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# TWAS newsletter

NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

*Focus on Brazil*

*Published with the support of the Kuwait Foundation for the Advancement of Sciences*

**C.N.R. RAO'S SIX-YEAR TENURE AS PRESIDENT OF TWAS IS COMING TO A CLOSE. IN THE FOLLOWING ARTICLE, HE ASSESSES TWAS'S ACCOMPLISHMENTS DURING HIS PRESIDENCY AND OUTLINES THE CHALLENGES THAT LIE AHEAD – FOR THE ACADEMY, FOR SCIENCE AND FOR OUR INCREASINGLY GLOBAL SOCIETY.**

# Fond Farewell

*As I prepare to relinquish the reins of the presidency of the Academy of Sciences for the Developing World (TWAS), I would like to convey to the membership what a pleasure it has been to lead TWAS over the past six years.*

*I have had the rare opportunity to preside over a strong institution that has grown even stronger. The Academy's future looks bright, not only because it deals with consequential matters in a meaningful way but also because its track record of success has led to ever-greater global respect and recognition for its accomplishments.*

*First, I would like to thank the Academy's previous presidents for their efforts: Abdus Salam for the vision and determination that he displayed and that proved so instrumental in the creation and early growth of TWAS, and José I. Vargas for so ably expanding the role of the Academy and transforming the institution into a global player – equally adept in the world of science and the world of policy.*

*Always mindful of those who came before me and what they accomplished, as president I have tried to pursue an agenda that would match the success of my predecessors and that would ultimately raise the Academy to a new level of significance and impact.*

*While I may have fallen short of my ambitious goals, I do think that TWAS has made substantial progress on a number of fronts. Our efforts have strengthened the institution and, at the same time, have helped to advance the worthy cause of science-based sustainable development in the developing world.*

*With the help of the membership and drawing on the administrative and diplomatic skills of Mohamed H.A. Hassan, the Academy's executive director, we have indeed become a more vibrant, purposeful and significant institution than we were six years ago. The Academy's programmes are both stronger and larger; its voice more recognized and respected*

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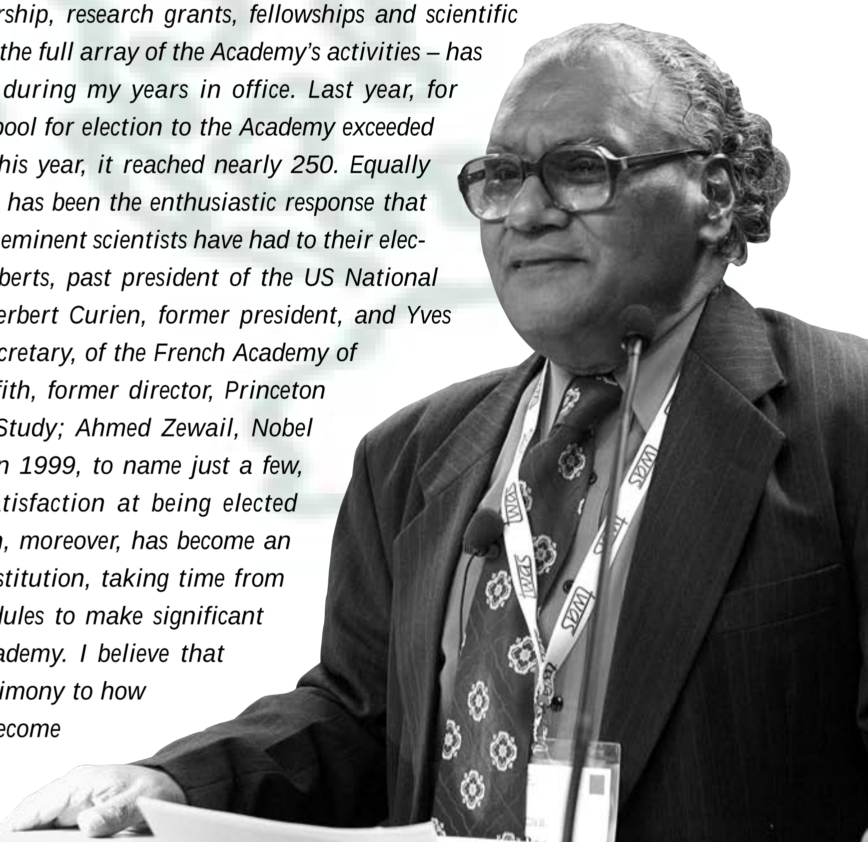
than ever before; and its opinions more welcomed, analysed and embraced than at any time in its 23-year history. For this, we should all be proud – and, more importantly, driven to achieve even more in the future.

There are four accomplishments that have taken place over the past six years that I think are particularly noteworthy and, if I could be so bold to suggest, might serve as the legacy of my tenure.

First, I think we have made significant strides in strengthening the academic credentials of the Academy. TWAS, as the name clearly suggests, is an 'academically inclined' institution, the primary purpose of which is to support and expand scientific excellence across the developing world. If the Academy conceded ground on its pursuit of scientific excellence, it would compromise one of its core values. That, in turn, would undermine its relevance to the global scientific community and, more generally, to society. The pursuit of scientific excellence, then, is not just an 'academic' issue; it is a strategic issue. More than any factor, the progress we make in identifying and supporting scientific excellence enables us to achieve so much more.

That is why I am happy to report that both the number and quality of candidates for TWAS membership, research grants, fellowships and scientific exchange programmes – the full array of the Academy's activities – has increased substantially during my years in office. Last year, for example, the candidate pool for election to the Academy exceeded 200 for the first time; this year, it reached nearly 250. Equally important and revealing has been the enthusiastic response that some of the world's most eminent scientists have had to their election to TWAS. Bruce Alberts, past president of the US National Academy of Sciences; Herbert Curien, former president, and Yves Quéré, former foreign secretary, of the French Academy of Sciences; Phillip A. Griffith, former director, Princeton Institute for Advanced Study; Ahmed Zewail, Nobel Laureate in Chemistry in 1999, to name just a few, have expressed deep satisfaction at being elected members of TWAS. Each, moreover, has become an active member of the institution, taking time from their already busy schedules to make significant contributions to the Academy. I believe that their commitment is testimony to how important TWAS has become to the world of science.



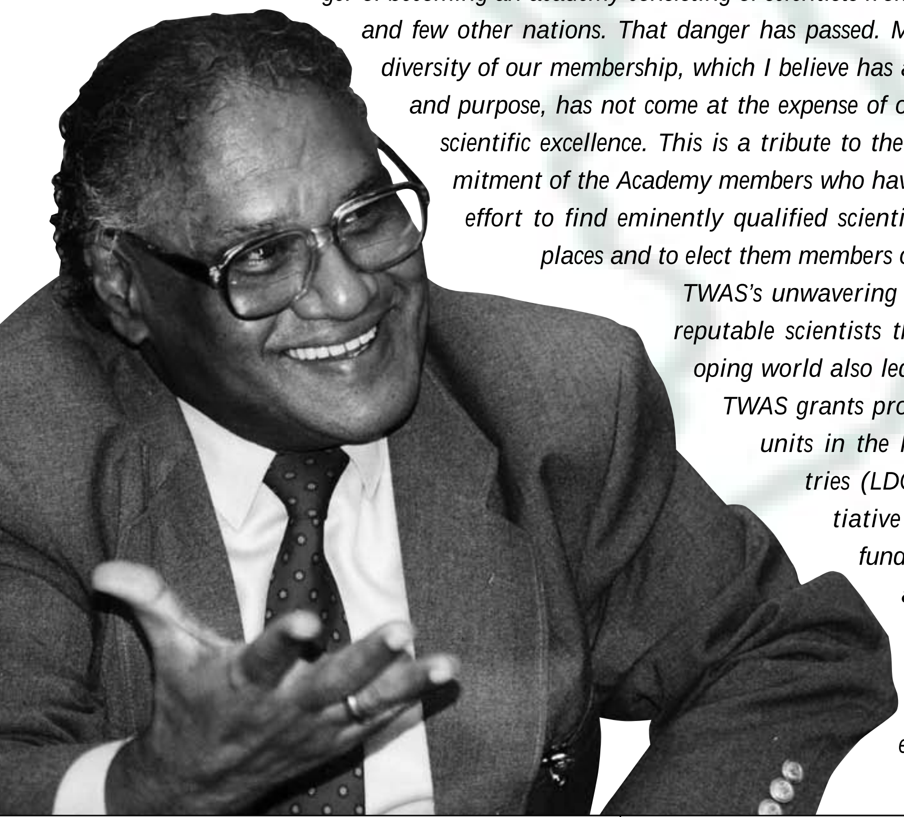
*Eminent scientists, in short, accept membership into TWAS as a source of pride and not as an act of magnanimity – and, after becoming members, they devote time and effort to advancing the Academy's agenda.*

*Second, and equally important, the Academy has made significant strides in reaching more scientists in more corners of the developing world than ever before. Over the past six years, scientists from countries never before represented in the Academy – for example, from Mongolia, Nepal, Togo and Uzbekistan – have been elected to TWAS.*

*I will never forget the enthusiasm and sincerity of newly elected TWAS member, Ulmas Mirsaidov from Tajikistan, as he participated in sessions of the TWAS 16th General Meeting in Alexandria last December. Nor will I forget the heartfelt expression of appreciation offered by Eugenia del Pino Veintimilla, from Ecuador, for being honoured to serve as a council member of TWAS and for receiving a TWAS Medal – actions, which, despite del Pino's welcomed praise, continue to be all-too-rare occurrences in our male-dominated institution.*

*TWAS has always had to perform a balancing act between two desired yet sometimes contradictory goals: recognizing and rewarding excellence, and providing broad access to as many scientists as possible across the developing world. The first requires the Academy to be exclusive; the second to be inclusive. Regardless of how difficult it may be to realize both goals, the Academy's uniqueness – and ultimately its success – will largely be determined by how well we maintain a proper balance between the two, enabling us to move forward on both fronts with confidence and conviction.*

*That is why I am proud to highlight the progress we have made over the past six years in identifying a large pool of accomplished scientists from remote, impoverished countries and electing the most eminent among them as TWAS members. In the late 1990s, we were in danger of becoming an academy consisting of scientists from Brazil, China, India and few other nations. That danger has passed. Moreover, the growing diversity of our membership, which I believe has added to our strength and purpose, has not come at the expense of our efforts to promote scientific excellence. This is a tribute to the dedication and commitment of the Academy members who have made a determined effort to find eminently qualified scientists in out-of-the-way places and to elect them members of the Academy.*



*TWAS's unwavering responsibility to help reputable scientists throughout the developing world also led to the launch of the TWAS grants programme for research units in the least developed countries (LDCs) in 2002. The initiative provides substantial funds – up to US$30,000 a year for three years – to research institutions in LDCs that have conducted good science under*

trying circumstances. Thus far, the Academy has awarded nine grants to research centres, for example, in such places as the Democratic Republic of Congo, Sudan and Yemen. These grants have been conferred without undermining TWAS's commitment to excellence. In fact, our efforts to assist deserving but scarcely known scientific research groups have enriched both the Academy and the global scientific community. What other scientific institution or funding agency, for example, has provided US$90,000 to a camel clinic in Sudan or a polymer research group in Yemen?

And that brings me to what I believe is the third most important accomplishment during my six-year tenure as president of TWAS. The Academy has emerged not only as one of the world's most authoritative and respected voices for science and science-based development in the South. It has also become an invaluable bridge for scientific cooperation among scientists and scientific institutions. Serving in this role, it has helped to connect people, places and activities that have benefitted greatly from the interregional and interdisciplinary partnerships that have followed. These partnerships, created by the bridges TWAS has helped to build, may be difficult to set up but are nevertheless essential for success in our globalized world, especially if the benefits of globalization are to spread to all people in all nations and not just be confined to a select few. For example, TWAS is increasingly serving as a 'bridge for science' between the developing and developed world and, perhaps even more importantly, between countries within the developing world as part of a larger trend towards South-South cooperation.

I am particularly proud of the TWAS fellowship programme, which the Academy oversees in cooperation with the governments of Brazil, China and India. Together, these nations currently sponsor up to 250 fellowships a year for promising young scientists in scientifically lagging developing countries, which allows these students to study at centres of excellence in the host countries: Brazil, China and India. As TWAS secretary general Jacob Palis, who was instrumental in forging the partnership between the Academy and these scientifically proficient developing countries, has said on many occasions, if we can continue to provide this number of fellowships, "we will change the face of science in the developing world over the next decade."

Finally, I would be remiss if I did not mention the Italian government's decision to provide financial support for TWAS on a permanent basis. This generous decision, rendered by the Italian parliament in January 2004, was indeed a historic event. My predecessor, José Vargas, who laid much of the groundwork that led to this decision, deserves a great deal of the credit for convincing the government of Italy that TWAS was worthy of its financial support. I can only hope that the Italian government – and ultimately the Italian people – remain pleased with their investment and that TWAS continues to earn Italy's respect and support in the years ahead.

*Financial stability is a primary source of the Academy's dynamism. Italy's generosity was not only responsible for the creation of TWAS, but it has also played a key role in what we have become today. Moving forward with the support of Italy, I am convinced that the Academy will continue to make significant contributions to science and science-based development across the developing world.*

*Despite all of our success and our current state of financial well-being, I would like to conclude with a word of caution.*

*TWAS is indeed a strong and vibrant institution, but our strength and vibrancy nevertheless remains fragile even as we grow. The Academy's success has depended on the commitment and enthusiasm of its members. As part of the founding generation of TWAS, I witnessed first-hand what a group of individuals – despite limited resources and scant recognition from the outside world – could accomplish with determination, creativity and persistence. But much of that generation is gone and those of us who remain active are either nearing or entering retirement.*

*TWAS now needs the next generation of its members to step up, take charge of the organization and instil it with new energy and new ideas. The Academy's mandate has remained remarkably unchanged despite (indeed because) of the unprecedented pace of change that the world has experienced over the past 23 years: that mandate is to promote scientific excellence in the developing world and to use whatever authority and resources that the Academy can muster to empower the less fortunate scientists – and, more generally, citizens – among us.*

*I would like to once again thank you for this wonderful opportunity and to ask the membership to consider this: Who among us will carry the organization forward to meet the challenges that lie ahead? Who among us will ensure that this institution will continue to play a vital role in the world of science and science policy? Who among us will make certain that the Academy continues to promote scientific excellence while extending support to scientists in all parts of the developing world? Who among us will help guarantee that this unique institution continues to play its unique role in science and society?*

*I have no doubt that the Academy's members will rise to the occasion and that TWAS will continue to grow in size and influence in the years ahead. So, as I leave the presidency, I do so with supreme confidence in TWAS's future and wish you all a fond farewell.* ■

> ***C.N.R. Rao***
*TWAS President (2001-2006)*
*Trieste, Italy*

# ADVANCING SCIENCE IN BRAZIL

**BRAZIL MAY RECEIVE LESS MEDIA ATTENTION THAN CHINA AND INDIA WHEN IT COMES TO ISSUES DEALING WITH SCIENCE AND SCIENCE-BASED DEVELOPMENT. BUT SOUTH AMERICA'S LARGEST AND MOST POPULOUS COUNTRY IS AMONG THE DEVELOPING WORLD'S MOST SCIENTIFICALLY ADVANCED COUNTRIES. JACOB PALIS, SECRETARY GENERAL OF TWAS, REVIEWS THE PROGRESS THAT HAS TAKEN PLACE IN BRAZIL OVER THE PAST TWO DECADES AND PRESENTS HIS VIEWS ON WHAT'S NEXT FOR HIS NATIVE COUNTRY'S ONGOING EFFORTS TO JOIN THE TOP RANKS OF THE GLOBAL SCIENCE COMMUNITY AND TO MAKE SCIENCE A PRIORITY IN THE DEVELOPING WORLD.**

*Brazil has experienced much progress in building its scientific capacity over the past few decades. More recently, it has applied its growing scientific and technological capabilities to some of the critical economic and social issues challenging the nation as it seeks to establish a pathway to sustainable growth.*

Brazil ranks among the developing world's top-tiered countries in terms of many indices – the percentage of scientists relative to the total population, the number of publications in international peer-reviewed journals, the relative citation impact compared to the world average in each field and, more recently, in devising strategies for integrating science and technology into its economic development strategies. In addition, it increasingly serves as a regional promoter of science and technology, it has just launched a scientific exchange programme with Africa, and it participates vigorously in TWAS activities and programmes.

Despite having been sidetracked by military rule and hyperinflation, despite suffering through periods of slow growth, despite attractive opportunities for its best scientists to move to the United States and Europe, despite all of this, Brazil has managed to sustain a reasonable level of investment in science and technology for more than two decades. That investment is now paying significant dividends for economic development on a national scale.

Brazil's gross domestic product (GDP) is currently rising at a rate of about four percent a year. That's good but still a relatively modest rate of growth, especially when compared to China, where annual GDP growth rates average nine percent, or India, where the annual GDP growth rate is seven percent. Yet by most other measures, Brazil's economy has made great strides.

Most notably, Brazil has gained control over its foreign debt. In fact, it is no longer beholden to international lending agencies. Such a welcome development is not only a source of national pride but, equally important, gives the Brazilian government the freedom and confidence that it needs to

pursue economic development policies according to its own plans and at its own pace.

One of the reasons that Brazil's rate of economic growth has failed to match China's or India's is that the government has decided to keep interest rates relatively high to ensure that inflation – which ballooned to 30 percent a month in the early 1990s – will not resurface with a vengeance to play havoc with the economy.

Today, the annual inflation rate is less than four percent a year, creating the price stability necessary for steady growth. Equally important, the success that Brazil has achieved in putting the lid on inflation, first during the administration of Fernando H. Cardoso and, more recently, during the administration of Luiz Inácio Lula da Silva, has spawned a national consensus on fiscal and monetary policies that reaches across political parties and ideologies: All now agree that one of the government's main responsibilities is to keep inflation in tow.

All political parties and ideological factions also agree that scientific capacity has been a major factor in the nation's economic growth. It is important to remember that science in Brazil has strong but shallow roots. The nation's oldest university, the Federal University of Rio de Janeiro, was established in 1920 and the University of São Paulo, today the nation's largest university, was founded in 1934; the Brazilian Academy of Sciences was created in 1916; and the Brazilian National Council for Scientific and Technological (CNPq) was founded in 1951.

While Brazilian science had its science heroes – for example, Carlos Chagas, a world-renowned medical clinician and researcher who, in the early 20th century, uncovered the pathology of the disease that now bears his name – it was not until half a century ago that scientific enterprises were systematically woven into Brazilian society as an integral part of the institutional fabric.

During these early years, and more specifically in second half of the 1960s, Brazil rendered two decisions that had profound impacts on science across the nation. These impacts continue to be felt to this day.

First, Brazil's National Bank for Economic Development, which played a major role in financing the nation's economic development (especially during the post World War II period) agreed to devote two percent of its annual investment funds to science and technology. This decision provided a sustained source of funds both for scientific research and technological applications. The funds have remained in place through all of the political storms and economic setbacks that followed, including a repressive period of military dictatorship from 1964 to 1985, a time of hyperinflation in the early 1990s, and the collapse of the currency – the *Real* – in the same decade.

A second fundamental decision, made in the late 1960s by the Ministry of Education, also had a profound effect on science in Brazil, not so much for the funding it provided but for the structure it created for research and training. Led, on one hand, by the Ministry of Education, which set the framework for graduate study programmes and, on the other hand, by the Bank for Economic Development, Brazilian authorities agreed that most of the funding for research and for graduate education and training would be given to talented individuals and groups and not to institutions as a whole. In particular, masters' and doctorate programmes would be carried out by talented groups wherever they were located, whether at universities or independent research institutions.

At first glance this decision may seem trivial. After all, what is the difference between funding individuals or groups of scientists and funding scientific institutions? Don't the former work in the latter, and wouldn't the government accomplish the same goals if it gave funds to institutions that could then use the money to promote research and graduate education and training?

But experience paints a different story. The truth is, a funding strategy focusing on individuals or groups of individuals makes all the difference, especially in a nation where institutions of higher education are not too strong and a culture of scientific excellence has yet to take hold. That's because funding individuals targets funds in ways that can maximize the investment, reward initiative and innovation, encourage flexibility and cooperation, and allow funds to be shifted to new dynamic groups as they emerge and withdrawn from old ones as they fade.

The irony is this: to institutionalize a culture of excellence in graduate education and training, Brazil focused on identifying and rewarding individual talent and ingenuity. It is a lesson that other developing nations may want to emulate as they seek to build their own research and graduate programmes in science and technology.

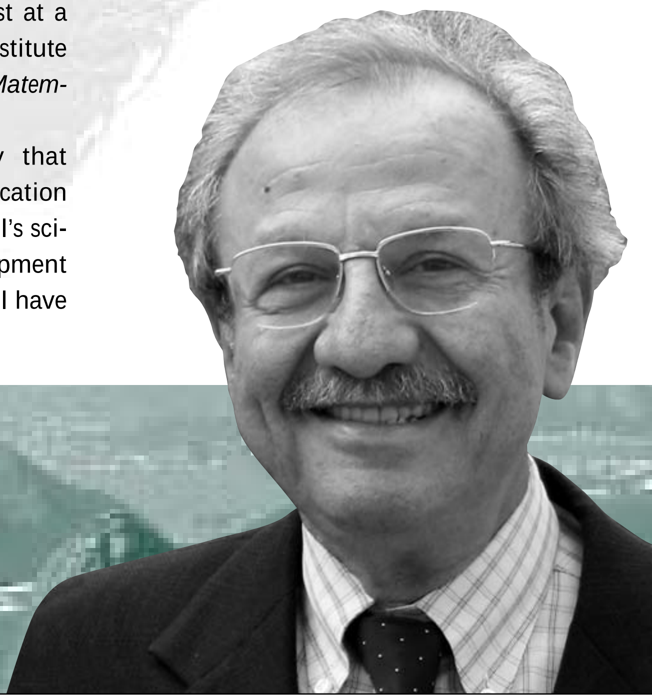
Today, this process is still at work in Brazil not only in the nation's master's and doctorate programmes but also in the funding of research for scientists throughout all stages of their careers. National review committees, comprised of experts in science and education, periodically evaluate the performance of scientific groups, upgrading or downgrading them based on their conclusions. These review committees also assess proposals for new graduate degree-granting programmes.

The strategy has not only rewarded programmes that have proven their worth, such as those at the University of São Paulo, but has also encouraged institutions to team together to offer graduate degrees, taking advantage of the diverse expertise that may exist at a university or a research institute such as my own, *Instituto de Matematica Pura e Aplicada* (IMPA).

I don't mean to imply that Brazil's system of higher education or, more generally, that Brazil's scientific research and development strategies are perfect. We still have a long way to go. In Brazil, for example, 10,000 students graduate with doctorates each year. About 70 percent of the total receive their PhDs in science and engineering. It's estimated that we need two to three times that number to ensure there is a sufficient pool of well-trained scientists and technologists to meet the growing needs for research and development in industry and, more generally, to address the critical challenges we face. Education and training, moreover, are stronger in the basic sciences than in the applied sciences. This means that Brazil still has too few scientists working on issues of paramount importance to society – science-based issues, for instance, related to the environment, public health and economic competitiveness.

The tilt towards the basic sciences in institutions of higher education also exacerbates another





glaring weakness in the nation's efforts to promote research and development – the limited involvement of the private sector in research and development (R&D). In developed nations such as the United States, more than 60 percent of the funds invested in R&D are derived from the private sector. In Brazil, that percentage has increased in recent years but it still stands at less than 40 percent.

Greater involvement of the private sector would expand the nation's research and development investment portfolio, provide additional funds for science, and likely draw research closer to the public policy arena, where science could better showcase its value to national economic development strategies.

The bottom line is this: science and technology has come a long way over the past 50 years when it was largely relegated to a select group of people who often worked more closely with colleagues abroad than they did with colleagues at home. In contrast, Brazilian science today is a thriving domestic enterprise making significant contributions to the nation's economic and social well-being. Nevertheless, we still must increase funding, work hard to keep pace with such innovative developing countries as China and India, and strive to achieve parity with scientifically advanced nations.

Science in Brazil needs to continue to grow in both numbers and excellence; it needs to care more about its top talents to ensure that they first receive training commensurate with their innate abilities and then employment opportunities that match their knowledge and skills; it needs to foster local scientific capacity to avoid creating a chequered scientific landscape marked by excellence in the cities and sub-par performances in rural areas; and, despite the progress that has been made, it needs to integrate science and science policy into other government responsibilities, working more closely, for example, with the ministries of finance and foreign affairs.

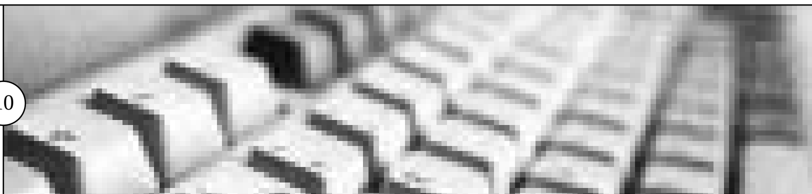
While doing all of this within its borders, Brazil needs to reach out to other nations to promote global scientific cooperation, especially among developing countries. It is both morally correct and strategically astute for scientifically proficient developing countries like Brazil to help other developing countries strengthen their scientific capacities. The Brazilian government recognized this when it established a Pro-South initiative that provides US$1.5 million a year for the development of joint research projects among universities and scientific institutes in South America. Similar thinking spurred the recent decision by the Brazilian government to establish a ProÁfrica initiative that is designed to nurture cooperation between universities and scientific institutes in Brazil and Africa.

While much of the progress in scientific capacity building that Brazil has experienced over the past two decades has been achieved on its own, it recognizes that science is an international enterprise and that all nations – those that give and those that receive – benefit from international exchange and cooperation.

We also recognize that, in the past, we received support from colleagues, universities and research institutes in the developed world.

Now Brazil's scientific community is poised to strengthen and, in some cases, launch its own exchange and joint research programmes in Latin America, among developing world nations and with the advanced nations too. Everyone profits from cooperation, and Brazil is determined to provide its fair share of funds and personnel to a global scientific enterprise that emphasizes openness, inclusion and the common good. ■

> ***Jacob Palis***
*TWAS Secretary General*
*(2000-2006)*
*Trieste, Italy*



# BRAZILIAN SCIENCE: ON THE VERGE

**MEMBERS OF TWAS MET IN BRAZIL IN 1997. NOW, NEARLY A DECADE LATER, THE ACADEMY WILL RECONVENE IN BRAZIL FOR ITS 10TH GENERAL CONFERENCE AND 17TH GENERAL MEETING, TAKING PLACE FROM 2 TO 6 SEPTEMBER. TWNSO'S 9TH GENERAL ASSEMBLY WILL BE HELD THE SAME WEEK. THE VENUE FOR THESE EVENTS IS THE SEASIDE RESORT OF ANGRA DOS REIS, 150 KILOMETRES SOUTH OF RIO DE JANEIRO. MORE THAN 300 SCIENTISTS FROM SOME 80 COUNTRIES ARE EXPECTED TO ATTEND.**

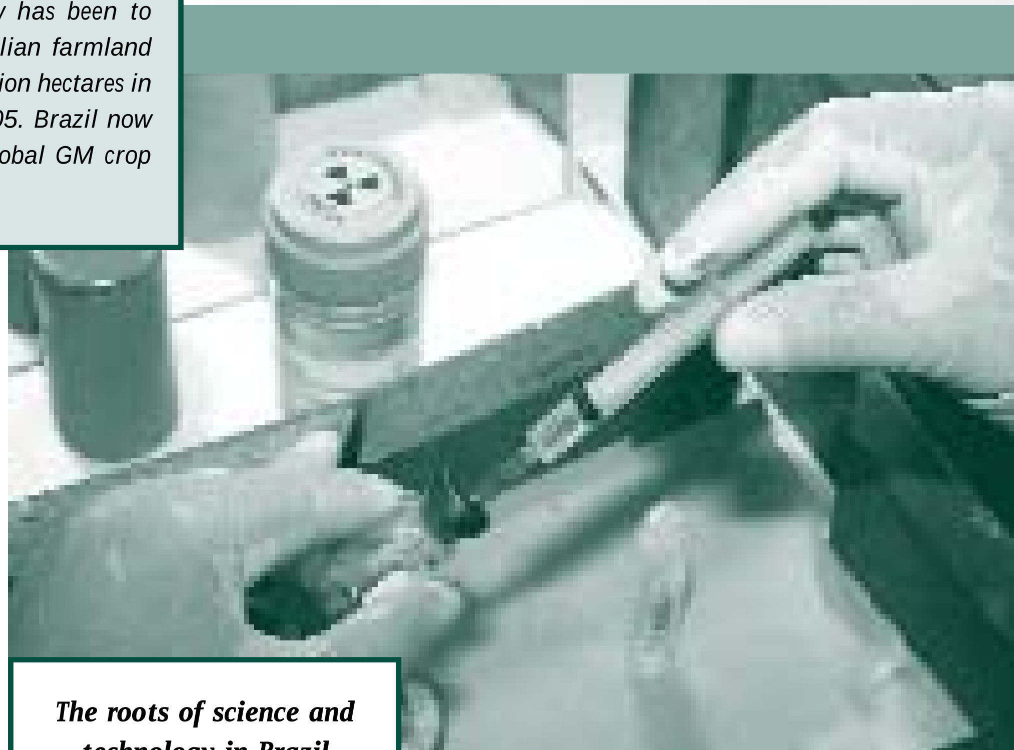
*Science and technology in Brazil have experienced unprecedented growth since TWAS members last met in Latin America's largest nation. As Sergio Rezende, Brazil's Minister of Science and Technology, recently remarked, his nation now stands ready to join the international science arena as a full and equal partner. The following article takes a look at how Brazil has managed to reach this promising stage of scientific development.*

You don't have to look far into the past to see the beginnings of science and technology in Brazil. Indeed, it was not until the early 20th century that science – and to a lesser degree technology – became integral parts of Brazil's economic and political landscape.

The roots of science and technology in Brazil lie with individuals, not institutions. For example, such eminent scientists as Oswaldo Cruz and Carlos Chagas account for the nation's first forays into international science. Cruz, a medical pioneer, worked tirelessly to curb the incidence of such infectious diseases as bubonic plague and smallpox, and Chagas, a physician, discovered the molecular basis of the disease that now bears his name. Both embodied Brazil's 'heroic age' of 'individualized' science. In contrast, universities offering a broad curriculum in the arts and sciences did not surface until the 1920s. The Federal University of Rio de Janeiro was founded in 1920 as the nation's first fully fledged university. It was followed by the University of Minas Gerais in

**BIOTECH IN BRAZIL**

*The Brazilian government has been laying the foundations for advancing research in biotechnology. In March 2005, the Brazilian parliament passed legislation that allows stem cell research and the planting and sale of genetically modified (GM) crops. One effect of the law has been to almost double the amount of Brazilian farmland planted with GM crops from five million hectares in 2004 to 9.4 million hectares in 2005. Brazil now accounts for some 10 percent of global GM crop production.*



***The roots of science and technology in Brazil lie with individuals, not institutions.***

1927 and the University of São Paulo in 1934.

Since then, Brazil has continually struggled to strengthen its system of higher education and research capacity. In the 1950s, Brazil created two government agencies that fundamentally changed the nation's science and technology enterprise: the National Research Council, now known as the National Council for Scientific and Technological Development (CNPq) and the Committee for Advanced Professional Training (CAPES). CNPq aids individual scientists through scholarships, fellowships and research grants. What began as a modest programme currently supports 50,000 scientists a year. CAPES, on the other hand, has been responsible for reforming the nation's university system. In the 1960s, it spurred the creation of masters' and doctorate programmes. It subsequently established a rigorous review process for these programmes that has played a key role in promoting scientific excellence.

In 1969, the government established the Studies and Projects Financing Entity (FINEP), granting it responsibility for managing the National Science and Technology Development Fund (FNDCT). This fund, which now exceeds US$350 million, supports institutional research projects. During the same period, the government created the forerunner of the National Bank for Economic Development to link science and technology more closely to Brazil's burgeoning industrial base. FNDCT's investments have helped to boost the nation's aerospace, oil exploration and telecommunications industries, largely through its Fund for Technical and Scientific Development (FUNTEC).

Scientists continued to persevere during Brazil's two decades of dictatorship lasting from 1964 to 1985. During this period, scientific research often served as a wellspring for strengthening the military and instilling a sense of national pride through, for example, the creation of an aerospace industry. Scientists, despite the political environment, often enjoyed a modicum of freedom to interact and discuss issues of mutual interest with colleagues both within and beyond the nation's borders, a freedom that was not afforded to other sectors of society. In these conflicting capacities, scientists were both 'part of' and 'apart from' the society they served.

Brazil's scientific enterprise, however, was not spared the consequences of the 'lost decade', as the 1980s are sometimes called. During the 1980s, scientific output slowed appreciably, shackled by the political repression and economic difficulties that characterized this 'iron-fisted' period.

With the reinstatement of civilian government in 1985, President Tancredo Neves created the Ministry of Science and Technology, reopening a dialogue between the federal government and the scientific and technological communities based on national priorities designed to promote sustained economic growth. Today, the ministry coordinates the implementation of Brazil's national science and technology policies in a broad range of fields, including biosecurity, nuclear research, space science and telecommunications.

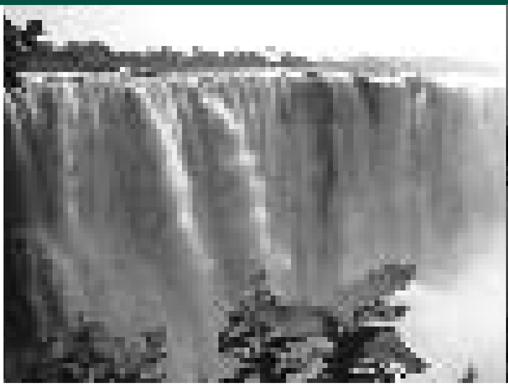
The path leading to the current state of science and technology in Brazil was first laid out in the 1990s during the administration of Fernando Henrique Cardoso. The key was the introduction of a new currency, the *Real*, and the enactment of stringent financial measures to curb Brazil's chronic foreign debt, which had fuelled runaway inflation and chronic currency devaluations that ultimately sapped the strength of the nation's economy.

Cardoso (TWAS Fellow 1984) spoke out forcefully in support of science and technology as the basis of economic growth, calling for budgetary reforms that would increase spending on science and technology to one percent of the nation's annual gross domestic product (GDP) (at the time, the percentage stood at 0.57 percent). Cardoso also appointed competent

### CENTRE OF EXCELLENCE

*The* Instituto Nacional de Matemáticas Puras e Aplicadas *(IMPA) is recognized globally for its research into partial differential equations and numerical analysis, differential geometry, dynamical systems, graphic computation and mathematical economics. Over the past decade, IMPA researchers have published more than 500 scientific papers in major international journals. In addition, IMPA is also considered the main educational and training centre in Latin America for advanced mathematics, having graduated more than 120 PhD students in the past 20 years. For additional information,* see www.abc.org.br.

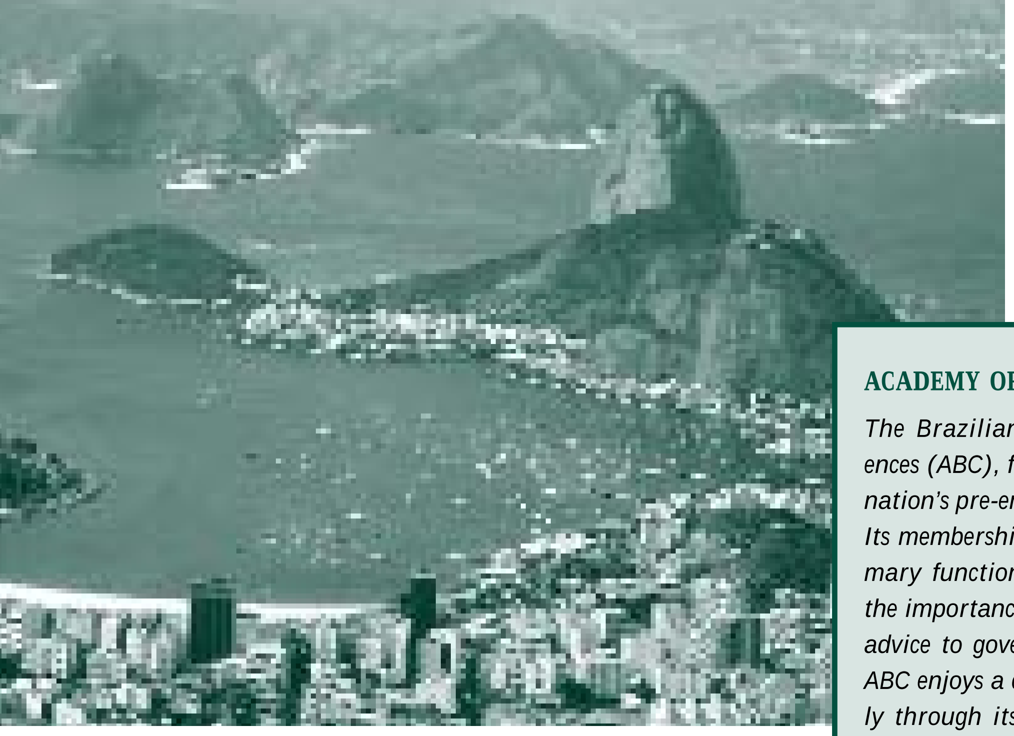
administrators to key government posts, including, as ministers of science and technology, José I. Vargas (1995-1999) and Ronaldo Sardenberg (1999-2002). Vargas also served as president of TWAS from 1994-2000.



Cardoso’s tenure as President, however, included a fair share of disappointments. Efforts to rein in the budget deficit led to deep cutbacks in public spending for science and technology, especially during Cardoso’s first term. These cutbacks stalled – and in some cases reversed – the progress that had taken place. The nation’s space programme, for example, suffered from a shortage of funds that ultimately eroded its expertise and forced it to renege on its stated policy goals. At the same time, while the number of researchers continued to increase, Brazil’s scientific and technological workforce remained relatively small in relationship to its large population as well as compared to other developing countries such as China and India.

**IN THE FIELD**

*The mission of the* Empresa Brasileira de Pesquisa Agropecuária *(EMBRAPA, the Brazilian Agricultural Research Corporation) is to provide feasible solutions for the sustainable development of Brazilian agribusiness through the generation and transfer of knowledge and technology. EMBRAPA runs a series of research institutions throughout the country, covering such areas as agroforestry, agriculture in the semi-arid tropics and the conservation and sustainable use of genetic resources. One of its major projects focuses on agricultural and environmental sustainability in the tropical forests of the state of Rondônia – a programme that is expected to continue for at least 100 years. An ongoing EMBRAPA satellite monitoring programme indicates where areas of rainforest and other natural habitat are being cleared for agricultural purposes. For additional information,* see www.embrapa.br.



**ACADEMY OF EXCELLENCE**

*The Brazilian Academy of Sciences (ABC), founded in 1916, is the nation's pre-eminent merit-based science academy. Its membership currently exceeds 600. ABC's primary functions are to raise public awareness of the importance of science to society and to provide advice to government on critical scientific issues. ABC enjoys a close relationship with TWAS, largely through its affiliation with the InterAcademy Panel (IAP), a global network of science academies that operates under the auspices of TWAS. Eduardo Krieger, president of the ABC, served as co-chair of the IAP from 2000 to 2003. For additional information, see* www.abc.org.br.

During Cardoso's second term (1999-2003), Brazil's economy began to strengthen and, as a consequence, investments in science and technology began to increase. A key initiative during this period was the introduction of the sectoral funding programme. Launched in 1999, the programme generates research funds by taxing the revenues of technology-intensive and natural resource-exploiting sectors of the economy – for example, the aerospace and biotechnology industries, agribusiness, computer manufacturers and oil companies. The initiative currently covers 16 different sectors, including 15 managed by the Ministry of Scienec and Technology and another by the Ministry of Communication, and is projected to generate US$650 to US$750 million this year.

***Launched in 1999, the sectoral funding programme is projected to generate US$650 to US$759 million this year.***

Although widely praised, the sectoral funding programme has not escaped criticism. The government, for example, has withheld a portion of the funds as a contingency to guard against budget shortfalls (in effect, using the funds to create a general reserve that could be tapped during an economic downturn). This decision sparked protests from the scientific community and ultimately led the government to proclaim earlier this year that, in the future, it would use sectoral funds only for the purposes for which the funds were intended. Other critics have noted that key sectors of the economy – for example, meteorology and microelectronics – are not part of the programme. Likewise, critics contend that the fund is not designed to promote multidisciplinary research, nor is it well positioned to assist nascent fields of scientific inquiry. Despite these shortcomings, the sectoral fund programme has become a primary pillar of funding for science and technology in Brazil, currently accounting for about 10 percent of total research and development expenditures.

When Cardoso left office in 2003, the policies he championed had considerably strengthened Brazil's science and technology capacity. During his presidency, the number of researchers tripled from 20,000 to 60,000; the number of articles published by Brazilian scientists in international peer-reviewed journals increased at an unprecedented rate from some 4,800 to more than 11,000; such cutting-edge sectors as biotechnology and information technology displayed virgorous growth; and both government and the public


**IN THE AMAZON**

*The* Instituto Nacional de Pesquisas da Amazônia *(INPA, National Institute of Amazon Research), which operates under the auspices of the Brazilian Ministry of Science and Technology, examines living and environmental conditions in the Amazon region. In addition to promoting the sustainable use of resources, the institut seeks to promote the well-being of the local population. INPA's research agenda ranges from studies of Amazon flora and fauna to computer modelling of climatic conditions. With a workforce that includes nearly 1,000 scientists, INPA oversees four forest reserves and five experimental stations. It also offers fellowships for postgraduate training in, for example, tropical agriculture and forestry, evolutionary biology, fisheries, entomology and genetics. For additional information, see* www.inpa.gov.br.

had come to embrace science and technology more strongly than ever before. Brazil also took its first significant steps towards becoming a leading nation for South-South cooperation in science, most notably through the creation of the China-Brazil Earth Resources Satellite (CBERS) programme, which led to the launch of CBERS-1 in 1999.

Nevertheless, Cardoso's successor, Luiz Inácio Lula da Silva, upon taking office, faced a set of challenges as daunting as those faced by Cardoso. The fundamental issue that Lula had to deal with was this: how could Brazil continue to build on Cardoso's success and, at the same time, address critical science and technology issues that had failed to receive the attention or resources that they deserved? Put another way, how could Lula tackle the outstanding problems in science and technology that had restrained Brazil's progress without jeopardizing the emerging areas of strength in the nation's science and technology enterprise?

Among the most outstanding issues that have required Lula's attention are:

- *More Growth*. While virtually all of the indicators for science and technology in Brazil point in a positive direction, the total number of scientists and technologists in the country remains extremely low. Indeed, in a nation with a rapidly growing population that currently totals more than 185 million, there are just 80,000 scientists and technologists. That amounts to 324 scientists and technologists for every one million people. Compare that to a ratio of 633 scientists and technologists for every one million people in China. An even more startling comparison is provided by Russia, which has more than 500,000 researchers despite a declining population that now totals 145 million. That's more than 3,400 scientists and technologists for every one million people. In light of its small number of scientists, the Brazilian government has continued to increase its investment in the education and training of young scientists. In 2005, 9,500 doctorate degrees were awarded, a number that is expected to grow to 10,600 this year. Last year, CNPq also granted scholarships for 26,000 doctoral students and another 81,000 fellowships for master's degree students. Most experts agree that Brazil should raise the number of scientists and technologists with advanced degrees by a factor of three. Current trends show that it is on track to accomplish this goal within the next decade or two.

***The total number of scientists and technologists in Brazil remains extremely low.***

- *Better Balance*. Historically, the southeastern coastal corridor, and particularly Rio de Janeiro and São Paulo, have been the primary hubs for science and technology in Brazil. Part of the reason for this is that a nation's greatest cities tend to be its greatest centres of learning. The other part of the reason is economic. Under Brazil's federated system, each state has the right to fund its own system of science and technology independent of the national system. Rio de Janeiro and São Paulo, Brazil's richest states, have invested in science and technology at funding levels that far exceed those in other states. As a result, these two states are home to the nation's most advanced scientific institutions. The current administration has devised a policy designed to redress these imbalances by calling for the creation of at least one federal university in each of the nation's 26 states. Twenty-three of these 'new' universities will be formed by upgrading existing state universities. In three states, new campuses will be built. The Lula administration is also seeking ways to ensure that deserving students and faculty in remote areas enjoy the same opportunities to receive fellowships and grants as those in the nation's premier metropolitan areas.
- *Closer Ties*. While Brazil deserves a great deal of credit for strengthening the capacity of its scientific community, it has failed to achieve the same level of success in transforming its rapidly growing scientific knowledge and expertise into products and services that help the nation's economy to grow. Only a few high-technology industries have flourished, and virtually all of these have operated under the military or as state-owned corporations. As a result, the Brazilian government has sought to forge strategies that create stronger links between universities and the private sector. In 2004, the government approved a law for 'innovation partnerships' between research institutions and industry. The law called for the creation of university science and technology incubators, gave researchers the freedom to work as consultants in industry, and provided private firms access to public research facilities. The goal is to create a demand-driven knowledge system that focuses greater attention on improving the nation's economy.

- *Private Matters*. Like most developing countries, science and technology in Brazil have depended largely on public sector funds. In 1995, an estimated 78 percent of the total investment in science and technology was derived from government sources. Consequently, Brazilian corporations, devoid of their own research and development departments, have depended largely on foreign technological products and services to drive their businesses forward and to keep them competitive in the global market place. Over the past decade, and particularly over the past five years, aggressive policies by the Brazilian government and increasingly the private sector have spurred a dramatic rise in the percentage of research and development funding coming from non-governmental sources. Today, that percentage is estimated to range between 40 and 45 percent – a figure that Brazilian authorities hope will continue to rise in the years ahead.
- *Global Connections*. Over the past few years, the government has initiated a suite of policies designed to place Brazil at the forefront of South-South cooperation in science. Building on the success of the China-Brazil Earth Resources Satellite programme, the two nations launched a second satellite in 2003 and, in 2004, agreed to jointly launch three more satellites by 2008. The government also recently announced a ProÀfrica initiative to forge closer ties between scientists in Brazil and Africa, particularly Portuguese-speaking Africa. This spring, for example, Brazil and Angola signed a protocol to create a cooperative training programme for environmental education in Angola. On other fronts, Brazil is working with South Africa to create research projects in a variety of fields and it has signed a memorandum of agreement with Ghana to forge joint programmes on food security, energy production and agribusiness.

**_The government has initiated policies designed to place Brazil at the forefront of South-South cooperation in science._**

A century ago, science and technology in Brazil were relegated to a few scientists working on their own, largely in isolation from their fellow citizens. At best, citizens viewed their native-born scientists as heroic individuals toiling in the shadows of society. Fifty years ago, the government took its first steps to build a scientific infrastructure worthy of a country as large and resource-rich as Brazil. Twenty-five years ago, Brazil was still reeling under the

### IN THE AIR

*The* Empresa Braziliera de Aeronautica *(EMBRAER) is one of the world's largest manufacturers of mid-sized jets for corporate and executive use (seating 70-110 passengers). It also plays a major role in the design and devleopment of Brazil's defence systems. EMBRAER was launched as a government-owned corporation in 1969 with the responsibility to manufacture the first Brazilian-designed military aircraft. In 2000, it issued public offerings on both the São Paulo and New York stock exchanges. It currently employs more than 16,000 people and has ranked either first or second in Brazilian exports for the past seven years. For more information, see* www.embraer.com.br.

weight of authoritarian rulers who had recognized the value of science – at least for militaristic reasons – but had been unwilling to sanction a social and political environment where research excellence could flower across a full range of disciplines and for the benefit of all citizens.

In light of this history, it is difficult to describe Brazil's path to scientific proficiency as a long trial. Indeed it could be argued that progress has been short and swift. But that does not, in any way, minimize what has been accomplished.

Government, universities, research institutions and individual scientists have all made contributions to the effort. Economic reforms, moreover, laid the financial foundation for progressive scientific policies and programmes that have spurred both excellence and greater research productivity. Brazil, as a result, may be on the verge of joining a select but growing group of nations where science-based sustainable development is the norm and where the strength of scientific institutions does not depend on individual benefactors but is woven into the fabric of government and society.

Science and technology in Brazil have clearly experienced much progress since TWAS last met in Brazil. The nation is now poised to make even greater progress in the future – progress likely to bestow increasing benefits on Brazil, Latin America and the entire world.

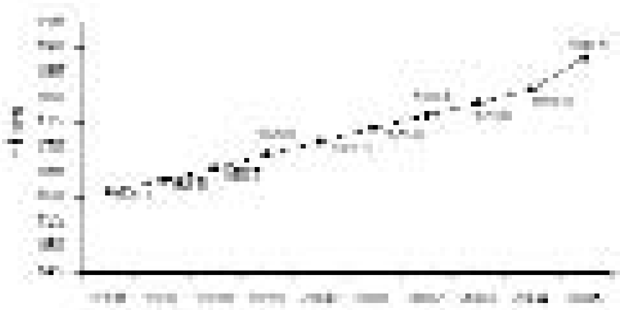
**BRAZIL @ TWAS.ORG**

*Since October 2005, the TWAS secretariat has been assisted by three Brazilian staff members. Experts in web design and public relations, Vinicius Faria and Gabriella de Mello have been seconded to TWAS by the Brazilian Academy of Sciences to build a web portal for TWAS and its affiliated organizations, the Third World Network of Scientific Organizations (TWNSO) and the Third World Organization for Women in Science (TWOWS). Thanks to their efforts, the new internet portals, with features that will allow on-line applications for fellowships and on-line nominations for TWAS Prizes, should be ready for operation by November 2006. In addition, Luiz Hayne of the Brazilian National Council for Scientific and Technological Development (CNPq) has been working with Cristina Simões in the TWAS fellowships office, helping to administer TWAS's fastest growing programme – its South-South fellowships scheme. This is another indication of the growing partnership between TWAS and Brazil's scientific community – a partnership that has also been strengthened by the opening of the TWAS regional office at the Brazilian Academy of Sciences in 2004 and the CNPq–TWAS Fellowships Programme.*

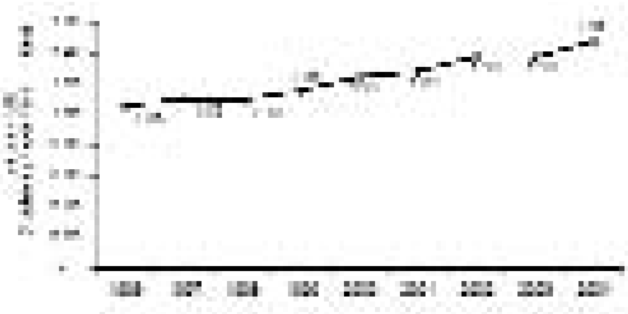
# S&T IN BRAZIL:

*TWAS members last met in Brazil in September 1997 for TWAS's 6th General Conference*

### POPULATION



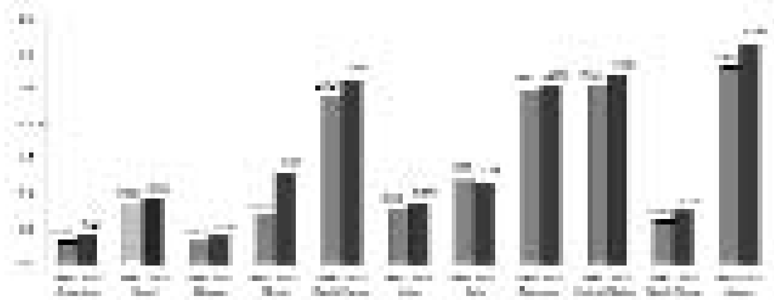
### GROSS DOMESTIC PRODUCT (GDP)



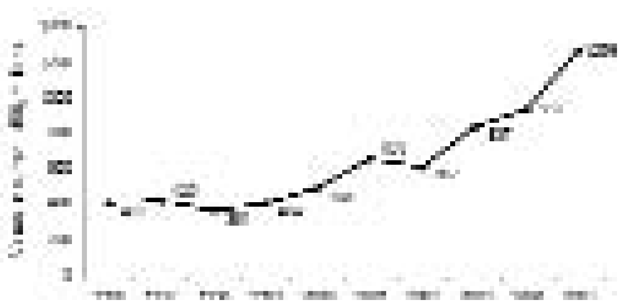
### ANNUAL GDP GROWTH (%)

| | |
|---|---|
| 1996 | 2.70 |
| 1997 | 3.30 |
| 1998 | 0.10 |
| 1999 | 0.80 |
| 2000 | 4.40 |
| 2001 | 1.30 |
| 2002 | 1.90 |
| 2003 | 0.50 |
| 2004 | 4.90 |

### R&D EXPENDITURES IN SELECTED COUNTRIES: PERCENTAGE OF GDP



### MINISTRY OF SCIENCE AND TECHNOLOGY: TOTAL BUDGET

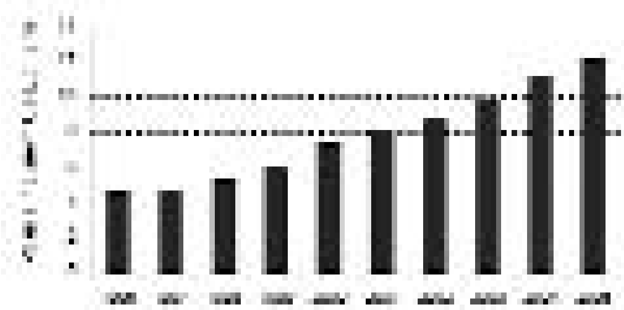


### S&T DEVELOPMENT FUNDS (FNDCT)

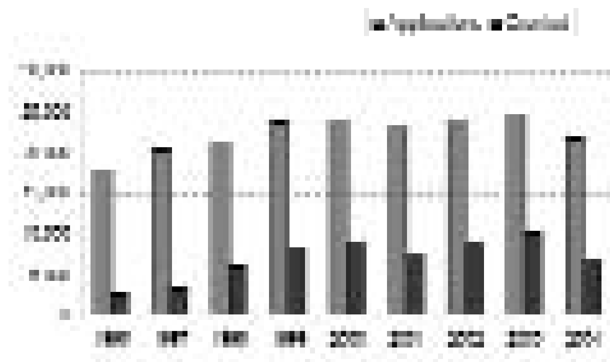
# A DECADE OF PROGRESS

*and 9th General Meeting. Here's a statistical profile of trends in Brazilian science and society since then.*

### INVESTMENT IN SCIENCE AND TECHNOLOGY: GOVERNMENT AND PRIVATE SECTOR



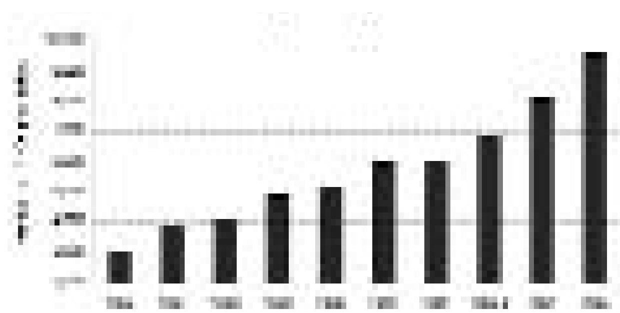
### PATENTS



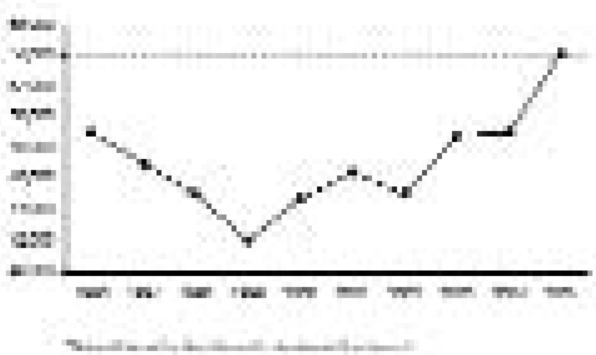
### S&T GRADUATES: PERCENTAGE OF WORKFORCE

| S&T | GRADUATES | % WORKFORCE |
|---|---|---|
| 1996 | 190,000 | 0.25 |
| 1997 | 203,000 | 0.26 |
| 1998 | 238,000 | 0.30 |
| 1999 | 228,000 | 0.27 |
| 2001 | 283,000 | 0.33 |
| 2002 | 338,000 | 0.38 |
| 2003 | 358,000 | 0.40 |

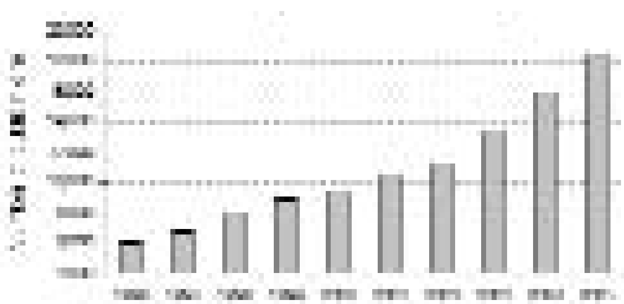
### PhD GRADUATES/ YEAR



### RESEARCH FELLOWSHIPS/GRANTS (CNPq)*



### PAPERS PUBLISHED BY BRAZILIAN INSTITUTIONS/YEAR (SCIENCE CITATION INDEX)



*Sources: Ministry of Science and Technology, Government of Brazil; National Council for Scientific and Technological Development (CNPq), Brazil; and UNESCO Institute of Statistics (UIS)*

**BRAZIL HAS THE LARGEST SCIENTIFIC AND TECHNOLOGICAL COMMUNITY IN LATIN AMERICA AND ONE OF THE LARGEST IN THE DEVELOPING WORLD. ITS SCIENTIFIC ENTERPRISE IS CURRENTLY GROWING AT AN UNPRECEDENTED PACE – IN TERMS OF FUNDING, RESEARCHERS, STUDENTS AND PUBLICATIONS. THAT HAS RAISED EXPECTATIONS THAT BRAZIL WILL SOON JOIN CHINA AND INDIA AS ONE OF THE DEVELOPING WORLD'S FOREMOST SCIENTIFIC AND TECHNOLOGICAL HUBS – EXPECTATIONS THAT THE GOVERNMENT CLEARLY HOPES TO FULFIL.**

# THE MINISTER ON SCIENCE

*Sergio M. Rezende (TWAS Fellow 2004), who was appointed Brazil's Minister of Science and Technology in July 2005, coordinates the federal government's broad-ranging efforts to promote science and technology. The Minister recently sat down with the editor of the* TWAS Newsletter *in Brussels while on a trip to promote scientific cooperation between Brazil and various European countries. Their discussion focused on the current state of science in Brazil and the prospects for strengthening the role of science in his nation's overall development efforts. Minister Rezende also examined Brazil's efforts to promote South-South cooperation in science, not only in Latin America but throughout the developing world. Excerpts follow.*

**What is the state of science and technology in Brazil? How have conditions changed since TWAS held its 6th General Conference in 1997?**

There have been two major developments in science and technology in Brazil over the past decade. The first involves the rising level of science and technology in terms of both funding and excellence. Simply put, substantially more science and technology is being done in Brazil and the quality of science and technology is higher than ever before.

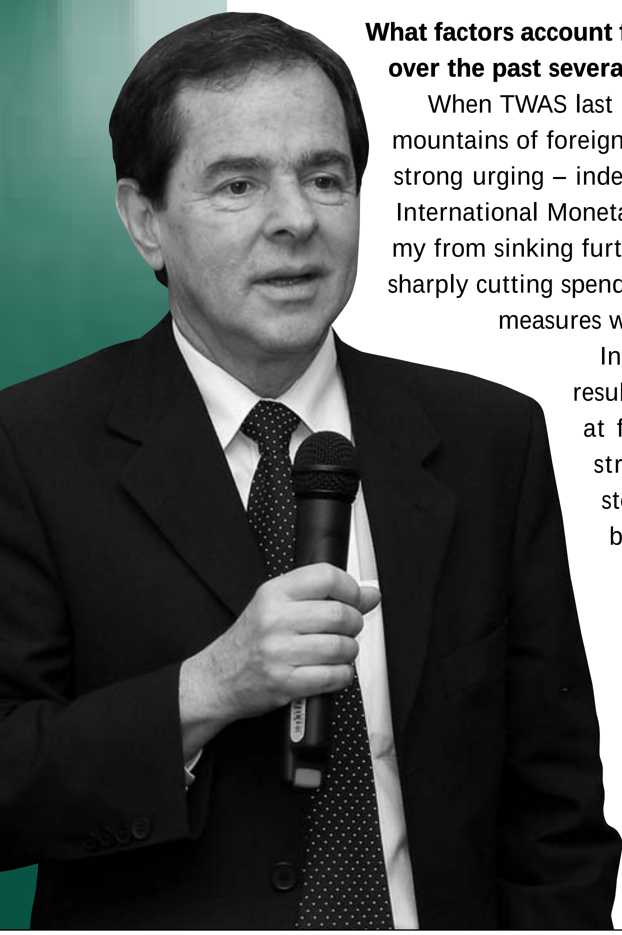
The second change involves public perceptions, most notably in government and industry but also among ordinary citizens. An increasing number of Brazilians from all walks of life now believe that scientific and technological capacity is a critical element of development, and not just a desirable but unnecessary luxury that can be pursued after other more pressing concerns have been addressed. As a result, support for science and technology has never been higher.

Virtually all of the indicators for science and technology in Brazil are on the rise. The numbers of students, researchers, projects, publications and international collaborations have all

increased substantially. Take, for example, the number of researchers. In 1997, Brazil graduated less than 4,000 doctoral students. That number has more than doubled to nearly 10,000 this year. Or take publications in peer-reviewed international journals. In 1997, Brazilian scientists published approximately 8,500 articles in the world's top scientific journals. Last year, they published more than 18,000.

While additional funding is by no means the only reason for these promising trends, it is important to note that funding for research and development has increased from approximately 0.8 percent of Brazil's gross domestic product (GDP) in 1997 to 1.3 percent today. And, of course, this percentage is drawn from a larger economic base. In 1997, Brazil's GDP was about US$600 billion. Today it is more than US$800 billion.

Indeed, a major reason for the increased funding for science and technology is the improved state of the Brazilian economy. Brazil's rising economic fortunes and its increasing investments in science and technology have advanced hand-in-hand. One has reinforced the other in a virtuous circle of progress.



**What factors account for the increased funding for science and technology in Brazil over the past several years?**

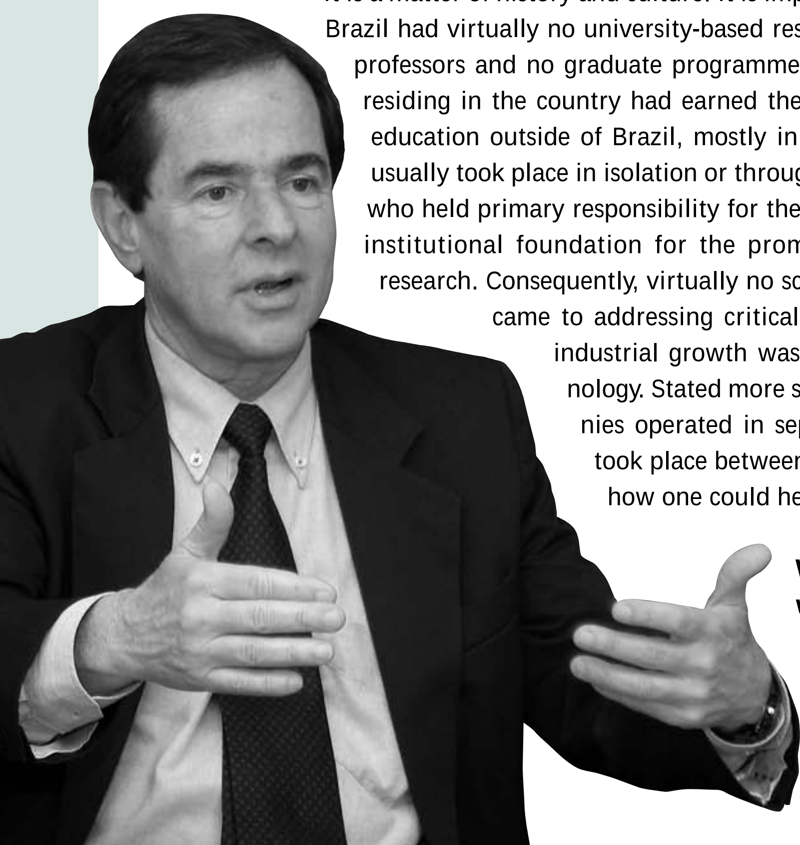
When TWAS last met in Brazil we were still battling an economic crisis created by mountains of foreign debt, run-away inflation and steep currency devaluations. With strong urging – indeed insistence – from such international funding agencies as the International Monetary Fund (IMF), which had lent Brazil money to keep the economy from sinking further, the government took stringent steps to combat this crisis by sharply cutting spending. One of the primary targets of the government's cost-cutting measures was science.

In the late 1990s, the nation's economy began to turn around. As a result, expenditures for science and technology began to rise – slowly at first but then at an accelerated pace as the economy gained strength. In 1997, expenditures for research and development stood at about US$5 billion. Today, expenditures are about US$10 billion.

One important reason for the government's increased support lies in the sectoral funding programme, an innovative strategy for investment in science and technology first approved by Brazilian legislature in 1999. The programme applies assessments – royalties, if you will – on revenues raised in certain key sectors of the economy – for example, energy, oil and telecommunications. In all, there are now 16 separate sectoral funds. Money raised from these assessments is invested in science-based research and development in those sectors. While some of the funds have been put into a 'rainy day' fund to be used in the event of an economic downturn, the fact is that the sectoral funding scheme has been enormously successful. Not only does it now account for about 10 percent of Brazil's funding for science and technology, it has also helped to reorient investments in science and technology in two important ways. First, it has created important sources of funding beyond the general tax coffers of the federal government. Second, it has focused increased attention on goal-oriented scientific research designed, on the one hand, to help address critical problems and, on the other, to create sustained sources of wealth that will benefit all citizens. Last May, the government decided to make the fund more flexible – and hopefully even more effective – by setting aside a percentage of the money for investment in promising sectors of the economy that do not yet have their own designated funds – for example, microelectronics and nanotechnology. This should make the initiative an even more valuable tool for the promotion of science- and technology-based economic development in Brazil.

**Why has it taken so long for Brazil to create strong links between science and economic development?**

It is a matter of history and culture. It is important to remember that until the early 1960s Brazil had virtually no university-based research infrastructure. There were no full-time professors and no graduate programmes for students. The few Brazilian researchers residing in the country had earned their advanced degrees at institutions of higher education outside of Brazil, mostly in Europe or the United States. Their research usually took place in isolation or through cooperative ventures with foreign scientists who held primary responsibility for the work that was done. There was, in effect, no institutional foundation for the promotion and pursuit of indigenous scientific research. Consequently, virtually no scientific research was done, especially when it came to addressing critical national concerns. Not surprisingly, Brazil's industrial growth was fuelled by foreign science and foreign technology. Stated more starkly, Brazil's universities and private companies operated in separate worlds. Practically no communication took place between the two, and neither community understood how one could help the other.



**When did it become apparent that Brazil would need to build its own scientific and technological capabilities? And how did the nation proceed?**

In the 1950s, the federal government launched the National Council for Scientific and Technological Development (CNPq) and the Committee for Advanced Professional Training (CAPES) to provide research grants and training to individual scientists to pursue their careers both within and outside Brazil. The government's decision to help individual scientists (instead of scientific institutions) as a first step in its overall efforts to improve research indicates just how weak it thought the universities were. Brazil's efforts to build indigenous scientific and technological institutional capabilities began in earnest in the 1960s, when the government established the Fund for Technical and Scientific Development (FUNTEC) at the National Economic Development Bank in 1963 and the Studies and Project Financing Entity (FINEP) in 1967. Later in the same decade, the government radically reformed the university system, creating, for example, full-time paid faculty positions. At the same time, it called on each of Brazil's 26 states to build at least one federal university and then provided funds to help ensure that this goal would be achieved. This marked the first step in a long-term effort to place universities at the centre of the nation's science-based economic development efforts.

In many ways, the effort has continued to this day. During the presidency of Fernando H. Cardoso (1995-2002), the government placed a great deal of emphasis on private universities as part of a larger strategy to advance the nation's university system and improve its quality. More recently, President Luiz Inácio Lula da Silva has called for greater investments in the nation's public university system as a core strategy for improving and expanding the effectiveness and impact of higher education, especially in terms of establishing links with the private sector. Today, Brazil's federal government is assisting states across the nation to transform 41 state university campuses into federal universities, largely by giving state universities the resources they need to improve their teaching and research.

Through the early 1990s, industry continued to draw on foreign science and technology to develop its products and services. Only a few select industries in Brazil had developed front-line research capabilities. These industries included offshore oil exploration and extraction, led largely by the work of the government-owned *Petróleo Brasileiro S.A.* (*Petrobras*), and the aerospace industry, led largely by the *Empresa Brasileira de Aeronáutica* S.A. (EMBRAER). The latter developed world-class mid-size jets that have become a favourite of corporate executives around the world. These initiatives represented bright spots in Brazil's mostly drab high-tech landscape, characterized by just a few world-class sectors capable of competing in the global marketplace. In short, Brazil remained beholden to foreign technology and know-how in most sectors of the economy.

My point in providing this brief outline of the weak relationship that has historically existed between the universities and industry in Brazil is to indicate that industry-university ties have not been part of the nation's past. Only recently, with the help and support of the federal government, have both communities come to realize the enormous mutual benefits that can be gained from working together. Given the deeply rooted historical circumstances that have kept the two communities apart and the entrenched cultural attitudes that have developed as a result (throughout much of the post-World War II period, for example, Brazil's political leaders took it for granted that Brazil could not address complex scientific and technological challenges on its own and that it would need assistance from more advanced countries to get the job done), it will take time to build the strong and enduring binds that are necessary for Brazil to generate productive interactions between the private sector and universities that you find, for example, in the United States. Yet I think it is fair to say we have made great progress over the past decade and particularly over the past five years.

**Brazil is a leader in South-South scientific cooperation. What accounts for Brazil's interest in promoting exchanges and partnerships with other developing nations? What future plans does Brazil have?**

Brazil has worked hard to forge closer relationships with nations that share the challenges and opportunities that we face. We do this out of a moral conviction that developing countries should help each other in their efforts to curb poverty and improve the material well-being of their citizens. And we do this as a practical matter, believing that in helping one another we are also helping ourselves. Like our efforts to promote indigenous scientific capacity, the steps we have taken to advance South-South cooperation began in small and measured ways and then expanded over time as we gained the knowledge and the confidence we needed to proceed. Similarly, our steps to advance South-South cooperation have been tied increasingly to larger efforts to build a strong foundation for sustainable economic growth that benefits not only Brazilians but also other people, especially poor people, throughout the developing world.

The first efforts to promote cooperation focused on commerce with our neighbouring countries. Our goal was to expand imports and exports among Latin American countries to strengthen our national and regional economies. These successful efforts led to broader discussions of possible cooperative initiatives in science – exchange programmes among professors and students, joint research projects, and long-term initiatives to collect and analyse data, particularly related to the monitoring of resources and the environment. A bilateral programme focusing on agriculture and biotechnology was launched in partnership with Argentina some 20 years ago. The programme's success, which drew upon both nations' long-standing expertise in agricultural research, has served as a model for a similarly structured programme in nanotechnology, which was announced earlier this year. Our hope is that the scientific communities in both countries can work together in this burgeoning field of science and technology, which could have a dramatic impact on a wide variety of other fields – from agriculture to medicine to water management.

Over the past decade, we have also launched several projects with developing countries beyond Latin America. The most noteworthy example is a joint project with China that has led to the launch of two satellites – the China-Brazil Earth Resources Satellite (CBERS-1) in 1999 and CBERS-2 in

2004. The satellites are designed to collect valuable information on such critical resource issues as air quality, forest cover and water resources. We have subsequently helped Portuguese-speaking African countries to build and operate ground stations necessary for acquiring and analysing the information that has been generated by the satellites. Brazil is also involved in a growing number of exchange programmes for students from developing countries, including Portuguese-speaking African countries, to attend universities and research centres here. In addition, we have established ties with India's science community, especially in the fields of oceanography, biotechnology and, most recently, nanotechnology. We are working with South Africa's scientific community in these areas as well, seeking to establish tri-lateral scientific partnerships.

And it is not just developing countries we are partnering with. For example, we enjoy long-standing bilateral relationships with the scientific communities of France, Germany, the United Kingdom and the United States in fields ranging from agricultural research to space science. I am now visiting scientific centres in Belgium, Portugal and the United Kingdom to explore possible joint activities and to discuss new avenues of scientific cooperation with the European Union. Brazil is well positioned to advance South-South cooperation in science and, increasingly, to play a key role in 'triangular' North-South-South cooperative efforts that link scientific communities in developed countries to those in the least developed countries. Science is a global enterprise. But one of the most effective ways to maximize its impact at the national and regional levels is to tailor scientific research and technological development to real-life national and regional problems. Brazil, as a developing country with growing scientific prowess, could serve as a bridge that draws science closer to society across the globe in mutually beneficial ways for both the developed and developing world.

**How do you view the relationship between TWAS and the scientific community in Brazil? What impact do you hope the Academy's 10th General Conference will have on that relationship?**

As I just mentioned, Brazil hopes to share responsibility for strengthening science and technology with other developing nations and we plan to have TWAS serve as a key partner in this endeavour. Yet, with thousands of researchers living and working within our borders, it should not be surprising to learn that awareness of the Academy is limited even among scientists. The Academy, in fact, is best known to members of the Brazilian Academy of Sciences, which has roughly 600 members, including 140 foreign members. We are hoping that the TWAS General Conference in Brazil provides an opportunity for our scientific community to get to know TWAS better. The Ministry of Science and Technology is convinced that a productive conference concluding with a compelling set of recommendations for future action could have a tremendous impact on both TWAS and Brazil's scientific and technological community, helping to set the stage for advancing our shared goals of science-based development both in my home country and throughout the developing world. ■

# BIOTECHNOLOGY AND SOUTH-SOUTH PARTNERSHIPS

**WITH THE NEED TO INCREASE AGRICULTURAL PRODUCTION AND YET CONSERVE ITS UNIQUE BIODIVERSITY, BRAZIL HAS MADE BIOTECHNOLOGY A FOCAL POINT OF ITS SCIENTIFIC CAPACITY BUILDING EFFORTS. RECOGNIZING THAT COLLABORATIVE EFFORTS OFTEN LEAD TO GREATER REWARDS, BRAZIL IS USING ITS GROWING STRENGTH IN BIOTECHNOLOGY – AND ITS POSITION AS A LEADING DEVELOPING COUNTRY – TO ESTABLISH A RANGE OF BILATERAL AND MULTILATERAL AGREEMENTS IN BIOTECHNOLOGY WITH OTHER DEVELOPING COUNTRIES.**

*Brazil is a huge country. It ranks fifth in the world both in terms of its land area – a massive 8.5 million square kilometres – and in terms of population – some 188 million. It is also considered to be the world's most biodiverse country, home to two of the recognized 34 'biodiversity hotspots'. Some 20,000 species of plant, 40 percent of which are endemic, have been recorded in the Atlantic forest region. The drier woodland-savannah Cerrado region, which covers more than 20 percent of the country, is home to such animals as the giant anteater and maned wolf, but is increasingly threatened by encroaching agricultural and cattle ranching activities.*

*This conflict – between the need to increase agricultural production and the need to conserve the country's unique biodiversity – has led Brazil to develop expertise in a field of science that can help tackle this issue – biotechnology.*

Argentina and Brazil have a long-standing rivalry inherited from the colonial struggles between Spain and Portugal. This rivalry reached a peak in the 1970s

## BIOTECH CAN DO

*The Convention on Biological Diversity defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." Interpreted in this broad way, biotechnology provides the tools and techniques that are commonplace in many aspects of agriculture and food production. In Latin America and elsewhere, biotechnology is being put to use to accelerate the breeding of improved crop varieties by tracking the inheritance of genes, especially in slow-maturing crops such as fruit trees; provide certified disease-free planting material through tissue culture; develop new, more accurate and quicker ways of diagnosing pests and diseases that can help the early detection of outbreaks and infestations; create transgenic crops resistant to pests or diseases, tolerant to drought or with improved nutritional qualities; develop vaccines to control diseases of cattle and other livestock; and produce energy from biomass using fermentation technologies.*

when Brazil proposed building the Itaipu Dam on the Parana River, which flows into Argentina. Concerned about losing control of a valuable water resource, Argentina responded by threatening air strikes against the construction site.

In the early 1980s, when both countries adopted democratic governments, this situation was reversed and, in 1985, the presidents of Argentina and Brazil signed a series of protocols, including one on cooperation in biotechnology.

At that time, Argentina had a relatively strong scientific base, especially in the biological sciences, and Brazil was expanding its university system, an essential component of which was the support of scientific research. The potential far-reaching impact of biotechnology, including genetic engineering, was also becoming apparent.

## PROTOCOL NO. 9

For both countries, agriculture provides some ten percent of the national gross domestic product (compared with just one percent for the United States or two percent for Canada). Realizing the potential of biotechnology in developing their agricultural industries (see box, 'Biotech Can Do'), the presidents of Brazil and Argentina signed Protocol No. 9 on Biotechnology in July 1986. As a result of this agreement, the *Centro Brasileiro-Argentino de Biotecnología* (CBAB in Portugese, or CABBIO in Spanish) was created.

By combining the strengths of the two countries' leading agricultural research institutes – the *Empresa Brasileira de Pesquisa Agropecuária* (EMBRAPA) in Brazil and the *Instituto Nacional de Tecnología Agropecuaria*

**BIOTECHNOLOGY AND BIODIVERSITY**

*It's all in the DNA: whether it is the transfer of a gene from one species to another – the technique used to genetically modify crops and other organisms – or the search for novel chemicals that may have useful pharmacological properties, the raw material is DNA. Simply put, genes are chains of DNA that carry the code for proteins that drive the chemical machinery of any organism, including the pathways leading to the production of so-called 'secondary metabolites', which often have interesting biological properties that can be tailored into useful drugs. In those species studied to date, thousands of potentially useful genes have been identified. Within Brazil's huge biodiversity resources, most of them yet to be studied in any detail, there must be millions more potential targets. Biotechnologists identify and characterize these genes, proteins and other chemicals and, if possible, help develop commercial products from them.*

(INTA) in Argentina – with numerous research stations scattered throughout both countries, CBAB allowed a broad range of biotechnological initiatives to flourish.

What makes CBAB unique is its administrative structure. In addition to Brazil's Ministry of Science and Technology and Argentina's equivalent Ministry of Education and Science, both countries' Ministry of Foreign Affairs are also involved, providing the high-level political backing for the programme. This arrangement, and the fact that Argentina and Brazil are both large countries with large agricultural sectors facing similar challenges, has helped guarantee the continued support for CBAB during its 20-year existence.

Even with political support, such a programme would have ceased to exist if it had failed to produce results. Among the 95 projects funded since its inception – selected by a binational council – are the production of an anti-foot-and-mouth disease recombinant vaccine, transgenic maize resistant to herbicides and insects, disease-free citrus trees, disease-free garlic production and methods for producing industrial enzymes, monoclonal antibodies and biodegradable plastics. In addition, a binational data bank of microbial strains and a binational germplasm bank focus on the collection and preservation of the region's biodiversity.

A regional survey, carried out in 1990, revealed that equipment and infrastructure did not represent the main constraints to research in biotechnology. Instead, the need for training in advanced biotechnological techniques was identified as a major obstacle to developing a more dynamic biotechnology enterprise. CBAB tackled this by establishing the Argentine-Brazilian School of Biotechnology (EABBIO), which provides both intensive courses and short-term training exchanges that are associated mainly with joint projects. Training courses are typically held in either Brazil or Argentina, but students from other Latin American countries can

now participate and, indeed, institutions in Colombia and Uruguay have hosted courses.

**The Chinese-Brazilian High-level Commission (COSBAN) commits Brazil and China to a series of collaborative scientific efforts.**

Since CBAB's inception, more than 100 courses have been held, providing advanced training to some 3,000 students in such topics as cell and tissue culture, the micropropagation of plants, genetics, fermentation processes, the purification of biomolecules, new technologies for the development of vaccines and immunobiological products, bioethics and biosafety.

## BILATERAL BIOTECH

The Brazilian Ministry of Science and Technology does not restrict its bilateral collaboration efforts to neighbouring Argentina. Indeed, 68 such agreements are currently in force with 15 developing countries. Among these are other Latin American nations such as Bolivia, Chile, Paraguay, Uruguay and Venezuela, as well as such nations as India, Morocco and Pakistan. Most of these agreements tend to cover science and technology more generally; yet, the importance of biotechnology means that it is always featured in collaborative programmes.

Another recent bilateral agreement is the Chinese-Brazilian High-level Commission (*Comissão Sino-Brasileira Alto Nível*, COSBAN). Signed in March 2006, the agreement commits Brazil and China to a series of collaborative agricultural, economic, educational, political and scientific efforts. Of particular scientific interest to the two nations are information and communications technologies, space science, biodiversity, biofuels and, of course, biotechnology.

China also has a great deal of expertise in biotechnology. Not only was it the only developing country that participated in the international Human Genome Project, but Chinese scientists have also unravelled the genome of rice, several microorganisms, and are working on the genome of the chicken. Brazilian scientists, meanwhile, have sequenced the genome of *Xylella fastidiosa*, which infects coffee, citrus and other woody crops, the genome of sugar cane, and are currently putting together the coffee genome sequence. Along with Brazil, China is also a world leader in the production of transgenic crops.

## THREE'S COMPANY

In June 2003, Brazil joined two other scientific 'giants' of the South in the so-called IBSA (India, Brazil, South Africa) Trilateral Commission.

As with the COSBAN agreement with China, the IBSA accord focuses on a range of issues from transportation to trade and from e-governance to health. Once again, however, collaboration in science and technology is a centerpiece of the agreement. Participating countries have highlighted alternative and renewable energies, oceanography, meteorology, climate change and astrophysics as key areas – as well as biotechnology, including agricultural biotechnology and bioinformatics. In particular, Brazil and South Africa have agreed to focus on such areas as dengue fever, HIV/AIDS, malaria and waterborne diseases.

The three IBSA signatory countries also agreed to share information on best practices in technology transfer and to engage in intellectual property rights (IPR) issues related to the protection of biodiversity and traditional knowledge.

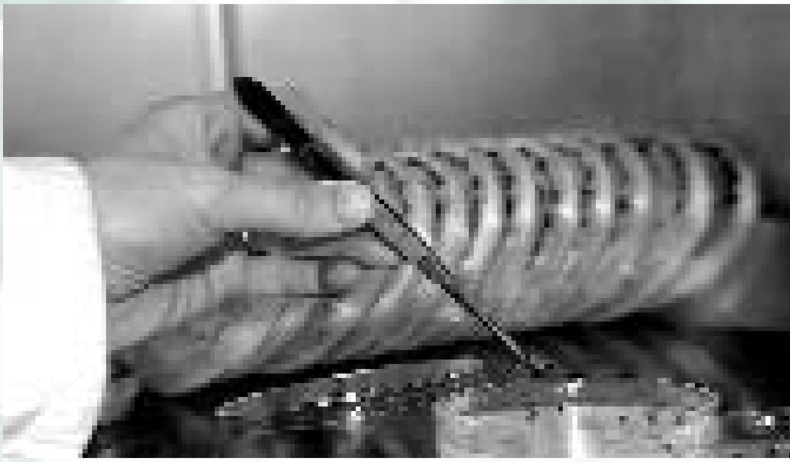
Under the international Convention on Biological Diversity (CBD), sovereign states own their indigenous biodiversity and, if this biodiversity is exploited in any way, the nations are entitled to share in the profits. Before the CBD, drugs used to relax muscles during surgical procedures were developed from curare, a toxin derived from the skin of a frog that has been used by generations of indigenous Brazilian people to coat the tips of their arrows when hunting. If such drugs were developed today, Brazil would receive payments from the pharmaceutical company involved. India, which has a rich culture of traditional medicines, has successfully challenged patents filed in the United States, in particular concerning the antibiotic properties of turmeric. Likewise, for centuries, the San people of the deserts of South Africa have chewed on the *Hoodia* cactus to suppress their appetites. A drug developed from such a plant could help fight the rising level of obesity, especially in rich, developed nations. There is a great deal of interest in the plant – and, therefore, a great deal of legal wrangling over the intellectual property associated with it. The IBSA forum will allow the three nations to share their experiences and expertise on such issues with their Southern colleagues.

**_South-South cooperation speaks to the common values and shared experiences of developing countries._**

Under the IBSA Trilateral Commission, science and technology cooperation will advance through trilateral workshops on mutually agreed themes; collaborative research and development programmes; the exchange of science and technology information; specialized training in areas of national strength; and the short-term exchange of young scientists.

## COMMON LANGUAGE

A particular focus of Brazil's South-South agreements for scientific collaboration has been based on its desire to find ways to help the scientific communities in countries that share the Portuguese language. Under an agreement signed in 2004, for example, Brazil's Council for Scientific and Technological Research (CNPq) provides support for graduate students in Angola and Mozambique and for undergraduate students in São Tomé and Príncipe, the tiny island nation off the coast of west Africa. Ways of enabling staff from Brazilian universities to teach postgraduate courses in these countries are also being investigated. The ProÁfrica programme, overseen by Lindolpho de Carvalho Dias, former CNPq president and a member of



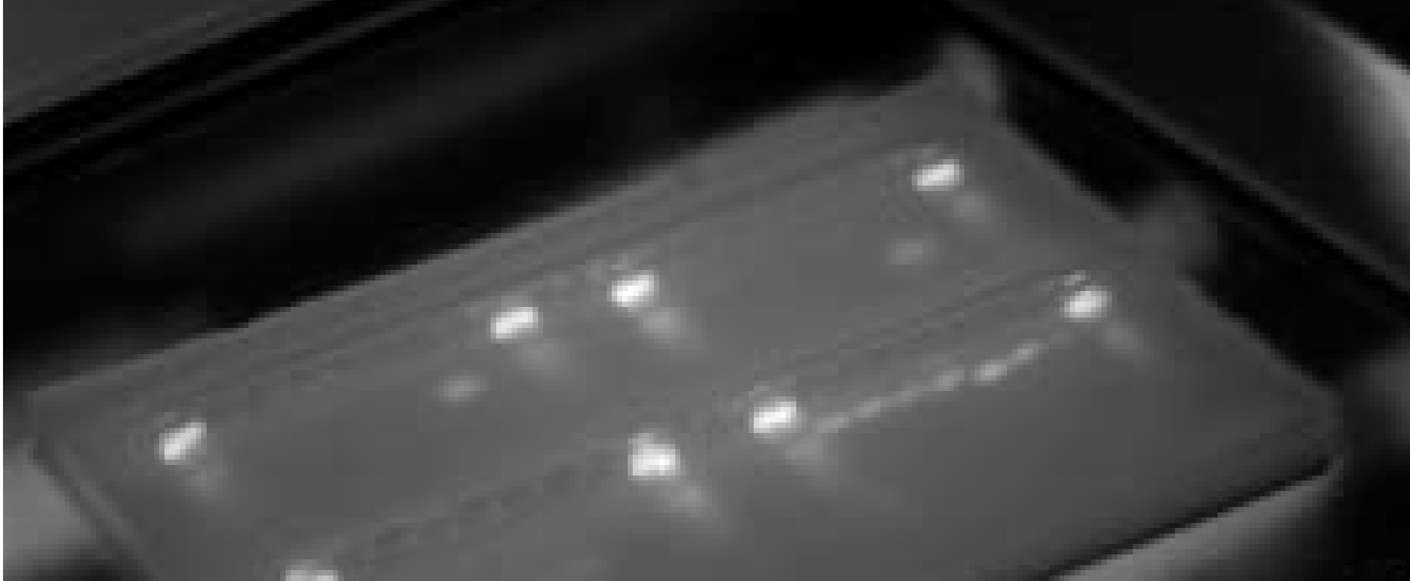
the Brazilian Academy of Sciences, has a budget of US$225,000.

## LATIN NETWORKS

Despite being the only Portugese-speaking nation on a continent where Spanish is the predominant language, Brazil, its scientific institutions and its individual scientists are involved in a number of Latin American-based regional networks that have biotechnology either at their core or as an integral component of their focus.

The most pertinent of these is *Red de Cooperación Tecnica en Biotecnología Vegetal para America Latina y Caribe* (REDBIO), which was established in 1989 following a recommendation by the Food and Agriculture Organization of the United Nations (FAO).

The principal objective of REDBIO is to "accelerate the process of adaptation, generation, transfer and application of plant biotechnology to contribute to the solution of crop production constraints and genetic



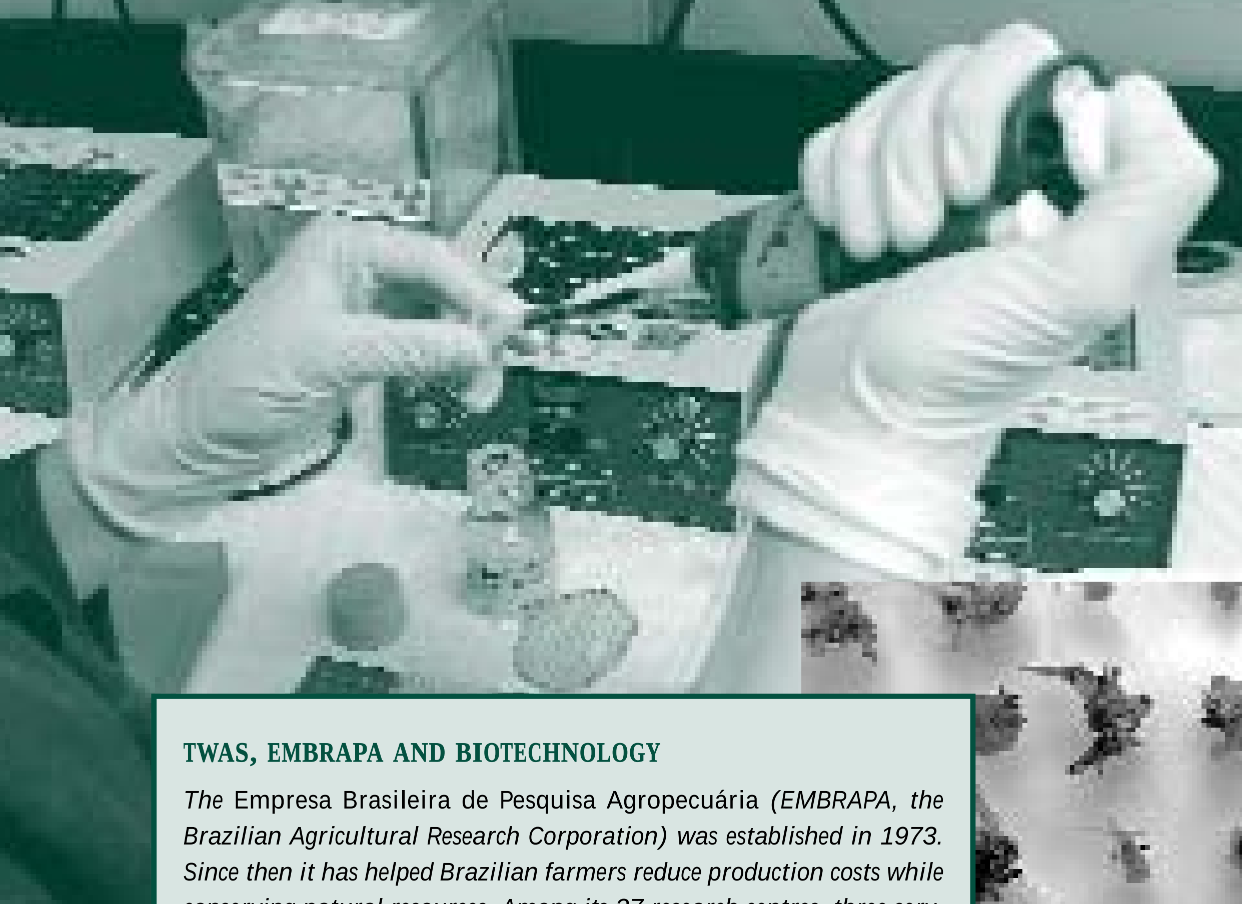
resources conservation for the countries of the region."

With this in mind, REDBIO supports training activities and the exchange of both biological materials and scientists; sponsors joint research projects; organizes international symposia; and provides a forum to help formulate national and regional policies and strategies in plant biotechnology for agricultural development. Training workshops have focused, for example, on the micropropagation of crops such as garlic, grapevine, potato, sweet potato and strawberry, and wheat production techniques, including the use of the latest genetic methods for breeding and selecting new varieties. Other workshops have focused on the regions major crops, including barley, maize, potato, rice and wheat.

REDBIO is also responsible for maintaining a database of biotechnology laboratories active in the Latin America region. This catalogue of university departments, research institutes and private companies, known as CATBIO, currently contains some 800 entries. The fact that about one-sixth of the entries are Brazilian entities underlines the strength of Brazil in this sector.

### SOUTH-SOUTH FELLOWSHIPS

*During the past two years, TWAS and CNPq have awarded 46 fellowships to scientists from developing countries other than Brazil, 29 at the postgraduate level and 17 at the postdoctoral level. Of these, more than one-third have been in the field of biotechnology. Examples of biotechnology-based projects supported by the TWAS-CNPq Fellowship Programme include: Hamdino M. Ibrahim Ahmed, Manoura University, Egypt, who studied seed technology in horticultural crops at the* Universidade Federal de Viçosa *(UFV); also at UFV, Mazhar Abbas Rana, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan, who identified and characterized strains of citrus tristeza virus using molecular based techniques; Liudy Garcia,* Centro de Estudios Aplicados al Desarrollo Nucleár *(CEADEN), Havana, Cuba, who identified and characterized proteins in the brains of bees that are related to learning and social function at the* Universidade de Brasília *(UNB); and Mary Tolulope Olayle, Department of Biochemistry, Federal University of Technology, Akure, Nigeria, who studied the antioxidant properties and protective potential of some tropical medicinal plants against hepatotoxicity at Brazil's* Universidade Federal de Santa Maria *(UFSM).*



### TWAS, EMBRAPA AND BIOTECHNOLOGY

*The* Empresa Brasileira de Pesquisa Agropecuária *(EMBRAPA, the Brazilian Agricultural Research Corporation) was established in 1973. Since then it has helped Brazilian farmers reduce production costs while conserving natural resources. Among its 37 research centres, three service centres and 11 central divisions, which are located throughout Brazil, are the National Research Centre for Agrobiology (CNPAB), located in Rio de Janeiro, and the National Research Centre for Genetic Resources and Biotechnology (CENARGEN), located in Brasilia. Both these centres are active participants in the TWAS-UNESCO Associateship Scheme, which allows scientists from developing countries to make two visits to a research institution in another developing country during a three-year period. Since this programme started, 11 scientists have visited CNBAP, including Jamal Ibijbijen, who visited in 2001 and 2004. Ibijbijen, of Moulay Ismael University, Meknes, Morocco, is undertaking collaborative research on the use of mycorrhizal fungi and nitrogen-fixing bacteria to rehabilitate degraded soils. Four scientists have been hosted by CENARGEN, including Rama Swamy Nana, Kakatiya University, Warangal, India, who is using genetic engineering and tissue culture techniques to develop disease-resistant and drought tolerant crops in collaboration with scientists at CENARGEN.*

Other functioning networks designed to bring together Latin American scientists that have at least a partial overlap with REDBIO include the Latin American Network of Biological Sciences (RELAB), the Latin American Network for Research on Bioactive Natural Compounds (LANBIO) and *Red Latinoamericana de Botanica*. The success of these networks has spawned the creation of similar networks in other areas of science, including astronomy, chemistry, earth sciences, mathematics and physics, all of which are dedicated to enhancing the communication and exchange of scientists in the region.

### SOUTHERN SOLIDARITY

"South-South cooperation has long been viewed as an ideal that speaks to the common values and shared experiences of developing countries," says Mayana Zatz (TWAS Fellow 2004), professor of genetics and director of the Centre for the Study of the Human Genome at the University of São Paolo. "But as Brazil's experience in biotechnology shows, cooperation has real pay-offs in strengthening our own capabilities. In helping others, it is sometimes useful to remember that we also help ourselves." ■

# BIOFUELS IN BRAZIL

**THE CURRENT OIL CRISIS, WHICH HAS SENT THE PRICE OF OIL SKYROCKETING TO MORE THAN US$70 A BARREL, HAS PROPELLED OIL-HUNGRY COUNTRIES INTO A FRENZIED BID TO SUPPLEMENT AND DIVERSIFY THEIR CONVENTIONAL ENERGY SUPPLIES. THIS, IN TURN, HAS PLACED INCREASING ATTENTION ON THE PROSPECTS FOR PRODUCING GREATER QUANTITIES OF BIOFUELS MANUFACTURED FROM ORGANIC MATERIAL SUCH AS SUGAR CANE MAIZE AND OIL-BEARING SEEDS.**

*Four decades ago, Brazil launched a nationwide biofuels initiative that is now attracting worldwide attention. This spring, while oil-dependent nations struggled to adapt to a world of high oil prices, Brazil announced that it would achieve energy self-sufficiency by the end of the year, thanks in part to its biofuels programme that now supplies about 25 percent of its energy needs. What lessons does Brazil's successful experience offer to other nations – both developing and developed – as they seek to overcome their addiction to oil?*

Driven by surging oil prices due to unprecedented levels of global demand and growing political uncertainties in several oil-producing nations, energy security has become an international concern, especially in developed countries that have relied on fossil fuels to sustain and drive their economies.

While this is not the first time that the world has faced an energy crisis (an oil embargo, imposed by the Organization of the Petroleum Exporting Countries (OPEC) in the late 1970s generated price spikes and spot shortages, especially in the United States), energy experts believe that today's oil crisis marks a fundamental alteration in the global energy landscape. That's because the current situation is spurred by a permanent upward shift in demand and not a temporary interruption in supply.

Over the past year, as the price of oil has doubled from US$35 to US$70 a barrel, oil-dependent countries have shown an increased interest – indeed a growing preoccupation – to develop alternative energy supplies.

Biofuels produced from sugar cane, maize, switch grass and other plants have attracted a great deal of attention in these burgeoning efforts to wean the world off oil. Based on a proven technology, able to supplement existing fossil fuel supplies (especially for transportation) and offering oil-dependent countries the prospect of energy self-sufficiency (or, at least, some leverage in containing, if not curbing, energy prices), the Food and Agricultural Organization of the United Nations (FAO) recently predicted that the 21st century could see a significant switch from a fossil fuel-based economy. This trend, FAO suggested, could result in "biofuels providing up to 25 percent of the world's energy needs in the next 15 years."

In February, US President George W. Bush, a longtime proponent of increased oil production, proposed a federal research initiative for new technologies designed to boost the efficiency of biofuels production. Earlier this year, the European Union (EU) announced that over the past year the production of biodiesel which, as the name suggests, is designed to run in diesel engines, rose 65 percent among its member states, enabling total production to reach 3.2 million tonnes. That makes the EU the world's largest producer of this 'green' fuel. Meanwhile, France, Germany, Sweden and the United Kingdom have all announced their own comprehensive national biodiesel production strategies.

***Brazil's National Alcohol Programme is the centrepiece of the world's largest initiative of biomass production for energy.***

Governments are not the only ones responding aggressively to the current oil crisis. Corporations, especially car manufacturers, are also taking action. For example, in May 2005, Chrysler Group, a unit of DaimlerChrysler AG, announced that 25 percent of its vehicles would be built with ethanol-ready engines by 2008.

But the real global champion of the biofuel movement is not to be found in the developed world, where much of the frenzy represents a belated response to a long-simmering problem.

The real global champion is Brazil.

Brazil's National Alcohol Programme (*ProAlcool*), which mass produces biofuels using ethanol derived from sugar cane, is the centrepiece of the world's largest initiative of biomass production for energy. A cooperative venture spearheaded by the Brazilian government and including farmers, alcohol producers and automobile manufacturers, *ProAlcool* oversees 70 percent of the world market for biofuels used in transport.

The ethanol produced by *ProAlcool*, a barrel of which currently sells for half the price of a barrel of oil, can be purchased in virtually all of Brazil's 34,000 petrol stations. Seventy-five percent of all new cars in Brazil, moreover, are now built with 'flex-fuel' engines, allowing them to run on gasoline, ethanol or a mixture of the two. Motor industry executives say these flex-fuel vehicles, introduced in 2003, have spread more rapidly than any other innovation in the history of Brazil's automobile industry. If current trends continue, virtually all new automobiles manufactured in Brazil will soon be equipped with dual-fuel engines.

In addition to its local market, Brazil currently exports more than 2.5 billion litres of ethanol each year and the opening of a new port in Santos will increase the nation's export capacity to 5.6 billion litres by the end of 2006. Some 1.5 million farmers currently cultivate sugar cane for biofuels and the industry itself now accounts for about one million factory jobs nationwide.

In the words of President Luiz Inácio Lula da Silva, Brazil's ethanol initiative "has reduced its dependence on fossil fuels, developed a thriving new industry, and contributed to environmental sustainability." The effort has earned Brazil worldwide media coverage, especially over the past year. Journalists and editorial page writers in leading newspapers, magazines, news broadcasts and websites around the world are now asking, "If Brazil can do it, why can't we?"

There is indeed much to praise about Brazil's foresight, persistence and careful planning. Yet what can

## CRITICS EYE THE PRIZE

*While their potential to serve as a substitute for fossil fuels is undeniable, biofuels are not an untainted panacea. Like any other technological advancement, they come with unintended and, at times, adverse consequences.*

*The production of biofuels creates potential conflicts between natural vegetation and cultivation, arable and marginal land use, and mechanized agriculture and employment opportunities. When full accounting and environmental impacts are taken into consideration, biofuels raise critical questions concerning costs and benefits that proponents would be wise to address if they hope to advance the goals of this alternative energy source.*

*Some critics, for example, believe there simply isn't enough land for energy crop cultivation and fear that land used for energy crops will come at the expense of land now covered in forests – an issue of particular importance to Brazil with its vast expanses of tropical rainforests.*

*Another major criticism of biofuels is the potential competition that may arise between land for food and land for fuel. "If you want to use 20 percent, instead of the current two percent, of all agricultural land for fuel production, you would have to direct so much of agricultural land from food to fuel, "there would be real competition between the two," says Georgia Institute of Technology professor, Arthur Ragauskas, who co-authored a study in* Science*. "Even worse, if there was a famine in one part of the world, we would have to make a decision between (the two)."*

*Additional flash points may arise between supply and pricing. Some experts contend that production of energy crops may not keep pace with long-term demand. Indeed Brazilian farmers are said to be struggling to keep up with demand. In addition, earlier this year, Brazil's sugar cane farmers opted to sell their crop to sugar manufacturers to take advantage of rising world prices for the sweetener. A similar scenario unfolded in the early 1990s leading to the near collapse of Brazil's biofuels industry at the time.*

*The UN Food and Agricultural Organization (FAO) has cautioned that growing global demand for biofuels could lead to intensive monocultures of crops. Not only would this carry potential adverse environmental consequences, but it could also result in a few agri-energy corporations dominating the industry, leaving scant room and few benefits for small-scale farmers.*

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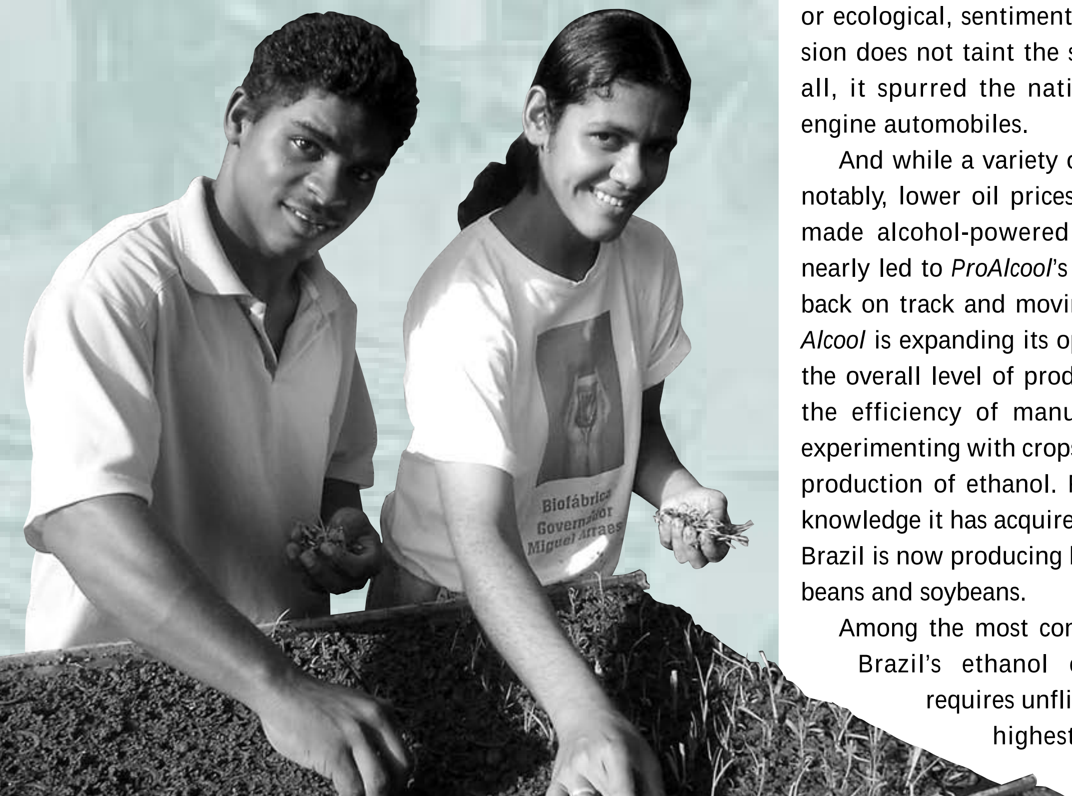
*As Giulio Volpi, coordinator of WWF's (formerly known as the World Wildlife Fund) climate change programme for Latin America and the Caribbean recently noted, successful biofuels production could stall global efforts for energy conservation. "Research shows that if Brazil was to implement an aggressive energy efficiency policy it could reduce the growth in power demand by as much as 40 percent, achieve energy savings of more than US$37 billion per year, and stabilize its power-sector", he says.*

*This thinking is supported by Tad Patzek, a professor of geo-engineering and biofuels expert at the University of California, Berkeley, USA. Patzek categorically dismisses ethanol as "the worst solution", undermined by "the highest energy cost and the least benefit. Here is the classic dilemma of biofuels," he says. "They fight for space in the environment, they fight food production, and they fight consumption trends."*

*However, according to Steven Koonin, chief scientist for British Petroleum (BP), UK, biofuels might not be the energy bane that critics portray them as. He says that the challenges biofuels pose await solutions that only the scientific and engineering communities can provide. Playing on the words often heard in the petroleum industry, Koonin says, "the prize (of biofuels) is too large to ignore".*




other nations, now seeking to develop alternative non-fossil energy sources, learn from this experience? Is the success that Brazil has achieved, regardless of how commendable it may be, an anomaly caused by a unique combination of the right opportunities perceived by the right people at the right time? Or, does it represent an experience that can be replicated by other nations?

While Brazil is the first country to use ethanol on such a large scale, the process of making ethanol from starch and sugar-based feedstocks is nearly as old as civilization itself, dating back to the pharaohs of Egypt, if not before. Ethanol production, therefore, is not based on new technologies. Indeed, it is based largely on ancient know-how that all nations – both developed and developing – should have no difficulty adopting.

In addition, it is important to recognize that Brazil is reaping the benefits of a three-decade-old initiative that was launched when Brazil's military government, which ruled the country from 1964 to 1985, decided to take bold steps to reduce the nation's dependence on the Middle Eastern petroleum following the 1970s oil crisis. The government, it is true, was motivated largely by nationalistic, not economic or ecological, sentiments. Yet, the source of the decision does not taint the success of the outcome. After all, it spurred the nation's first round of ethanol-engine automobiles.

And while a variety of factors in the 1990s – most notably, lower oil prices and a rise in sugar prices – made alcohol-powered vehicles less desirable and nearly led to *ProAlcool*'s collapse, the initiative is now back on track and moving quickly ahead. Today, *ProAlcool* is expanding its operations not only in terms of the overall level of production but also by improving the efficiency of manufacturing processes and by experimenting with crops other than sugar cane for the production of ethanol. For example, drawing on the knowledge it has acquired over the past three decades, Brazil is now producing biofuels from oil palms, castor beans and soybeans.

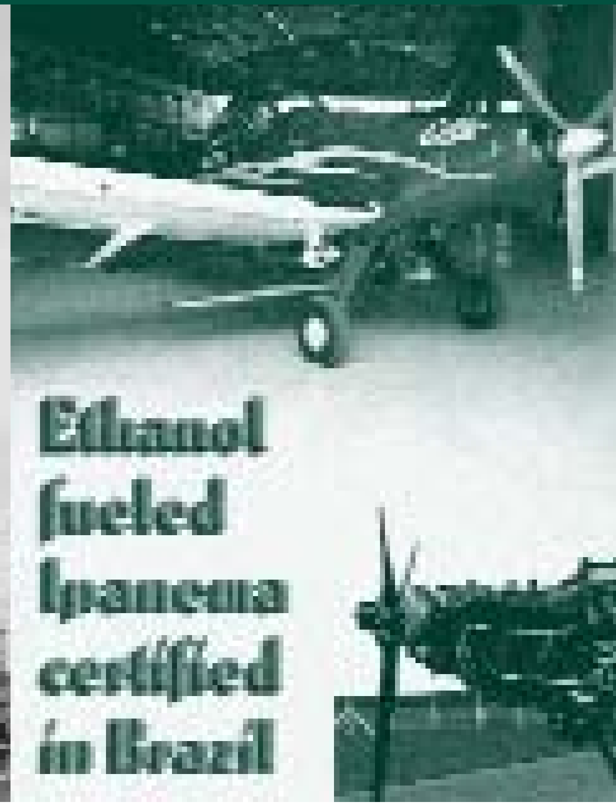
Among the most compelling lessons conveyed by Brazil's ethanol experience is that success requires unflinching political support at the highest levels of government and

that large-scale ethanol production and distribution strategies will fail to achieve their objectives unless they take into consideration the interdisciplinary and intersectoral challenges that these efforts entail. A successful ethanol programme, for example, requires efficient agricultural cultivation, well-tooled production processes, innovative automobile manufacturing and the development of broad-based fuel distribution networks. Price is a major consideration, but so too is convenience and assurances that the use of biofuels will not compromise engine performance.

***Fourteen Brazilian ministries plan and implement its biofuel initiative.***

The complex nature of the biofuels programme has led the Brazilian government to call on 14 Brazilian ministries to plan and implement its biofuel initiative. The ministries operate under the aegis of the Interministerial Executive Committee (CEI). The work of the CEI, in turn, is being coordinated by the President's office, an indication of the importance that the government has placed on this initiative. CEI receives technical support from the Biodiesel Technological Network (BTN), consisting of more than 20 research institutions across the nation. The Ministry of Science and Technology has budgeted nearly US$6 million for advanced research on the processing of biodiesel fuel, and the Ministry of Agrarian Development (MDA) is currently investigating strategies for providing tax incentives to biodiesel producers. Based on all of the efforts that are now under way, the government is drafting an over-arching national blueprint for gradually increasing the percentage of biodiesel to be blended with regular diesel fuel.

From the earliest days of the ethanol programme, Brazil's government officials have recognized that biofuels could not compete economically with fossil fuels without a variety of government interventions. Officials reasoned that the oil industry had been the beneficiary of government interventions that had nurtured a favourable climate for growth, largely through subsi-

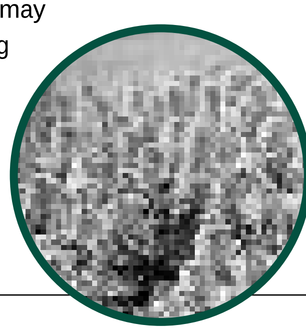



dies, and there was no reason not to nurture a similar environment for biofuels. And so, from the beginning, the government instituted agricultural subsidies to encourage an expansion of sugar cane cultivation and tax incentives for industry to encourage the building of new distilleries. It also legislated price guarantees for the sale of biofuels, helping to ensure that these alternative 'green' fuels could compete with petrol at the pump.

Brazil enjoys clear competitive advantages in its biofuels programme. The nation, the world's fifth largest, has vast amounts of rich farmland, which has allowed it to increase the cultivation of sugar cane without having to reduce the output of other crops. Nevertheless, increased cultivation of sugar cane, according to some critics, has placed greater pressure on efforts to preserve the Amazon rainforest. That's because land once used for grazing is now used for sugar cane production, leading cattle farmers to convert the rainforests into pastureland to maintain their livelihoods. Despite such challenges, most experts agree that there is significant scope for replicating Brazil's ethanol efforts, not just in other developing countries, but in developed countries as well.

Indeed, countries in Latin and Central America have begun to mimic Brazil's success. In Honduras, sugar producers have planted an additional 11,000 hectares of sugar cane to provide the raw materials for two soon-to-be-built ethanol refineries. Chile has announced plans to launch a biofuels programme with an eye towards exports and not just domestic consumption. And it's not only Brazil's neighbours that have expressed interest in biofuels. Impoverished Pacific Rim nations are looking to coconuts to produce biofuels, with electricity companies in Fiji, Samoa and Vanuatu currently testing blends.

Rather than worrying about the possible competition that these new efforts may bring, Brazil is actually supporting such efforts. As President da Silva recently noted, his nation is not interested in becoming the Saudi Arabia of ethanol. At a more practical level, Brazilian officials



believe that initiatives designed to expand the market for biofuels are bound to boost their own ethanol initiatives since more customers will likely mean more business.

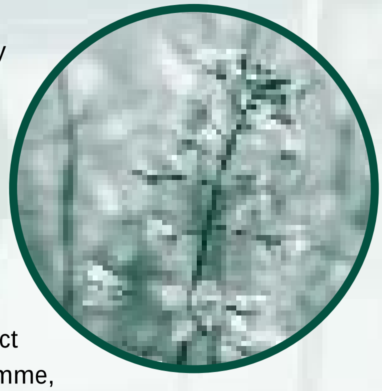
The Brazilian oil company *Petrobas*, for example, is providing funds for Costa Rica's US$15 million national gas refinery pilot project, RECOPE. Launched in early 2006, RECOPE's goal is to raise the percentage of ethanol in the nation's gasoline supply to 7.5 percent. It will begin as a pilot project in some 60 petrol stations across the nation. Similarly, in May, Brazil and Japan announced an agreement to launch a joint venture to create an ethanol market in Japan.

In an editorial published in the UK's *The Guardian* newspaper on 7 March 2006, President Lula called on other countries to join Brazil in "planting the oil of the future".

This time, the call to sugar cane, switch grass, maize stalks and other plant commodities may well be heeded, especially if the price of a barrel of oil remains at its current level, which many energy experts predict it will. Biofuels, after all, simultaneously address a host of critical concerns: the challenge of providing sustainable and accessible energy sources; the need to reduce greenhouse emissions to curb global warming; and the desire of all nations, and especially developing nations, to support domestic agriculture and spur rural development. Among its most ardent proponents, biofuel initiatives represent not only a wise energy policy but also a far-sighted strategy for addressing many of the world's most critical economic and environmental issues.

***Countries in Latin and Central America have begun to mimic Brazil's success.***

A move from fossil fuels to biofuels will have profound geopolitical implications that could turn the most recent oil crisis into a global opportunity with benefits that resonate in rich and poor countries alike. Yet, the current expressions of optimism, while based on encouraging trends, must be tempered by the challenges that lie ahead. Will dramatic increases in the cultivation of sugar cane in Brazil render the Amazon rainforest more vulnerable to development? Will a solution to today's oil crisis make it possible to fuel more cars that require more roads sparking development patterns that only deepen the scars on the landscape? Will ethanol production reach levels that truly make a difference in reducing oil consumption?



José Goldemberg (TWAS Fellow 1990) and the architect of Brazil's ethanol programme, warns us not to reach conclusions that lie beyond our current state of understanding. "I do think it's possible to replace petrol with ethanol," Goldemberg says, "but it's a tall order." He contends that critical issues of supply remain unanswered, adding "What's the limit? How much more can be produced?"

Multidisciplinary research and development involving biologists, agronomists, chemical engineers, fuel specialists and social scientists will likely lead to reduced production costs, greater energy conversion efficiency and declining biofuel prices. The use of other crops, including *Jatropha* that is grown in arid regions and is capable of producing approximately 1,850 litres of oil per hectare compared to approximately 940 litres of oil per hectare from soybean, is promising. More encouraging still is the fact that research is clearing the way for the use of biomass from timber mills, agro-industries and even urban landfills.

So, what does the world have to learn from Brazil's successful ethanol programme? One of the most important lessons may be this: although the price of a barrel of oil may fluctuate widely from US$15 a barrel in 2002 to US$75 a barrel in 2006, we can all be sure that as the world uses more fossil fuels, supplies will diminish; and, that as cars and trucks burn more fossil fuel, problems associated with air pollution and global warming will increase. Such a long-term prognosis is irrefutable and can only be addressed by long-term planning. Although the programme is far from perfect, Brazil has shown the world an alternative path to follow if it hopes to build a more secure energy future. The question is this: is the world now ready to follow? ■

# BRAZIL'S PLACE IN SPACE

**IN WHAT WAYS HAS BRAZIL BENEFITTED FROM ITS SPACE PROGRAMME? WHAT IMPACT HAS THE PROGRAMME HAD ON SCIENTIFIC CAPACITY BUILDING, ECONOMIC DEVELOPMENT, ENVIRONMENTAL CONSERVATION AND NATIONAL PRIDE? AND HOW MUCH HAVE THESE BENEFITS COST THE NATION – BOTH DIRECTLY AND IN TERMS OF LOST OPPORTUNITIES? THESE ARE SOME OF THE CRITICAL QUESTIONS THAT BRAZILIAN AUTHORITIES ARE SEEKING TO ANSWER AS THE NATION CONTINUES ITS ON-GOING VENTURE INTO SPACE.**

*On 1 April 2006, Marcus Pontes became Brazil's first astronaut when he was lifted into space inside a Russian-made satellite bound for the International Space Station (ISS), orbiting some 360 kilometres above the Earth.*

For Pontes, a lieutenant colonel in Brazil's air force, it marked a long-delayed yet successful conclusion to decades of training and perseverance, transforming the already well-known test pilot into a national hero. At the same time, Brazil's space programme, one of the oldest and most ambitious in the developing world, received a much-needed boost after a difficult period of tragedy and doubt that had left critics wondering whether the effort was worth it.

Both the take-off, from Russia's Baikonur Cosmodrome launch site, and the touch down, at a remote site in Kazakhstan, received broad coverage on Brazilian television. Throughout the journey, newspapers published banner headlines and websites posted constant updates. The Brazilian Space Agency honoured Pontes's journey into space by issuing a commemorative stamp and coin, and President Luiz Inàcio Lula da Silva, who awarded Pontes the National Order of Merit, Brazil's highest honour, praised the astronaut in a nationally televised ceremony, with the words, "Few have been the moments in which we've been as proud of a Brazilian as we are of you."

The flight carried a price tag of US$10.5 million, which Brazil paid to the Russian government. That was the cost of the ticket to ride, leading critics to argue that Pontes was nothing more than a space tourist.

But more than money was at stake. Just two-and-a-half years earlier, in August 2003, Brazil's space programme suffered its greatest calamity when the nation's

first domestically built rocket, designed to lift satellites into orbit, exploded on the Alcantara launch pad just three days before the scheduled launch. The tragedy, which left 22 people dead, raised serious questions about whether Brazil had devoted sufficient resources to develop a world-class space programme – questions that lent additional gravitas to Pontes's space-bound journey.

All nations, rich and poor, must respond to critics who cast doubt on whether investments in space science and technology are worth it. This issue is particularly acute in such scientifically proficient developing countries as Brazil, which has made a commitment to join the world's elite group of 'space' nations while they continue to confront critical development challenges demanding indigenous scientific expertise.

Brazilians from all walks of life are raising this issue with increasing frequency, and public officials owe it to their citizens to respond by persuasively describing what space missions have accomplished.

There is, of course, the contribution that satellites make to resource management through Earth observations and data collection. Such efforts have aided the study of weather patterns, forest cover, soils and oceans, all of which have a bearing on a nation's environment and economy. Satellites also have a dramatic impact on both communication and education, improving radio and television reception and telephone services. More recently, satellites have become the backbone of the internet, which has revolutionized the ways in which we communicate. (The internet is widely viewed as the driving force behind the rapid growth of science currently taking place in many developing countries, including Brazil). Satellites have also played a valuable role in improving the safety of air travel and, of course, in boosting military strength, especially in terms of surveillance and rocketry capabilities. And it is important to remember that the highly skilled staff necessary for the management and full utilization of satellite technology has impacted such diverse fields as climatology, computational science, engineering, information technologies and physics.

***On 1 April 2006, Marcus Pontes became Brazil's first astronaut.***

Although the earliest years of space activity in the late 1950s and early 1960s were monopolized by the world's two superpowers – the United States and the Soviet Union – many nations felt the need to develop their own space science and technology capabilities.

Drawing on the successes of the Soviet and American space programmes, several countries began to organize government-sponsored activities aimed at the exploration of space. Attention focused on the development of rockets, satellites, space probes and space capsules.

Brazil was among the first developing countries to pursue such activities when, in 1961, it established the Organizing Group for the National Space Commission (GOCNAE), under the auspices of the National Council for Scientific and Technological Development (CNPq). In 1971, the commission was reconstituted into the Institute of Space Research (INPE). The same year, the government created the Brazilian Commission for Space Activities (COBAE), a joint military-civilian initiative that was mandated to plan and implement national space priorities for space research and development. The ultimate aim of COBAE was to attain self-sufficiency in space technology.

***Space activities have concentrated on resource data collection, satellite communications, atmospheric science and space technology.***

Since then, space activities in Brazil have concentrated on resource data collection, satellite communications, atmospheric science and the development of space technology. In the pursuit of these activities, Brazil has succeeded in building an internationally recognized space programme comprised of well-trained engineers, scientists and technicians working in facilities comparable to those found in other 'space' nations.

During the first 30 years of its space programme, Brazil depended on foreign space programmes, largely in the United States (and to a lesser extent in France), to train its personnel and pursue its programmatic objectives. Many of Brazil's space scientists, for example, were educated in universities in the United States; Brazil's astronaut received his training at the US National Aeronautical and Space Administration (NASA); and Brazil's first home-grown satellites and rockets were built and then launched in the United States.

Yet, over the years, Brazil has slowly but steadily developed indigenous space science and technology capabilities. Its long-standing strategy has been to acquire the knowledge necessary for such a programme and ultimately to use that knowledge to construct its own satellites, rockets and launch pads.

From the start, Brazil's space capabilities have not only paled in comparison to those of first-tier 'space' nations – most notably, the United States and Russia – but have also fallen short of the capabilities of such secondary 'space' nations as China, France, India, Israel and the United Kingdom. Even today, Brazil spends about US$100 million a year on its space activities; India, in contrast, spends about US$300 million.

Nevertheless, Brazil has made remarkable progress in space science and technology. In 1997, the global space community acknowledged Brazil's status as a major player in space science and technology when it invited Brazil to participate in the International Space Station (ISS) initiative, enabling it to partner with 15 other nations working on – and ultimately in – the orbital laboratory.

Among the main achievements of Brazil's early space programme on the domestic front was the installation, in 1972, of a Landsat Satellite Ground Station, which enabled it to join the United States and Canada in deploying sophisticated instruments for collecting satellite-generated information in the Americas. In 1981, Brazil established the Complete Brazilian Space Mission (MECB) to facilitate the domestic design and construction of satellites for the purposes of environmental data collection. To accommodate the anticipated launch of these satellites, Brazil upgraded its facility at *Barreira do Inferno* Rocket Range in Natal, *Rio Grande do Norte*, and began construction on the Alcantara Launch Centre in Maranhao, northeast Brazil, which was officially opened in 1990.

In February 1993, Brazil's space programme took a big leap forward when it launched the first Brazilian-built satellite – *Satellite de Coleta de Dados* (SCD-1). In addition, Brazil continued to assemble the technical infrastructure necessary for future space missions – most notably, through the construction of the Integration and Tests Laboratory (LIT), Satellite Tracking Centre (CRC) and Satellite Launch Vehicle (SLV).

Political changes within Brazil, marked by the demise of the military government that had ruled the nation for 20 years between 1964 and 1985, combined with external pressures, coming largely from the United States, to demilitarize the space programme, led to the creation of the Brazilian Space Agency (AEB) to replace COBAE in 1994. In name and deed, the agency emphasized the civilian role of Brazil's space activities.

In a bid to ensure that the country continued to enjoy wide-ranging advances in space science and technology, the AEB initiated the National Plan for Space Activities (PNAE), which outlines the objectives for Brazil's space initiative from 1998 to 2007. On the domestic front, the programme emphasizes the need to focus space initiatives on issues of importance to the nation – for example, its treasure trove of largely unmapped natural resources, its large expanse of tropical rainforest in the Amazon basin that cover 40 percent of the nation, and its vast coastline stretching some 7,500 kilometres along the Atlantic Ocean. Space science and technology, PNAE contends, should be used to learn more about these resource-rich environments.

On the international front, PNAE emphasizes the need to develop strategies that would help Brazil's space programme become more closely integrated with the international space community. Following PNAE's broad outline, the AEB signed an agreement with the French *Centre National d'Etudes Spatiales* (CNES) to jointly build micro-satellites. It also forged partnerships with Argentina and Spain for the design and manufacture of remote sensing satellites that have been put to work acquiring data on water resources, agriculture and the environment. In conjunction with the United Nations Educational, Scientific and Cultural Organization (UNESCO), Brazil has offered to build resource-data-collecting ground station platforms to enable African nations to receive this satellite-generated information.

The China-Brazil Earth Resources Satellite (CBERS) project, begun in 1998, has pooled the scientific and technological skills and financial resources of these two developing countries to launch two Earth-imaging satellites. The first satellite was launched in 1999, and the second in 2003 – both from China. An agreement signed between the two countries in 2004 calls for the launch of two additional satellites to collect data on agriculture, water pollution and the environment. The first of these satellites, CBERS-3, is planned for 2008. In addition, Brazil and China agreed to form a Space Technology Cooperation Commission to help coordinate their activities.

PNAE also urged Brazil to take advantage of Alcantara's position as the world's most efficient launch site. The Earth's spin helps to lift satellites into space much like a discus thrower spins to add speed and distance to his or her toss. As a result, satellites sent into orbit near the equator, where the Earth's rotation is fastest, consume at least 10 percent less fuel than satellites launched elsewhere. The faster equatorial spin also enables satellites lifting off from Alcantara to carry heavier payloads for the same amount of fuel consumption. To take advantage of this, Russia and, more recently, the Ukraine, have signed agreements with Brazil to launch satellites from Alcantara. The United States has also expressed interest in using the site.

Finally, PNAE has called for the increased participation of Brazilian industry in the nation's space ini-

***Nearly half a century since humans first ventured into space, this most global of scientific activities is becoming truly global here on Earth.***

tiatives, leading to the creation of the Brazilian Aerospace Industries Association (AIAB) in 1993. This sector has been dominated by the *Empresa Brasileira de Aeronautica* (EMBRAER), one of Brazil's most successful high-technology ventures (see 'In The Air', page 18).

Except for communication satellites, Brazil's space activities have failed to offer either direct or immediate financial returns on the public investment in space. While government funding for space science and technology has been modest – amounting to less than one percent of the nation's gross domestic product (GDP) – critics contend that the money could be better spent on more pressing societal concerns. As a result, there has been growing public pressure to explore ways to make the space programme more relevant to society and, if possible, to devise strategies that would generate revenues from space-related activities.

In response to these concerns, in late 2004, the government held a national conference to examine the future of the nation's space programme. The conference ultimately led to a series of recommendations designed to update PNAE. These recommendations include, for instance, continuing to advance Brazil's domestic launch capabilities and pursuing industry funding to upgrade the Alcantara launch site. One proposal that received a great deal of press coverage was a call to transform Alcantara into the world's first space centre for tourists, complete with interactive museums, educational facilities, hotels and restaurants. Brazil plans to solicit proposals from private corporations that would allow them to buy or rent land for the purpose of developing tourism facilities.

Following another key recommendation of the conference, Brazil has decided to continue to participate in the ISS, agreeing to contribute an additional US$10 million to the project over the next four years. Brazil's participation in the ISS affords it the opportunity to conduct experiments on the space station, thus

helping it to maintain strong ties with the global space community.

Pontes's pioneering journey into space is not only emblematic of Brazil's space programme in all its dimensions – from research to technology to flight. It also reflects what José I. Vargas, former Minister of Science and Technology and past-president of TWAS, has called "the southernization of the North's scientific agenda" – an effort designed to ensure that cutting-edge scientific advances do not remain the sole domain of the developed world.

Pontes lifted into space just days before the 45th anniversary of the historic space flight of Yuri Gagarin, the Russian cosmonaut who was the first person to orbit the Earth. Pontes, in fact, reportedly began his journey from the same launch site that propelled Gagarin into space – a telling symbol. Nearly half a century since humans first ventured into space, this most global of scientific activities is becoming truly global here on Earth. ■

# WORLD HEALTH MADE BETTER

**"YOU DO NOT HAVE TO BE RICH TO BE HEALTHY". THAT IS THE MESSAGE OF THE DISEASE CONTROL PRIORITIES PROJECT (DCPP), A MULTI-YEAR, US$3.5 MILLION PROJECT SPONSORED BY THE BILL AND MELINDA GATES FOUNDATION AND ORGANIZED BY THE FOGARTY INTERNATIONAL CENTER AT THE US NATIONAL INSTITUTES OF HEALTH (NIH), THE WORLD BANK, THE WORLD HEALTH ORGANIZATION (WHO) AND THE POPULATION REFERENCE BUREAU (PRB).**

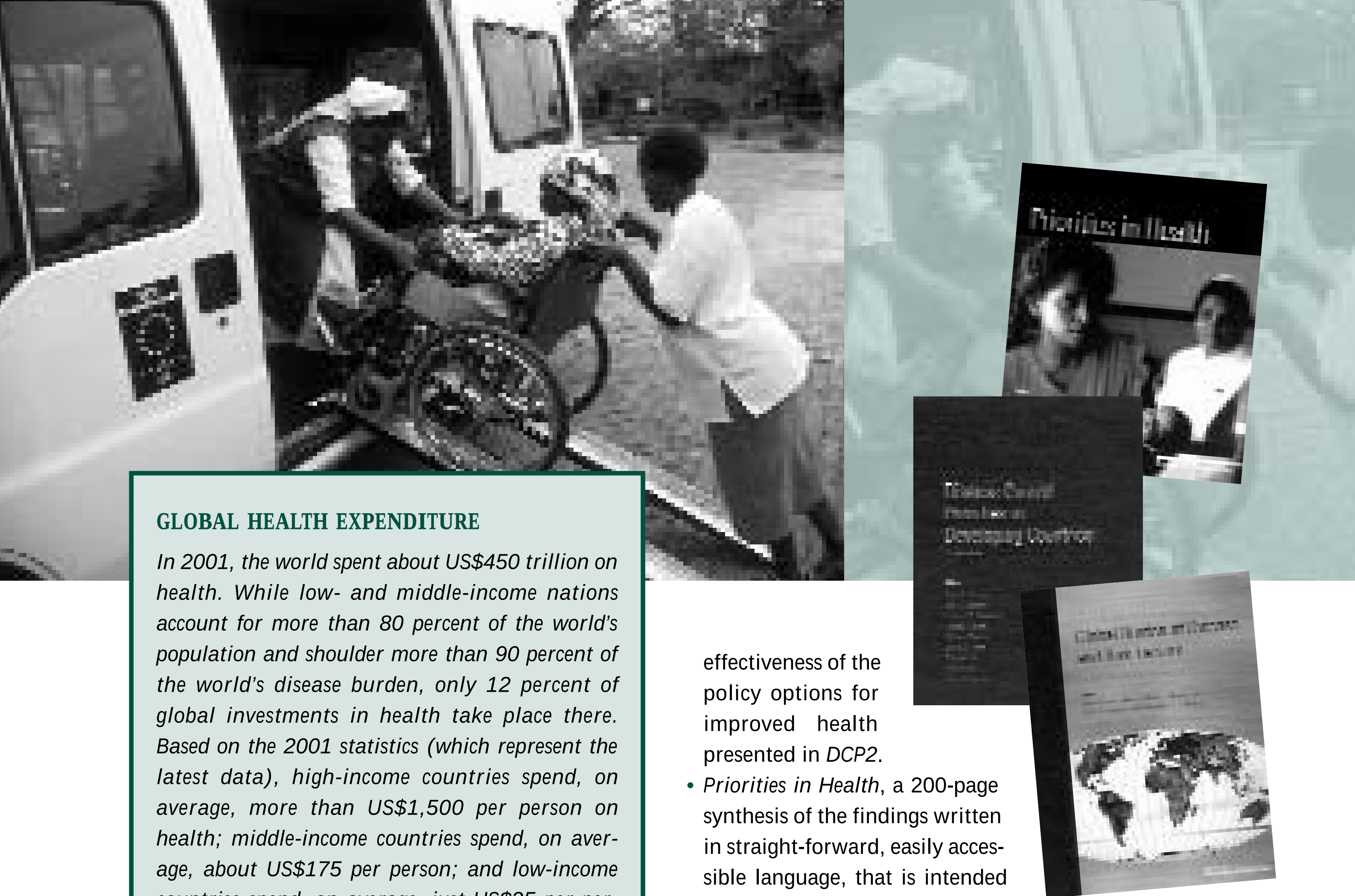
*More than 500 experts – practitioners, clinicians, researchers and economists – from around the world participated in the Disease Control Priorities Project (DCPP). Members of the Trieste-based InterAcademy Medical Panel (IAMP) served on the project's advisory committee to the editors. The IAMP Second General Assembly, which took place 2-6 April 2006 in Beijing, China, was the venue for the official launch of three books detailing the DCPP's findings and outlining cost-effective measures for addressing critical health problems in the developing world.*

What is the state of health in the developing world? How are developing countries dealing with the traditional health challenges posed by malaria and tuberculosis? How effective have efforts been to curb the scourge of HIV/AIDS? What measures are developing countries taking to address the rising incidence of disease due to tobacco and alcohol use and psychiatric disorders, and the increasing number of injuries and deaths caused by traffic accidents?

More importantly, what can be done to address these challenges in low- and moderate- income countries, many of which have made substantial improvements in their healthcare systems but, at the same time, face old and new challenges that seem to make efforts to improve public health as daunting as ever?

DCPP has recently published a trio of books to address these complex issues.

- *Disease Control Priorities in Developing Countries, 2nd edition (DCP2)*, a follow-up to the first edition (DCP1) that was published in 1993, is a comprehensive pres-




**GLOBAL HEALTH EXPENDITURE**

*In 2001, the world spent about US$450 trillion on health. While low- and middle-income nations account for more than 80 percent of the world's population and shoulder more than 90 percent of the world's disease burden, only 12 percent of global investments in health take place there. Based on the 2001 statistics (which represent the latest data), high-income countries spend, on average, more than US$1,500 per person on health; middle-income countries spend, on average, about US$175 per person; and low-income countries spend, on average, just US$25 per person. Ethiopia and Nepal average expenditures on health are just US$2 to US$3 per person, while in Canada, Europe, Japan and the United States expenditures average between US$2,000 and US$5,000 per person.*

entation of the project's findings, featuring cost-effective analyses of health interventions, healthcare systems and potential prevention and treatment programmes. Designed for researchers, clinicians and policy experts, it presents a detailed assessment of the current state of health in the developing world and outlines strategies for effectively addressing health challenges in low- and moderate-income countries.

- *Global Burden of Disease and Risk Factors* creates a snapshot of the state of health across the globe, providing a detailed account of disease and death rates worldwide. It not only assesses the critical risk factors that help to explain these rates, but also outlines the underlying methodologies used to determine the cost-effectiveness of the policy options for improved health presented in *DCP2*.
- *Priorities in Health*, a 200-page synthesis of the findings written in straight-forward, easily accessible language, that is intended to serve as a reference guide for public officials, policy makers and donors seeking to maximize their investments in programmes designed to improve public health. This volume is available in seven languages.

The publications, plainly stated, seek to provide "flexible, practical and simple tools" for helping low- and middle-income countries address their critical health problems. More specifically, *DCP2* offers comprehensive, commonsense strategies for advancing the Millennium Development Goals (MDGs), which call for marked improvements in such critical issues as childhood mortality, maternal health and combatting HIV/AIDs, malaria and other infectious diseases that are prevalent in developing countries (see *www.un.org/millenniumgoals*).

The *DCP2*'s 'best health buys' – that is, the most cost-effective interventions for improving public health in developing countries – include:

- Vaccinate children against such major childhood killers as measles and tetanus.

- Monitor children's health to prevent and treat such debilitating and potentially fatal diseases as pneumonia, diarrhea and malaria.
- Tax tobacco products and launch major public information campaigns on the health risks posed by tobacco use.
- Attack the spread of HIV/AIDs through public education and the use of condoms.
- Provide children and pregnant mothers with easy access to the nutrients that they need for good health.

Other 'best health buys' include providing widespread access to insecticide-treated bed nets in tropical regions to reduce the incidence of malaria and other mosquito-borne diseases; instituting such measures as speed bumps to curb the speed of automobiles, especially on busy thoroughfares; treating tuberculosis with short-term chemotherapy; training mothers and birth attendants in simple measures, such as keeping newborns warm and clean, to increase the well-being of infants; and promoting the use of aspirin and other cheap drugs to counteract hypertension and curb the incidence of strokes.

**DCP2 *offers comprehensive, commonsense strategies for advancing the Millennium Development Goals.***

When it comes to health in the developing world, the fact is that there are numerous case studies of dramatic advances in both the care and treatment of diseases. Examples include community-based family-planning programmes in Bangladesh that have not only improved the health of both mothers and children but have led to a reduction in the average number of children per family from seven to 3.3; successful public awareness and educational campaigns in Uganda on the hazards of unprotected sex that have slashed the incidence of HIV/AIDs from 20 percent to five percent of the population; and a nationwide initiative in Honduras that has reduced maternal mortality due to complications during pregnancy, childbirth and the post-partum period by 40 percent.

Such efforts offer great hope that public health is a developing-world challenge that can be successfully addressed with our current state of knowledge. As Dean Jamison, a senior editor of *DCP2* and professor of social research methodology at the University of California, Los Angeles, USA, puts it, "many of the health-care measures that we have identified are simple and inexpensive."

**NEONATAL DEATHS**

*Only one percent of neonatal deaths worldwide take place in high-income countries where neonatal mortality rates average 4 per 1,000 live births. In low-income countries, the average is 33 deaths per 1,000 live births. The majority of neonatal deaths occur in South Asia due to its large population. Twenty of the countries with the highest neonatal mortality rates are in sub-Saharan Africa. Neonatal death rates are especially high in countries experiencing political instability and violence – for example, Ethiopia, Liberia and Sierra Leone, where neonatal mortality rates reach more than 50 per 1,000 live births.*

**TOBACCO**

*Smoking rates are accelerating in low- and middle-income countries, where more than four out of five smokers live. DCPP recommends taxing tobacco products to increase the cost of cigarettes by at least 33 percent. The enactment of such a policy could save the lives of up to 65 million smokers.*

Another major finding is that improving healthcare delivery systems is just as important as increasing our knowledge on the pathology of disease.

"As recent experiences of China, Cuba and Sri Lanka have shown," Jamison says, "huge improvements in human health are possible without huge increases in national income or health expenditures." Life expectancy in China, for example, has more than doubled from approximately 35 years of age in 1960 to 72 years of age today, a trend that began when China was a very poor country. Cuba has developed one of the most advanced healthcare systems in the developing world despite its low national income. Sri Lanka has successfully implemented a low-budget programme for improved healthcare during pregnancy and birth and for routine examinations of infants that has sharply reduced mother and child mortality rates.

As developing countries have become more prosperous, they have had to continue to confront the challenge of addressing health problems historically associated with low- and medium-income countries – for example, infectious diseases such as tuberculosis and malaria – while, at the same, dealing increasingly with such 'lifestyle-related' maladies as cardiovascular disease, cancer and diabetes previously associated with high-income countries. For example, more than 25 percent of all deaths in the developing world are now due to heart attacks, strokes and high blood pressure compared to five percent due to HIV/AIDS and three percent for malaria. "The changing profile of morbidity and mortality," Jamison observes, "creates even greater pressure on healthcare systems across the developing world that rarely have the resources they need to meet the challenges they face."

As Jacques Baudouy, director of Health, Nutrition and Population in the Human Development Network at the World Bank, notes, "The world will not meet the Millennium Development Goals unless financial resources increase, new partners and instruments for healthcare are established, and greater recognition is given to the globalization of health issues, particularly the intricate links between health and sustainable development."

The truth is that unhealthy societies are usually poor societies and that poor health is as much a cause of poverty as it is a symptom. That's why the primary poverty-reduction MDG, calling for the number of people living on US$1 a day to be cut in half by 2015, is intricately related to such other MDGs as providing greater access to safe drinking water, improving sanitation and providing better care for mothers and children. As Jeffrey Sachs, director of the Earth Institute at Columbia University and special advisor to UN secretary-general Kofi Annan, often says: health is not just a health problem; it is also an economic development problem. Indeed studies show that 10 to 15 percent of global economic growth between 1960 and 1990 was the result of reductions in adult mortality and that one additional year of life expectancy correlates with a four percent increase in gross domestic product (GDP).

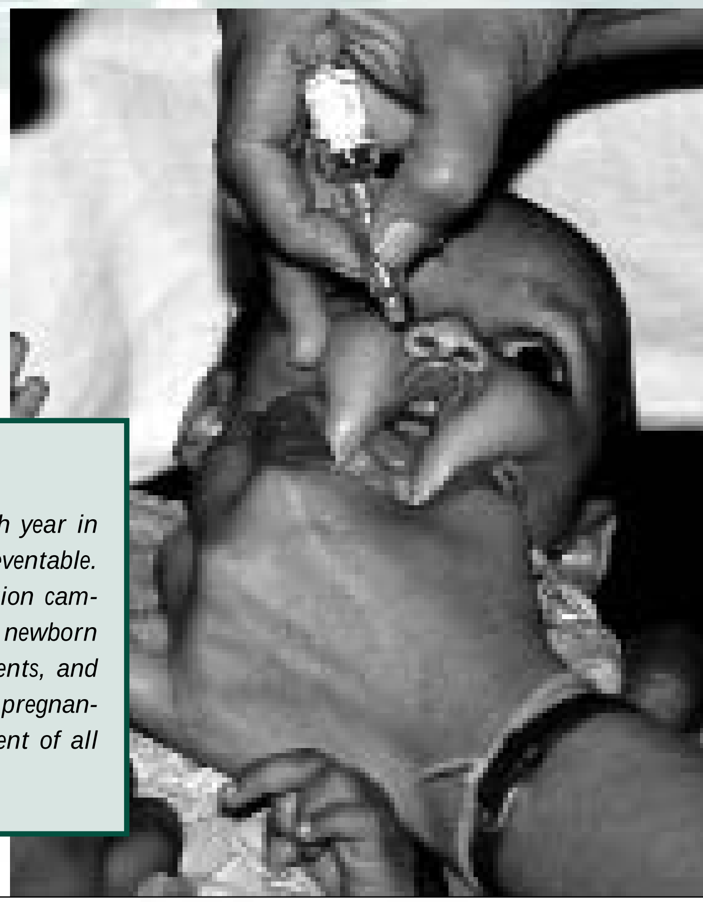
**_More than 25 percent of all deaths in the developing world are now due to heart attacks, strokes and high blood pressure._**

Reliable, detailed data is essential in the global campaign to improve public health. Such data help to identify the critical health problems faced by nations, including problems that may not be evident (for example, the growing problem of obesity in low- and middle-income countries); shed light on successful efforts to combat health maladies; and enable public health officials to design more effective strategies for addressing their nation's health needs. As Jamison states, "good data is a key to evidence-based health strategies."

Some of the challenges faced by public health officials in poor countries are long-standing problems – for example, inadequate nutrition for infants. Even today, millions of children in sub-Saharan Africa do not receive sufficient nutrients to ensure their well-being.

Meanwhile, some of the challenges faced by public health officials in poor countries thought to be on the verge of being conquered have reappeared with a vengeance. For example, medical experts hoped – not so long ago – that infectious diseases would ultimately be a thing of the past, relegated to history through comprehensive vaccination programmes that would reach all corners of the globe. Wasn't that the case for small pox, which was eliminated in 1972? And hadn't polio been confined to just a few countries? The rise of such emerging infectious disease as HIV/AIDS and new strains of influenza have taught us how misplaced those assumptions were.

And some of the challenges faced by public health officials in poor countries are new. Who would have guessed that traffic accidents would become a primary cause of injury and death in developing countries?



**CHILD CARE**

*More than 13 million children under the age of five die each year in developing countries. At least 70 percent of these deaths are preventable. DCPP advocates a set of interventions, including immunization campaigns to prevent measles and polio, educating mothers on newborn care, giving children and pregnant mothers adequate nutrients, and providing access to family planning services to avoid high-risk pregnancies, which are estimated to cause between 20 and 40 percent of all infant deaths.*

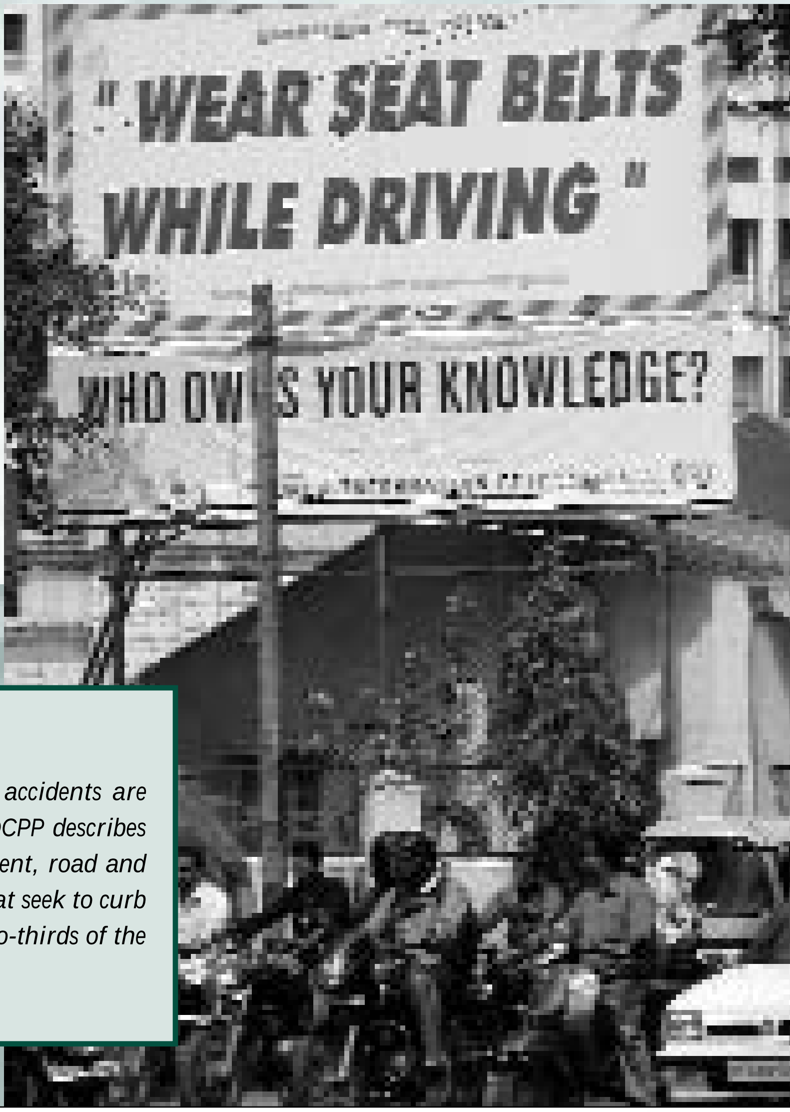
"The critical factor that we all face," observes George Alleyne, director emeritus, Pan American Health Organization and an editor of *DCP2*, "is turning information into action," and that is what the DCPP reports hope to accomplish in the months and years ahead.

Among the challenges cited by the participants at the DCPP launch in Beijing are:

- There is an urgent need for additional investments in public health training and infrastructure. Many developing countries have made significant progress in addressing the health needs of their citizens, but investments in public health remain low, especially when compared to investments in the developed world. At the same time, even among developing countries that have made great progress in improving their healthcare systems, certain segments of the population continue to be under-served – for example, rural residents and women. This trend has led to a widening of the health gap *within* countries even as it narrows *between* countries.
- There is a need to improve healthcare delivery systems. What good is it to have sufficient knowledge on how to treat diseases and accidents if that knowledge cannot be delivered to the patients who need it? Successful public health systems, as a result, depend as much on political will and administrative expertise as they do on medical know-how.

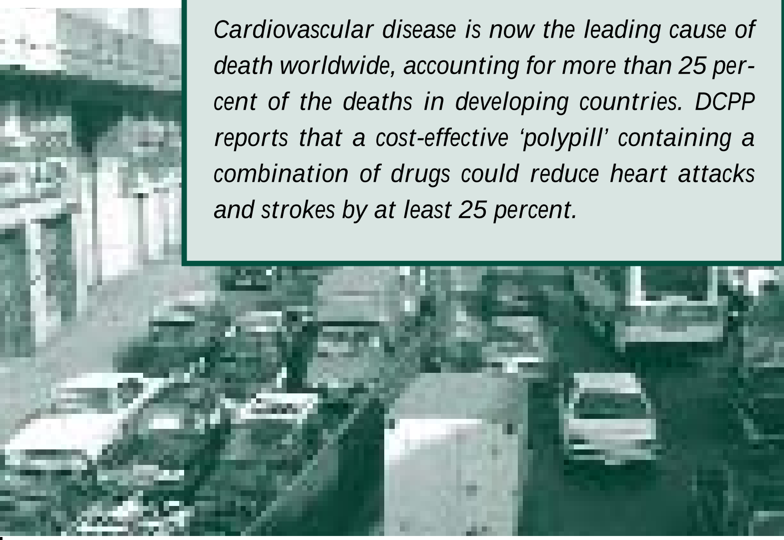
***Successful public health systems depend as much on political will and administrative expertise as on medical know-how.***

- There will be an increasing need for developing nations to shift their emphasis in healthcare from therapeutic to preventative medicine. This trend will be due, in part, to the advances in healthcare that developing countries are now experiencing and, in part, to increased wealth and changes in life styles among their citizens.
- There is no substitute for constant vigilance, especially when it comes to infectious and communicable diseases. Conquering a disease is a rare occurrence but successfully controlling diseases through long-term, comprehensive health programmes is not.




### ALCOHOL, DRUG AND TRAFFIC ACCIDENTS

*Reckless behaviour related to alcohol abuse and traffic accidents are responsible for an estimated one million deaths a year. DCPP describes how to ensure safer driving through traffic law enforcement, road and vehicular improvements, and policies and programmes that seek to curb alcohol and drug abuse, which are implicated in up to two-thirds of the traffic fatalities in developing countries.*




### CARDIOVASCULAR DISEASE

*Cardiovascular disease is now the leading cause of death worldwide, accounting for more than 25 percent of the deaths in developing countries. DCPP reports that a cost-effective 'polypill' containing a combination of drugs could reduce heart attacks and strokes by at least 25 percent.*

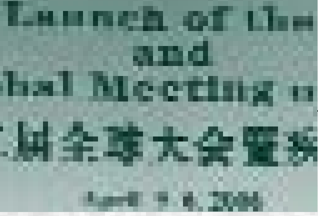
### HIV/AIDS

*HIV/AIDS has claimed 25 million lives worldwide since 1981. Today, 95 percent of the people who are affected with HIV live in developing countries. DCPP proposes to curb the spread of HIV/AIDS through a coordinated programme that includes 100 percent condom use among high-risk populations, antiretroviral therapy and breast-milk substitutes.*

- Protecting public health requires a dynamic response system. Public health systems draw a great deal of their strength from local knowledge and cultural mores, especially in developing countries. The disease profiles of countries moreover, change over time and healthcare systems must be responsive to these changes. For example, health clinics and hospitals in developing countries must pay increasing attention to incidences of cardiovascular disease among their patients.
- There has been virtually no interaction between research communities dedicated to agriculture and animal health, on the one hand, and human health, on the other. The former are usually funded by ministries of agriculture and the latter by ministries of health. Such disengagement is becoming a serious handicap for improving public health, especially in the developing world, in light of the increasing incidence of infectious diseases that also affect animals.

"The *DCP2*'s primary purpose," notes Anthony MBewu, recently elected co-chair of IAMP and president of the Medical Research Council of South Africa, "is to provide a roadmap for better health in the developing world based on cost-effective and preventative patient management interventions. The DCPP publications themselves are bound to intensify and broaden discussions on how to make the world a healthier place. Everyone has a stake in this debate. IAMP and other health-related organizations across the globe will do their best to ensure that both the data and the analyses that *DCP2* affords will be distributed to as a large an audience as possible." ■

*For additional information about the DCPP and the text of the reports produced by the project,*
*> see www.dcp2.org.*





# IAMP: BEIJING AND BEYOND

**THE TRIESTE-BASED INTERACADEMY MEDICAL PANEL (IAMP), A GLOBAL NETWORK OF 64 MEDICAL ACADEMIES AND MEDICAL DIVISIONS WITHIN SCIENCE AND ENGINEERING ACADEMIES DEDICATED TO IMPROVING GLOBAL PUBLIC HEALTH, HELD ITS SECOND GENERAL ASSEMBLY IN BEIJING, CHINA, 2-6 APRIL 2006. THE EVENT WAS SPONSORED BY THE CHINESE ACADEMY OF ENGINEERING AND THE CHINESE ACADEMY OF SCIENCES.**

*During the IAMP Second General Assembly, held in Beijing, China, 2-6 April 2006, IAMP members elected a new co-chair, Anthony MBewu, president of the Medical Research Council in South Africa. MBewu replaces David Challoner, foreign secretary, US Institutes of Medicine at the US National Academies of Sciences, who had shared leadership responsibilities for IAMP with Guy de Thé, professor emeritus at Institute Pasteur, France, since the organization's inception in 2000. de Thé will remain as co-chair for another four years. IAMP members also discussed and then endorsed an ambitious agenda for future activities. The agenda calls for the launch of a number of research projects dealing with critical global health issues, including a global assessment of the means to improve the quality of healthcare, especially in hospitals, and an examination of the effectiveness of scientific networks focusing on the incidence and spread of infectious diseases, especially in developing countries. At the assembly, IAMP members voiced strong support for the findings of the Disease Control Priorities Project (DCPP), a multi-year initiative supported by a grant from the Bill and Melinda Gates Foundation (see pages 47-53). The DCPP publications, officially launched at the IAMP assembly in Beijing, offer a detailed cost-effective strategy for addressing the developing world's most critical public health problems.*

"You are travelling to an area affected by avian influenza. The illness affects primarily poultry. Cases of transmission to humans have been confirmed."

That was the sobering message conveyed in a brochure handed to each passenger boarding Air France flight 128 on the way from Charles de Gaulle Airport in Paris to Beijing, China. It's a brochure that many participants received on their connecting flight


**_Like so much else in life, globalization carries both opportunities and risks._**

to attend the IAMP Second General Assembly, which was held in Beijing at the tail end of the 2006 flu season in early April. More than 300 scientists and health experts, policy makers and journalists from nearly 50 countries attended the event, including the first two days that were devoted to the launch of reports from the Disease Control Priorities Project (DCPP) and a comprehensive discussion of its findings.

Like so much else in life, globalization carries both opportunities and risks. One of the most serious risks posed by the phenomenal increase in trade and travel that has taken place over the past few decades is the potential for the worldwide spread of infectious diseases.

Yes, the world has come closer together. And, yes, proximity breeds peril as well as opportunity. The key to success is managing both through initiatives that recognize the global, regional and local dimensions of the challenge.

The InterAcademy Medical Panel (IAMP), created in 2000, is designed to bring medical academies and medical divisions in science and engineering academies together for the purposes of addressing the growing challenges of global health. During its initial years of operation, in addition to establishing its management and administrative procedures (culminating with the approval of the IAMP statutes at the Beijing assembly), the organization embarked on a series of programmatic initiatives intended to tap into the expertise of the scientists who belong to its member academies while simultaneously strengthening the academies themselves, especially in their efforts to engage public officials and the public at large. For example, under the auspices of the French Academy of Sciences and the Canadian Academy of Health Sciences, IAMP created an interactive website dedicated to issues focusing on the health of mothers and children. It also launched a mother-child health research network for promoting research on this critical health sector, especially in the developing world.

"The IAMP Second General Assembly in Beijing," says David Challoner, the organization's former co-

chair, "showcased the progress we have made in transforming the organization from a worthy ideal into a functioning institution. Many important steps have been taken to ensure the long-term organizational 'health' of IAMP, most notably the creation and approval of its statutes. In addition, we have launched a number of programmatic initiatives that have been successful in their own right. IAMP has benefitted greatly from its association with the DCPP, which has emphasized the importance of improving health in the developing world through more effective investments and more efficient health delivery systems.

"The assembly in Beijing," adds Guy de Thé, who will continue as IAMP co-chair for the next four years, "is both a sign of the growing maturity of our organization and a strong indication of our potential to play a key role in worldwide efforts to better understand and improve public health through evidence-based research and action. We not only have our administrative house in order now, but we have devised a far-reaching programmatic agenda that promises to serve as an important source of unbiased information, especially for medical and public health practitioners and, equally important, public officials across the developing world."

Challoner's departure as co-chair opened up an opportunity for a representative from the developing world to serve in that capacity, as stipulated in IAMP's statutes. Anthony MBewu, president of the Medical Research Council in South Africa, was elected to replace Challoner.

***IAMP has the potential to influence the health of millions of people worldwide, especially the world's poorest people.***

"IAMP," says MBewu, "was created, in large part, to help its members become more adept at informing public officials about the current state of expert knowledge concerning critical medical and public health issues. The organization has been particularly concerned about strengthening the role of its members in developing countries in shaping public health policies. To help advance this goal, I hope to help bolster the organization's ties with both medical research institutions and health ministries throughout the developing world and especially in sub-Saharan Africa.

"IAMP," MBewu continues, "has the potential to influence the health of millions of people worldwide, especially the world's poorest and most vulnerable people, and I strongly believe that we have developed an agenda that, if successfully implemented, can begin to make a significant difference in the years ahead."

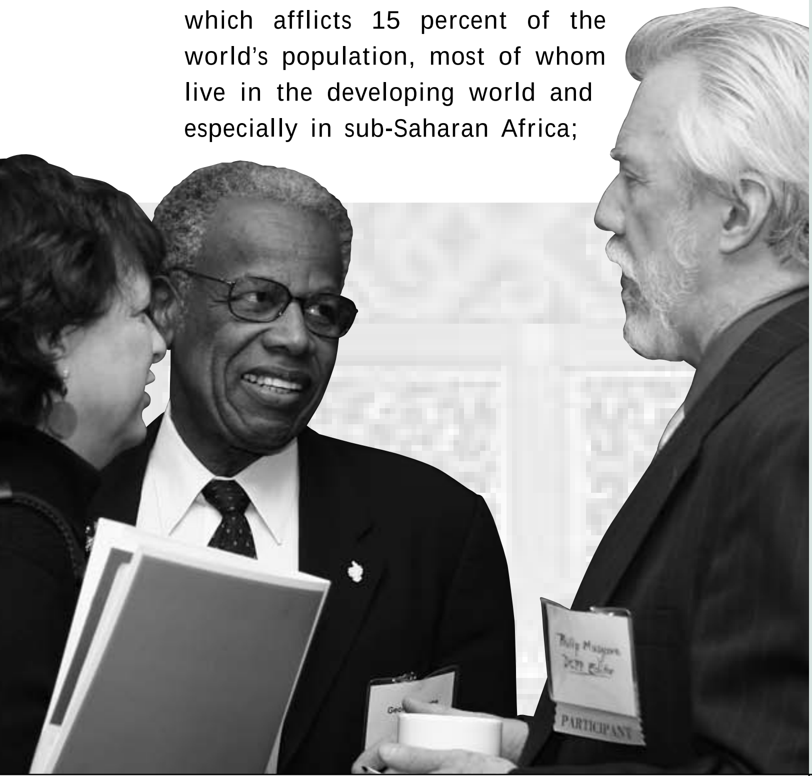
Two major topics of discussion at the conference served as the themes of its scientific sessions: first, the spread of infectious diseases in the developing world and the risk that such diseases as HIV/AIDS and avian influenza pose to global health. And, second, the rising incidence of automobile accidents in developing countries as road construction and traffic safety fail to keep

pace with the increasing number of automobiles in many low- and middle-income countries.

"IAMP," Challoner also notes, "played a key role in the DCPP where its members served on the advisory committee to the editors. The DCPP's focus on devising strategies for improving the efficiency of public health investments in the developing countries fits well with IAMP's mandate."

At the conference, IAMP members issued a statement strongly supporting the DCPP's findings (see *www.iamp-online.org*). The organization's future plans call not only for helping disseminate the findings of the DCPP reports but for working closely with institutions across the developing world – ministries of health, universities, hospitals and public health clinics – that are seeking to follow up on the DCPP's recommendations and strategies. (For more information on DCPP and full access to the publications and other materials, see *www.dcp2.org*).

To advance its agenda in the years ahead, IAMP members in Beijing agreed to launch several new programmes, including study projects surveying and analysing strategies for reducing perinatal and maternal morbidity and mortality in poor countries; an investigation of better diagnostic techniques and preventive treatments for rheumatic fever, which afflicts 15 percent of the world's population, most of whom live in the developing world and especially in sub-Saharan Africa;




### CARS AND HEALTH

*"Measures to improve road traffic safety represent a great opportunity to improve health, especially in the developing world," says Mark Rosenberg, an adjunct professor in the Rollins School of Public Health and School of Medicine, Emory University, USA, who spoke at the 2nd General Assembly.*

*The number of traffic deaths and injuries are decreasing in the developed world, thanks largely to improved automobile safety, better road design, and stricter law enforcement.*

*But the developing world has a different story to tell. According to Rosenberg, traffic accidents in developing countries now account for more than 1.2 million deaths annually and cause another 20 to 50 million serious injuries. In the United States, there are 66 deaths for each 10,000 crashes; in Kenya 1,800 deaths; and in Vietnam 3,000.*

*"Traffic accidents are not only a human tragedy," says Rosenberg. "They also do damage to the economy." He estimates that accidents cost developing countries some US$65 billion annually and that they shave one to two percent from the gross domestic product – more than the total amount of international aid that low- and middle-income countries receive each year.*

*Pedestrians, walking on the side of the road or crossing an intersection, are particularly at risk. In Thailand, pedestrians account for 90 percent of all traffic-related fatalities. In China, they account for 60 percent.*

*So what's to be done? Rosenberg cites three interrelated strategies that could lead to a significant decline in automobile accidents in developing countries.*

*First, nations should take simple measures that encourage drivers to reduce their speed, especially in areas where there are a large number of pedestrians. Speed bumps, for example, significantly alter the behaviour of drivers, causing them to slow down and drive more cautiously.*

*Second, nations should enact and enforce legislation that penalizes drivers who go too fast or who drink and drive.*

[CONTINUED PAGE 58]

*And third, the government should introduce policies that encourage people to wear seat belts when driving and helmets when riding motorcycles or bicycling.*

*Rosenberg also urges governments in developing countries to establish stronger administrative frameworks to deal with the problems caused by traffic accidents. Among the more effective actions he cites are: creating a lead government agency that has primary responsibility for addressing the problem; conducting comprehensive assessments of the issue so that policies can be based on firm evidence; preparing a national safety strategy to guide policy makers and raise public awareness; and allocating sufficient resources to ensure effective action can be taken.*

*A certain number of traffic accidents is inevitable. That's a risk most people are willing to take for the freedom they receive in return. But, as Rosenberg notes, the explosive growth of accidents in the developing world has reached epidemic proportions. The problem, moreover, seems to be accelerating as car ownership increases even in the poorest countries.*

*"The sad news," Rosenberg notes, "is that traffic accidents have become a problem that is perfectly predictable. The good news is that they are perfectly preventable."*

*For additional information, see 'Unintentional Injuries',* Disease Control Priorities in Developing Countries, *2nd Edition, Chapter 39. http://www.dcp2.org/pubs/DCP/39 .*

the launching of a series of workshops on science writing for young scientists and clinicians designed to help them improve their ability to prepare grant proposals and to report their findings to funding organizations that are supporting their research; an assessment of networks devoted to the monitoring and sharing of information on the spread of infectious diseases – networks that could play a critical role in international efforts to combat the spread of avian influenza if changes in the molecular make-up of the virus should render human-to-human transmission possible; and a comprehensive study of quality care in hospitals that will seek to identify the gap between 'care' and 'quality care' in hospitals and examine how that gap can be closed.

Beyond mapping out a new programmatic agenda, IAMP members in Beijing also unanimously approved the organization's statutes and elected a new executive committee.

The committee, which will remain in place until 2009, consists of the following institutions: African Academy of Sciences; Chinese Academy of Sciences; *Accademia dei Lincei*, Italy; Royal Swedish Academy of Sciences; US Institutes of Medicine at the US National Academy of Sciences; and Polish Academy of Sciences.

Eleven new members were also officially welcomed to IAMP, bringing IAMP's total membership to 64. IAMP's newest members are: Bangladesh Academy of Sciences; Cameroon Academy of Sciences; Canadian Academy of Health Sciences; *Académie des Technologies*, France; German Academy of Sciences, *Leopoldina*; Indonesian Academy of Sciences; Academy of Medical Sciences, Iran; Kenyan National Academy of Science; Nigerian Academy of Science; National Academy of Sciences of Sri Lanka; and Uganda National Academy of Sciences.


***The true measure of IAMP's success will be determined by its impact on public health, especially in the developing world.***

At the conference, IAMP announced it had forged a strategic alliance with the InterAcademy Panel (IAP), a global network of science academies, which shares many of the same goals as IAMP. IAP, which, like IAMP, is located in Trieste, Italy, and operates under the administrative umbrella of the Academy of Sciences for the Developing World (TWAS), provided IAMP with US$50,000 in 2005, and has agreed to provide the same amount in 2006 to help the organization advance its programmatic activities.

"IAMP's potential for growth is enormous," says de Thé. "But the true test of our success will not be measured simply by the number of projects we engage in or the increased public and media attention we receive for our efforts. Instead, the true measure of our success will be determined by the impact that our studies and networks have on public health, especially public health in the developing world."

"We, the member academies of IAP, pledge our continued support for improving human health and building human capacity through evidence-based public health and healthcare practices, especially in the developing world," participants at the Beijing conference proclaimed in a statement issued during the conference's closing session. "IAMP member academies are convinced that a safer, more productive and harmonious human condition worldwide depends on fostering polices that promote indigenous human and institutional capacity on health-related issues, especially in nations where such capacity has been chronically weak and under-funded.

"We therefore urge governments and international organizations; medical, scientific and engineering institutions; nonprofit organizations and civil society; foundations; and the private sector to give priority to health promotion on a global scale through initiatives that effectively control diseases and to provide adequate funding for research and the construction of health infrastructures and systems that can meet the health challenges of the 21st century." ■

*For additional information about IAMP,*
*> see www.iamp-online.org*

# WHAT'S TWAS?

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

TWAS has more than 800 members from 90 countries, 73 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a secretariat, headed by an Executive Director and located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of Italy.

The main objectives of TWAS are to:

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

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

> **www.twnso.org**

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

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 90 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. > **www.interacademies.net/iap**

The secretariat of the InterAcademy Medical Panel (IAMP), a global network of 64 medical academies and medical divisions within science and engineering academies, relocated to Trieste in May 2004 from Washington, DC, USA. IAMP and its member academies are committed to improving health worldwide, especially in developing countries.

> **www.iamp-online.org**

## WANT TO KNOW MORE?

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

## FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes: **www.twas.org/Exchange.html**

TWOWS offers postgraduate fellowships to women from least developed countries (LDCs) and other countries in sub-Saharan Africa: **www.twows.org/postgrad.html**

## GRANTS

Are you a scientist seeking funding for your research project? Then take a look at the TWAS Research Grants scheme: **www.twas.org/mtm/RG_form.html**

Is your institution seeking funds to collaborate with a research institute in another country in the South? The TWNSO grants programme may be able to provide support: **www.twnso.org/grants.html**

## EQUIPMENT

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

## TRAVEL

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

## CONFERENCES

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