



RWANDAN SCIENCE

RWANDA: RACING TOWARD THE FUTURE

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**

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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



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



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

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TWAS executive director. In 2016, he was named director of the Division of Science Policy and Capacity Building in UNESCO's Natural Sciences Sector.]

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 rigorously 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



▲ 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.

policy upgraded to 12 years in the 2013-2018 plan.

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



▲ 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]

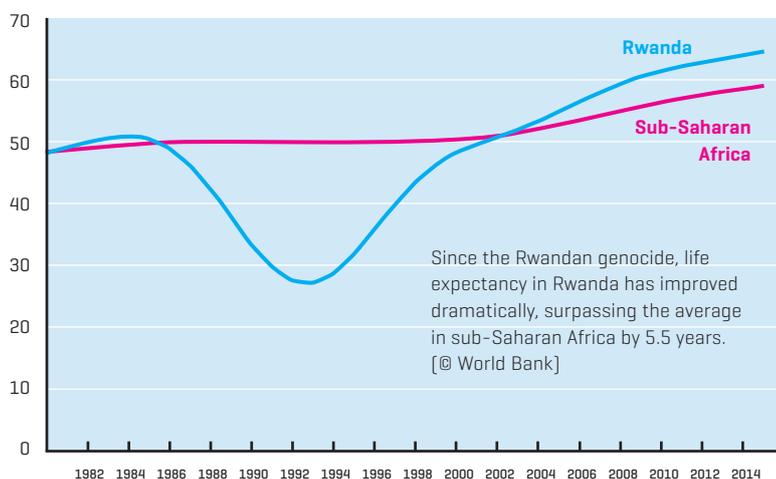
working to establish a major climate change observatory atop Mt. Karisimbi, at 4,507 metres the highest point in Rwanda.

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





“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. Florian 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

▼ 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)



▲ 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.

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.

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.”