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NEWSLETTER

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Science for humanity

27th TWAS General Meeting in Kigali, Rwanda

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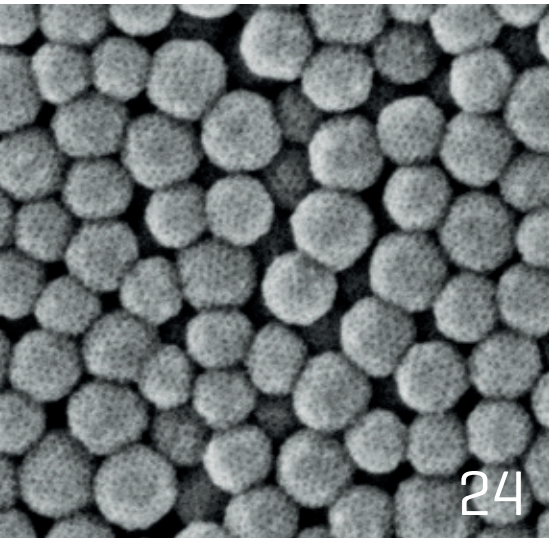

▲ Top to bottom: Rwandan President Paul Kagame (left) greets TWAS President Bai Chunli at the start of the Academy's 27th General Meeting. (Photo: Robert Mugabe/Rwanda Ministry of Education). Tiny drug-delivering microspheres from the research of TWAS-Lenovo Prize winner Zhao Dongyuan. (Photo provided)

Cover: Rwandan President Paul Kagame offered the keynote address in the General Meeting's opening ceremony. (Photo: Robert Mugabe/Rwanda Ministry of Education)

▼ Ylann Schemm (left), programme director of the Elsevier Foundation, was among the key partners and high-level participants at the General Meeting. (Photo: Robert Mugabe/ Rwanda Ministry of Education)

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EDITORIAL

BUILDING A STRONGER TWAS COMMUNITY

▲ Bai Chunli, TWAS President; Mohamed H.A. Hassan, TWAS executive director (interim)

Across more than three decades, TWAS has worked with partners and allies to advance science in the developing world. Working together, we have contributed to a global transformation that is evident in the research strength of nations such as Brazil, China, India and South Africa.

But with success has come a new challenge: While a significant number of nations are making progress linked to investments in research and science education, for others progress is coming more slowly. The result: for at least a decade, we have seen a gap opening between the emerging nations and others that continue to lag.

This gap is troubling, and it has global implications for the health of human communities and the environment.

We see this gap in TWAS's membership, as well. Too many developing nations still have no TWAS Fellows; others have only a few. And despite strong efforts, women still count for only 12% of our Fellows. In recent years, we have taken steps to address the gap, but it remains central to TWAS's mission that we do everything possible to close it.

Following our General Meeting in Rwanda, TWAS is initiating a number of new efforts that will make the Academy more truly global and maintain our commitment to excellence.

First, the TWAS Council has advanced new initiatives to extend our membership, with a special focus on poorly represented countries, regions and groups, sub-Saharan Africa and the Least Developed Countries (LDCs) in particular. Our membership committees will give more balanced consideration to candidates from poorly represented countries and to women. At the same time, we will work with our regional offices and the Organization for Women in Science for the Developing World (OWSD) to identify new candidates. We are asking current Fellows and Young Affiliates to help us in this campaign.

Second, we are adjusting some key programmes to focus more tightly on countries with the greatest needs. For example, over the past 10 years, our research grants and other programmes have been targeting 81 countries identified as science- and technology-lagging. We now have revised the list to 66 countries – including the LDCs and others with low income levels and specific needs for capacity building. OWSD, too, will adopt this list for its growing PhD fellowships programme.

These adjustments increase our focus on sub-Saharan Africa, where the needs – and the potential – are so great. Without intensive commitment from TWAS and its partners, Africa will struggle to catch up with other countries. We cannot afford a gradual approach.

At the same time, a number of TWAS members, partners and offices are already working to extend the TWAS community. The OWSD-Elsevier Awards for Early Career Women Scientists in the Developing World have quickly established a global reputation. And three new prizes named for our Fellows – the TWAS-Fayzah M. Al-Kharafi Prize, the TWAS-Abdool Karim Award and the TWAS-Samira Omar Prize – will help us to recognize and encourage women scientists in less-developed countries.

As with any science, our efforts must continually be tested, evaluated and improved. But with commitment and creativity – and sustained support from our community – we will strengthen our Academy and deepen our impact. Taken together, these initiatives are bound to produce benefits for scientists today, and in generations to come.

Bai Chunli
TWAS President

Mohamed H.A. Hassan
TWAS Executive Director (interim)

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IN THE NEWS

Girl-focused data is critical for Africa

The United Nations has made the gathering of data on girls across the world the focus of 2017. Marking the International Day of the Girl Child, the U.N. issued a call for action for increased investment in collecting and analysing data that's focused on and relevant to girls.

Robust and reliable data collected on a regular basis is essential for policymaking. For Africa, girl-focused and girl-relevant data is a critical tool for identifying the challenges that continue to disadvantage girls. This will enable African politicians, lawmakers and civil society to better understand the barriers that confront girls and design policies and services to respond to their specific needs.

The Conversation:
www.bit.do/GirlData

Desalination plants – risky investments?

India, China and the Middle East are hot markets for desalination plants. But efforts in Australia to increase capacity are a cautionary tale of growing the sector too big, too fast.

Australia's stranded desalination plants, coupled with huge electrical power demands, have put the world's desalination sector on the defensive, especially for developers of big and expensive seawater plants. About 150 such plants, producing the bulk of desalination capacity, operate around the world. The greatest density of seawater plants is in the Caribbean and the Arabian Gulf states.

Circle of Blue:
www.bit.do/Desalination

Robots on farms are coming of age

From tracking cattle and measuring crop health to counting yields and dispensing agro-chemicals, robotics technologies promise solutions to pressing farm labour shortages, yield and productivity issues as well as environmental concerns.

Because leaps forward in computing power have made real-time data gathering and analysis possible, farmers could now be able to make critical decisions that address the issues of an individual plant, tree or animal, rather than having to apply decisions across a whole farm or orchard.

SciDevNet:
www.bit.do/FarmRobots

Excitement builds for new HIV vaccine

Glenda Gray, head of South Africa's Medical Research Council, leads the first large study of an HIV vaccine's effectiveness since 2009. It's expected to end the 33-year-long wait, since 1983, to develop an effective vaccine.

The current study is based on a vaccine used in a trial in Thailand in 2009. The success rate of that vaccine was 30%. The new vaccine has been made stronger so that its effects last longer. Results from South Africa are expected in four years.

Down to Earth:
www.bit.do/HIV-Vaccine

Midwives on motorbikes aid mothers in Kenya

International development agencies believe that providing funding for motorbikes as part of the Rural Transport Network scheme, rates of maternal mortality in Isiolo County, Kenya, will improve.

According to the World Health Organisation, more than 6,300 women died in childbirth last year in Kenya, one of the highest rates in East Africa. Deep in Kenya's interior, health facilities are sparse, with some up to 100 kilometres from the communities they serve. For pregnant women, reaching a centre can be perilous, particularly when dirt roads flood and bridges become submerged.

The Guardian:
www.bit.do/MidwivesKenya

"TO REACH OUR FULL POTENTIAL"

In a ceremony opening TWAS's 27th General Meeting, speakers from both Rwanda and the Academy recognized the value of closer cooperation.

by **Cristina Serra** and **Edward W. Lempinen**

The opening ceremony of the 27th TWAS General Meeting celebrated a mission shared by both Rwanda and TWAS: to advance science and technology in support of sustainable human prosperity.

Standing before 500 science and policy leaders from Rwanda and 50 other countries around the world, Rwandan President Paul Kagame offered a stirring call to embrace science, citing its power to transform economies and human relations. Then TWAS President Bai Chunli, in his opening address, cited the shattering impact of the 1994 genocide against the Tutsi people and the long and difficult recovery led by Kagame. [For full speeches, see page 9 and page 11]

Rwandan Education Minister Musafiri Papias Malimba, in his welcome to the audience, cited a large team of Rwandan scientists who had been invited to the meeting.

"I know that there are many opportunities to be gained from a strong collaboration with TWAS," Musafiri said. "I trust that you will truly benefit from the interactions with the many esteemed scientists gathered here from around the developing world."

The TWAS General Meeting opened on Monday 14 November in Kigali, Rwanda's capital city. It featured symposia and lectures on a range of topics related to science and development.

The opening ceremony, following a TWAS tradition, celebrated scientific excellence by awarding prizes and awards to researchers from across the developing world. It also offered an opportunity to celebrate Rwanda's progress, and to affirm the Academy's partnership with Rwanda and all of sub-Saharan Africa. The event drew journalists from Rwanda and China; it was broadcast live on Rwandan television and livestreamed to the world.

The mood of the event was both solemn and hopeful, a recognition of the remarkable commitment Rwanda has made to employ education, science and technology – and international partnerships – to recover from devastation. The genocide left up to a million people dead, including many teachers. It destroyed schools and equipment.

Claire Lyngå recalled a two-year stay in Rwanda earlier in her career, teaching physics at the National University of Rwanda. Though few resources were available, the university "had its aims set high, and with a vision of how to transform itself".

Today, Lyngå is a research adviser in the Unit for Research Cooperation at the Swedish International Development Cooperation Agency (Sida). "Coming back, more than ten years later, to what is now the University of Rwanda, I see a university that is transformed," Lyngå told the audience. "The government of Rwanda should be commended for their commitment to science."

Flavia Schlegel, UNESCO's assistant director-general for natural sciences, struck a similar note in a video address to the conference. Under President Kagame's leadership, she observed, Rwanda has increased its efforts to build prosperity and economic growth through science, and today the nation is emerging as an African leader in science.

▼ His Excellency President Paul Kagame of Rwanda, joined by TWAS President Bai Chunli and Rwandan Education Minister Papias Musafiri Malimba, makes a ceremonial entry into the opening session of the TWAS General Meeting in Kigali, Rwanda. (Photo: Robert Mugabe/Rwanda Ministry of Education)

▲ Left to right: Stefano Salmaso, Secretary of Legation, Scientific and Technological Unit, at the Italian Ministry of Foreign Affairs and International Cooperation (Photo: Robert Mugabe/Rwanda Ministry of Education); Flavia Schlegel, UNESCO's assistant director-general for natural sciences; and Claire Lyngå, research adviser in the Unit for Research Cooperation at the Swedish International Development Cooperation Agency (Sida).

"Rwanda is a shining example in harnessing education and scientific research to meet national development needs and in creating a strong basis for scientific cooperation in the region," Schlegel said.

Her point was underscored by Stefano Salmaso, Secretary of Legation, Scientific and Technological Unit, at the Italian Ministry of Foreign Affairs and International Cooperation.

"Italy strongly believes that TWAS can act globally and locally, with an integrated approach toward the local scientific communities and an expanding global vision," Salmaso observed. "We are confident that TWAS will be able to play an important role in the perspective of further improving its synergies in the context of the Trieste Scientific Hub."

Speakers noted TWAS's valuable efforts to create opportunities for women in science – but increasing those opportunities remains a crucial need. The participation of women in scientific fields must increase, Lyngå said.

"It's not only a human rights issue, but also an economic imperative," she said. "It makes sense to use the full potential of the population."

The Rwanda Academy of Science was formally launched during the week of the TWAS meeting to support the role of science and to provide evidence-based analysis to leaders at all levels. And Rwanda has built a productive network of partnerships.

As illustration, Kagame offered several examples of high-quality scientific centres based in Rwanda that have been developed with overseas partners. Among them is the East African Institute for Fundamental Research, based in Rwanda, a partner to the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy, and a Category 2 UNESCO institute.

"The transformative power of science is known," Kagame said, "and we must harness it to serve our ambitious goals for sustainable development and prosperity.

> "Our common dignity as human beings matters. And no one can be left out of the scientific enterprise."
>
> *Rwandan President Paul Kagame*

"But science has another, less visible, but no less valuable, dividend: The scientific mindset makes us better people. In both conception and utilisation, scientific work is blind to divisions or prejudices that only hinder further progress for everybody.

"Our common dignity as human beings matters," the president concluded. "And no one can be left out of the scientific enterprise." ◘

Learn more: www.twas.org/node/11964/

KAGAME: HUMANKIND RELIES ON SCIENCE

Science is critical to narrowing the gap between developed and developing regions, Rwandan President Paul Kagame said in the keynote speech at the 27th TWAS General Meeting.

Let me welcome you to Rwanda.

It is a great pleasure to join you today to open this important meeting bringing together scientists and engineers from around the world.

Let me start by thanking you for the medal that has been awarded. It honours all the Rwandans whose hard work has got our country to where it is today.

Allow me also to congratulate the prize winners just announced for their outstanding contributions to science. Your work will certainly make lives better.

Throughout history, humankind has relied on science to find practical solutions to its challenges.

In the developing world in particular, science plays a critical role in our socio-economic transformation by helping to narrow the gap between us and the more developed regions.

This is what has driven Rwanda's focus on science and technology over the last two decades, even when some might have thought that we had more important things to worry about.

The focus has always been about opening up to the wider world and finding a pathway to understand our situation, identify the best tools available to us and then use that knowledge to reach our full potential.

For any country, achieving a comprehensive vision while also getting into a position to contribute to global solutions depends on several factors.

First, is investment in the necessary institutional and academic infrastructure, as well as in the people, who ultimately are both the drivers and consumers of scientific work.

Second, is collaboration and partnership both among scientists and between policy-makers and researchers.

The World Academy of Sciences is an excellent example of collaboration at both levels, as well as a clear demonstration of the power and relevance of increased South to South cooperation.

The third factor is research. Strengthening scientific research capacity has never been more urgent, particularly on our continent, where it can have a transformational impact on the pace and quality of development.

In Rwanda, we want to do our part.

This is why we have established the Rwanda Academy of Science to promote and support the role of science in sustainable development and to provide evidence-based solutions to leaders at all levels.

We greatly value the partnerships our country enjoys in various fields, to strengthen our national and regional knowledge systems and find innovative solutions to the challenges and opportunities that we all face.

Rwanda is honoured to host several important centres of excellence, among them the regional UNESCO Abdus Salam International Centre for Theoretical Physics.

A few years ago, our government invited Carnegie Mellon University to provide graduate education in ICT because of its strong tradition

▶ Rwandan President Paul Kagame speaks at TWAS's 27th General Meeting. [Photo: Robert Mugabe/Rwanda Ministry of Education]

> The scientific mindset makes us better people. In both conception and utilisation, scientific work is blind to divisions or prejudices, that only hinder further progress for everybody. *Rwandan President Paul Kagame*

of research and scholarship. Today, CMU Rwanda forms the core of our Kigali Innovation City.

We have also partnered with the Massachusetts Institute of Technology to create a world-class global climate observatory.

Other centres of excellence have been established in fields as diverse as biomedical engineering and e-health, the internet of things, energy for sustainable development, data sciences, and innovative math and science teaching.

Rwanda will continue to provide an enabling environment and the support required for the success of these partnerships.

There is still a lot of work to be done on our continent and beyond.

Investment in research and development in Africa, and other developing areas, is still too low. In most countries, less than one in three scientific researchers are women. And our continent urgently needs to produce many more scientists and engineers generally.

That is why the Partnership in Applied Science Engineering and Technology initiative, to train 10,000 PhD-level researchers and multiply the number of applied science, engineering and technology students, is absolutely critical.

We recognise that doing this requires significant resources. Governments must do our part while making it attractive for private sector to get involved as a beneficiary of innovation ecosystems.

The transformative power of science is known, and we must harness it to serve our ambitious goals for sustainable development and prosperity.

But science has another, less visible, but no less valuable, dividend.

The scientific mindset makes us better people. In both conception and utilisation, scientific work is blind to divisions or prejudices, that only hinder further progress for everybody.

Our common dignity as human beings matters. And no one can be left out of the scientific enterprise.

Before I end my remarks, I want to thank you for the partnerships with all of you, and with the governments of Italy and Sweden, represented here by the previous speakers.

Once again, we are very happy to host the World Academy of Sciences and thank you for choosing to meet here in Rwanda.

I wish you productive deliberations.

Thank you. ◘

BAI CHUNLI: RWANDA IS "A BEACON OF HOPE"

In remarks at the opening ceremony of the 27th TWAS General Meeting, TWAS President Bai Chunli praises the scientific progress of the East African nation.

It is with great pleasure that I welcome you to the 27th TWAS General Meeting in Kigali, Rwanda. Convening in this nation marks a profound occasion for TWAS, and we are honoured and humbled by the generosity and warm welcome shown to us by the President's Office, the Ministry of Education, and indeed, so many people who have had a part in organising this meeting.

It is a profound occasion: 22 years ago, genocide against the Tutsi people left perhaps a million Rwandans dead. The nation was shattered. So, too, were its institutions of science and education. Schools were badly damaged. Equipment was destroyed. Teachers and professors were forced to flee, and many were killed.

Our meeting this week in Kigali is a testament to the vision of President Kagame and to the energy of thousands of people who have been working to rebuild the country. It is a testament to the resilience of the Rwandan people.

Rarely in history has science been summoned to address such challenges as Rwanda has faced. And yet, here we see a nation that embodies the TWAS ideal: It invests in science and science education. It is building South-South and South-North partnerships. It knows the importance of basic science, but it uses applied science to meet human needs and drive economic growth.

Now we are very pleased that Rwanda is establishing its own academy of science. This will be vitally important in setting standards of research excellence, supporting young scientists, and connecting Rwanda to global science networks.

Rwanda has become a beacon of hope in Africa, and its sustained dedication to science, technology, conservation and innovation should be known throughout the world.

African farmers and researchers are pioneering new methods of farming and food production. Africans are sending satellites into orbit. The Square Kilometre Array, being built in South Africa, will have influence on science and engineering across much of the continent. Increasingly, African research institutions and policymakers are focused on the potential of the Big Data revolution.

African women are providing bold new leadership in research. School enrolment is soaring, and many nations are investing in new universities.

Cell phones in Africa are putting technology – and knowledge – in the hands of the people. Nearly 400 million Africans are cell phone subscribers. In Nigeria and South Africa, the rate of cell phone ownership is the same as in the United States. Today, just over 20% of Africans have mobile broadband connections – by 2020, that number will approach 60%. The phones are providing direct human benefit in health care, agriculture and other fields.

All of these developments are cause for optimism. But we must keep in mind: Significant needs remain. Some estimates say that, over the coming decades, Africa will need 1 million new scientists, engineers and technicians. They will be needed to research clean energy and

▼ TWAS President Bai Chunli addresses the opening ceremony of the TWAS General Meeting in Rwanda. (Photo: Robert Mugabe/Rwanda Ministry of Education)

health care. To address climate change and protect ecosystems. To build safe buildings and strong bridges.

And to teach and train new generations of scientists and engineers.

Rwanda is achieving success that should be studied throughout the developing world. It has the highest rate of primary school enrollment in Africa – just shy of 100%. At the time of the genocide, it had perhaps 50,000 students in secondary school. Today, that number has grown ten-fold. And sciences are by far the most popular field of study. Before the genocide there were about 3,000 Rwandans enrolled in universities. In 2015, that number passed 86,000.

These projects remind us that in Rwanda, and in Africa, partnerships are essential for progress – both South-North and South-South partnerships.

Educating and training young scientists, building global science networks – these are areas of strength for TWAS and its partner organisations.

Since the Academy's earliest days, TWAS has been a leading advocate for science in sub-Saharan Africa. At this meeting, we celebrate that history and the successes we have accomplished together. But we also come here to consider the work ahead. There is so much more to do in Rwanda, in Africa, and throughout the developing world.

President Kagame knows the importance of investment, partnerships and long-term commitment. Rwanda knows that young people are the key to future progress – and we are pleased to see so many young Rwandans joining us for this meeting.

Abdus Salam, the founder of TWAS, was also deeply committed to nurturing young scientists. In 1979, just a few years before TWAS was born, Salam won the Nobel Prize in physics. In a brief speech at the Nobel banquet, he said:

"Let us strive to provide equal opportunities to *all* so that they can engage in the creation of physics and science for the benefit of all mankind."

November 21 – next Monday – marks the 20th anniversary of Salam's death. I am certain that he would approve of our work here in Kigali. He would be proud of Rwanda, and proud of TWAS's role in African progress. He would be proud of the many nations that are advancing science and education for a more prosperous and peaceful world.

> "TWAS has been a leading advocate for science in sub-Saharan Africa. At this meeting, we celebrate that history and the successes we have accomplished together. But we also come here to consider the work ahead."
>
> *Bai Chunli, TWAS President*

President Kagame, dear colleagues from Rwanda and around the world – thank you very much.

RWANDAN SCIENCE

RWANDA: RACING TOWARD THE FUTURE

A woman participates in the Rwandan monthly day of community service. (Photo/Government of Rwanda)

More than two decades after genocide shattered the country, Rwanda has established itself as an S&T model for Least Developed Countries.

by **Edward W. Lempinen**

Sean Treacy contributed to this report

In the summer of 1994, when the genocide perpetrated against Tutsi people had ended, Rwanda was a nation in ruin. As many as a million of its people were dead. Already one of the poorest countries on Earth, its businesses were decimated. The educational system, too, was shattered: Buildings damaged, equipment stolen or destroyed. Hundreds of teachers were killed, while others had fled. In the aftermath of such a cataclysm, what map could show a road to recovery?

And yet, today, the nation is transformed. Kigali, the capital city, is humming with construction, growth and sense of possibility. Primary schools are near full enrolment. And under the policies of the Rwandan government, led by President Paul Kagame, Rwanda has established itself as a leader of African science, with lessons for impoverished countries everywhere.

In 2016 alone, Rwanda scored a remarkable series of successes in science and technology (S&T). One report found that Rwanda ranked third among African nations in science capacity. It was named the home for the global Next Einstein Forum. When the elite World Economic Forum on Africa met here, Rwandan officials announced their new Kigali Innovation City initiative, with a vision of technology clusters that would drive the nation's economic growth and link to global markets. Later in the year the Rwanda Academy of Sciences was launched, and soon after the nation hosted the 27th General Meeting of The World Academy of Science (TWAS).

"In the developing world in particular, science plays a critical role in our socio-economic transformation by helping to narrow the gap between us and the more developed regions," Kagame told the high-level audience at the TWAS meeting. "This is what has driven Rwanda's focus on science and technology over the last two decades... The focus has always been about opening up to the wider world and finding a pathway to understand our situation, identify the best tools available to us and then use that knowledge to reach our full potential."

Rwanda is a small nation, landlocked, with limited natural resources. It faces an array of challenges that come with poverty, just like other Least Developed Countries. But the country is dedicated to its blueprint for development through science and technology, a holistic commitment which recognises that a nation's S&T strength begins with its 12 million people – with pre-natal health and child health, access to quality education from early childhood through PhD studies, plus robust international partnerships. Rwanda's impressive evolution was in evidence throughout the TWAS meeting.

"This country has come so far on a long and difficult road," said TWAS Vice President Moctar Toure of Senegal. "Thirty years ago, Rwanda was among the poorest nations on the continent, and in the 1990s, it endured a tragedy of historic proportion. But today, the nation is rising thanks to the vision of President Kagame and the hard work of the Rwandan people. It is a role model for Africa, and for other Least Developed Countries."

COWS, BEER – AND ADVANCED TECHNOLOGY

The genocide against Rwanda's Tutsi people was initiated in 1994, when the government was under Hutu control. Kagame was the commander of the Rwandan Patriotic Front, which ended the genocide, and when a new government formed in July 1994, he was vice

president and minister of defence. In 1997, even before the country had adopted a new constitution, it initiated a collaborative national process on the nation's goals. This would become Vision 2020, a sweeping, ambitious development plan – with science, technology and education at the core – to bring stability and prosperity to the ravaged nation.

Rwanda's National Assembly elected Kagame president in 2000, the same year that Vision 2020 went into effect. The next year, Rwandan mathematician Romain Murenzi was summoned from an academic post in the United States to become the minister of education.

"The president told me how important education was – not just for students, but for the people of Rwanda and the strength of the country," recalls Murenzi. "He emphasized the importance of science and science education. After this meeting, I realized that his commitment to education was not only intellectual, but also deeply heartfelt." [Murenzi served until 2009 as a Rwandan government minister; he would later serve five years as TWAS executive director. In 2016, he was named director of the Division of Science Policy and Capacity Building in UNESCO's Natural Sciences Sector.]

> "Better primary and secondary schools mean that Rwanda needs to build its system of higher education to accommodate the graduates."

In those early years, energy and resources were focused on basic human and economic needs – but with an eye to the future.

One programme provided a cow to families that could care for it, but required that they gave the first or second female offspring calf to a neighbour. The aim was not just to provide a cow, but also to encourage education in agricultural and animal husbandry practices. The slogan: "A cow is a teacher and an agent of technology transfer/diffusion."

An information campaign – "Beer is chemistry" – pointed to the science of everyday life.

▲ Agricultural improvement has been central to Rwanda's progress.

Within just a couple of years, the high ambitions were producing advanced results. A fleet of buses with laptops and other equipment brought the Internet to rural areas. At about the same time, a submarine fibre optic cable system brought broadband Internet connections to East Africa; that allowed the Rwandan government to initiate a national fibre-optic network that created high-speed connections between the country's major institutions and that helped establish some of the fastest Internet service on the continent.

POLICY, PARTNERSHIPS AND PROGRESS

With all of Rwanda's economic growth, with its progress in public health and Internet access, it is possible to overlook a central driver of success: public policy. It's not flashy, it's not sexy, but in Rwanda, innovation is powered by detailed and rigourously implemented policy.

Consider education: the 2003 Rwandan constitution defines education as a basic human right. Vision 2020 places human development at the core of the country's plan for progress, with a particular emphasis on education in science and technology, plus skills in information and communication technology (ICT). The Ministry of Education develops and implements five-year strategic plans. Within that framework, a policy guaranteed nine years of basic education for all Rwandan children – a policy upgraded to 12 years in the 2013-2018 plan.

▲ From top: Rwandan Education Minister Musafiri Papias Malimba; Romain Murenzi, director of the Division of Science Policy and Capacity Building in UNESCO's Natural Sciences Sector.

The result: Rwanda embarked on a fast-track effort to build schools. And it has achieved near universal enrolment in primary education, for both boys and girls. In doing so, it achieved its Millennium Development Goal for education, and won international acclaim.

The education policies are "leading to increased numbers of students able to enter university to pursue science and technology related subjects," Education Minister Musafiri Papias Malimba said in a recent interview. "However, it is recognised that more still needs to be done."

Already, Musafiri said, initiatives are in place to increase student performance in science, technology, engineering and mathematics fields. A centre of excellence is being developed at the University of Rwanda (UR) focused on innovative teaching and learning for mathematics and science. With the African Institute for Mathematical Sciences, Rwanda is developing a gender-responsive mathematics teacher training program.

Better primary and secondary schools mean that Rwanda needs to build its system of higher education to accommodate the graduates. Here, too, government policy is holistic – and ambitious. In 2013, seven public colleges and universities were merged into the new University of Rwanda, with satellite campuses all over the country.

Meanwhile, Rwanda is building international partnerships in higher education. The Ministry of Education is working with the Swedish International Development Cooperation Agency (Sida) to produce hundreds of new PhD scholars in the years ahead. The prestigious US-based Carnegie Mellon University has opened a master's degree programme in Rwanda to train students in information technology. The Abdus Salam International Centre for Theoretical Physics (ICTP), based in Trieste, Italy, is developing the East African Institute for Fundamental Research, a Category 2 UNESCO institute. It is expected to start the initial Masters programmes in early 2018.

"Both the Rwanda government and the country's academic sector showed a strong interest in ICTP's mission to support basic

science in the developing world," said ICTP Director Fernando Quevedo. "Our new partner institute there will play a unifying role among countries in the region."

As those new PhDs move into the workforce, they could help to accelerate Rwandan science. The capacity is in place: According to the Africa Capacity Report 2017, Rwanda already ranks third on the continent – though it has only 54 scientists per 1 million population, just a fraction of the ratio in many other African countries.

RWANDAN SCIENCE IN ACTION

Even in the early days of Rwanda's recovery from genocide, initiatives proved that science could drive human prosperity. Public health initiatives helped to nearly double Rwandans' life-expectancy. Improvements in coffee bean production and processing led to dramatic increases in harvests and income.

Rwanda recognised that conservation could bring a range of benefits, including eco-tourism. Support from the US-based Dian Fossey Gorilla Fund International helped to establish the Centre for Geographic Information Systems and Remote Sensing at the former National University of Rwanda (UR); by the year 2000, the centre was using advanced technology to track the region's mountain gorillas and their habitat.

Today, conservation and environmental science influences priority areas ranging from precision agriculture to urban design and climate change. The Ministry of Education and the Massachusetts Institute of Technology are working to establish a major climate change observatory atop Mt. Karisimbi, at 4,507 metres the highest point in Rwanda.

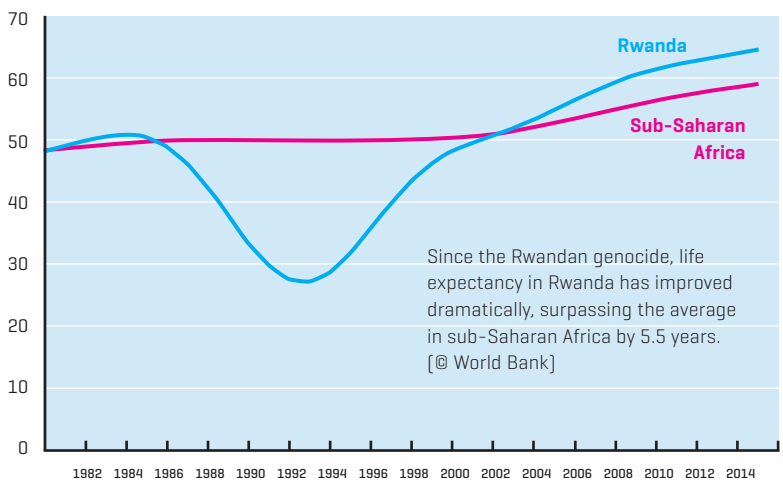
▲ Rwandan President Paul Kagame (centre) building houses for vulnerable families in Shyorongi in Kigali in 2011 during the nation's monthly community service day. (Photo: Government of Rwanda)

The National Fund for Environment and Climate Change in Rwanda (FONERWA), founded in 2008, has had a broad impact: nearly 22,000 hectares of land reforested, nearly 13,000 hectares of watersheds and water bodies restored, and some 17,500 families connected to off-grid clean energy. Known as Rwanda's Green Fund, its investments will have created 100,000 green jobs by the end of 2017.

But Rwanda's vision is holistic: it is pushing development across its scientific culture. Education Minister Musafiri says centres of excellence are being established in biomedical engineering, health supply chain management, data sciences, the internet of things, and energy for sustainable development, among others.

The breadth of Rwanda's innovation plans was on display during a symposium at the TWAS General Meeting, with compelling presentations by UR scholars. Beth A. Kaplin, UR School of Science deputy dean and acting director of the Centre of Excellence in Biodiversity and Natural

Life expectancy



▼ The Kigali Genocide Memorial pays tribute to some 1 million people killed in the 1994 genocide against the Tutsi. (Photo: Trocaire | Flickr | CC BY 2.0)

> "Africa should not still be playing catch-up by the time the Fifth Industrial Revolution comes around."
>
> *Paul Kagame, President of Rwanda*

Resource Management, described ecosystem function and wildlife behaviour in Nyungwe National Park, one of the most important remaining montane tropical forests in Eastern Africa. Sylvie Mucyo detailed how bio-gas technology "digests" organic solid waste to produce gas for cooking and lighting, and for bio-fertiliser. Florien Nsanganwimana described how plants tolerant of toxic metals can be used to clean up degraded mines and prevent health risks.

Other researchers detailed initiatives in education, ICT, biomedical laboratory sciences, and efforts to account for the country's "natural capital", including land, water and other resources.

THE FOURTH INDUSTRIAL REVOLUTION

Even with Rwanda's remarkable S&T progress, challenges remain. The long-term increase in high school enrolment in science fields has recently slowed. At the university level, there remains a need to further increase the number of students in science and engineering fields as opposed to social sciences and humanities. These are important concerns, but at the same time, policymakers are pursuing bold measures by which Rwanda can 'leapfrog' to the future.

▲ From left: Sylvie Mucyo, University of Rwanda College of Agriculture, Animal Sciences and Veterinary Medicine; Beth A. Kaplin, UR School of Science deputy dean and acting director of the Centre of Excellence in Biodiversity and Natural Resource Management.

Musafiri says that all 3,500 of Rwanda's schools should be connected to the Internet by 2020. Policymakers are launching a "green city" pilot programme; eventually, they hope to turn six of the country's secondary urban areas into green cities. They're pressing to transform Rwanda into a developed, low-carbon economy by 2050.

Starting with President Kagame, Rwandan leaders make clear that they're looking to a more distant future: They aim for the country to be a full participant in the Fourth Industrial Revolution, an economic transformation driven by technology, sustainable development practices, and above all by the knowledge and energy of Rwanda's people, and the African people.

In a May 2016 speech at the World Economic Forum on Africa, Kagame stressed that "our hopes and ambitions for the future must be built on a foundation of clear-headed realism." He continued: "The Fourth Industrial Revolution builds on the previous ones, which largely passed Africa by... [But] Africa can only claim its place at the table by earning it. Leapfrogging has its limits, and we must remain mindful of the gaps that hold us back, and be able to address them. Africa should not still be playing catch-up by the time the Fifth Industrial Revolution comes around." ◘

Q&A DR. MUSAFIRI PAPIAS MALIMBA, MINISTER OF EDUCATION

Though small and landlocked, Rwanda is widely seen as a leader in African science. One key to success is strong policy for science and science education, the minister says.

In the aftermath of the devastating genocide against the Tutsi people of Rwanda, the country made a commitment to science and technology as drivers of recovery and development. Today, more than two decades later, that commitment continues – and creates a profound responsibility for Musafiri Papias Malimba, the nation's minister of education. It is not just schools that he oversees, and not just research, but a holistic system central to present and future prosperity for Rwanda's people.

A breadth of leadership experience has prepared Musafiri for the challenge. Before President Paul Kagame appointed him minister in 2015, Musafiri was principal of the College of Business and Economics at the University of Rwanda. He served as vice-rector in charge of Academic Affairs & Research at the School of Finance and Banking (SFB) for four years; he served intermittently as SFB's acting rector. He also served high-level positions in the Rwandan Higher Education Council; the Kigali Institute of Science and Technology; and the Rwandan Ministry of Justice.

Following the TWAS General Meeting in November 2016, Minister Musafiri provided written answers to questions posed by TWAS Public Information Officer Edward Lempinen.

In general terms, how would you characterize Rwanda's science, technology and innovation (STI) enterprise today versus how it was 10 years ago?

There is a strong recognition within Rwanda relating to the importance of science and technology to the nation's development and economic growth. During the last two decades, Rwanda has invested significant efforts in putting in place the governance as well as physical infrastructures to support sustainable development of national STI.

We focus on four cross-cutting themes: knowledge acquisition and deepening; knowledge creation; knowledge transfer; innovation and entrepreneurship culture.

The National Policy on Science Technology and Innovation was approved in 2005 and this Policy is currently under review to ensure the national STI policy will continue to play a crucial role.

Is it possible to measure the impact of Rwanda's investment in science and science education on the development

of the nation and the prosperity of the people?

● Science, technology, research and innovation capacity in Rwanda has expanded over the past ten years through government, development partners, and private sector investment. This, in turn, has impacted a significant number of Rwandans – from school children using the Internet to scientists using the newest technologies to solve critical challenges.

A number of studies have been carried out recently into the effectiveness and impact the capacity-building in STI is making on Rwanda's economy, including Mapping Research and Innovation in the Republic of Rwanda, which was prepared by the Global Observatory of Science, Technology and Innovation Policy Instruments, (GO-SPIN), a new UNESCO initiative. The reports detail several significant recent achievements.

In the past five years, Rwanda has put infrastructure in place to enable it to become an African ICT hub. In 2012, Carnegie Mellon University in Rwanda was established as a regional centre of excellence in ICT. In 2013, Parliament passed a law establishing the University of Rwanda as an autonomous academic research institution with the objectives to produce better-trained graduates and to strengthen the research capacity of Rwanda's higher education system. Also in 2013, the Ministry of Education established the Knowledge Transfer Partnership programme, in collaboration with the African Development Bank, to foster industrial development.

The Abdus Salam International Centre for Theoretical Physics (ICTP), a UNESCO Category 1 institute in Trieste, Italy, has established a regional branch in Rwanda, the East Africa Institute for Fundamental Research. And the government introduced a National Fund for Environment and Climate Change in Rwanda, which acts as a cross-sector financing mechanism.

> The focus is on ensuring that the students of the University of Rwanda acquire both information and skills that can enable them compete in the job market – not just in Rwanda, but internationally.

What are Rwanda's primary areas of research focus today?

● The Government of Rwanda is establishing Centres of Excellence focused on building high-level academic and research capacity to address specific development challenges facing Rwanda and the region. These include centres of excellence in fields ranging from biodiversity and natural resources management, to biomedical engineering, energy and data sciences.

We also run the Global Climate Observatory in partnership with MIT.

The focus in the revised Science, Technology, Innovation and Research policy is to encourage and promote the formation of research and innovation clusters in advanced science and technology fields across many fields – biotechnology; biomedical engineering; nanotechnology; quantum sciences; neurosciences; genetic engineering; internet of things; big data; photonics; nuclear sciences and engineering; and precision agriculture.

Can you point to a particularly promising or exciting project right now that may be under the radar?

● One very important developing initiative is the partnership between the Government of Rwanda and the African Institute for Mathematical Sciences (AIMS) – Next Einstein Initiative. The global AIMS headquarters has been established in Rwanda, and Rwanda will host the Next Einstein Forum Global Gathering in March 2018. In addition, there is AIMS Rwanda, a pan-African centre of excellence in mathematical sciences. This was opened in August 2016 with the first intake of 45 master's degree students selected from 10 countries in Africa, including 16 women students.

The Government of Rwanda believes that the partnership with AIMS-Next Einstein Initiative will accelerate the development of talent in science, technology, engineering and mathematics (STEM) fields that are greatly needed in Rwanda and throughout the region.

The partnership includes the establishment of the Quantum Leap Africa Research Centre. This is positioned to be a world-class centre that will build capability in the information technology of the future. The centre will focus on the emerging area of quantum information science and technology.

> "There remain many challenges to ensure that the young students of our region are able to fully participate in this Fourth Industrial Revolution."

As early as the 1990s, Rwandan policy recognised the clear connection between primary education and science development. Now, roughly two generations later, are you seeing the impact of improved primary education in students arriving at university?

● Many initiatives are ongoing to increase the quality of STEM education at primary and secondary school levels. There are incentives such as prizes and scholarships for top students beginning in primary school. To assure the relevance of education, one major reform underway will bring to secondary schools a competence-based system with student-centred learning and a focus on areas such as critical thinking and learning by doing. We are developing a centre of excellence at the University of Rwanda in "Innovative Teaching and Learning Mathematics and Science". And one of the initiatives in the partnership with AIMS is a gender-responsive mathematics teacher-training program at the primary and secondary levels.

These initiatives, coupled with the move to 12-year basic education,

▲ The University of Rwanda campus. [Photo: University of Rwanda]

are already increasing the numbers of students able to enter university to pursue science- and technology-related subjects. We expect to see further improvement in the years ahead.

Rwanda's higher education system for science and technology has grown and evolved significantly in recent years. What is the goal of this evolution? Where does Rwanda want its higher education system to be a decade from now?

● The Higher Education sector in Rwanda has grown from around 3,000 students in 1995 to more than 80,000 at present. This in itself has led to many challenges because we need both to build infrastructure and train faculty to accommodate this growth.

One of the strategies to meet the challenge has been to merge all of the public universities into the University of Rwanda, with a total of six colleges. This creates great efficiencies.

The focus is on ensuring that the students of the University of Rwanda acquire both information and skills that can enable them compete in the job market – not just in Rwanda, but internationally. Our mission is to ensure that the students we produce are as good as, if not better than, students elsewhere in the world.

The ten-year plan is to engage our students in research and to build a research-based institution. We want to support that through wider access to open and distance education and learning, increased use of ICT, and increased research and innovation outputs through collaboration with industry and government.

The East Africa Community (EAC) is known as an innovator in regional development cooperation. Are there any significant current projects in education or STI where the East African countries are cooperating?

● The partner states of the EAC have set themselves an agenda for cooperation in STI. This is recognized in the treaty establishing the EAC which includes a set of common principles and undertakings by partner states in the area of science and technology. The East African Science and Technology Commission has subsequently been established and headquartered in Rwanda.

Among the regional projects is the Regional Centre of Excellence in Health Supply Chain Management, which is supported by the East African Community. The Centre of Excellence for Biomedical Engineering and e-Health is a part of a network of four, soon to be five, centres related to health supported by the African Development Bank. Each of the EAC countries will host a centre, but each of the centres will support the other countries in the EAC.

Such cooperation gives us an opportunity to maximise the efficient use of human and financial resources. Each country will focus on one particular area of strength, while contributing to, and benefitting from, the other countries in the region.

Considering both the Rwandan STI experience over the past two decades and its orientation to the future, what lessons does Rwanda offer to other African nations? Or to Least Developed Countries beyond Africa?

● As identified through the World Economic Forum, the world is currently experiencing a Fourth Industrial Revolution. This revolution is evolving at an ever-increasing pace disrupting all aspects of Industry and life in every country.

There remain many challenges to ensure that the young students of our region are able to fully participate in this Fourth Industrial Revolution. Science, technology, engineering and mathematics need to be promoted from a very early age, starting in primary education and in support of early detection and incentivising talents in STEM fields.

We believe that the capacity-building initiatives currently underway will go a long way to ensure that Rwanda and the region are able to stay in touch with all these global developments in support of the continent's needs for innovation, creativity and youth employment. ◘

JEAN BOSCO GAHUTU: A BETTER LIFE FOR RWANDA

Dr. Jean Bosco Gahutu, a Rwandan physiology researcher, was named to give a TWAS Medal Lecture at the Academy's 27th General Meeting. He was born in 1961; he completed his primary, secondary and medical education in Rwanda. He did PhD studies at the University of Ghent in Belgium from April 1990 to December 1993, then returned to Rwanda in early 1994, just before the genocide against the Tutsi. His experience mirrors the nation's: a time of unspeakable loss, followed by a profound commitment to recovery. Today Gahutu is a professor of physiology in the School of Medicine and Pharmacy of the University of Rwanda and head of the Clinical Department of Medical Biology at Butare University Teaching Hospital. He is also acting director of research, innovation and postgraduate studies at the College of Medicine and Health Sciences, University of Rwanda.

When I was young, I lived with my family in the countryside. There was not even a small town. My father was a carpenter. He was so bright – even the intellectuals liked him – but when he was young, going to school was difficult. So he wanted me to do it – he wanted me to be bright, and he really encouraged me.

We spoke Kinyarwanda at home, but my father and mother taught me some French and some arithmetic. I even went to kindergarten. To go to primary school, I would walk three or four kilometres – some people walked a longer distance. This was a good experience, because I know Rwandan culture from living in the countryside. The primary schools were built correctly, with benches and everything. It was not under the trees. The difference from today is that there were not many schools, and not many children going to school.

I was always trying to go ahead of what the master is asking of me, to go and advance and learn fast. Each time I would learn to count – say, from 1 to 20 –I would give myself an assignment: count from 1 to 50. When the teacher gave us an assignment to count to 50, I would count to 200.

It was exceptional to go to secondary school in that time. You had really to work hard. If you had a class of 30 to 40 pupils, possibly only two would go to secondary school. I attended a school in a small town 25 kilometres from home. Most students would stay at the school and go home only for holidays.

After secondary school, I was sent to the National University of Rwanda [today the University of Rwanda] to study medicine. It was a good opportunity – I thought I could make my career. The School of Medicine then was supported by the University of Ghent in Belgium. When I came to the university, there was a mixture of teachers, Rwandese and Belgians. After graduation as a medical doctor, in 1986 I became university staff, in the department of physiology, thanks to my good scores. After a few years, I went to Ghent University for my doctoral studies.

In the early 1990s, I went through a difficult period. For health reasons, I had to interrupt my studies and return home to Rwanda. It was in December 1993, a very difficult period. I was really afraid, actually, but I didn't tell anybody. In that time, I didn't have a capacity to work. I stayed home for a while, and then after a few months there began this period of genocide. I lost my father and my mother and many others, hundreds of members of my large family.

When the university re-opened, on 18 April 1995, I was the first to give a lesson; it was in physiology. We were not many lecturers at the university – about 30 in total. We were determined to work as much as we could, that

was the most important aspect. Many others came back in the following months. At the time there was a great patriotism– everyone doing his or her best to rebuild the university. I felt honoured to be able to teach.

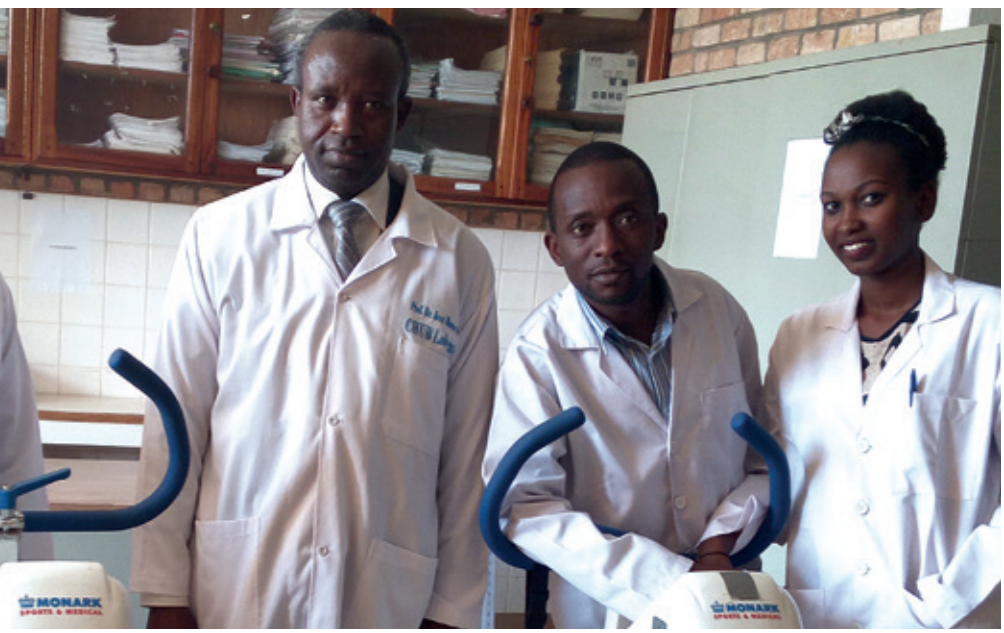
There was great uncertainty in those days. In a laboratory, you might not have anything, but people did their best. But some countries supported us to acquire some equipment and renovate the university.

The students in those first years after the genocide were very, very hard-working at school, but also in their reflection about the problems the country faced at that time. They would organise conferences and invite people for lectures and discussions.

They were really committed. With time, we felt that now we had a good institution. In 1999, a research commission was established at the university with limited funds provided by the government – that was a first step. And then in 2002, Sida – the Swedish International Development Cooperation Agency – came to support the university. Then people could get some funds for research.

When I started my fieldwork again, it was about physiological adaptation to moderate altitude in Rwanda. My project was producing results and I felt happy. I submitted it for publication and it was accepted, and things were evolving. The University of Ghent came back to Rwanda in 2003 in a cooperation project. Four of my professors from Ghent had continued to supervise me. And so in 2007, I was the first person to present my PhD thesis in Rwanda – it was a first, I was a pioneer, and I received my PhD in medical sciences.

▼ Dr. Jean Bosco Gahutu with colleagues at the University Teaching Hospital of Butare in Rwanda. (Photo provided)



My current research – the work on biofortification of beans is very interesting. Between 1.5 and 2 billion people worldwide suffer from iron deficiency. We have been working with HarvestPlus, an international programme for nutritional research, with headquarters in Washington D.C. They target micronutrient malnutrition, like deficiency in zinc, iodine, vitamin A and iron, by developing biofortified crops, with high micronutrient content through cross-breeding. For iron, one of the crops that can be targeted is beans.

Every day a Rwandese consumes on average 150 grammes, and 80% of Rwandese – the rich and the poor – eat beans every day. So if you want to address the problem of iron deficiency, biofortified beans will be efficient. Over the last 10 years, based on the research results, HarvestPlus proposed new varieties of beans to the Rwanda Agricultural Board and similar institutions in other countries. So now people are interested in getting these beans.

Of course for Rwanda there are still challenges, most of the time financial. But it's up to scientists and academicians to really work at a level that is capable of producing results, to make a difference in the lives of people. ◘

A COMPLEX MAP FOR S&T DEVELOPMENT

At the annual Ministerial Session, top science leaders emphasised the important role of education and international partnerships.

by **Edward W. Lempinen**

Over the past generation, many developing countries have embraced a basic axiom for escaping poverty: Science and technology are essential for powering the engine of development. But putting the principle into practice is more difficult. Policy, investment, education, gender equality, partnerships – where does a country begin?

In the traditional Ministerial Session at the 27th TWAS General Meeting, eight government ministers and high-level science policy leaders explored different facets of scientific advancement, connecting them to the challenge of achieving the 17 Sustainable Development Goals (SDGs) by 2030.

Elioda Tumwesigye, minister for science, technology and innovation (STI) in Uganda, said most countries in sub-Saharan Africa are focused on achieving the SDGs and the African Union's Agenda 2063.

But the job is complex, Tumwesigye said. It entails reducing poverty, which means providing food, water and housing security, plus sanitation systems, transit and a healthy environment. It means providing more jobs, especially for women and young people. All of these require policy at the local, national and global levels.

The prescription is especially important to Africa, said Thomas Auf der Heyde, deputy director general of South Africa's Ministry of Science and Technology. "The SDGs will only succeed...if they can succeed in Africa," said Auf der Heyde, representing Minister Naledi Pandor. "If they don't succeed in Africa, Africa will impede global progress on the SDGs."

A plain but powerful point emerged from the ministerial session: a country with development ambitions must have a holistic perspective. Policy, education, gender, diplomacy, partnerships – all must work with synergy to achieve scientific progress and development.

The ministerial session was held 14 November 2016 before a high-level audience attending the first day of the TWAS General Meeting in Kigali, Rwanda. The session was chaired by Rwandan Minister of Education Papias Malimba Musafiri. Other speakers were: Joyce Ndalichako, minister for Education, Science, Technology and Vocational Training, Tanzania; Yaye Ken Gassama, vice president, National Academy of Sciences, Senegal (representing Mary Teuw Niane, Senegal's Minister of Higher Education and Research); Tieniu Tan, vice president, Chinese Academy of Sciences; Romain Murenzi, director of UNESCO's Division of Science Policy and Capacity Building, Natural Sciences Sector; and Vaughan Turekian, science and technology adviser to the US Secretary of State.

▼ From top: Rwandan Education Minister Musafiri Papias Malimba; Vaughan Turekian, science advisor to the U.S. Secretary of State.

Murenzi, a former minister of science in Rwanda, noted that developed countries generate some 80% of the world's scholarly research; emerging countries such as Brazil, China and India account for 80% of the rest. But Africa, he said, accounts for only 2.3% of global research papers. The SDGs pledge that no one must be left behind as the world advances. But, said Murenzi: "If these numbers continue as they are, more than 100 countries worldwide will be left behind in the next 50 years."

While speakers explored a range of development drivers, two have overarching importance: education and partnerships.

TWAS Fellow Tan Tieniu, vice president of the Chinese Academy of Sciences (CAS), noted that the CAS-TWAS President's PhD Fellowships annually enroll some 200 talented young scientists for their doctoral studies at Chinese universities and institutes. "People are the key," Tan said. "We should pay more attention to to human training and development."

Women require a particular focus, and Tanzanian Minister Joyce Ndalichako suggested "women-friendly scholarships". Especially in developing countries, she said, "a woman going into sccience is going to need extra support in that journey.... To be caregiviers, to get married, to have the cultural role of caring for children – they need skills that can enable them to multitask."

▲ Clockwise from top left: Yaye Ken Gassama, Elioda Tumwesigye, Tan Tienlu, Romain Murenzi, Joyce Ndalichako and Thomas Auf der Heyde.

For all countries, science education should extend from early childhood to those long past school age, said Vaughan Turekian, science and technology adviser to the US Secretary of State. Policymakers have to remember the innate curiosity of children – and feed that curiosity. And, Turekian added: "Building a science-literate public truly means engaging the public in every part of the scientific process, and not just science in school."

Partnerships are essential across the research enterprise, the speakers said. Auf der Heyde urged that major research centres be based in developing countries, to help build and deepen South-North cooperation. Scientific interests in the South should have full co-ownership and co-management of such projects. At the same time, he said, regional partnerships could effectively focus on priorities such as public health.

The takeaway message: A cooperative, holistic approach is essential to addressing challenges and achieving the SDGs. ◘

◀ The ministerial session during the 27th TWAS General Meeting. (Photo: Robert Mugabe/Rwanda Ministry of Education)

ZHAO DONGYUAN WINS LENOVO PRIZE

The Chinese scientist developed innovative nanomaterials that could be used to clean water, deliver medicine and improve batteries.

by **Sean Treacy**

Chinese materials scientist Zhao Dongyuan was named winner of the 2016 TWAS-Lenovo Science Prize for his work discovering new materials that are now widely used. The award, one of the most prestigious honours given to scientists from the developing world, was announced in a special ceremony during the yearly General Meeting of The World Academy of Sciences (TWAS).

Zhao is a 2010 TWAS Fellow and a chemistry professor at Fudan University in Shanghai, China. His work focuses on mesoporous materials – structures that feature tiny, microscopic holes. Across two decades, his research and nano-scale applications have been used to clean water for drinking and agriculture, improve the capacity and efficiency of batteries, and deliver drugs with pinpoint precision in human bodies. In 2009, he won the TWAS Prize in chemistry.

The annual TWAS-Lenovo prize includes an award of USD100,000 provided by the Chinese technology company Lenovo, the global leader in consumer, commercial, and enterprise technology that is the largest PC company in the world.

"Professor Zhao's body of research exhibits the highest values of scientific inquiry," said TWAS Executive Director Mohamed Hassan. "Materials science requires advanced knowledge of fundamental science. But Professor Zhao develops applications with a direct usefulness in people's lives – clean water, energy and health. Such innovative research is deserving of our Academy's highest honour."

"Zhao is a renowned veteran chemist with over 30 years of research experience publishing over 600 scientific papers and winning over 50 research awards," said Lenovo Senior Vice President George He. "Especially in the synthesis and application of mesoporous materials, Zhao and his research team have made great breakthroughs. We are very honoured to present the TWAS-Lenovo Science Prize to him, and look forward to more of his impressive achievements."

TWAS - Lenovo Science Prize

Zhao welcomed the award as an opportunity to highlight his field of research and the vast diversity of potential applications. "It is a great honour to get the award," he said. "I would like to see more applications for developing countries that would economically benefit."

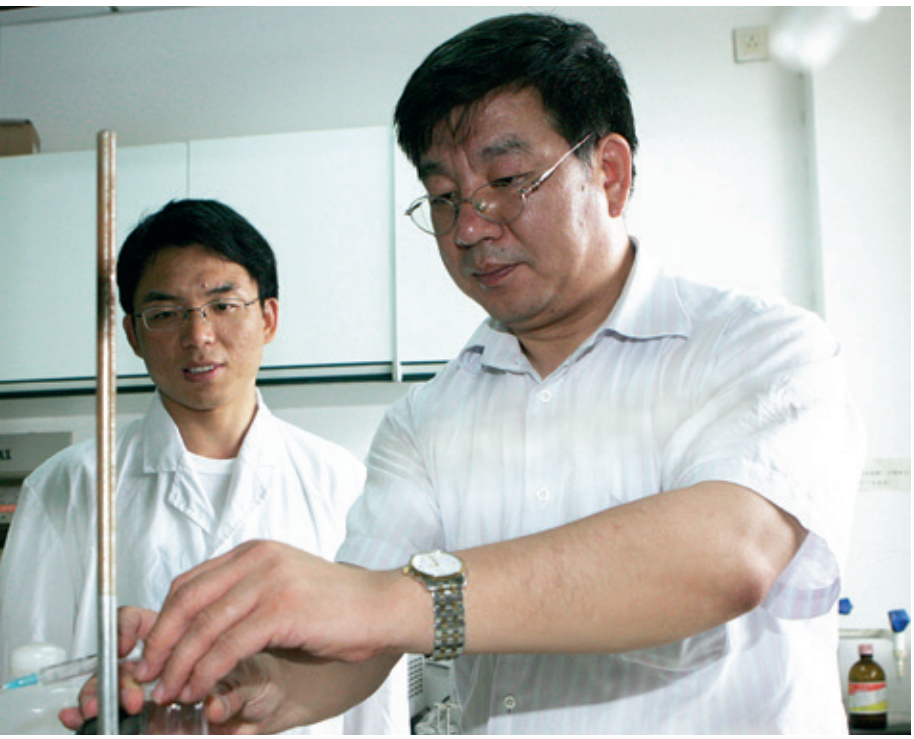
SMALL MATERIAL WITH A BIG IMPACT

The nanometre scale – a nanometre is one-billionth the size of a meter – is so small that the mesoporous materials can very precisely manage the movement of chemicals on the molecular level. A water molecule, for example, is about a quarter of a nanometre wide, while a haemoglobin molecule is about five nanometres wide.

Perhaps the simplest way to conceive of a mesoporous material is as a filter – a surface full of tiny holes that range from two to 50 nanometres wide. The holes let some

substances through, such as clean water, and hold others substances back, such as pollutants. China and other countries had been using mesoporous materials as filters for many years, but Zhao, as a postdoctoral student in the United States in the late 1990s, began discovering new ways to create and use them.

Zhao and his colleagues experimented with the materials' shapes and attached them to other materials, taking into account their electromagnetic properties.



▲ TWAS-Lenovo Prize winner Zhao Dongyuan works in his lab. (Photo provided)

One use for this discovery has been improving the quality of batteries. When a surface is covered in molecule-sized holes, that increases its surface area by adding the surfaces along the insides of the holes themselves. Since batteries store energy on the surface area of materials that are good at managing electricity, a porous carbon material can store more energy than a non-porous material of the same size.

Carbon is highly efficient for holding electricity, and Zhao developed a mesoporous carbon material that is now used widely in supercapacitors in Chinese-made cars and streetlights. And the strategies he has used to combine porous carbon and other organic materials have been adopted by other researchers throughout the field.

Zhao also found a way to use mesoporous materials to clean up toxic water that is more precise than simple filtering. A category of toxins called microcystins, which can damage the liver and are suspected to increase the risk of cancer, plague water supplies throughout the world. Unlike many other forms of pollution, microcystins are not caused by industry, but by common algal blooms.

> "I would like to see more applications for developing countries that would economically benefit."
>
> *Zhao Dongyaun, TWAS-Lenovo Prize winner*

People can't just filter the microcystins out. Tools are needed that can attack them where they exist in the water, and that's where Zhao's organic mesoporous materials come into play. They play a key role in another of his inventions – magnetic mesoporous microspheres.

These microspheres, tiny balls as little as 300 nanometres wide, function as microscopic couriers for chemicals that can neutralize the microcystins. An organic core made of iron and oxygen uses the magnetic force to hold a chemical in its pores. That core sits behind an equally porous shell of inorganic silica. The microspheres are then sent to a destination, such as polluted water, which disrupts the magnetic force and set the chemical loose through the shell.

The pores are an essential reason Zhao's microspheres work. In the iron core, the pores provide an empty space for the chemical to be stored. While the pores in the silica shell provide passageways that the chemical can move through once they're at the destination.

Zhao said this technique is currently used to produce high-quality water in various parts of the world, including Shanghai. The microspheres have also been adapted to deliver medicine – for example, injected into a human body to release a drug at the site of a cancerous tumour. ◘

Learn more:
www.twas.org/node/11954/

◀ Marian Nkansah working in her lab. [Photo provided]

MARIAN NKANSAH WINS FIRST AL-KHARAFI PRIZE

by **Sean Treacy**

The Ghanaian scientist is involved in heavy-metal screening research, helping raise awareness of dangerous elements in food, drink and the environment.

A Ghanaian chemist whose research has shed light on the heavy metal content of tea, clay and dust in her home country is the first-ever winner of the Fayzah M. Al-Kharafi Prize, which recognizes exceptional women scientists from science- and technology-lagging countries.

The announcement that Marian Nkansah is its first winner was made in Kigali, Rwanda, at the 27th TWAS General Meeting. The award recognizes her research for shedding light on the health risks raised by the human exposure to hazardous heavy metals in routine activities of daily life.

Nkansah started her heavy metals research as a master's student from 2003 to 2005 at the Kwame Nkrumah University of Science and Technology, taking groundwater samples from pumps used for drinking water. Some of the pipes were decades old and had never undergone maintenance, contaminating their water with lead.

That research would, in turn, shape her career. She joined the University's faculty in 2007 and broadened her efforts into searching for toxic heavy metals that Ghanaians might encounter routinely.

The prize is named for 2004 TWAS Fellow Fayzah M. Al-Kharafi from Kuwait, who provides the USD4,000 prize. Al-Kharafi, the former president of Kuwait University, was the first woman to head a major university in the Middle East. She is also a former TWAS vice president for the Arab Region.

Nkansah's research analyses substances that Ghanaians consume to determine both whether they contain metal elements with nutritional value as advertised, such as calcium and iron – and harmful metals such as arsenic, cadmium and lead. The effects of heavy metal poisoning can be serious and long-lasting.

One study by Nkansah and her colleagues focused on commercially available tea products in Ghana. She found heavy metals that were possibly connected to plants cultivated for the tea, which could become contaminated through unclean water, smoggy air or polluted soil. In a study published in the journal *Environmental Monitoring and Assessment*, she and her colleagues found that the arsenic levels in some of those teas, but not all, could pose a significant health risk.

Studying tea and other products in search of heavy metals is not a new practice, but not very widespread in Ghana. She's hoping that her research will influence local policymakers to support more research of this kind. "I think generally scientists have been confined to their laboratories and there seems to be a disconnect between scientists and policymakers," she added. "That is an area we have to work on, and hopefully help bridge the gap." ◘

Learn more: www.twas.org/node/11955/

BIJAY SINGH OF NEPAL WINS RAHMAN PRIZE

by **Cristina Serra**

Singh is a pioneer in a new kind of biomaterials that could be used to deliver drugs right to cellular and biological targets.

Bio-nanoparticles, a new type of carrier molecule that may encapsulate several compounds and direct the delivery of drugs, genes and vaccines, are a frontier of innovation in medicine.

Nepali chemist Bijay Singh, a principal investigator at the Research Institute for Bioscience and Biotechnology (RIBB) in Kathmandu, Nepal, is using nanoparticles to cross biochemical barriers in the organism and carry drugs and genes to specific targets. For his outstanding results, Singh received the 2016 Atta-ur-Rahman Prize in chemistry at the TWAS General Meeting in Rwanda.

"I'm very grateful for this prestigious prize, as it will raise my scientific profile within the Nepali scientific society," Singh said. The prize is granted annually by 1985 TWAS Fellow Atta-ur-Rahman, a Pakistani chemist and a past president of the Pakistan Academy of Sciences. It acknowledges the work of researchers from scientifically lagging countries.

Singh holds a master's degree in chemistry from Tribhuvan University in Nepal, and a PhD in biochemistry from Sun Moon University in South Korea. In Korea, he began a career focusing on the global problem of antibiotic resistance.

Upon his return to Nepal in 2011, Singh founded RIBB, now among the nation's most renowned institutes.

At the Institute, Singh has continued his research on antibiotic production, studying indigenous Streptomyces bacteria of Nepal to find novel molecules that might be used to combat emerging drug-resistant diseases.

"Overuse of antibiotics in hospitals and health centres has forced pathogens to find strategies to survive, becoming resistant," he explained. Now he is trying to engineer Streptomyces bacteria that will produce new, modified antibiotics to help solve the problem of resistance.

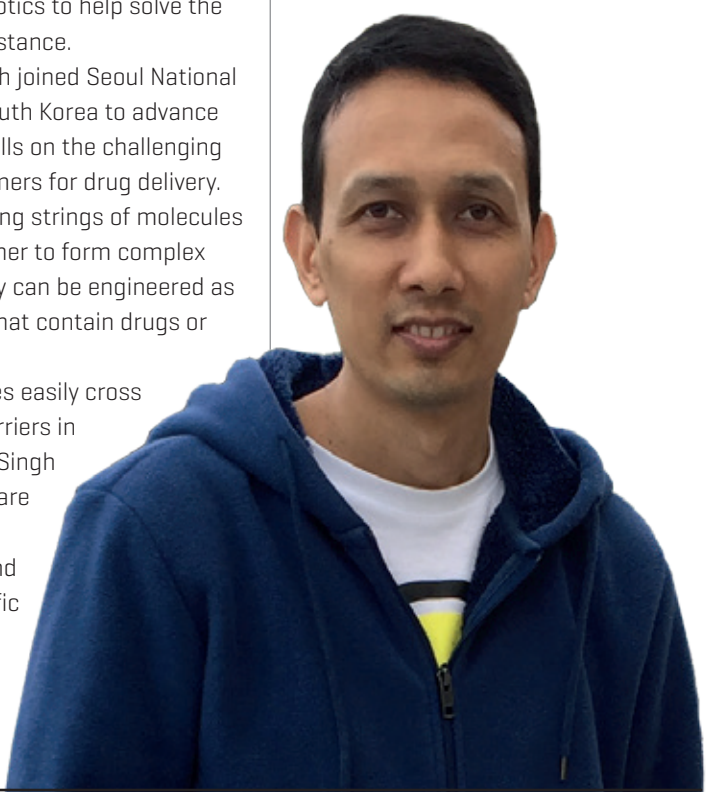
In 2013, Singh joined Seoul National University in South Korea to advance his research skills on the challenging field of biopolymers for drug delivery. Polymers are long strings of molecules that bind together to form complex structures. They can be engineered as nanoparticles that contain drugs or genes.

"Nanoparticles easily cross biochemical barriers in the organism," Singh explained. "We are using them to deliver drugs and genes on specific targets. Using targeting drugs, we can selectively kill cancer cells and spare the healthy ones."

Singh is now testing this approach in laboratory models, but he is confident that they will soon be able to move to humans. He also works to educate young scientists in Nepal by organizing scientific meetings and seminars.

"Although I'm proud of it, being a scientist in Nepal is not easy," he observed. "I'm sure that the Atta-ur-Rahman Prize will help me and my career, and will allow me to be more competitive in joining some faculty in the Academy." ◘

Learn more: www.twas.org/node/11953



▶ Nepali scientist Bijay Singh.

M.N. HOUNKONNOU WINS RAO PRIZE

by **Cristina Serra**

Benin mathematician honoured for high-level research and his commitment to maths education and training.

Mathematics is not only about calculations. It is also about applications in many disciplines, including physics, oceanography, health, management of water and ecosystems, climate studies and energy issues.

Mahouton Norbert Hounkonnou, a 2004 TWAS Fellow and a professor of mathematics and physics at the University of Abomey-Calavi in the Republic of Benin, is well aware of this. In fact he has always offered training to students, to help them develop critical thinking and problem-solving attitudes in various fields.

For the outstanding level of his research in mathematics and his sustained commitment to mathematics education, Hounkonnou was awarded the 2016 C.N.R. Rao Prize for scientific research.

"The C.N.R. Rao prize is an important recognition of more than 20 years of research activity," said Hounkonnou. "It is also a sort of encouragement and motivation to continue in the same direction, doing good research and promoting younger people in science."

The prize was announced on 14 November in Kigali, Rwanda, during the opening ceremony of the 27th TWAS General Meeting. TWAS Founding Fellow and former President C.N.R. Rao offers the award to celebrate high-impact scientific research carried out by scientists from Least Developed Countries.

▼ M.N. Hounkonnou

Hounkonnou is an accomplished mathematician and an undisputed authority also in theoretical physics, where he explores noncommutative and nonlinear mathematics, nonassociative algebras, nonlinear systems, noncommutative field theories and geometric methods in physics. He was the first to provide a resolution to some challenging mathematical problems.

How did he develop such a passion for maths and science? "I belong to a family where my eldest brothers and sisters are scientists, so they also contributed to build in me a passion for mathematical sciences, including theoretical physics," he explained in an interview.

Hounkonnou is the founder of the International Chair in Mathematical Physics and Applications (ICMPA-UNESCO Chair) of the University of Abomey-Calavi, which selects African students from over 13 French- and English-speaking countries to follow graduate programmes. He is also a visiting professor at African, Asian, European and North American universities, and the supervisor of more than 32 PhD and 31 master's degree students.

Commenting on his engagement in education, he said: "Training in mathematical physics is important as it prepares students to eventually move into a career in almost any of the areas where technical, physical and mathematical expertise is in high demand." That skill can be combined to address human challenges across a range of important fields.

Learn more: www.twas.org/node/11951

◀ Former TWAS President C.N.R. Rao

SHAPING THE FUTURE THROUGH CHEMISTRY

by **Cristina Serra**

Former TWAS President C.N.R. Rao of India offered a passionate view on the power of chemistry, past and future.

When you think about chemistry, forget about boring formulas and reactions. Think instead of what surrounds you – environment, energy, new materials – because chemistry is everywhere.

Chemistry has impacts across a range of disciplines, TWAS Founding Fellow C.N.R. Rao said in a vibrant lecture at the TWAS General Meeting in Rwanda. But its early steps were simple, such as Antoine-Laurent de Lavoisier's discovery some 250 years ago that oxygen allows combustion.

From that seminal discovery, Rao surveyed the extraordinary progress that followed: from the dissection of atoms at the nanoscale dimension to the possibility of using smart, innovative materials that change properties under specific conditions. "Who would have imagined knowledge could come so far, so fast?" he asked.

Rao's lecture offered a passionate overview of major discoveries and the chemists who made them.

Rao, a former TWAS president, is an undisputed authority whose knowledge encompasses chemistry and extends far beyond. He currently is Honorary President & Linus Pauling Research Professor at Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India.

In the past, he has been a professor in the most prestigious universities worldwide: King's College, Cambridge, UK (1983-84); Université Joseph Fourier, Grenoble, France (1990); and the University of California, Berkeley (2008 - 2011).

Rao is also a polished communicator, and in Kigali he ranged easily through the history of chemistry, complex scientific ideas and the men and women who have driven progress.

Starting with Lavoisier, the father of chemistry, Rao mentioned other giants who shaped the history of the field: John Dalton, who studied the behaviour of gases, and Friedrich Kekulé who discovered that carbon could make four bonds. He did not forget Dmitri Mendeleyev, the father of the Periodic Table of elements that remains a cornerstone of chemistry today.

However, Rao explained, it was the dawn of the 20th century that witnessed a remarkable burst of discovery that made it "the century of chemistry".

As he moved from Einstein to Linus Pauling's molecular studies that helped elucidate the structure of proteins, the passion seemed to build in Rao's narration. This is no surprise, as Rao has been a contemporary of world leaders in chemistry, including Pauling, who died in 1994. And Rao himself has made significant contributions to emerging fields such as solid-state chemistry, developing innovative research on metal oxides, graphene and nanomaterials.

"Chemistry is everywhere," he said, and there remain vast opportunities for progress. "Even if we stand on the shoulders of giants, we still have much to explore ahead." ◘

Learn more: www.twas.org/node/11965

TYAN: WORKING AND NETWORKING

The new TWAS Young Affiliates Network will give early-career scientists a platform for high-level engagement and a strong voice in global science.

by **Cristina Serra**

They are young and enthusiastic scientists from developing countries and have joined forces to promote joint research and new partnerships in the South. The just-launched TWAS Young Affiliates Network (TYAN) will give young scientists a more prominent role within the Academy and a stronger voice globally.

TYAN's members will be positioned to provide TWAS with important feedback on the needs of young scientists in developing countries, and they plan to have a global impact by creating new partnerships, sharing knowledge and problems and building networks for cooperation. They will provide feedback on various issues of sustainable development, while exploring issues related to the social responsibilities of scientists and the popularisation of science.

TYAN was officially launched during the TWAS 27th General Meeting in Kigali, Rwanda. "The founding and development of TYAN is a good platform for collaboration and communication among young scientists," said TWAS President Bai Chunli, who also serves as president of the Chinese Academy of Sciences (CAS). "I think that TYAN will become a platform where young scientists can make contributions to the excellence of science, and also encourage collaboration in developing countries. I believe that, with its wisdom and capacity, TYAN will be successful for the future."

The TWAS Young Affiliate programme was launched in 2007 to strengthen the presence of scientists under the age of 40 in the Academy, and to take advantage of their perspective and energy. Every year, TWAS's five Regional Offices each select up to five Affiliates. After a five-year term, they become Alumni.

TYAN was envisioned a few years ago by Yin Li, the director of the CAS-TWAS Centre of Excellence for Biotechnology in Beijing. TWAS and CAS welcomed the proposal, and the Chinese company Lenovo, the largest PC company in the world, is supporting the initiative with a three-year grant of USD150,000 per year.

"I was elected as a TWAS Young Affiliate in 2010 and I attended my first TWAS General Meeting in Trieste, in 2011," Li said. "I realized that Young Affiliates are a powerful resource for the Academy, but that at the same time they play a minor role in TWAS's family." Often, he explained, they feel they have to take a back seat to senior scientists who are TWAS Fellows. That means they have less engagement, and less impact on the Academy.

"There is a vertical connection between them and TWAS, not a horizontal relationship as there should be," Li stated. "I felt I had to do something."

Li was awarded the 2012 TWAS Regional Prize for Building Scientific Institutions. He is also the deputy director-general at the Tianjin Institute of Industrial Biotechnology, a non-profit national research institute established in 2012. He serves as a professor at the CAS Institute of Microbiology in Beijing, which is currently the nation's largest comprehensive research institution of microbiological science.

TWAS Programme Coordinator Max Paoli said: "TYAN is a strategic initiative that will bring fresh energy and creativity to the Academy.

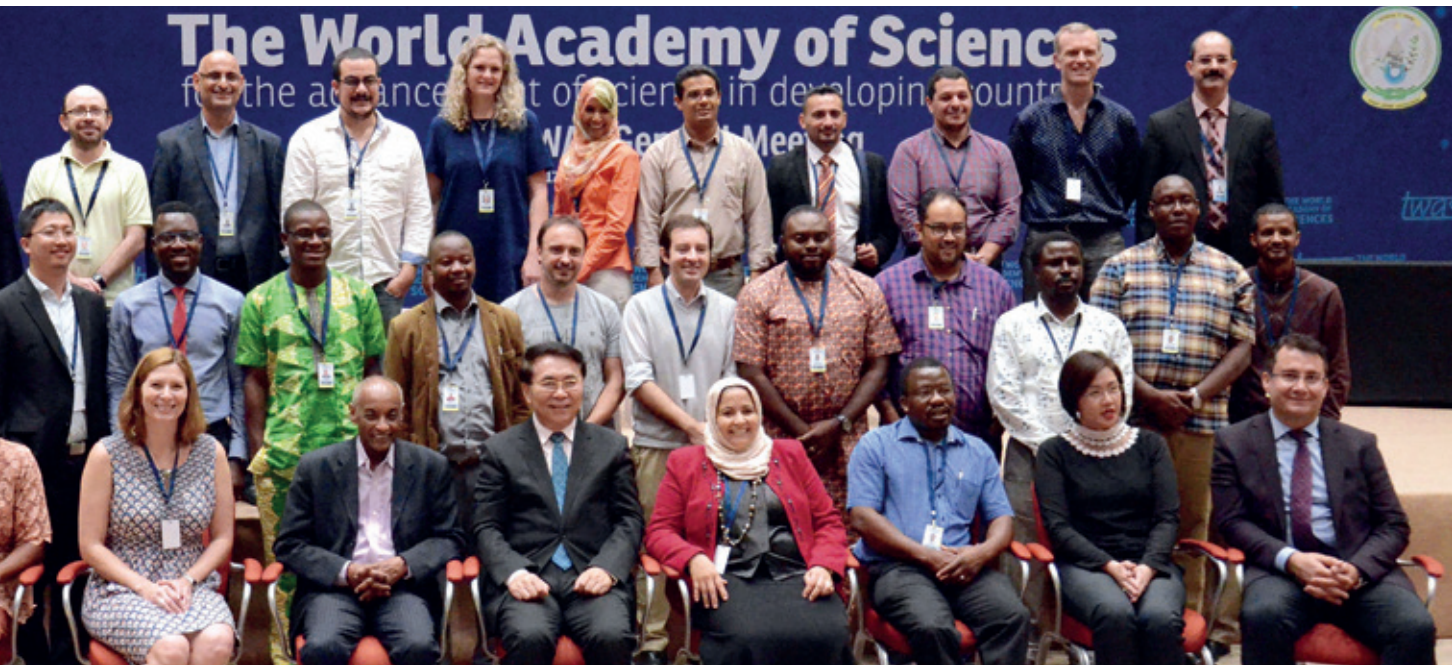
▲ TYAN Affiliates in Kigali. (Photo: Robert Mugabe/ Rwandan Minister of Education)

"At present, we have some 250 Young Affiliates and Alumni," Paoli added. "About 60 of them have enthusiastically agreed to participate in this project, and we are confident that many more will join us when the group becomes fully operative."

In Kigali, TYAN members discussed activities that they should pursue in the future, like strengthening the relationship with organisations such as the Global Young Academy.

On 16 November they elected the first TYAN Executive Committee, with gender and geographical balance. Along with Li, other members are: Jalila Ben Salah-Abbès, an associate professor at the Higher Institute of Biotechnology in Monastir, Tunisia; Patricia Zancan, an associate professor at Universidade Federal do Rio de Janeiro, Brazil; Franco Martin Cabrerizo, an associate professor at IIb-Intech, in Chascomús, Argentina; Bolanle Ade Ojokoh, a senior lecturer at Federal University of Technology in Akure, Nigeria; Collet Dandara, an associate professor at University of Cape Town, South Africa; Sok Ching Cheong, a group leader at Cancer Research Initiatives Foundation, Selangor, Malaysia; and Yusuf Baran, a professor at Abdullah Gul University in Kayseri, Turkey.

"TYAN will help all of us to expand our networks as well as our students' opportunities to pay for exchange visits to foreign laboratories," said Zancan, who studies cancer metabolism.



> TYAN will help all of us to expand our networks as well as our students' opportunities to pay for exchange visits to foreign laboratories. *Patricia Zancan, associate professor at Universidade Federal do Rio de Janeiro, Brazil*

At the meeting, Zancan made an important announcement: In 2017, Brazil will host the first TYAN meeting, under the aegis of the TWAS's Regional Office for Latin America and the Caribbean and the International Council for Science (ICSU) Regional Office for Latin America and the Caribbean. The meeting will take place in Rio de Janeiro, with support from the Brazilian Academy of Science.

Baran studies molecular mechanisms of drug resistance in cancer. He too sees great potential for TYAN. "We are a family from around the world and we have to work hard," he said. "I believe that science is the best way to bring peace, to provide sustainable and economic development, and to use diplomacy around the world." ◘

Learn more:
www.twas.org/node/12053

BETTER CHICKENS FOR AFRICA

by **Cristina Serra**

TWAS Young Affiliate Julius Hagan of Ghana studies local chickens to find breeds that best adapt to the humid weather.

Chicken breeding is a major source of income for Ghana's farmers, especially in poor areas. Local chickens, in fact, are well adapted to hot and humid tropical environment.

However, chickens imported recently from abroad to breed with local ones and increase performance have altered the market, as the newcomers suffer from the tropical climate and do not survive.

"Over the years, Ghanaian chickens have developed heat-tolerance that make them well-suited to the country's climate," explained Ghanaian scientist Julius Kofi Hagan, a 2016 TWAS Young Affiliate.

This makes them an important resource for local economy, especially in times of climate change where temperatures can cause heat stress to the birds. Heat stress, as Hagan observed, generally affects the growth and reproductive performance of the animals, especially birds.

Hagan, a senior lecturer in the Department of Animal Science at the University of Cape Coast in Ghana, presented his research on 17 November 2016 at the 27th TWAS General Meeting in Kigali, Rwanda.

"Conservation of local genetic resources is one of the surest ways of ensuring food security, especially in the developing world," he maintained. "That's why we carried out a study to first describe the morphological features and how they impact on the behaviour of different populations of indigenous chickens in five ecological zones of Ghana."

◀ TWAS Young Affiliate Julius Hagan. (Photo provided)

A total of 1,484 indigenous chickens in several areas of Ghana – each with different rainfall pattern, temperature and humidity – were studied. Ten qualitative traits were taken into consideration, including naked-neck, frizzle feathers, dwarfism, and polydactyly (extra toes). Two of them, naked-neck and frizzling in particular proved to be associated with heat tolerance.

From the morphological traits, Hagan and his colleagues moved to identify associated genes that govern heat-tolerance. They found two such genes and decided to incorporate them into exotic layers that were heat-stress susceptible, to make them as well adapted to Ghana as the indigenous ones.

In another line of investigation, they did similar experiments to improve egg production. Both experiments are still in progress, but results so far are promising and Hagan wants to develop commercial layers and broilers with heat-tolerant traits for the tropics, not only in Ghana but also in other African countries.

Hagan stands out high on African science. In 2014 he was named one of the world's top 20 innovators by the Technical Centre for Agricultural and Rural Cooperation, and in 2013 he placed third in a competition for the Best Young Professional Scientist in Africa, organised by the Forum for Agricultural Research in Africa.

"Local chickens are unique and represent special genetic resources in Africa and the tropics," he concluded. "We must do our best to preserve them and, possibly, improve them." ◘

Learn more: www.twas.org/node/12070/

◀ South African scientist Olaniyi Fawole. [Photo provided]

TURNING LOSS INTO A NUTRITIONAL GAIN

by **Cristina Serra**

Olaniyi Fawole from South Africa investigates strategies to extract valuable biological compounds from sun-damaged pomegranates.

They're beautiful to look at and have an appealing sweet-sour flavour, and now pomegranates are catching the interest of scientists because they contain more than 120 bioactive compounds good for human health.

South Africa is investing in pomegranate cultivation despite a significant risk: severe sunburn inflicted by the strong South African sun, which spoils about 30% of the annual harvest. Because these damaged fruits cannot be eaten, juiced or used for other purposes, they are usually thrown away.

Olaniyi Fawole from Stellenbosch University in South Africa has been studying pomegranates' properties for several years. He found that even sunburned fruits contain substances with potential medical and nutritional applications, and now his goal is to find a way to extract high-quality bioactive substances from the damaged pomegranates.

"Pomegranates are an important resource for South Africa, and when I realized that there were few studies on their biological properties, I felt I needed to fill this gap," Fawole explained at the TWAS General Meeting in Kigali.

Fawole, elected as a TWAS Young Affiliate in 2016, earned a bachelor's degree at Obafemi Awolowo University in Nigeria and a master's at the University of KwaZulu-Natal in South Africa. He completed his PhD work from 2010-2013 at Stellenbosch University, where he is now a researcher in the South African Research Chair in Postharvest Technology, Department of Horticultural Sciences. He is also a founding member of the recently established TWAS Young Affiliate Network, TYAN (see pg. 30-31).

Pomegranates, he explained, contain antioxidant, anti-diabetic and anti-microbial compounds. They also find applications as animal feed, as natural dye and for nutraceuticals and pharmaceuticals.

All these properties prompted Fawole to determine optimum fruit maturity and postharvest handling protocols in order to help maintain quality and reduce losses during postharvest handling.

Sunburn bleaches the red colour of pomegranate arils (the inner red seeds), making the fruit undesirable for processing into other products; in addition, the disposal of unsold fruit stresses the environment.

Fawole chose a popular South African cultivar called 'Wonderful'. He extracted oils from sunburned as well as from healthy fruits, and identified new biological properties.

"I was glad to see that sunburned fruits were still potentially useful for their antibacterial activity against bacteria such as Klebsiella pneumoniae and Escherichia coli," he said.

As a next step, he wants to optimise the processing technique and patent his results, then launch a spin-off company to exploit this unexpected resource. ◘

Learn more: www.twas.org/node/12045

TWAS: KEY ROLE IN BEIJING DECLARATION

by **Edward W. Lempinen**

International science leaders called for broad scientific cooperation for shared development in the "Belt and Road" region.

Scientific cooperation in the "Belt and Road" region could help deliver shared development to billions of people, and TWAS joined international science leaders in endorsing plans to bring the vision to life.

At the first-ever International Science Forum of National Scientific Organizations on the Belt and Road Initiative, TWAS joined more than 20 national scientific organisations and a number of international organizations in issuing the "Beijing Declaration". The statement calls for improved scientific cooperation in the region, which extends from the Western Pacific across Asia to Africa and Europe.

"The Belt and Road Initiative aiming at shared development harmonizes the fundamental interests of the international community and adds a new positive force to peace and development in the world," the declaration says. "National and regional scientific organizations, scientists and experts from different fields need to strengthen cooperation by sharing of information and joining their efforts together in the supply of continuous and strong scientific support to the shared development and common prosperity."

In 2013, Chinese President Xi Jinping proposed the Silk Road Economic Belt and the 21st Century Maritime Silk Road. Known as the Belt and Road initiative, it is a unified framework for development and cooperation in a region that touches three continents and their contiguous oceans and seas, with human population numbering in the billions.

The initiative has drawn support from over 100 countries, and already has led to establishment of the Silk Road Fund; the expansion of trade and business; the development of high-speed railways; a deepening of communication on policy and enhanced exchanges between people and cultures in the region. Projects under the initiative are expected to multiply in the years ahead.

Chinese Academy of Sciences (CAS) President Bai Chunli, who also serves as president of TWAS, played a leading role in the forum held 7-8 November 2016 in Beijing. Mohamed Hassan, TWAS interim executive director, and CAS Vice President Tan Tieniu, a TWAS Fellow, moderated a discussion on the role of STI in shared development.

"The Belt and Road initiative is an historic opportunity for countries to share resources, knowledge and experience in support of shared development," Bai said. "The International Science Forum of National Scientific Organizations is a positive recognition that science, technology and innovation will be central to the success of this initiative. TWAS clearly has an important role to play, and many valuable contributions to offer." ◘

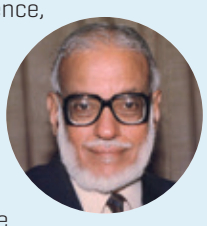
▼ Chinese Academy of Sciences President Bai Chunli, who also serves as TWAS president, played a leading role at the forum. [Photo: Chinese Academy of Sciences]

See the full text of the Beijing Declaration: www.bit.do/BeijingDeclaration

PEOPLE, PLACES & EVENTS

IN MEMORIAM: M.G.K. MENON

TWAS Founding Fellow **M.G.K. Menon**, an acclaimed Indian physicist whose research and advocacy for science exerted global influence, passed away in November 2016, at the age of 88.



Menon was one of the scientists who in 1981 met in Rome and signed a document that led to the creation of TWAS. He was a TWAS Founding Fellow and served as the Academy's first vice-president from 1983 to 1988. He served as president of the International Council for Science (ICSU) from 1988 to 1993.

A native of Mangalore, India, Menon exhibited a precocious talent in physics. He earned a master's degree in physics from the Royal Institute of Science in Bombay, and his PhD in 1953 from Bristol University in the UK. But even before earning his PhD, he made important contributions to the study of the decay of charged K particles into so-called pions.

Another important contribution to physics came in 1955: at that time Menon was at the Tata Institute of Fundamental Research (TIFR), where he paved the way to neutrino physics by recording the first-ever interaction of a cosmic ray neutrino generating a particle called the muon.

In 1966, at the age of 35, he was appointed TIFR director. In 1972, he chaired the Indian Space Research Organization, heading the Indian Space Programme during a crucial period from January-September 1972 right after the sudden death of Vikram Sarabhai, the father of India's space programme. With his skill in leadership, Menon was appointed as secretary to the government of India (1971-1982). Menon has been described as the architect of India's modern science and technology culture. "M.G.K. Menon was one of the most brilliant men that I have known," said C.N.R. Rao, a TWAS Founding Fellow and former TWAS president. "He contributed much to scientific organizations in India. Above all, he had a warm personality and was a dear friend of mine."

Menon expressed his talent not only in high-energy physics, but also in fields such as atomic energy, electronics, environment and technology.

His diplomacy and *savoir faire* played an important role in gathering consensus among intellectuals over the protection of a fragile ecosystem in the Silent Valley rainforest (Kerala), which was in danger due to plans to build a hydro-electric dam. He saved this precious area, and now there are suggestions to rename the Silent Valley National Park in his name: MGK Menon National Park.

Menon was the recipient of the Padma Vibhushan, the second-highest civilian award of the Republic of India. He was also a Fellow of the Indian Academy of Sciences and the Royal Society (UK).

HASSAN WINS SCIENCE DIPLOMACY HONOUR

Mohamed H.A. Hassan, TWAS founding executive director and currently the Academy's interim director, has been awarded one of seven Science Forum South Africa (SFSA) 2016 Science Diplomacy Awards. The prize recognises his commitment and career-long efforts to use science to build international cooperation.

Hassan is a Sudanese mathematician who played a leading role in TWAS's founding and growth, working closely with TWAS founder Abdus Salam, a Pakistani physicist and Nobel Laureate. After directing the Academy for 25 years, until 2011, Hassan served as TWAS treasurer until the end of 2015. Using his foresight and charisma, he succeeded in establishing international bonds that made the Academy an influential institution, with networks that reach to the highest levels of science, education and government across the world.

Hassan was also influential in bringing the InterAcademy Partnership (IAP) to Trieste. IAP today represents more than 130 academies of science, medicine and engineering, frequently offering guidance on science-related policy to address regional and global challenges.

Hassan is also the founding president of the Network of African Science Academies - NASAC (2001-2012). He was the president of the African Academy of Sciences from 2000 to 2011 and helped in establishing the Organization for Women in Science for the Developing World (OWSD).

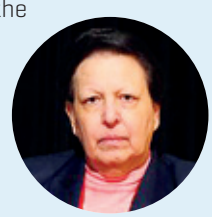
He strengthened ties with the Italian government and the Swedish International Development Cooperation Agency (Sida), two key supporters of the Academy and its programmes.

The prize was announced by Naledi Pandor, South Africa's Minister of Science and Technology, on 9 December 2016 during the Science Forum South Africa event in Pretoria.

PEOPLE, PLACES & EVENTS

IN MEMORIAM: NAJIA KBIR-ARIGUIB

Najia Kbir-Ariguib, an esteemed Tunisian chemist, passed away on 17 November 2016. Kbir-Ariguib was elected to TWAS in 1985, and was among the first women elected to the Academy. She was the founder and former director of the National Institute of Scientific and Technical Research in Tunisia.



She obtained her PhD at the University of Paris, and then returned to Tunisia where she became full professor (1978) at the University of Tunis. There she carried out research in inorganic chemistry.

Her field of investigation was natural mineral resources, including briny water, lake salts and clays.

Kbir-Ariguib was a member of the Tunisian Chemical Society and a fellow of both the African Academy of Sciences and the Arab Academy of Sciences. She served as the coordinator of the National Programme on Phosphates and Briny Water, and served on national committees and other bodies focused on environment, remote sensing and chemical education.

HARSH K. GUPTA RECEIVES AXFORD MEDAL

Harsh Kumar Gupta, a 1995 TWAS Fellow and a world-renowned expert in Earth sciences, has been presented with the 2016 Axford Medal for his outstanding contributions in geosciences.

Gupta served as a secretary to the government of India (2001-2005) and as a member of the National Disaster Management Authority of India (Status: Minister of State of Government of India, 2011-2014).

His scientific activity has focused on the investigation of the Himalaya and Tibet Plateau region, where he proved for the first time the existence of an abnormally thick crust below. His leadership in disaster management is globally recognized, as well as his competence in building major geoscience programmes at the global level. Among his major accomplishments is the establishment of the Indian Tsunami Early Warning System.

In addition, he set up a model to distinguish between normal earthquakes and quakes triggered by water reservoirs.

He has authored over 200 scientific papers and five books. Further, he compiled and edited *Encyclopaedia of Solid Earth Geophysics* (Springer, 2011), a landmark treatise of more than 1,500 pages in two volumes.

The Axford Medal is bestowed by The Asia and Oceania Geosciences Society in the name of Professor W.I. Axford, for his vision of academic excellence and scientific cooperation in Asia and Oceania.

JONATHAN JANSEN TO LEAD ASSAF

The Academy of Science of South Africa (ASSAf) has a new president: Professor **Jonathan D. Jansen**, a 2010 TWAS Fellow.

Born in South Africa, Jansen is the immediate past vice-chancellor and rector of the University of the Free State (UFS), and is currently a fellow at the Centre for Advanced Studies in the Behavioural Sciences at Stanford University (USA).

Jansen earned his PhD at Stanford.

His interests focus on education policy, science education and sociology of knowledge.

His engagement in promoting tolerance, democracy and defending human rights has earned him the Education Africa Lifetime Achiever Award and the Spendlove Award, both in 2013.

His book, *Knowledge in the Blood: Confronting Race and the Apartheid Past* (Stanford, 2009), won the Nayef Al Rodhan Prize, the largest award from the British Academy for the social sciences and humanities.

Jansen holds honorary degrees from the University of Edinburgh, the University of Vermont and Cleveland State University.

ASSAf was founded in 1996 to respond to the need of merging science and democracy in South Africa. It works to generate evidence-based solutions to national problems, and at developing partnerships with national, regional and international organisations to help build South Africa's capacity in science, technology and innovation.

BE A CONTRIBUTOR

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Please send an email to Cristina Serra (cserra@twas.org) with a brief explanation, links to more details, and contact information.

ISSN 2222-7369

The World Academy of Sciences for the advancement of science in developing countries – TWAS – works to support sustainable prosperity through research, education, policy and diplomacy.

TWAS was founded in 1983 by a distinguished group of scientists from the developing world, under the leadership of Abdus Salam, the Pakistani physicist and Nobel Prize winner. Today, TWAS has about 1,190 elected Fellows from 96 countries; 15 of them are Nobel laureates. It is based in Trieste, Italy, on the campus of the **Abdus Salam International Centre for Theoretical Physics (ICTP)**.

Through more than three decades, TWAS's mission has remained consistent:

- Recognize, support and promote excellence in scientific research in the developing world;
- Respond to the needs of young scientists in countries that are lagging in science and technology;
- Promote South-South and South-North cooperation in science, technology and innovation;
- Encourage scientific and engineering research and sharing of experiences in solving major problems facing developing countries.

TWAS and its partners offer over 490 fellowships per year to scientists in the developing world for PhD studies and post-doctoral research. TWAS prizes and awards are among the most prestigious given for scientific work in the developing world. The Academy distributes more than USD1 million in research grants every year to individual scientists and research groups. It supports visiting scientists and provides funding for regional and international science meetings.

TWAS hosts and works in association with two allied organizations on the ICTP campus:

The Organization for Women in Science for the Developing World (OWSD). At its founding in 1989, OWSD was the first international forum uniting women scientists from the developing and developed worlds. Today, OWSD has more than 5,800 members. Their objective is to strengthen the role of women in the development process and promote their representation in scientific and technological leadership.

The InterAcademy Partnership (IAP) represents more than 130 academies worldwide. IAP provides high-quality analysis and advice on science, health and development to national and international policymakers and the public; supports programmes on scientific capacity-building, education and communication; leads efforts to expand international science cooperation; and promotes the involvement of women and young scientists in all its activities.

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