earth Summit, held in Rio de Janeiro in 1992, represented a commendable effort to address the most critical global problems confronting humankind. A decade later, while some progress has been made, global warming continues to pose a threat to our survival, and what has been described as 'the savage inequalities' between North and South continues to persist. The problems of global warming and poverty must be addressed if sustainable human development is to become a reality. The InterAcademy Panel (IAP) and, by extension, the scientific community at large have key roles to play in such efforts. Both the academy and the broader scientific community can help, as they have been doing in Africa, to build badly needed capacity in the South. The Caribbean region, including Colombia and Venezuela, has been unable to protect and sustainably use its biodiversity due to a lack of expertise, which could be developed with help from our scientific colleagues from outside our region. In addition, IAP can assist science-based efforts for sustainable development by helping to make new technologies, such as biotechnology and information technology, more accessible. Indeed IAP could serve as a coordinating centre for the scientific community's broad efforts for the creation of a knowledge-based society that embraces poorer countries. "The alternative," according to world-renowned historian Paul Kennedy, "is to perpetuate a world which is fundamentally undemocratic and structurally unsound."

Harold Ramkissoon
Foreign Secretary, Caribbean Academy of Sciences
Port of Spain, Trinidad and Tobago

GOVERNMENT'S ROLE

Governments worldwide should take the following measures to promote sustainable development: first, provide guidance for meeting sustainable development goals by promoting macroeconomic policies and programmes that recognize the importance of natural resources for long-term economic and ecological health of a nation; second, support economic and social development practices that bolster sustainable development through the enactment of appropriate laws and regulations; third, channel public investments towards projects, especially construction projects, that adhere to sustainable development principles; fourth, nurture and develop human resource capacities through investments in education in general and science and technology education in particular; and fifth, test and then highlight successful demonstrations of sustainable development that can serve as models for others to follow. Governments can also play a key role in this effort by enhancing public awareness of the goals of sustainable development through encouraging the media to pay special attention to sustainable development initiatives. ■

Guanhua Xu

Minister of Science and Technology, Beijing, China

SCIENCE AND SUSTAINABILITY

In May 2000, members of the InterAcademy Panel (IAP) pledged in their Tokyo statement their commitment to the goal of promoting science and technology for sustainability. Since then the US National Academies have taken a number of measures to fulfill this commitment. The academies, for instance, have been working with the US government to develop concrete themes for the World Summit on Sustainable Development (WSSD). The most significant themes include an assessment of the capabilities of international institutions for science-based decision making; an examination of prospects for capacity building, especially through North-South cooperation; and potential applications of geospatial data systems for sustainable development. US Secretary of State Colin Powell, in addressing the US National Academies' annual meeting this spring, emphasized the importance of science and technology for sustainable development. The academies will hold several events both before and after the WSSD, including (1) a roundtable workshop in June for senior US government officials to discuss the coordination of sustainability priorities, and (2) an October symposium on 'Linking Science and Technology with Sustainability Outcomes' as a follow-up to WSSD that will address potential strategies for translating sustainability science and technology knowledge into action. Additional activities will likely focus on the strategies for bringing the scientific community into closer partnership with the private sector; the InterAcademy Council's forthcoming report on capacity building in developing countries scheduled for publication in early 2003; bilateral projects with other academies; and prioritizing a research agenda for sustainability science-and-technology activities within the academies. It is an agenda that we hope will be worthy of this significant event and one that will help give the WSSD a life beyond this summer's summit. ■

Sherwood Rowland

Nobel Laureate in Chemistry (1995)

Foreign Secretary, U.S. National Academy of Sciences, Washington, DC, USA

DEVELOPMENT PLUS

The popularization of science, rooted in a strong educational system and an active media that serves as a viable and enduring channel for life-long learning, is the key to efforts for the promotion of sustainable development. Nowhere is this truer than in the developing world where progressive and effective steps towards sustainable development require all citizens to share the responsibilities and benefits that are inherent in this complex effort of critical importance. That is why Mexico's National Science and Technology Council (CONACYT) has promoted a multifaceted strategy that addresses each of these concerns by giving priority to educational reform and by encouraging newspapers and television stations to devote special sections and programmes to science and technology issues of significance not just to Mexico but to the global community. CONACYT has also called for the development of more sophisticated and reliable science and technology indicators to build valuable benchmarks that can help determine the progress we have made as well as the shortcomings that continue to hold back the nation's science and technology enterprise. Finally, all governmental bodies, including CONACYT, must devise sustainable development plans that are attentive both to infrastructure development and job creation, particularly at regional and local levels. Sustainability and development must go hand-in-hand if we are to achieve a proper balance between the needs of today's citizens and those of tomorrow.

Jaime Parada Avila
Director General, National Science and Technology Council (CONACYT)
Mexico City, Mexico

SCIENCE AND COMPLEXITY

Widespread and continual degradation of natural resources worldwide calls for a better understanding of the complex and dynamic relationship between nature and society. Improving our understanding of this relationship will require inputs from both the natural/applied sciences and social/human sciences. In this regard, academies can play a critical role in promoting new strategies for solving issues of societal relevance. The Indian National Science Academy (INSA) has frequently organized activities designed to encourage the scientific community to adopt new (namely, multi-disciplinary, multi-institutional) ways of organizing science activities. Academies must now play an even more aggressive role in catalysing the change that is required for enabling scientific organizations to respond effectively to issues of societal relevance. The role of academies should include:

- Creating greater awareness of the need to adopt new innovative approaches.
- Promoting change by nurturing interaction and dialogue among relevant partners.
- Identifying and prioritizing research themes with the greatest potential to address societal needs.
- Influencing institutions (including funding agencies) to respond to emerging research paradigms for addressing sustainability issues, particularly by emphasizing indigenous knowledge and values.

M.S. Valiathan
President, Indian National Science Academy, New Delhi, India

MOVING THE AGENDA FORWARD

The Turkish Academy of Sciences believes that the world's science academies in general and the InterAcademy Panel (IAP) in particular have significant roles to play in efforts to promote science-based sustainable development. These roles extend beyond support for conventional research pursuits to include efforts to raise public understanding and real-world applications of sustainability science. Indeed we believe academy-led initiatives to build platforms for public dialogue on sustainability issues are as important as efforts to nurture scientific developments and advise governments. We are convinced that priority should be given to the following issues: improving public understanding of the dimensions of sustainability; strengthening policy instruments for enhancing sustainability programmes; narrowing the gap among disciplines in their examination and pursuit of sustainability; clarifying the consequences of various sustainability policy options; raising awareness among the public and scientists alike concerning the ethical dimensions of scientific research; and, finally, increasing public sensitivity towards sustainability, especially through reforms in the educational system.

Ilhan Tekeli
Turkish Academy of Sciences, Instanbul, Turkey

WOMEN AS FACILITATORS

Girls, wives and mothers: Women live varied and complex lives. Through both formal and informal education, as well as often shouldering major responsibilities for managing households, they have developed different skills and have assumed different priorities and responsibilities than those of men. Over the past three decades, moreover, women have displayed broad leadership and managerial talents, suggesting that if gender discrimination and male-biased cultural practices were eliminated, women could make even more significant contributions to sustainable development than they do now.

To empower women and better prepare them for major roles in present and future efforts to promote science- and technology-based sustainable development, emphases must be placed on:

- Educating more girls in science- and technology-related fields.
- Developing a directory of women who have accomplished a great deal in the world of science and technology and who could serve as role models for others, especially young girls who have displayed proficiencies in scientific knowledge and/or technical know how.

- Promoting capacity building through training in ways that would foster leadership qualities among women.
- Sponsoring sustainable development projects designed and implemented by women.

These kinds of initiatives would prove beneficial to the economy, the environment and women. In fact, for sustainability to be successful, women must play a central role. Their absence will only spell failure.

Christina Nso Mbi
Executive Member, Third World Organization for Women in Science
Fellow, Cameroon academy of Sciences, Yaounde, Cameroon

MULTIPLE MEANINGS

Mongolia is a large remote country blessed with a wealth of natural resources, but it is handicapped by a weak infrastructure and a forbidding climate. In Mongolia, the elusive concept of sustainable development raises critical issues that reflect the concept's multi-meanings, on the one hand, and the vastly different strategies that will need to be put in place to fulfill sustainability's worthy goals, on the other. Here are several examples. Mongolia would like to develop a mineral processing industry to take advantage of its treasure of resources. However, we would like to do so in ways that do not further undermine the health of our ecosystems. Mongolia also hopes to increase the percentage of land devoted to parks and nature reserves. Today, protected areas cover 20 percent of the land mass. In the decades ahead, we would like to increase that percentage to 30 percent. Mongolia is surrounded by three nations that have embraced nuclear power: China, Russia and Kazakhstan. As a result, we are very concerned about nuclear proliferation, power plant safety, and waste cleanup. Each of these issues – mineral processing, park development and nuclear energy – are central to the future of sustainable development in Mongolia. Yet, each raises a different set of challenges and policy solutions. That's what makes sustainable development both so intriguing and so difficult to pin down.

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THE CHALLENGE OF AFRICA

Among other things, the Rio Earth Summit in 1992 helped to catalyze interest in the study and protection of biodiversity worldwide. In Africa, this is a big challenge, in part, due to the paucity of African-born experts in basic sciences, especially in biology. In fact, plant taxonomists are becoming an endangered species. Africa's biodiversity is not only rich; it is intriguing, harbouring biota that could prove a strong candidate for novel pharmaceutical products, food products and environmental regenerative strategies. A University of Namibia regional research project funded by the United Nations Development Programme (UNDP) Regional Bureau for Africa and executed by the UN Office for Project Services (UNOPS), with help from other institutions that include the African Academy of Sciences (AAS) and Third World Academy of Sciences (TWAS), is seeking to document Africa's impressive wealth of biological resources (for example, seaweeds and other aquatic biota, mushrooms, and vascular plants) and to identify candidates that have the potential to be commercialized. We believe that the network of scientists who will be brought together will help spur the creation of an international centre of biodiversity in Africa. We believe that many institutions both within and outside the UN system have a critical role to play in the realization of this vision. Most important, however, we believe that we must inspire our own governments to give the highest priority to such efforts, especially through increased funding for education and training in science and technology.

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S&T COMMUNITY

Sustainable development must be based on scientific and technological knowledge. Creating this knowledge, however, is costly, and that is why much of it originates in industrial countries. The OECD countries spend more on research and development (R&D) than the economic output of the world's 61 poorest nations taken together. High-income countries have twelve times the per capita number of scientists and engineers working in R&D, and they publish 25 journal articles for every one published by a low-income country. This imbalance poses a threat to sustainable development. If young scientists and engineers in developing countries are not offered reasonable working conditions, there will be no hope of bridging the gap with more affluent nations. Research is the motor through which knowledge continuously expands, and technology can provide the impetus to supply products that provide a basis for sustainable development and a better livelihood for the poor and needy. That is why a vision for a sustainable future should be based on knowledge societies. The science and technology community will have to play an important role in these societies, and it should by all means accept the challenge to provide leadership in meeting this critical challenge.

Thomas Rosswall

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TEMPERATURES RISING

DENGUE FEVER IS ON THE RISE IN MANY TROPICAL REGIONS AROUND THE GLOBE. ONE REASON MAY BE RISING TEMPERATURES. A PROJECT, SPONSORED BY THE GLOBAL ENVIRONMENT FACILITY (GEF) AND 'CO-EXECUTED' BY TWAS, IS EXPLORING POSSIBLE LINKS BETWEEN THE DISEASE AND CLIMATE CHANGE IN THE CARIBBEAN.

Dengue fever. It sounds bad enough. But the symptoms, which include the rapid onset of severe headaches, fever, joint and muscle pain, as well as skin rashes, nausea and vomiting, are often much worse than it sounds. At its most advanced stages, dengue hemorrhagic fever poses debilitating health problems – skin hemorrhaging, circulatory system failure and shock – that sometimes result in death.

"The first reported global epidemic of dengue fever, which is spread by day-biting mosquitos (*Aedes aegypti*) that prefer human hosts, took place in the late eighteenth century," says Anthony Chen, a professor of applied atmospheric physics at the University of West Indies. "Outbreaks occurred simultaneously in Asia, Africa and North America indicating that the virus and disease travelled intercontinental pathways 150 years before the advent of air planes."

But historical outbreaks of dengue fever, in many ways, were distinctly different from current outbreaks. For one thing, dengue fever until the mid twentieth century was largely a bothersome, yet ultimately benign, ailment. For another thing, there were often lengthy intervals – sometimes 30 to 40 years – between outbreaks. That's because the mosquitoes carrying the virus could only be transported long distances on sailing ships that would take 30 days or more to complete their arduous transcontinental journey.

"The first post-war outbreak of dengue fever took place in southeast Asia during the 1950s," says Sam Rawlins, an entomologist at the Caribbean Epidemiology Centre (CAREC) in Trinidad. "Since then, the disease has spread to other parts of Asia (including India, Pakistan and Sri Lanka), Africa and Central and North America. Equally important, outbreaks have taken place with greater frequency and more intensity. For example, dengue fever has become the leading cause of hospitalization and death among children in many countries in southeast Asia."

"Dengue fever," Rawlins adds, "has emerged as one of the most significant mosquito-borne viral diseases affecting the human population worldwide, rivalling malaria in its scope and distribution." Experts estimate that 2.5 billion people are currently at risk and that 50 to 100 million people each year are infected, including several hundred thousand who suffer acute cases of dengue hemorrhagic fever. In most countries, about 5 percent of those afflicted with dengue hemorrhagic fever die – primarily, children and young adults.

"Since the late 1990s," Rawlins continues, "the most dramatic increase in dengue fever has taken place in the Americas, including the Caribbean, where epidemics of all four serotypes of the disease have been detected. The most recent epidemics have been fuelled by the reintroduction of serotype 3 that had been absent from the region for more than 20 years."

Chen, a physicist turned climatologist, and Rawlins, an entomologist and parasitologist, have recently teamed together, first, to investigate the reasons for the increased incidence of dengue fever in the Caribbean and, second, to propose strategies for reducing both the number of outbreaks and their intensity. Funding for the three-year, US$7.5 million, initiative is coming from the Global Environment Facility (GEF) through the United Nations Environment Programme (UNDP). The initiative itself is being co-executed by the Global Change System for Analysis Research and Training (START) programme, Washington, D.C., USA, and TWAS (see "Climate Change Sparks New TWAS Partnership," *TWAS Newsletter* Vol. 13 No. 4 (October – December 2001, pp. 22 – 23).

Dengue fever until the mid 20th century was largely a bothersome, yet ultimately benign, ailment.

The START project on climate variability and change carries the complicated title, Assessments of Impacts and Adaptation to Climate Change in Multiple Regions and Sectors (AIACC).

"The project's name conveys its goals," says Hassan Virji, START's deputy director. "First, through a series of training and research workshops, we expect to enhance the knowledge and skills of scientists in the developing world who are working on climate change issues.

Second, through the implementation of national and regional projects, we hope not only to learn more about climate variability and change in various areas of the developing world but to develop effective strategies for coping with the wide-ranging environmental and social impacts associated with this phenomenon."

That is exactly what Chen and Rawlins are seeking to accomplish in their project.

"I work in the physics department's climate studies group at the University of the West Indies," says Chen. "Over the past couple of years, a small staff, consisting of four people, has devoted a good deal of effort both to regional weather data collection and climate study."

"In the course of our work," Chen continues, "we've spotted two potentially important trends. First, as average temperatures in the Caribbean have crept slightly upward, so too has the total number of cases of dengue fever." Overall, the cases of dengue fever in the region have climbed from 1000 in 1990 to 8000 in 1998. Second, incidences of dengue fever in the Caribbean have peaked during the year of – or the year following – *El Niño*, a periodic (about once every four years) occurrence in the ocean-atmosphere 'weather-engine' system in the tropical Pacific that has significant consequences for weather worldwide, especially in coastal regions.

[CONTINUED PAGE 32]

In the Caribbean, *El Niño* seems to fuel warmer temperatures and drier conditions in the year in which it takes place. Then, in the year following *El Niño*, there tend to be higher temperatures and wetter conditions, especially in late spring and early summer. When *El Niño* struck in 1995, the Caribbean not only experienced higher temperatures that year and the year after, but also a dramatic increase in the number of cases of dengue fever.

"Whether the perceived links between climate change and the rise of dengue fever are causal or incidental remains to be seen," notes Chen. After all, other factors – for example, incessant population growth and uncontrolled urbanization, rundown housing and a decline in sanitary conditions, inadequate public health and emergency management systems, and greater international air travel – could all play a role in the spread of dengue fever. As Chen notes, "one of the primary goals of this project is to try to determine whether there is a statistically valid association between climate variability and the disease."

Whether the links between climate change and the rise of dengue fever are causal or incidental remains to be seen.

How do Rawlins, Chen, and their colleagues plan to investigate this possible correlation?

First, they will conduct 15-year 'retrospective' studies in all 21 Caribbean countries searching for scientifically verifiable links between regional temperature changes and rising incidences of dengue fever. These studies will be based on three sources of information: archival weather records currently stored in governmental agencies and private sugar plantations; disease data stored at CAREC; and mosquito vector data stored in Caribbean health ministries.

Second, they will undertake three-year 'real-time' studies, using models and data compiled in geographic information systems (GIS) formats to track disease vectors with changing temperature levels.

And what will happen if their suspicions are correct: that is, what if the evidence shows a statistical correlation between rising temperatures and increasing incidences of dengue disease?

As Chen notes, "we may not be able to control the Caribbean's changing climate but we might be able to control its impact on public health."

"If we can prove that rising temperature and more intense rainfall patterns in the region are positively associated with the increasing incidence of dengue fever," adds Chen, "we might be able to convince both the public and public officials that the problem is, on the one hand, serious and, on the other hand, manageable. Part of our responsibility as project organizers is to conduct verifiable scientific research and part of our responsibility is to help the public better understand the nature of the risk – and how they might respond and ultimately adapt to it."

"The key to success lies in the development of effective environmental management strategies," adds Rawlins. "Strategies likely to prove effective may look easy to execute on paper but are often extremely difficult to put in place on the ground."

Rawlins notes, for example, that uncovered water drums are a prime breeding ground for disease-carrying mosquitoes. "The advice," he asserts, "is straightforward: Cover the drums."

But what public health officials often don't realize is that there are a lot of drums to cover. For example, because community water supply and sanitation systems in Trinidad and other Caribbean islands have deteriorated over the past several decades and because drier conditions have placed greater stress on the systems, 80 percent of households in eastern parts of Trinidad have placed rain-collecting drums outside their homes to supplement their water supplies. "Many of these residents are not aware of the health hazards that uncovered drums pose. That's why public awareness and educational campaigns are so important," observes Rawlins.

Other measures that may prove effective in combating the rising incidence of dengue fever include reducing the number of abandoned tires and discarded containers that serve as catch basins for water and, as a result, breeding grounds for the disease-carrying mosquitoes; developing an effective 'alert' system that cautions people of the elevated health threats during high-risk days; devising cost-effective strategies for increasing the number of households with screened windows and doors; and, when necessary, introducing a limited programme for spraying mosquito-infested areas in ways that do not pose a risk to public health or the environment.

"Ultimately, the solution to the rising incidence of dengue fever," says Rawlins, "resides in shrinking the habitat of disease-carrying mosquitoes. These pests, which are very opportunistic organisms, have an enormous capacity to breed in still water. Reducing their habitats will adversely affect their ability to reproduce. That, in turn, will ultimately lessen the incidence of dengue fever."

"The goals of the Caribbean project reflect the overall goals of the START programme," says Virji. "We are determined to build both the skill levels of scientists and institutional capacities of universities and research centres throughout the developing world, not only to promote good basic science but to advance applications of science in ways that help regions and nations adapt to the changing climatic conditions that they are likely to face in the years and decades ahead."

In all, the START project will sponsor some 20 projects in as many countries. Those selected for funding include a proposal to examine climate change and food security issues in sub-Saharan Africa (Obafemi Awolowo University, Nigeria); potential impacts of climate change and a broad assessment of potential adaptation strategies focusing on grass- and grazing-lands in Mongolia (Institute of Meteorology and Hydrology, Mongolian Ministry of Nature and Environment); an integrated assessment of social vulnerability and adaptation to climate change among farmers in Mexico and Argentina (Center for Atmospheric Science, National Autonomous University of Mexico); and the development of integrated methods and models for assessing coastal vulnerability and adaptation to climate change in Pacific island countries (Centre for Environment and Sustainable Development, University of the South Pacific, Fiji). Each of these projects, which are expected to last three years, will receive about US$200,000 in funding.

"The key words in all of these projects," says Virji, "are assessment and adaptation. Our goals are to help as many regions of the developing world as possible to better assess the potential risks posed by climate change and to help them devise home-grown strategies for adapting to the environmental and ecological changes that may take place. If the project is successful, we will have increased the scientific capacities of nations and regions throughout the developing world and applied these capacities to a critical global problem in ways that benefit the entire population." ■

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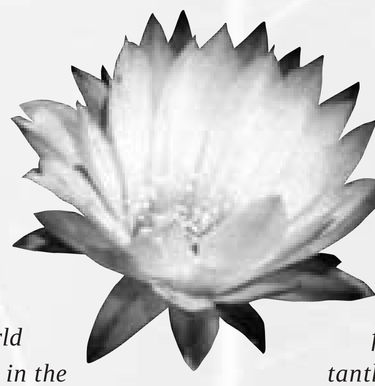
SEEDS OF COLLABORATION

THE LATIN AMERICAN PLANT SCIENCES NETWORK REPRESENTS ONE OF THE REGION'S MOST SUCCESSFUL EFFORTS IN SOUTH-SOUTH SCIENCE-BASED COOPERATION.



The Third World Network of Scientific Organizations (TWNSO), working closely with TWAS, has sought to promote effective science and technology capacity-building programmes among nations throughout the developing world ever since the organizations were created in the 1980s.

To further advance this goal, beginning in the 1990s, TWNSO, in partnership with other international organizations, began to publish a series of monographs designed to highlight successful experiences in the application of science and technology throughout the South. These experiences have varied widely – from efforts to upgrade the design of ancient ploughs in Ethiopia for the purposes of improving that nation's ability to till its parched soils, to the creation of a jet-plane manufacturing industry in Brazil that has competed successfully in international markets.

All of these efforts have this much in common: an ability to draw on scientific and technical talent in their own nations to address concerns that have a direct bearing on the economic and social well-being of their citizens.

At the same time, TWNSO, with its partners, has examined the principles and strategies that help to account for the creation and, perhaps more importantly, the sustainability of institutions and networks that help to foster the advancement of science and technology in the South.

The Latin American Plant Sciences Network, formed in the late 1980s by a group of Latin American plant scientists with support from their own institutions and Northern donors, is one of many examples of South-South cooperation that has allowed institutions, working together, to exert much greater influence than any one institution could ever exert on its own.

Over the past 15 years, the Latin American Plant Sciences Network, in fact, has become one of the most influential scientific networks in the region. A combination of deep personal commitment, institutional backing and consistent funding has been instrumental in the network's success.

But beyond these basic ingredients for progress resides a modest yet diverse programmatic agenda that focuses on helping Latin America's plant science community one scientist at a time. The result has been slow but steady advances that have only become noticeable over years if not decades.

Such initiatives, which depend on long-term, incremental progress, have often been overlooked in assessments of science in the South. One of TWNSO's primary goals in publishing its series of monographs on successful experiences in the development and effective use of science and technology is to highlight such experiences in the hope that they can serve as models for others.

Since TWNSO's first monograph, published in 1999, the organization has worked with a number of partners, including the United Nations Development Programme's (UNDP) Special Unit for Technical Cooperation among Developing Countries (SU/TCDC), the United Nations Environment Programme (UNEP), the Global Environment Facility (GEF), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the World Meteorological Organization (WMO), to explore successful experiences in the application of science and technology involving a host of issues of critical importance to the developing world. These issues include the conservation and wise use of indigenous and medicinal plants, effective water management policies, and the protection and conservation of biodiversity in arid and semi-arid lands.

Scientists believe that Latin America supports about one-third of the plant species found on Earth.

TWNSO's goals are twofold: to establish an expanding archive of successful experiences that others can learn from, and to help create and/or nurture networks of specialists across a broad cross-section of fields in science and technology to facilitate communication not only among scientists but between scientists and others, including policy makers and the lay public. That is why this broad-based effort has carried the common label, "Sharing Innovative Experiences: Examples of Successful Initiatives in Science and Technology in the South."

While we often hear that Africa or even Asia are the continents blessed with the highest percentage of global plant and animal species, the truth is that South America is the world's richest source of biodiversity. Colombia, Ecuador and Peru, for example, together have some 50,000 flowering plant species, which scientists estimate to be one-sixth of the world's total. Mexico alone has 25,000 flowering species as well as the world's largest number of reptiles and the second largest number of mammals (only Indonesia has more). In all, scientists believe that Latin America supports about one-third of the plant species found on Earth, a reflection of the continent's diverse eco-

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systems that range from tropical rainforests to arid deserts.

But the cornucopia of plant and animal species that forms such a rich part of South America's natural heritage – and is destined to play a major role in its future welfare – has been placed at risk for some time. As the ecosystems that give sustenance to the continent's unparalleled biodiversity become increasingly disturbed and degraded, animal and plant populations are often reduced in number and, in some cases, rendered extinct.

The forces driving the loss of habitat – and the ensuing threats to biodiversity – are many: poverty, weak political structures inattentive to such concerns, the undervaluing of resources and preoccupation with development, and a general lack of knowledge, both among policy makers and the public, about the critical role that biodiversity plays in the region's economic, environmental and social well-being.

It is this latter concern that led to the development of the Latin American Plant Sciences Network in 1988. Since then, the network has become one of the primary sources for university education and training for plant scientists in Latin America.

"The contrast between South America's rich biodiversity and its paltry number of well-trained scientists in such fields as botany, biochemistry, ecology and genetics is striking," says Osvaldo Sala, a researcher at the University of Buenos Aires' Ecology Laboratory, who serves as the network's coordinator. "The problem exists not only in South America but throughout the developing world, which has nearly 80 percent of the world's biodiversity but only 6 percent of the world's scientists."

"The lack of skilled human resources to address the biodiversity challenges in Latin America and elsewhere throughout the South," notes TWAS Fellow (1998) Gloria Montenegro, professor at the Pontifical Catholic University of Chile, Santiago, Chile, "is not just a scientific issue; it's also a policy issue. Montenegro serves as one of four regional coordinators for the network

"After all," she adds, "without reliable scientific information, it will be impossible to assess what the trends are or to devise a sensible and effective response to the degradation or loss of plant and animal species. At the same time, it will be difficult to gain public support for this issue unless people believe that policy decisions are being driven by trustworthy, unbiased research and analysis."

More than a decade ago, prestigious institutions in six South American countries joined together to form the Latin American Plant Sciences Network. The founding institutions include: the University of Buenos Aires in Argentina; the Botanical Institute at the University of Sao Paulo in Brazil; the University of Costa Rica; the Pontifical Catholic University of Chile; the National Autonomous University of Mexico; and the Institute of Scientific Research at the University of the Andes in Venezuela.

Mexico alone has 25,000 flowering plant species, and the world's largest number of reptiles.

The network, which received its initial funding from the Jessie Smith Noyes Foundation in New York City, USA, has been driven by three interrelated aims:

- To increase the number of trained plant scientists in South America by pursuing research activities and conservation management strategies that address the needs of the region.
- To reduce the isolation among plant scientists in Latin America that, together with their small numbers, has been a primary impediment to their voices heard in policy-making circles.
- To nurture a strong sense of scientific community within the region through international exchanges not just within South America but beyond. Such efforts are necessary not just to ensure scientific excellence but to help build individual confidence and institutional prestige. That, in turn, will raise both the profile and impact of science among decision makers.

Since its inception, the network has pursued a diverse set of strategies ranging from short-term specialized courses for mid-career professionals to support for young doctoral students seeking degrees in research-based graduate programmes. The network has also sponsored post-doctoral research in highly specialized laboratories and provided funds for researchers to attend workshops and seminars. Finally,

the network has organized several collaborative research projects among scientists in different institutions in Latin American countries to address cross-boundary ecological issues of common concern.

"Our funding has been modest," explains Susana Maldonado, the network's executive director. "In total, we've received approximately US$3.5 million over the past 15 years. That averages out to little more than US$200,000 a year. As a result, our impact has been modest. Nevertheless," adds Maldonado, "we've been able to make slow but steady progress in achieving our goals."

Maldonado prefers to let the network's statistics speak for themselves. To date, it has provided academic training for more than 150 men and women from 16 Latin American countries, including support for master's and doctoral students. It has supplied full or partial funding for more than 40 graduate courses that have been attended by some 500 students, all from Latin America; it has helped support 80 or so scientific workshops and conferences; and it has awarded 150 small grants for plant- and habitat-related research throughout the region. In total, about 100 scientific articles have been published and 150 presentations have been made based on research, laboratory investigations, and field work conducted through the network.

But beyond these numbers, the network has helped to raise the level of public awareness concerning the importance of biodiversity and habitat preservation. And, as a result, it has raised public understanding of the role that plant science and related fields in biology, chemistry and ecology can play in addressing such issues. This knowledge has been put to good use in dealing with the critical 'eco-challenges' that Latin America confronts today.

As Maldonado notes, the Latin American Plant Science Network has helped the region to better understand a number of critical issues in ecology, food production and the protection and preservation of natural resources that require scientific expertise to be addressed effectively.

"I am not saying that the network has revolutionized either the public's or policy maker's understanding of ecological or biodiversity issues. But I am suggesting that things would be much worse if some far-sighted people had not launched the network some 15 years ago. What they started has certainly made a difference not only for Latin American scientists but for Latin American society as well." ■

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MOULDING THE FUTURE

TWOWS POST-GRADUATE FELLOWSHIP RECIPIENT FELICITÉ NOUBISSI HAS EMBARKED ON A FASCINATING JOURNEY OF DISCOVERY TRYING TO DETERMINE WHY CERTAIN ORGANISMS 'SILENCE' THEIR 'COPIED' GENES. THIS COMPLEX BEHAVIOUR COULD HOLD THE KEY FOR TREATING SOME OF THE WORLD'S MOST DEADLY DISEASES.

Throw it out. That's what you're likely to do when you spot mouldy bread in your kitchen cabinet. These unpleasant looking fungi, which come in a variety of spongy colours, can ruin a morning breakfast or midday lunch. Mention of it in the opening paragraph of this newsletter story might encourage readers to turn to another article or even pick up another magazine.

But Felicité Noubissi, a recipient of the Third World Organization for Women in Science (TWOWS) post-graduate training fellowship, has a different 'take' on mould. For her and her laboratory colleagues, the peculiar genetic behaviour of these fungi represent a fascinating scientific challenge.

And for other researchers more involved in clinical applications, pink bread mould may, over the long term, hold the key for developing effective treatments of cancer, Parkinson's disease, sickle cell anaemia and other serious chronic ailments in which abnormal cell growth creates undesirable, often fatal, health effects.

"My current research," explains Noubissi, "focuses on *Neurospora crassa*, which is more commonly referred to as pink bread mould. For most people, it doesn't sound like glamorous work. After all, who wants to spend their days examining how fungi grow – or don't grow?"

The fact is, however, that pink bread mould has been a hot research topic for 60 years – ever since George Beadle and Edward Tatum, then researchers at Stanford University in California, USA, began their ground-breaking laboratory experiments in biochemical genetics for which they won the Nobel Prize in chemistry in 1958. The subject of their investigations was nothing less (some would say nothing more) than pink bread mould.

"These fungi," says Noubissi, "are easy to manipulate. A genetic cross, for example, only takes two weeks to mature and you can add or subtract any genes you want without too much trouble."

But genetic researchers are enamoured with pink

bread mould not because it is easy to work with. Rather it has become a favourite source of study and experimentation because of its unique 'gene silencing' mechanism that is expressed during reproduction and at the very earliest stages of development. This mechanism, which remains poorly understood, is both interesting as a biological phenomenon and potentially important to understand as a tool for medical science.

Noubissi explains: "Like all organisms, including humans, pink bread mould parents donate DNA to their offspring to reproduce. During reproduction, chromosomes from each parent – seven in the case of pink bread mould and 23 in the case of humans – join together and then split apart in a process of genetic mixing that researchers call meiosis. For a brief moment during this process, the zygotes resulting from the fusion of both gametes have double the number of chromosomes of their parents. Then, when the chromosomes split apart, the number is cut in half, leaving the progeny with the same number of chromosomes as their parents."

Pink bread mould has become a favourite source of study because of its unique 'gene silencing' mechanism.

So far, the complex reproductive processes in moulds and humans described above parallel one another. However, scientists have discovered that, within this process, pink bread mould displays a unique biological mechanism not found in humans.

Again Noubissa explains: "During reproduction and very early development, if a segment of a chromosome is duplicated, the fungus will 'turn off' all the genes present in that duplicated segment in the cell. This 'stop-action' takes place before karyogamy – that is, before the nuclei of both gametes fuse." In other words, a gene that may have been transported by a virus or a mobile DNA-segment is 'silenced' before it has an opportunity to invade the population.

The pink bread mould's unique checking system, which scientists have labelled 'repeat induced point mutation,' could have broad implications for the treatment of such chronic diseases as cancer, Parkinson's disease and sickle cell anaemia. If scientists can learn how pink bread mould 'silences' unwanted and potentially harmful chromosomes at the moment of reproduction or the earliest stages of development, they

[CONTINUED PAGE 40]

may eventually be able to apply that knowledge to human beings as well.

Noubissi acknowledges that "scientists are a long, long way from acquiring such understanding." She quickly adds, however, that "the genetic silencing mechanism found in pink bread mould is intriguing enough to have attracted a great deal of interest among genetic researchers over the past several decades. And recent breakthroughs in genetic engineering will likely accelerate our pace of discovery and understanding in the years ahead."

The TWOWS programme allows students to receive training without losing contact with their native countries.

Noubissi, who hails from Cameroon, embarked on her career in science during the late 1980s. She subsequently earned bachelor (1991), master's (1993) and doctorate (1998) degrees from the University of Yaoundé in her native country.

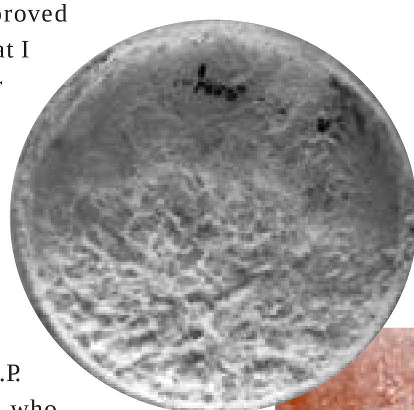
"My major field of interest," she notes, "was lipid metabolism and cardiovascular disease. Specifically, I conducted research on cotton seed and palm oil to try to determine which of these cooking oils was healthier for your heart. I enjoyed my research – by the way, concluding that palm oil was better for you – but I became increasingly fascinated by the potential impact of biogenetic research and biotechnology on human health and the environment. After careful consideration, I ultimately decided that I wanted to enter these emerging fields not as a simple novice researcher but as a well-trained scientist able to build on my existing base of knowledge."

The only problem – and it was indeed a daunting obstacle – was that Noubissi did not have the financial resources to pursue another advanced degree. "My family and I paid for my previous university studies and we simply could not afford to spend additional money on my education."

That's where the TWOWS post-graduate training fellowship programme has come into play. The programme, which is funded by the Department for Research Cooperation (SAREC) of the Swedish International Development Agency (Sida), is designed to help women scientists from sub-Saharan Africa and least developed countries (LDCs) pursue post-graduate scientific studies in centres of excellence throughout the South. Students are required to continue to enroll in universities in their home countries. In fact, that's where they earn their degrees. The time spent abroad, usually one or two years during the four or five year course of study, is designed to allow students to receive more advanced training without losing contact with their native countries.

To date, 134 young women from 37 countries have participated in the programme, which began in 1998 and received additional funding in 2000. Noubissi, who was awarded the fellowship in 1999, is currently pursuing her studies at the Centre for Cellular and Molecular Biology (CCMB) in Hyderabad, India.

"The programme," says Jeanne Ngogang, professor of medicine and biological science at the University of Yaoundé who is serving as Noubissi's supervisor, "enables excellent students like Felicité to continue their education at institutions that have first-rate facilities for advanced research training. At the same time, because these students do not lose touch with their home universities, the universities are able to take advantage of their improved knowledge and skills. I'm sure that I speak for my colleagues in other African universities when I say that we hope most of the students in this programme will remain in their native countries to teach and pursue their research after receiving their advanced degrees."



"The programme," adds D.P. Kasbekar, a researcher at CCMB who oversees Noubissi work while she is in India, "benefits my centre as well. One of the shortfalls of research institutions in the South – even institutions like my own that have excellent scientists and facilities – is that there is often only a limited amount of international exchange. Fellowship programmes like the TWOWS postgraduate programme for women scientists help to increase interactions between institutions in the South, a benefit that is likely to pay even greater dividends in the future as these young researchers carve out careers of their own."

As for Noubissi, she will be spending the next few years examining – as carefully and methodically as she can – every bit of chromosome responsible for the genetic makeup of pink bread mould to see if she can determine exactly what is responsible for the organism's unique silencing mechanism.

"It's a huge genetic puzzle," she says, "but one that is worth puzzling over. After all, if researchers can put together the pieces in a way that helps to draw a detailed picture of the mould's silencing mechanism, at some future date we may be able to treat some very serious diseases that afflict millions of people worldwide." ■

For more information about the TWOWS postgraduate training programme for women scientists from sub-Saharan Africa and least developed countries (LDCs) at centres of excellence in the South, contact

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BIOTECHNOLOGY: A SUSTAINABLE FUTURE?

BIO-EARN, A NETWORK OF INSTITUTIONS IN EAST AFRICA, HOPES TO MAKE BIOTECHNOLOGY A VALUABLE TOOL FOR BUILDING SCIENTIFIC CAPACITY AND PROMOTING SUSTAINABLE DEVELOPMENT.

Does East Africa need to develop its own research capacity in advanced biotechnology? The answer is "yes" according to members of BIO-EARN (East Africa Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development), which was founded in 1999 with funding from Sida-SAREC (the Department for Research Cooperation of the Swedish International Development Agency). BIO-EARN's objectives focus on building national capacity and competence in biotechnology, biosafety and biotechnology policy in the region. Four countries – Ethiopia, Kenya, Tanzania, and Uganda – are currently members.

What accounts for East Africa's rising tide of interest in biotechnology? After a promising start in the 1980s, followed by a period of contention and controversy in the 1990s, biotechnology has recently re-emerged as an integral part of the scientific research agenda and a key aspect of economic development strategies for many countries in the South. As a result, a potentially bright future now seems to await a technology whose path to success not too long ago was clouded by suspicion, uncertainty and resentment.

BIO-EARN'S mission statement seeks to capture the dual nature of the organization as a centre designed to promote biotechnology research and development: The organization's principal objectives are "to build capacity in biotechnology in Ethiopia, Kenya, Tanzania and Uganda and to promote appropriate research and related policies." Equally important, the organization envisions fostering programmes and policies that enable biotechnology to be used "in a sustainable manner...to help improve livelihoods, ensure food security and safeguard the environment."

BIO-EARN's expressed goals include:

- Enabling countries in the region to develop biotechnologies and policies according to their own needs, abilities and opportunities.
- Promoting collaboration in biotechnology, biosafety and biotechnology development to address key challenges and opportunities in the region.
- Fostering communication, nationally and regionally, among biosafety regulators and private investors.

"Biotechnology holds great promise for East Africa," says Charles Mugoya, BIO-EARN's regional coordinator. "It's up to East Africans to overcome current obstacles and harness the potential of this technology with prudence and persistence. That's what BIO-EARN is all about."

Mugoya discussed the activities of BIO-EARN at a workshop, "Building Biosafety Scientific Expertise in Sub-Saharan Africa," held in Grottaferrata, Italy, from 12-14 March 2002. Funded by the Rockefeller Foundation and facilitated by the Meridian Institute, the workshop was attended by some 25 biotechnology experts from a dozen or so countries, mostly from sub-Saharan Africa. TWAS was asked to join the discussion and to lend its perspective on one of the developing world's most important scientific – and, increasingly, economic development – issues.

While genetic engineering has captured the greatest public attention, biotechnology encompasses a broad range of research and development tools, including bioinformatics, micropropagation, molecular diagnostics, marker-assisted breeding and vaccine development. Such pursuits have applications in agriculture, environmental protection, industrial development and public health.

Despite the promise it holds, efforts to advance biotechnology in the South have not taken place without controversy. In fact, the technology has been at the centre of a heated debate.

"First, there has been the question of ownership," says Mugoya. "Efforts to exploit the technology have been led by international corporations whose economic interests are most closely tied to the North." As a result, the biotechnology research agenda has largely focused on Northern concerns – for example, improving crop yields of corn grown in the U.S. midwest or developing frost-resistant strawberries for growers in the U.S. northeast.

Efforts to advance biotechnology in the South have not taken place without controversy.

"The interests of farmers in developing countries," says Mugoya, "have been largely ignored. Perhaps even more troubling, when transgenic seeds with the potential for use in the South have been developed by global corporations, the discovery has been protected by international patents and made available at a price that developing world farmers cannot afford."

"In addition," says Ivar Virgin, programme manager of the Bio-Earn Secretariat at Stockholm Environment Institute in Sweden, "the potential benefits of biotechnology have been obscured by controversy over the possible environmental risks associated with genetically modified organisms (GMOs)." As a result, coun-

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tries in East Africa, and indeed throughout the world, have been under increasing pressure to develop and implement biosafety regulatory frameworks.

While the potential risks associated with genetic engineering have grabbed the headlines and provoked public distrust and resentment, many scientists believe that the technology holds great promise for increasing crop yields by making plants more resistant to pests and severe weather-related events that could stymie their growth. At the same time, biotechnology could also help boost the storage capacity of nutrients and vitamins within plants, increasing the dietary value of agricultural commodities in regions where food security remains a critical issue.

Biotechnology could transform food production from a chemical- to a biology-based system.

"The point is," says Mugoya, "that biotechnology, if developed wisely, could transform global food production from a chemical- to a biology-based system. Such a transformation could generate enormous benefits for worldwide food production as well as for the global environment and economy."

For Third World countries to take full advantage of biotechnology's potential and, at the same time, to build public confidence that the technology is not being used by outsiders as a sophisticated form of exploitation, countries in the South must build their own scientific capacity by:

- Providing adequate training for scientists.
- Building well-equipped research laboratories.
- Constructing an adequate biosafety regulatory framework and nurturing national and regional risk assessment capabilities.
- Creating a policy environment that protects intellectual property rights and ensures that programmes are responsive to both national needs and international standards.

BIO-EARN has sought to advance these goals by fostering a network of institutional partners that include, among others, the Biodiversity Conservation and Research Institute and Addis Ababa University (Ethiopia); the University of Nairobi's Department of Botany and Kenya Agricultural Research Institute (Kenya); the University of Dar es Salaam's Applied Microbiology Unit and Mikocheni Agricultural Research Institute (Kenya); and the Makerere University's Department of Crop Science and the Uganda National Council for Science and Technology (Uganda). In addition it has established close links with universities and research centres in Europe, most notably in Sweden.

The first phase of the project, which took place from 1999-2001, focused directly on capacity building. Specific activities included the training of Ph.D. students, investments in biotechnology laboratories, drafting of a biosafety manual, and the organization of regional and national workshops on such key biotechnology issues as intellectual property rights, cost-benefit and impact analyses, and sustainable funding mechanisms for research and development.

The second phase of the project, which was launched just several months ago and will continue through 2004, will again "concentrate on ensuring high quality training for graduate students and the further development of institutional networks. "The second stage," adds Mugoya, "will hopefully create a strong and enduring foundation of individual and institutional capabilities throughout East Africa, ensuring that issues related to biotechnology can be effectively addressed by the people of the region in the future."

Ultimately, it is hoped that the project attains financial independence later this decade by securing fund-

ing from a wide range of donors (not just sida-SAREC), forging strong partnerships with like-minded institutions in the South and North (universities, research centres and private firms), and developing income-generating activities based on its own services and products.

Over the course of the past three years, BIO-EARN has funded the study of more than a dozen doctoral students majoring in a variety of biotechnology research areas related to agriculture, the environment and industry. It also has financed the education of a half a dozen graduate students concentrating on research fields related to biosafety and ecological risk assessment. In addition, the network has held workshops focusing on biotechnology policy development, which have been attended by some 150 scientists and policy makers, and on biosafety regulation, which have been attended by more than 80 scientists.

"BIO-EARN-funded research projects have without exception concentrated on crops and environmental issues of critical importance to East Africa," says Virgin. "For example, network-financed researchers have helped identify genetic markers for the characterization of sweet potato and maize virus diseases." Such efforts have been designed to assist breeders in the region to combat these problems. "Researchers have also identified genetic makers for coffee germplasm," he adds, "as part of a larger effort to increase the yields and quality of local plant varieties." Other agriculture commodities receiving attention include cassava, sorghum and sesame seeds. At the same time, network researchers have examined ways in which biotechnology may be used to improve local waste treatment – for example, in Lake Victoria.

On a more general level, advanced through a series of workshops and seminars, BIO-EARN has helped increase awareness among both policy makers and the public concerning critical biotechnology issues, including the debate over intellectual property rights and biosafety. This, in turn, has helped to lay the groundwork for a more balanced approach to biotechnology national policies as reflected, for example, in the reports issued by the Ethiopian National Steering Committee on Biotechnology, which recently presented a "plus-and-minus" assessment of strategies for biotechnology development in agriculture intended for policy makers and the public.

While proponents of biotechnology believe that biotechnology can help secure a more stable food supply, provide critical new tools for cleaning up the environment, jump-start knowledge-based high-tech industries, and lead to an increased supply of vaccines for combating disease, skeptics express concerns about the environmental, economic and social risks associated with this new technology.

Do genetically modified plants threaten global biodiversity? Will pests develop resistance to plants that have been made pest-resistant through genetic engineering and, as a result, will farmers have to increase the level of chemical inputs to control them? And who, after all, will own these genetically modified seeds and plants? Are the plants an integral part of the global community's natural heritage or do the rights to exploit and profit from them belong to the private company that invested in the technology "creating" these modified organisms?

"Such issues," says Mugoya, "cannot be ignored, first, because they carry important environmental, economic and social implications and, second, because they play a critical role in the shaping of public per-

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ceptions of biotechnology – perceptions that may ultimately determine whether the technology is embraced or rejected."

"BIO-EARN," he continues, "is dedicated to the goal of developing sufficient biotechnology capacity within East Africa's scientific community to ensure that the region can participate in the debate in a meaningful way. At the same time, BIO-EARN hopes to enable nations within the region, if they so choose, to pursue biotechnology research and development in ways that have a direct benefit on the people of East Africa without causing unexpected long-term harm to the environment. That, after all, will be the ultimate test of biotechnology likely to determine its long-term impact."

Today, the United States, Argentina and Canada account for 99 percent of the total global agricultural land area devoted to transgenic crops. The United States alone accounts for 70 percent of the total.

"While the developing world, until recently, has been largely excluded from biotechnology research and development initiatives," Virgin observes, "countries throughout the South, not least in Africa, could benefit greatly from such efforts if biotechnology programmes and policies are targeted to their needs."

That means conducting research on crops that are important to the developing world, paying special attention to the needs of small farmers, ensuring that indigenous knowledge is protected and rewarded, placing regional environmental safety at the forefront of concerns, and building individual and institutional capacities appropriate to each nation and region, particularly those in the developing world.

These are the large and complicated set of issues that are likely to remain at the centre of the BIO-EARN agenda in the years ahead. ■

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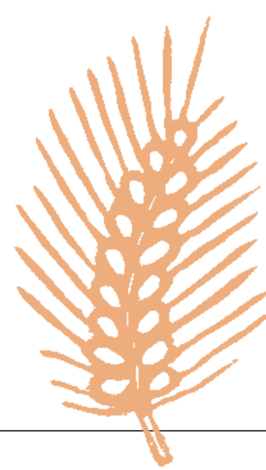
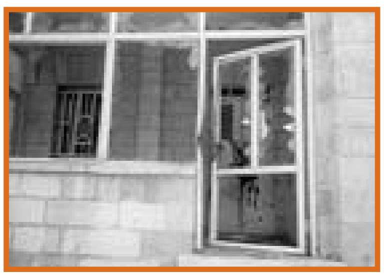


THE HOPE OF SCIENCE

THE PALESTINE ACADEMY FOR SCIENCE AND TECHNOLOGY HOPES TO HELP THIS WAR-TORN LAND MOVE TOWARDS A PEACEFUL AND PROSPEROUS FUTURE BUILT ON A STRONG AND ENDURING FRAMEWORK OF SCIENCE AND TECHNOLOGY. THE INTERACADEMY PANEL WOULD LIKE TO LEND A HAND IN THIS EFFORT.



On 7 April 2002, the secretariat of the Palestine Academy for Science and Technology became yet another casualty of the Israeli-Palestine conflict when Israeli's soldiers forcibly entered the academy's offices in Ramallah, smashing the furniture and destroying electronic and paper files. The incident led some members of the global scientific community to call for a boycott of Israeli cultural and research links until Israel "abides by UN resolutions and opens serious peace negotiations with the Palestinians."

Nature, Science, *other science journals and the International Human Rights Network of Academies condemned the proposed boycott claiming that the global science community should support cooperation and exchange, not isolation, even (indeed, especially) during times of political crisis. Such efforts at international understanding, they claimed, would not only help promote research but, perhaps more importantly, have the added benefit of opening up avenues for cross-cultural interaction that could ultimately enhance global understanding and harmony.*

In October 2001, less than six months before the Israeli assault and one year into the second intifada, *the Palestine Academy for Science and Technology issued a draft 'white paper' describing the central role that science and technology could play in the building of a prosperous and peaceful Palestinian state. The report highlighted the role that the academy, which was created in 1998, could assume in such efforts.*

Today, the Palestine Academy for Science and Technology has 11 members, a small but elite roster that includes most accomplished Palestinian scientists. The academy is not only seeking to play a central role in the promotion of science throughout the territory but also envisions itself as a key actor in programmes designed to promote science-based development. As Imad Khatib, the academy's secretary general recently noted, the organization "constitutes the focal point for Palestinian science

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Palestine Academy for Science & Technology

أكاديمية فلسطين للعلوم والتكنولوجيا

and technology initiatives, virtually all of which are geared towards capacity building at both individual and institutional levels."

The InterAcademy Panel on International Issues (IAP), an organization of 85 science academies from around the world that is dedicated to promoting the capacity of its member institutions, recently expressed its concern over the damage incurred at the headquarters of the Palestine Academy for Science and Technology, and, more generally, over the surge in violence and terrorism in many parts of the world, including the Middle East. The IAP, whose secretariat is located in Trieste where it operates under the administrative umbrella of the Third World Academy of Sciences (TWAS), also expressed its support for doing whatever it could to help boost the capacity of the Palestine Academy for Science and Technology as quickly as possible.

What follows is a story of hope, based on the Palestine Academy for Science and Technology's future plans for development and action first outlined in October 2001 in the midst of a conflict that would soon engulf the academy itself. It is a story of eternal hope in a land that seems to have experienced nothing but eternal conflict.

What is the role of a science academy? The InterAcademy Panel on International Issues (IAP), launched in 1993 as a global network of science academies dedicated to increasing both the capabilities of its members and the role of academies within their societies, embraces a broad view of the academies' responsibilities – a view that is most comprehensively articulated in the organization's statutes.

First, as the IAP notes, academies are designed to serve as merit-based institutions that honour the most accomplished scientists within their nations through their election to the academies. Second, they are organizations that focus on scientific capacity building through a variety of programmes, including the awarding of prizes to their most distinguished members; research and training grants, especially for younger scientists; and initiatives that seek to raise public understanding and support for basic and applied research. Third, academies are organizations that often provide advice to governments either through consultations on critical science-related issues or the publication of reports that outline the nature of science-based problems and the science-based options that are available to address these concerns.

The broad range of activities spelled out in these responsibilities apply to all academies. But what about academies that find themselves in difficult situations due to a lack of resources, paltry and fickle government support, or an insufficient number of scientists within their countries to create a critical mass of membership that such organizations need to survive and prosper?

And what about academies, such as the Palestine Academy for Science and Technology, that find themselves caught in an intricate and deadly web of conflict that not only forces their nations to focus on other, more immediate concerns but also places the academies' very survival at risk?

The answer to the latter question is surprisingly simple. Academies under such severe stress tend to explore ways to do what other academies do – that is, to be of service to their nation's scientific community and of use to their larger society by nurturing opportunities to apply their knowledge and skills to a host of everyday concerns.

The difference is that academies under severe stress need help from others – either other academies in better straits, organizations such as the IAP that have been created in part to help such institutions, and/or external agencies (most notably, foundations) that can provide funding for both administrative responsibilities and programmatic initiatives.

Most of all, these academies need a stable and supportive political environment that allows scientific research to take place unencumbered by economic and social uncertainty, political disruptions, threats and even violence. There is no better example of the academies' persistence to do what academies have always done than the recent experience of the Palestine Academy for Science and Technology.

The Palestine Academy was established when the movement towards peace seemed to promise a better future.

The Palestine Academy for Science and Technology was established in 1998 at a time when the movement towards peace within the region seemed to promise a better future for Palestinians and Israelis alike. "Our motivation," says Imad Khatib, the academy's secretary general, "was to create a scientific organization that could provide a sound foundation for the territory's growing scientific community and, at the same time, create an institution that could advise the government on a variety of science-related policy issues. In essence, we hoped to create a hybrid structure that was part science academy and part research council."

The fledgling organization soon enjoyed a degree of success both as a respected nonpartisan institution within the territory and one of the primary focal points of Palestinian science for those outside the region.

"One of the misconceptions that the rest of the world has of Palestine is that it is a place devoid of education and science," says Khatib. "While our facilities are not well funded and while education and research are often interrupted by events beyond our control, it is important to note that there are a number of universities and research centres that have survived despite the harsh environment in which they have been forced to operate."

For example, the University of Al-Quds (notably, its Applied Research Institute of Jerusalem, which concentrates on agricultural research); the An-Najah University (notably, its Centre for Renewable Energy Research); and the University of Birzeit (notably, its Community Health Unit which conducts health policy research) are sparse oases of higher education in an otherwise parched research environment. At the same time, the ministries – for example of environment, industry and education – provide at least bare-bone research frameworks designed for the study of long-term, chronic problems in a land where the only future that usually counts is the here and now.

"As a result, part of the job of the academy," says Khatib, "has been to coordinate and efficiently utilize existing scientific personnel and institutional resources. In short, we have tried not to launch activities that would duplicate existing efforts. And we have sought to tap the talents of Palestinian scientists currently working in the nation's universities and research centres to advance the academy's agenda."

One of the most intriguing activities to take place during this period was a study of regional water issues, undertaken by scientists from the Israel Academy of

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Sciences and Humanities, the Palestine Academy for Science and Technology, the Royal Scientific Society of Jordan, and the US National Academy of Sciences.

"We worked together," says Khatib, "on a problem that knows no political boundaries and one that is likely to be of crucial importance to Israel, Palestine and the entire region in the years ahead." The study did not lead to any significant changes in policy but it did help raise the public profile of an issue that often gets drowned out by more immediate political and diplomatic concerns. This is just one example of why a revival of a fruitful dialogue between the Israel Academy of Sciences and Humanities and the Palestine Academy for Science and Technology on matters of common interest would benefit the entire region.

Like so much else in the Palestine territory, progress on the scientific front was brought to an abrupt halt by events surrounding Palestine's second *intifada* that began in September 2000 and

The Palestine Academy stands ready to lend its hand to build a stable and prosperous future.

the Israeli military action that ensued. "Like much of the rest of Palestine, the academy and the territory's educational and research centres have been under a state of siege that has only intensified as the fighting has intensified," says Khatib. "It's a siege that culminated with assault on the academy's headquarters last April.

Despite this serious setback, Khatib and his colleagues hope to rebuild and indeed broaden the reach of the academy in the years ahead. "Peace must come first," he observes, "but once we achieve a degree of lasting tranquility, I hope that we can again begin the process of building the academy in ways that follow the blueprint outlined in our "Science and Technology Draft Report" published in October 2001.

The report envisions the academy as the "premier science and technology body in the country" and it calls on the institution to "pursue programmes guided by the principles of competence, competitiveness and conscience." Because the report's authors believe that science and technology are "the most important factors for national economic growth," they foresee the academy being fully engaged in "the socio-economic development" of Palestine.

To advance this ultimate goal, the report proposes a three-pronged strategy that focuses on developing a sturdy and sustainable science and technology infrastructure; devising an agenda that makes science more relevant to Palestine's current problems; and improving the governance and management of science and technology to ensure that the resources invested in these enterprises are used wisely and effectively. "Issues related to health, education and nutrition," the authors note, "should be at the top of the science policy agenda and programmes designed to promote science-based development should receive primary attention."

"We know that we will not be able to rebuild the academy on our own, let alone transform it into a powerful and influential voice for science-based development without external help," Khatib acknowledges. "We also know that the Palestine Academy for Science and Technology is just one small player among many (and not a very big player at that) trying to address an bewildering array of complex issues that now seem to defy solution."

"Nevertheless, we hope the groundwork we have laid over the past several years will not go to waste. As circumstances improve, we will be ready to lend our hand to building a stable and prosperous society for our long-suffering people. With assistance from our scientific friends from around the world, we believe that we can ultimately make a difference."

SUSTAINING SUSTAINABILITY

Capacity building for science-based sustainable development are words likely to be heard time and again at the upcoming World Summit on Sustainable Development (WSSD) scheduled to take place in Johannesburg, South Africa, this summer. These words, which are not easy to remember unless repeated time and again, will resonate continually at the sessions, press conferences, lunches and dinners that have been planned for this global gathering – especially those activities with scientists and technologists in attendance.

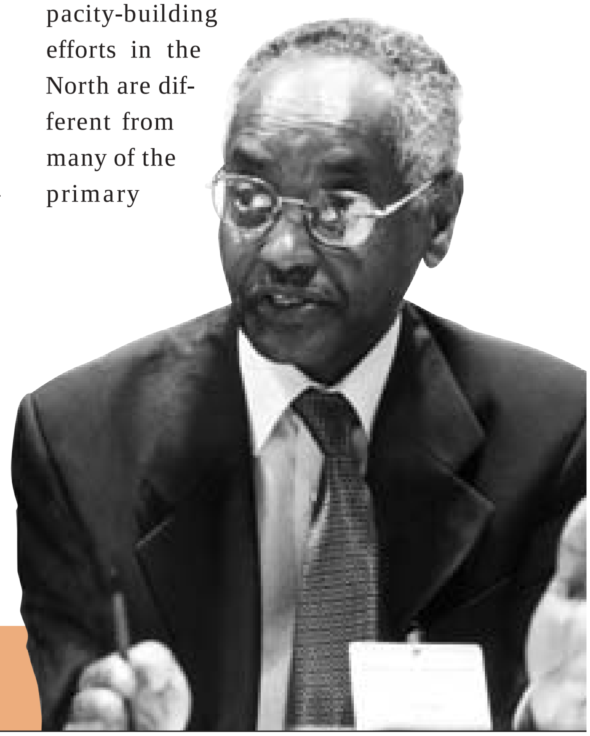
The good news is that the discussions taking place at WSSD preparatory meetings over the past 18 months indicate that a lot of powerful people may well be listening. Capacity building and science-based sustainable development have been central to these preparatory discussions and are likely to be central to discussions in Johannesburg as well.

But what exactly do the these words mean and, equally importantly, what strategies can be put in place to turn these words into action?

These are the critical issues participants face at a conference that will be the most important global eco-get-together since the Rio de Janeiro 'Earth Summit' in 1992. Heads of government, ministers, economic development experts, environmentalists, educationalists, community activists and media representatives will all be present in large numbers. Consequently, scientists and technologists will be just one community among many – their voices to be heard in a forum estimated to attract more than 65,000 people.

The North–South divide – at the centre of discussions of so many global economic and environmental issues since the East–West divide faded into history more than a decade ago – promises to be a critical issue at the WSSD too, especially among those who fervently agree that science-based sustainable development should be a defining principle of national and international programmes designed to improve global social and environmental conditions now and in the future.

The problem is that many of the primary goals driving science and technology capacity-building efforts in the North are different from many of the primary



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goals driving science and technology science capacity-building efforts in the South.

In the North, first and foremost, capacity building is part of a larger effort to modify existing scientific research agendas and institutions in order to address long-term sustainability issues that are largely related to global ecological resources.

In the South, on the other hand, capacity building is just that: an effort to nurture homegrown research skills and to construct homegrown research institutions so that nations and regions throughout the developing world can apply scientific knowledge and technological know-how to their critical social and economic needs – not just tomorrow but, more importantly, today.

Put another way, for the North, capacity building means tweaking – some critics would say revamping – existing scientific and technological infrastructures. For many places in the South, particularly in sub-Saharan Africa, it means building new scientific and technological infrastructures virtually from scratch.

Some statistics tell the story. According to the United Nations Educational, Scientific and Cultural Organization's (UNESCO) 1998 *World Science Report*, total global expenditures on research and development amount to about US$500 billion per year or roughly 1.5 percent of the world's gross domestic product. Approximately 85 percent of this expenditure takes place in the developed world. China, India and the newly industrialized countries of east Asia, moreover, are responsible for two-thirds of the remaining 15 percent of R&D investments made in the South. That means the rest of the developing world accounts for less than 5 percent of global R&D investments.

Put another way, North America currently spends about US$500 per person on R&D, while the developing world spends about US$20.

With just 70 researchers per million inhabitants, Africa's scientific community is no match for North America's scientific community, which has 3500 researchers per million inhabitants (let alone Japan which has nearly 4400). Latin America, with 550 researchers per million inhabitants, Asia with 340, and the Middle East with 130 are in slightly better shape, but the word 'divide' does not do justice to the comparison. Indeed the North–South divide in scientific capacity is often more like a chasm.

As history has shown, capacity building strategies imported from the North usually do not work in the South. Such efforts have simply been unsustainable for a variety of reasons, not the least of which are: (1) the strategies were designed to address concerns of primary importance to the North and often did not translate well when shipped South, and (2) the focus was on importing existing technologies instead of building in-country scientific capacities that could be tapped to address a variety of economic-development issues.

In fact, because scientists in developing countries have often viewed themselves as international citizens first and citizens of their



own countries second (a consequence of their international education, training, travel and job opportunities), it has often been difficult to get them to concentrate on critical problems in their own countries.

Developing countries that have recently experienced some success in achieving sustained economic growth – for example, Brazil, China, India and South Korea – are usually the same ones that have made a determined effort to build their scientific capacities. That does not mean they have avoided interaction with the North. In fact, each of these countries have tapped the North's scientific knowledge and technological know-how in a variety of ways to boost their own development process – through education, training, scholarly exchange and trade.

What has most accounted for their success, however, is their ability to set their own agendas and develop their own strategies for scientific capacity building.

Now Africa hopes to achieve similar success through the creation of the New Partnership for African Development (NEPAD), which, among other goals, will seek to create a comprehensive strategy for sustained science-based development driven by the continent's own definition of the problems and solutions inherent in such an effort.

For all of these reasons, I am convinced that the first – and perhaps only – focus of the WSSD in Johannesburg should be on scientific capacity building in the developing world.

The fact is that you cannot construct a new global framework for sustainable development unless you provide people – particularly people with the most pressing economic and social needs – the basic tools and skills that they will need to build that framework. The long-term impact of the WSSD, in fact, will largely depend on the capacity of people throughout the developing world to address sustainability issues on their own and in ways that do not diminish their desires for improving their current living conditions.

In short, the nurturing of scientific knowledge and technological know-how must lie at the centre of this effort and therefore must be placed at the centre of both WSSD discussions and post-WSSD strategies and action programmes. Too many resources and too much time have been invested in this event for only words to be left behind.

Mohamed H.A. Hassan
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Third World Academy of Sciences
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TWAS AND ITS PARTNERS

THE THIRD WORLD ACADEMY OF SCIENCES PROVIDES ADMINISTRATIVE SUPPORT FOR A NETWORK OF INTERNATIONAL SCIENCE INSTITUTIONS. THESE INSTITUTIONS INCLUDE:

THIRD WORLD NETWORK OF SCIENTIFIC ORGANIZATIONS (TWNSO)

The Third World Network of Scientific Organizations is a non-governmental alliance of more than 150 scientific organizations in the South, including ministers of science, technology and higher education, science academies and research councils. TWNSO's primary goals are to help build political and scientific leadership in the South for science-based economic development and to promote sustainable development through South-South and South-North partnerships in science and technology.

www.twnso.org

THIRD WORLD ORGANIZATION FOR WOMEN IN SCIENCE (TWOWS)

The Third World Organization for Women in Science is an independent, non-profit and non-governmental body based at the offices of the Third World Academy of Sciences (TWAS) in Trieste, Italy. The organization – which counts some 2,500 individual and institutional members in 87 developing countries and 27 countries in the North – is the first international forum to unite eminent women scientists from the South with the objective of strengthening their role in the development process and promoting their representation in science and technology policy circles.

www.twows.org

INTERACADEMY PANEL ON INTERNATIONAL ISSUES (IAP)

Founded in 1993, the InterAcademy Panel on International Issues is a global network of 85 science academies worldwide. Its primary goals are to help member academies work together to inform citizens and advise public officials on the scientific aspects of critical global issues. Since May 2000, IAP's secretariat has been located at TWAS in Trieste, Italy.

www.interacademies.net/iap/

TWAS AND ITS PARTNERS

TWAS IS FORTUNATE TO WORK WITH A LARGE NUMBER OF INSTITUTIONS IN BOTH THE SOUTH AND THE NORTH. AMONG THOSE MENTIONED IN THIS SPECIAL EDITION OF THE TWAS NEWSLETTER ARE:

ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS (ICTP)
www.ictp.trieste.it

DEPARTMENT FOR RESEARCH COOPERATION (SAREC) OF THE SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY (SIDA)
www.sida.se

GLOBAL CHANGE SYSTEM FOR ANALYSIS RESEARCH AND TRAINING (START)
www.start.org

INTERACADEMY PANEL ON INTERNATIONAL ISSUES (IAP)
www.interacademies.net/iap/

INTERNATIONAL CENTRE FOR GENETIC ENGINEERING AND BIOTECHNOLOGY (ICGEB)
www.icgeb.org

INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY (ICS)
www.ics.trieste.it

INTERNATIONAL COUNCIL FOR SCIENCE (ICSU)
www.icsu.org

INTERNATIONAL SOCIAL SCIENCE COUNCIL (ISSC)
www.unesco.org/ngo/issc/

ITALIAN MINISTRY OF FOREIGN AFFAIRS (MAE)
www.esteri.it

KUWAIT FOUNDATION FOR THE ADVANCEMENT OF SCIENCES (KFAS)
www.kfas.org

OPEC FUND FOR INTERNATIONAL DEVELOPMENT
www.opecfund.org

SOUTH AFRICAN DEPARTMENT OF ARTS, CULTURE, SCIENCE AND TECHNOLOGY (DACST)
www.dacst.gov.za

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)
www.undp.org

UNDP'S SPECIAL UNIT FOR TECHNICAL COOPERATION AMONG DEVELOPING COUNTRIES (TCDC/SU)
www.undp.org/tcdc/

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)
www.unesco.org

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)
www.unep.org

GLOBAL ENVIRONMENT FACILITY (GEF)
www.gefweb.org

WORLD FEDERATION OF ENGINEERING ORGANIZATIONS (WFEO)
www.unesco.org/fmoi/fmoi/html/home/

WORLD METEOROLOGICAL ORGANIZATION (WMO)
www.wmo.ch

WHAT'S TWAS?

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

At present, TWAS has more than 600 members from 76 countries, 62 of which are developing countries. A Council of 14 members is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat of 9 persons, headed by the Executive Director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. 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 scholarship.

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

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2000 women scientists from 87 Third World 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 85 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**

WANT TO KNOW MORE?

TWAS offers scientists in the Third World a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS web-pages! Our main page is at:
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/Fellowships.html
www.twas.org/AssocRules.html

GRANTS

Need funding for your research project? Take a look at the TWAS Research Grants:
www.twas.org/RG_form.html
TWNSO runs a similar scheme, for projects carried out in collaboration with institutions in other countries in the South:
www.twnso.org/TWNSO_RG.html

EQUIPMENT

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

TRAVEL

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

CONFERENCES

You're organizing a scientific conference and would like to involve young scientists from the region? You may find what you are looking for here:
www.twas.org/SM_form.html