CALESTOUS JUMA

9 June 1953 — 15 December 2017
Until his untimely death in December 2017 Professor Calestous Juma was an internationally-recognized authority and leader in the application of science, engineering and innovation to sustainable development in developing and developed countries. His continuing original work focused on analysing the co-evolution of technological innovation and institutional change in socio-economic systems. He ran programmes that advanced science, technology and innovation policy research, especially biotechnology, provided high-level science and technology advice and promoted the conservation of biological diversity. Juma was a Kenyan national and US permanent resident.

INTRODUCTION

The story of Calestous Juma is a truly remarkable one. He was born and raised in the relative poverty of rural western Kenya near Lake Victoria with few of the advantages open to most. However, with the inspiration of his parents and the support of an increasing number of mentors, he broadened his horizons, explored educational possibilities and, through sheer hard work and an enquiring mind, rose to become one of Africa’s leading authorities on the use of technology in developing countries. He did not follow the normal path of academic progress—primary and secondary school, university, graduate school, post-doc training and specialist single-discipline research/publication. Indeed, for long periods in his early youth he seems not to have thought in such terms, instead realizing through his education and experiences that the world is a truly interesting place where there is so much to learn and so little time to understand and consolidate this learning.

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Perhaps for this reason he never became narrowly focused on the conventional channels of academia, but rather set out almost on his own to understand how things functioned, where they failed to do so and how this could be remedied. Formal education was an essential key to all this, but he came to realize that it could not be fitted neatly into boxes. Rather, it should also be sought in terms of practical relationships and how these can be used to improve the human condition. It was from here that he embarked on a career as a school teacher and journalist. This later morphed into more formal academic work, influenced especially by his graduate studies at the University of Sussex in the UK. The Science Policy Research Unit (SPRU) had been established by Christopher Freeman and Asa Briggs in the 1960s with a cognate philosophy, and Juma’s arrival there proved seminal. From then on, his work took on an evolutionary flavour focusing on how best science and technology education and practice could be used for the betterment of all.

THE EARLY YEARS

Calestous Juma was born in 1953 to parents whose precarious livelihoods were mainly based on subsistence farming and fishing in western Kenya near Port Victoria on the lake of the same name. In his draft unpublished autobiography (uncompleted at his death in December 2017), he describes the social and natural environment of his birthplace at the end of colonialism, and how it shaped his outlook as a child and youth. The natural cycle of floods led to a need to experiment and innovate. His mother and father continually grappled with the challenges of raising a family using creativity and experimentation, sometimes resulting in success and sometimes in failure. He sets the stage for recognizing that while a local community may benefit from innovation, it often resists owing to rivalries and political differences. He describes his own inventiveness as a child, starting an electronics repair business. He and his friend listened to foreign news broadcasts and ordered brochures and books from embassies to learn about the world. This search to equip himself technically was an on-going feature of his early years and encouraged by his parents. It also instilled into him the importance of thinking laterally about issues both personal and institutional.

Juma had to overcome enormous handicaps in his search for education, as did many subsistence families. Kenya had only recently achieved independence, and economic conditions were poor. Juma’s father had difficulty finding regular work as a furniture-maker and the available land provided only enough for subsistence living and petty trading. Children were thus expected to work on the land and in the market as part of normal life, and there was little money left for school fees. Concurrently, the period leading up to and just after independence was fraught with conflict, often associated with religious differences. Book-burning was a frequent occupation on the part of local authorities. Indeed, on one occasion his father was accused of witchcraft for introducing a new crop. Tribal rivalries did not help.

So while Juma’s family were keen that their children got access to education, this proved hard to achieve. School fees were often a barrier and access to books was limited. Libraries were few and scattered, with access often being denied. To compensate for this, Juma and his friends sought out their own educational support systems, through acquiring publications (sometimes nefariously) and sharing these among friends, and listening to radio broadcasts. Eventually, however, Juma was able to complete high school and became eligible to enrol
at the Egoji Teachers Training College in Central Kenya. This allowed him to become an accredited school teacher specializing in scientific subjects, which he went on to teach to GCE level in the coastal city of Mombasa until he was 21.

Juma’s drive to expand his knowledge meant that he would not be satisfied being a school teacher. Starting in the early 1970s he had developed a deep interest in environmental issues. Over the course of that decade he grew to become a major figure in Kenya, recognized by many as someone to reckon with in environmental diplomacy. How he did this without much formal background is typical of his broad and innovative approach to life. It was a historical period of considerable change—Independence had been attained, the Cold War was ending and international relations were realigning. Juma decided that, without the advantages of a formal university education, the best way to test his ideas was by writing letters to the editor of the main Kenyan newspaper, The Daily Nation.

It was a voyage of discovery that involved learning by doing. The 1970s marked an important turning point in what he called his ‘expeditionary education’. The intense international activities dominated by the Cold War were reflected in the contents of Kenyan newspapers. They displayed a level of international curiosity that was attractive to young people searching for new directions. The columns of ‘Letters to the editor’ became an open forum for debate, especially on issues directly affecting the African continent. Juma found that he could create a network of feedback mechanisms through writing letters to the editor. This became his basis for open learning. He had control over the curriculum because he could choose the topic to write on. The topic range of his self-education was quite broad, but focused especially on science, the environment and international politics. In his own words:

Much of the choice of topics I wanted to learn about was determined by the contents of the daily newspapers, so my first act in the morning when I woke up was to get that day’s newspaper and simply browse through it, then go teach. Because I taught lower elementary classes, I had ample time in the afternoon to read the newspaper carefully. I accomplished this by using the library of the British Council in Mombasa, which was generally underutilized. I was one of the few users of the library who actually got the support of the librarians to help me identify sources that could support the letters to the editor. This was particularly important because I was not just sharing information – I was advancing positions that needed to be backed by evidence, so I drafted my letters at the British Council Library and then dropped them off at the Mombasa regional office of the Daily Nation. That was located an eight minute walk from the British Council Library. This routine included carefully reading my published letters to see how they had been improved and to build on the improvements to make my letters publishable. It is through this feedback mechanism that I emerged as one of the most prolific contributors to letters to the editor of the Daily Nation.*

It was on this basis that Juma began to become well known both nationally and internationally. Writing from the British Council Library in his spare time, he gained a reputation as someone who could tackle any topic and articulate an informed opinion. This eventually earned him a job at The Daily Nation newspaper, where he was to become its first writer on science and the environment, reflecting the growing interest in environmental activism. The United Nations Conference on the Environment in Stockholm in 1972 was the first world conference to make the environment a major global issue. Its participants adopted a series of principles for sound

* All quotes in this memoir, unless otherwise credited, are from Juma’s unpublished memoir and are used with permission from the Juma family.
management of the environment, including the Stockholm Declaration and Action Plan for the Human Environment and several resolutions. It placed environmental issues at the forefront of international debate and marked the start of a dialogue between industrialized and developing countries on the link between economic growth, the pollution of the air, water and oceans and the well-being of people around the world. One of its major results was the creation of the United Nations Environment Programme (UNEP), located in Nairobi, in 1972 alongside the Environment Liaison Centre International (ELCI), its new non-governmental organization (NGO) watchdog.

UNEP’s establishment reflected and sparked off a period of intense controversy and debate, affected not least by a series of events that had begun to impact the use of energy, such as the OPEC (Organization of the Petroleum Exporting Countries) oil embargos of 1974 and 1979, and growing controversies about nuclear power and the polluting effects of coal-based energy sources. In Kenya, concerns about deforestation were beginning to appear in newspaper columns. In 1978 the political environment was further affected by the death of Kenya’s founding president, Jomo Kenyatta, and problems associated with his successor, Vice President Daniel arap Moi.

As the decade progressed, Juma’s letters became increasingly focused on environmental issues, culminating in 1978 when he was offered the science and environment job at *The Daily Nation* under the mentorship of the paper’s editor, Philip Ochieng. By this time he was becoming well known as a ‘go to’ person on cognate things and, after a short time as a journalist, he was then recruited by the embattled Wangari Maathai (later Nobel Laureate), at the ELCI in Nairobi, to join them as the editor of their house magazine *Ecoforum* (figure 1). At the ELCI he swiftly got involved in the multitudes of meetings and conferences constantly taking place across the country, and it was not long before he became recognized by relevant international NGOs with whom he frequently interacted.
Although he enjoyed his work with *Ecoforum*, Juma realized that formal higher education would be necessary to equip him with the resources and opportunities needed for a sustainable career. By this time he had become well known to major donor bodies for whom he had begun to carry out small pieces of work. Particularly important was a British economic geographer, Professor Phil O’Keefe, working out of Clark University in the US and focusing on issues of deforestation in Africa (figure 2).

O’Keefe introduced him to the Canadian International Development Agency and its sister organization, the International Development Research Centre (IDRC). IDRC offered Juma a scholarship to study for a masters degree and, after considering his options, he chose the University of Sussex in the UK, helped in his choice by Andrew Barnett, at that time working at both bodies. There were a number of factors influencing this choice, but a key one was that this university provided the kinds of cross-disciplinary training that fitted with his emergent interests: how scientific and engineering knowledge could improve his understanding of the environment and have a lasting impact on the welfare of developing countries, particularly those in Africa.

The University of Sussex was one of the first of the new wave of higher education bodies in the UK to be created following the publication of the Robbins report on higher education in 1963. This report, written at a historical juncture following decades of war and depression, recommended the creation of forms of higher education that would serve a new age of necessary change and provide a radical alternative to the traditional model (Robbins 1963). The existing system was dominated by elite universities, in particular by Oxford and Cambridge, the Scottish universities and the English civic universities founded in the nineteenth century, although by the time Juma entered Sussex, the so-called ‘red bricks’ established between the two world wars and the first wave of ‘new universities’ were emerging fast.

The founders of the University of Sussex had taken the strictures of Robbins very seriously and from the outset introduced patterns of teaching much less based on the traditional disciplinary faculty/departmental model, instead focusing more on ‘schools of study’ which emphasized the systemic nature of knowledge, better understanding of which would improve the use of this knowledge appropriately. For example, it was no longer possible to read for a degree in a subject like economics without locating it also within a wider context such as social studies, English/American studies, African/Asian studies, and so on. Disciplinary departments were renamed as ‘subject groups’, and the curriculum balance was modified accordingly depending on the ‘school’ in question.

All undergraduates were required to participate in what became known as the ‘Arts/Science’ scheme, in which undergraduate science students were required to take one term of an arts course and *vice versa*. In these and other ways the overriding object was to ‘redraw the map of knowledge’, a popular description at the time. Even the disposition of the university buildings (by the architect Basil Spence) was designed to permit greater cross-disciplinary forms of interaction. Research emphasized specialized non-teaching centres (e.g. in insurance, international development or operations research). These would be largely self-funded bodies in areas that promised a significant future growth.

However, it was to the School of Mathematical and Physical Sciences (MAPS) and a linked research body, SPRU, that Juma was drawn. In addition to its traditional subjects MAPS had
created a subject group in the history and philosophy of science, which was later renamed as
the history and social studies of science (HSSS). SPRU had been established in 1966 under
the leadership of Christopher Freeman (director), assisted by Jackie Fuller (administrator)
and (a year later) by Geoffrey Oldham (deputy director), to explore the role of science and
technology policy in economic and social change. It had been given three formal core posts
by the then vice chancellor, Asa Briggs, and tasked to raise non-core funds to pursue its
programme of research. By the late 1970s the chair of the HSSS, Roy MacLeod, had left
to take up a professorship in London, and his replacement, Norman Clark, was appointed in
1980 to integrate the research activities of SPRU with the broad teaching function of HSSS.
This he did in becoming the founding director of science and technology policy studies,
a new postgraduate programme in science and technology policy comprising masters,
doctoral and linked degree and non-degree curricula. Juma was introduced to its MSc
degree programme in 1982. Although he had no formal undergraduate degree, it was
clear that he would be perfectly able to complete a graduate programme successfully.
And so it proved. He graduated as MSc within a year, writing a thesis on the use and
development of photovoltaic technology. Immediately, he was encouraged to join the doctoral
degree programme, completing this successfully in 1986 with a dissertation on fuel ethanol
technology development having special reference to Brazil and Zimbabwe (in a record time
of two and a half years).
A particular feature of both dissertations was his immediate grasp of the importance of
evolutionary thinking, probably also inbuilt from his early experiences as a young teacher and
journalist. It was this that encouraged collaboration with one of his supervisors, Norman Clark,
in the joint writing of *Long-run economics* (2)*. Clark, a development economist, had been arguing for some time that formal standard general equilibrium analysis becomes increasingly inappropriate to describe and understand long-term movements in economic systems the longer the timeframe in question—the so-called ‘long-run’. Clark had been working with a group led by Peter Allen, at what was then the Cranfield Institute of Technology, on planning models that attempted to facilitate long-term structural change driven by innovation, science and technology.

Allen, himself a physicist by training, had worked previously with Ilya Prigogine at the Solvay Institute in Brussels, where Prigogine had received a Nobel Prize in Chemistry some years before for his work on evolutionary chemical systems. At Cranfield, Allen was leading a team exploring the possibilities of applying non-linear thinking to the behaviour of economic systems, and had begun to build a non-linear model for the Senegal economy in West Africa. In *Long-run economics*, Clark and Juma suggested a more realistic conceptual framework for the analysis of economic and technological change, developing a model that was evolutionary and systemic in character. Special reference was given to the entropic role of information flows in the innovation process, while the overall argument was illustrated by Juma’s empirical work at SPRU (see also Clark *et al.* 1995).

**RETURN TO NAIROBI**

Completion of his doctoral degree and return to Kenya meant the need to get a job. One possibility was to return to his previous work with the ELCI in Nairobi to continue his interest in the promotion of sustainable development in Africa. Another was to join the Public Law Institute in Nairobi, with which he had had sporadic contact in his recent months of fieldwork before returning. What drove Juma in this direction was the interest in innovation and technology development he had built while at Sussex and his belief in the need to reform intellectual property protection in economically poor countries like Kenya. Indeed, a few years later he edited, with constitutional lawyer (and later Supreme Court Associate Justice) J. B. Ojwang, a book entitled *Innovation and sovereignty* (5), which eventually resulted in Kenya’s first patent law and the creation of a national office for patent protection.

The general problem Juma had in getting a job was the credibility of his interdisciplinary background, which made it difficult to categorize him professionally. Nor did his approach fit with the prevailing ‘Washington Consensus’ paradigm of international development prevailing at that time. In his own words:

Most people in my situation at the time simply teamed up with senior professionals to work as consultants for international donors. In my case this was not an option for two important reasons. First, the leading sources of consultancy assignments were donor agencies that subscribed to neoclassical [economic] thinking. My PhD and first book had already antagonized that community. Second, that same theoretic framework considered technological innovation as being external to the process of development. Even more significantly, the development paradigm at the time considered Africa as a consumer of imported manufactured products and not as an innovator. These were also the early days of the World Bank’s structural adjustment programs that targeted

* Numbers in this form refer to the bibliography at the end of the text.
For practical reasons of employment, he decided to embark on a venture that would ensure his name for the next 20 years and beyond. For some time he had been thinking about creating a research centre similar to the SPRU at Sussex. Although establishing a new NGO was restricted at that time by the Kenya government, he persisted and succeeded in setting up the Africa Centre for Technology Studies (ACTS) in April 1988 in Nairobi. Juma envisaged ACTS as a kind of SPRU clone but having characteristics more directly concerned with African developmental issues and with a greater environmental focus. This turned out to be a complex process, but he was helped by friends and mentors locally, such as Professors Ojwang and H. W. Okoth-Ogendo (both eminent Kenyan legal authorities), Chris Aleke-Dondo (of K-Rep, a local NGO), Catherine Mwango (Office of the President) and some international figures including Gary Gallon, the former executive director of ELCI (figure 3).

The notion of an independent agency focused on science and technology policy analysis was new in an African context. Indeed, it was still relatively new internationally and donors were hesitant to commit funds to something they did not fully understand, preferring to leave aid to established international mechanisms orchestrated largely by the industrialized countries. Juma propagated the idea with his own consultancy work, and received key seed funds from individuals who believed in him, such as Harold Miller of the Mennonite Central Committee and National Council of Churches in Nairobi, Kenya, and Dianne Rocheleau of the Ford Foundation in Eastern and Southern Africa.

An important innovation that Juma introduced as a major activity was the ACTS Capacity Development Programme (CDP) (figure 4). He was very focused on ensuring the practical outcomes of ACTS’s policy research, and the CDP was designed to play a key role in this. He chose to work with the middle to senior ranking government civil servants—those responsible for advising on public policy and its execution. In his experience, many government officials in Africa did not perform this function well: very often they acted as uncritical ciphers passing ministerial orders down to subordinates with no attempt to put these in an effective context; they rarely passed advice up the line and they certainly did not foster relevant policy research.
Also, people from different parts of the administrative apparatus simply did not speak to each other, seeing others as competitors for scarce funding.

Of course, this happens in all governments, but Juma identified the practice as a major obstacle to African development and resolved to do something about it, at least in the areas ACTS was working on. He attracted quite a lot of donor funding, initially from the Government of Norway and subsequently from other governments and foundations, particularly from the MacArthur Foundation (Dan Martin). The way he set it up was as a Sub-Saharan Africa-wide programme where trainees would spend two weeks or so at ACTS learning the basics of the policy issue in question. Initially the issues tended to be linked to the United Nations Conference on Environment and Development (UNCED) biopolicy themes such as access to genetic resources (see ‘Biodiplomacy’ below). Trainees were given the foundations of these issues by brought-in experts and then encouraged to develop a small piece of research to be carried out in their own countries back home. At the end of three months or so they then returned to ACTS to present their findings at a regional workshop, to which were invited relevant stakeholder groups and individuals.

At the inception of the programme the aim was to have the courses validated by a university on the basis of continuing professional development qualifications. He tried two UK universities, who were not interested. He then tried two Kenyan universities (in one case with the enthusiastic support of the vice chancellor), but again failed. Finally ACTS succeeded with the University of Strathclyde’s Graduate School in Environmental Studies in Scotland, but only to the extent that trainees were accredited with attendance. He was learning that a major problem lies in administrative structures that cannot accept the idea of cross-disciplinary validation. Juma was thus confronted by the same problem he had begun to face in other
contexts. Universities could not decide which boxes the courses fitted into, and competition among deans helped prevent attempts to validate them.

He later came across the same problem, and was similarly unsuccessful in instituting change, when asked to advise the University of Guyana on its undergraduate syllabus. In 2002 he took on the position of the university’s chancellor. The university had been through a bad period and he was asked to recommend appropriate structural changes. With a grant from the United Nations Development Programme (UNDP), he set out a range of measures designed to have a beneficial effect, but unfortunately the recommended structural changes in the management of disciplines could not be accepted. Nevertheless, at ACTS the programmes were successful. Continued under John Ouma-Mugabe, his successor at ACTS, well over 200 civil servants were trained, many of whom have since gone to senior positions in governments and international agencies such as the African Union (AU). When Professor Judi Wakhungu took over as ACTS executive director in 2003, she continued the programme with a focus on innovation policy issues. In this way, Juma’s aims continued to bear fruit long after he had left.

Over time, support for ACTS as an Africa-based think tank was secured. A range of international donors came on board, including the Ford, MacArthur and Rockefeller Foundations to begin with, then several national aid agencies began to commit funding. Suitable staffing was assembled from faculties of local universities (designated as ‘ACTS Scholars’), local young professionals and university interns. The dissemination of the centre’s policy research was done through a new scholarly publishing company Juma had set up with his wife Alison (Initiatives Ltd) that co-located with ACTS. In this way ACTS’s success was built from the bottom up. Juma left ACTS in 1995 to join the United Nations, one year short of the eight years specified in his contract as executive director. From the beginning he had ensured that ACTS would not suffer from ‘founder’s syndrome’ and had written his own departure into the ACTS bylaws.

As noted above, he was succeeded by John Ouma-Mugabe, now a research professor in innovation systems at the University of Pretoria in South Africa. Ouma-Mugabe received his doctorate at the University of Amsterdam under the supervision of Professor Gerd Junne and became responsible for changing ACTS from an NGO to an international non-governmental organization located on the international campus near UNEP. This was completed in 2006, although Ouma-Mugabe continued to head the organization until 2002. He was succeeded by Professor Judi Wakhungu, previously at Pennsylvania State University in the US and director of the Africa Technology Policy Studies Network, who later became the Kenya cabinet secretary for environment and regional development authorities and is currently Kenya’s ambassador to France. In the 25 years since Juma’s departure, ACTS has continued to play an important role in Africa’s development. It is now headed by Professor Tom Ogada, guided by a governing council led by Professor Alfred Oteng-Yeboah from Ghana.

Biodiplomacy

Juma’s return to Kenya in 1987 (figure 5) prompted another important episode in his life. His earlier work at the ELCI had prompted a growing belief in the need to promote better environmental sustainability at global level—and this was happening at an auspicious time. The year 1987 marked the release of Our common future, the report of the World Commission
of Environment and Development, chaired by the Norwegian Prime Minister Gro Harlem Brundtland. The report reflected the kinds of ideas Juma had been toying with at ELCI, which were contained in his monograph *The quest for harmony* (1), which he had published earlier in 1980; and the focus of his graduate work on renewable energy had put him in the forefront of prospective thought leaders on technological and sustainable development. Indeed it was no accident that he had begun to research the material for his book *The gene hunters* (3), published in 1989. In addition he had helped prepare a report of a meeting convened in Nairobi in 1982 to mark the tenth anniversary of the Stockholm Conference on the Human Environment.

*The gene hunters* focused on the potential threat of biotechnology to developing countries which are sources of plant-based genetic materials engineered by international pharmaceutical corporations. At this time he became a collaborator in a network organized by the International Federation of Institutes of Advanced Studies (IFIAS) in The Netherlands, where he published a short book on prospects for biotechnology development in developing countries (6). He went on to become director of the IFIAS Biotechnology Programme and was responsible for editing the journal *Biopolicy International* that IFIAS had launched. At the same time he helped to author a report on the environment and development in Kenya entitled *Sustaining the future: environment and development in Kenya* (4). He subsequently went on to become an adviser to the AU in all matters relating to biotechnology and development.

Juma then became closely involved in the preparations for the first United Nations Conference on Environment and Development—UNCED for short, but better known as the
Earth Summit—finally held in Brazil in 1992. This had begun through the success of *The gene hunters* and reflected his growing interest in issues of biodiversity. In a sense, too, it represented a re-kindling of his earlier work with ELCI in the 1970s, but the experiences gained in the build-up to the Earth Summit were a lesson in the complexities of international diplomacy—and the build-up turned out to be extremely complex.

Part of the problem lay in the issues themselves, some of which Juma had already written about extensively.

They included access to genetic resources on the part of industrial interests and their sustainable use, intellectual property protection, issues linked with genetic resource conservation especially relating to deforestation, alternative sources of energy, wildlife conservation and competition with agricultural livelihoods. The formation of UNEP had brought these to the attention of policymakers at international level and they were the topic already of many relevant discussions, disputes and agreements, such as the Convention on International Trade in Endangered Species, but there had arisen numerous organizations and interest groups, all of whom had to be brought onside in a prospective future agreement. In addition there were important questions concerning the role of science in achieving these international agreements, and Juma felt that here was precisely an area where ACTS could cut its teeth.

It had become clear that Juma was one of the few figures who combined the range of talents and expertise needed in the creation of what would come to be known as the Convention on Biological Diversity (CBD). On the science front he was in the news for winning the 1989 Pew Scholar Award for environment and natural resources; this came with US$150,000 to be spent over three years. The funds were administered by the World Resources Institute in Washington, DC, where Juma worked closely with Walter Reid on bioprospecting issues. Juma was a Kenyan national known to have broadly-based and disinterested views on the issues involved and had been working closely with relevant senior figures such as Elizabeth Dowdeswell, when she was executive secretary of UNEP, and her deputy, Professor Reuben Olembo. By the time of the Earth Summit in 1992 Juma had become an established figure in international environmental circles and it was really no surprise that he was later appointed as the executive secretary of the CBD, which was one of the UNCED outcomes, a position he filled from 1995 to 1998.

**PUBLIC ACADEMIC**

By 1998 Juma had come to the conclusion that a career in international diplomacy was not something he particularly enjoyed. He was anxious to return to academic life and to use this as a basis for future advice and consultation in areas where he had developed a considerable reputation. He had no particular job to move to, merely a general desire to go back to his earlier ambitions, which were to use his expertise in the service of education and international development, particularly with respect to science and technology in economically poor countries. While exploring his options he recalled longstanding professional colleagues, especially Peter Raven (ForMemRS 2002), director of the Missouri Botanical Garden, and Jane Lubchenco (ForMemRS 2004), at Oregon State University, who gave him general advice on how to proceed.
This exploration led to re-establishing contact with John Holdren (ForMemRS 2009), William Clark and Graham Allison, at the Harvard University Kennedy School (HKS), who helped him to secure a position of visiting fellow there in 1999. The visiting fellow status at the HKS Belfer Center for Science and International Affairs became an inflection point in Juma’s professional development. In his own words:

Along this personal growth path, I was blessed to have outstanding mentors that guided me along. They included Dr. Robert Frosch, former administrator of NASA and longstanding senior fellow at Belfer Centre. Others who gave me equal support in my transition to being a public academic included Professor Venkatesh Narayanamurti, founding dean of the Harvard School of Harvard John A. Paulson School of Engineering and Applied Sciences. In matters related to international relations and politics, I benefitted immensely from the support of Professor Joseph Nye, Professor David Ellwood, and Professor John Ruggie.

In 1999 he was appointed professor of the practice of international development and director of the Science, Technology and Globalization Project at the HKS Belfer Center.

The Belfer Center is the hub of the HKS’s research, teaching and training in international security and diplomacy. This includes environmental and related resource issues such as science and technology policy; it was the perfect springboard for Juma’s new career in science and technology diplomacy. Although his primary activity was the training of graduate students, Belfer became a base for re-positioning himself as a public sector academic scholar with an emphasis on promoting practical advice and disinterested consultation with people and groups at an international level. As always, the focus was on how science, technology and innovation could inform and facilitate public policy development goals and, although his primary audience was an African one, he went on to have assignments with countries and individuals at all levels of development.

Belfer also provided a venue to interact with people and groups not normally associated with academia. One such person was Issa Baluch, a businessman operating out of a logistics company based in Dubai. Baluch happened already to be part of a programme that required participants to use resources provided by the entire university. This included attending different courses and receiving advice from faculty, but he was not getting along very well. He felt he had exhausted the possibilities of his aim to develop a social enterprise. As Juma remembers in his unpublished memoir, Baluch said to Juma:

I am used to making money. I am having difficulties conceptualizing and founding a social enterprise that is not focused on earning profit, so I need your help to think through how to create such a social enterprise.

After their discussions, Baluch decided to give the creation of social enterprise a chance. Through a series of persistent efforts, he finally established the Agribusiness Knowledge and Innovation Leadership Initiative. One of its founding projects was a daring effort to revive agriculture in southwestern Somalia. Baluch’s continued engagement with the HKS deepened and expanded to the point where he was invited to join its dean’s council as an adviser on how to strengthen the school’s collaboration with Africa.

He was instrumental in helping Juma appreciate even more profoundly the importance of logistics in economic transformation. Not only did he introduce Juma to his global networks, but he also became an important source of financial support for Juma’s work on logistics, which included funding research by Juma’s students. Juma’s interactions with Baluch helped
to expand Juma’s professional work to the Gulf Cooperation States, which demonstrated another important feedback loop which included inspiring new research activities based on real world experience. With Baluch, Juma was able to develop a programme of work that combined science and technology advice arising from internal HKS research, with new research projects inspired by practical experience. The example of Issa Baluch also illustrates the importance of maintaining mechanisms that interface public sector academic and entrepreneurship initiatives.

In the domain of social entrepreneurship, Juma was invited by Professor Nicholas Negroponte of the MIT Media Lab to support his One Laptop per Child (OLPC) initiative (figure 6).

The goal was to advance children’s education using new technologies. Negroponte felt that such a grand initiative could not be effectively implemented using market mechanisms or public sector support, which motivated him to create OLPC as a social enterprise (figure 7). It was one of the most exciting practical initiatives Juma had been involved in. It entailed designing a radically new technology that could meet longstanding educational objectives, and involved a large number of people around the globe connected to a research facility in Kendall Square on the campus of MIT. Indeed, Juma’s then eight-year-old son Eric became one of the testers of the software developed under the auspices of Walter Bender at OLPC, where he was introduced to programming and became interested in his present study of computer science.
Juma was assisted in all this through the HKS’s executive programmes, which provided an efficient mechanism for policy engagement and capacity development in emerging economies. He started his own executive programme entitled Innovation for Economic Development (IFED), which produced more than 600 alumni worldwide.

These include participants who used IFED to advance their professional careers to the level of ministers and deputy ministers. The programme also became a source of new research ideas. For example, contributions to his class by a senior official in the presidency of Namibia resulted in the creation of a research project on the role of presidential advisers in Africa. The project focused on presidential science and technology advice.

Juma’s outreach activities did not confine themselves to key individuals. There were also important initiatives at global level. Perhaps the outstanding example of this was his co-chairmanship of the Millennium Development Task Force alongside Malaysia’s Dato Ir Lee Yee-Cheong (7). The Millennium project was the independent advisory body to United Nations Secretary-General Kofi Annan, commissioned to recommend operational strategies for meeting the Millennium Development Goals (MDGs). This included reviewing current innovative practices, prioritizing policy reforms, identifying frameworks for policy implementation and evaluating financing options. The project’s ultimate objective was to help ensure that all developing countries met the MDGs.
As a United Nations-sponsored initiative, the Millennium project proceeded under the overall guidance of the Secretary-General and UNDP Administrator Mark Malloch Brown in his capacity as chair of the United Nations Development Group. Professor Jeffrey Sachs directed the project, which brought together the expertise of world-class scholars in both developed and developing countries, United Nations agencies and public, non-governmental and private-sector institutions. Ten task forces carried out the bulk of the Millennium project’s analytical work with support from a small secretariat based at UNDP headquarters in New York. The task forces reported back in 2005 to the United Nations General Assembly, and identified a number of options for action, suggesting ways in which science, technology and innovation could contribute to the implementation of the MDGs.

Over the period from 2000 to his death in 2017 Juma continued to consult for governments as well as United Nations and other agencies (such as UN Environment Programme, Nairobi; the UN Conference on Trade and Development, Geneva; UN Educational Scientific and Cultural Organization; UN Industrial Development Organization; UN Development Programme; World Intellectual Property Organization; Food and Agriculture Organization of the UN, Rome; and World Bank) on science and technology policy, technology transfer, the environment, population migration, energy development and food production. And throughout the period from 2006 to his death, Juma also played a major role in advising the AU. He co-chaired the AU High Level on Modern Biotechnology (2005–2008) and the AU High Level Panel on New and Emerging Technologies (2014–2017).

In the United States he was a key figure in the work on the environment and development of the US National Research Council, serving there on the Board of Agriculture and Natural Resources, the Committee on Scientific Support for Sustainable Development, the Committee for Geographical Information and Agenda 21, and the Committee on Agricultural Biotechnology, Health and the Environment. Juma’s contributions were recognized with election as a fellow of the Kenyan Academy of Sciences, the African Academy of Sciences and the World Academy of Arts and Sciences, as well as to foreign membership in the US National Academy of Sciences, the Royal Society of London and the UK Royal Society of Engineering. He was also presented with an honorary doctorate from the University of Sussex in 2006 (figure 8).

**Scholarship**

Juma never abandoned his pursuit of scholarship. According to his Harvard colleagues: ‘By the time he came to Harvard [1999], Calestous had already published an even dozen books, including his pioneering 1989 study of the interaction of biodiversity, biotechnology, and development in the *Gene Hunters*’ (Clark *et al.* 2017). From 2000 on, there followed a series of books and papers dedicated to the exploration of issues of relevance to socio-economic development, especially in Africa, amounting to well over 100 publications of papers, short monographs, books and book chapters written over a 35-year period since 1980. Perhaps it was in this later period that he began to consolidate his experiences in a literary form most explicitly. By 2000 at Harvard he had consolidated his views about what was necessary to revitalize economic development not only in Africa, his own region, but also in most parts of the world that were subject so much to the disadvantages of modern globalization.
He suspected that a major part of the problem was the monetary relationships associated with international debt and the link this had with inequality and poverty, but, in his view, the way out was to rely not on short term institutional fixes but rather in putting the issue firmly into a long-run perspective—and this meant harnessing the power of modern science and technology. This he argued in a series of publications. Two that I should draw attention to were *The new harvest* (8) (figure 9) and *Innovation and its enemies* (9).

In *The new harvest* Juma suggested new approaches to promoting agricultural innovation in African agriculture. This encapsulated the work of the Agricultural Innovation in Africa project funded by the Gates Foundation and involved inputs from around 20 leading international experts. African agriculture is still the central focus of economic activity and employment in all countries there. Much of it is less than fully productive, and persistent food shortages are being compounded by climate change threats, while migration to urban centres is causing huge problems of overcrowding and social decay.

*Innovation and its enemies* is an encyclopaedic survey of the emergence of new technologies throughout 600 years of history, paying close attention to the importance of institutional factors that both inhibit and promote change.

In press just before his untimely death were two further pieces of work, *Emergent Africa* (10) with Francis Mangeni (until recently the director of Trade, Customs and Monetary Affairs at the Common Market for Eastern and Southern Africa), in which possibilities for improving regional trade links are explored in some detail, and *A new culture of innovation: technology, entrepreneurship, and prosperity*, a follow-up to *Innovation and its enemies*. Aside from a long-term perspective, Juma concentrated primarily on the main themes he had been working
on throughout his professional life, infrastructure improvement, practical education, science and technology investment and the overriding importance of encouraging innovation at all social levels, from school age to changes within the broader workforce.

APPRECIATION

The death of Calestous Juma in 2017 was a tragic and unexpected event. His life was cut short just as he was beginning to consolidate and disseminate his knowledge globally. The scope of his reputation may be seen in the awards received by him listed below. He was in every conceivable sense truly a renaissance man. Starting from humble beginnings he spent his every waking hour learning life’s richness, mysteries, possibilities and channels for change. His aim was ultimately how best to use knowledge for improvement in the human condition. Education in science, technology and innovation was always central—and not just related to higher education.
At the time of his death he and his close family were working on establishing what would hopefully be called the Lake Victoria Institute of Science and Technology, a college to provide the technical skills needed to promote employment for youth in that region.

On a personal level, all with whom Calestous Juma interacted without exception found him kind, supportive and courteous and with a marvellous sense of humour. He understood well people’s innermost worries, cares and ambitions. He would always help where he could. He will be much missed. He is survived by his wife Alison Field-Juma, his son Eric (figure 10) and his sister, Roselyda Nanjala Juma.

AWARDS AND HONOURS

1989 Fellow, World Academy of Art and Science, USA
1991 Pew Scholars Award in Conservation and the Environment
1992 Justinian Rweyemamu Prize, Council for the Development of Social Science Research in Africa
1993 Global 500 Roll of Honour for Environmental Achievement, United Nations Environment Programme
2000 Fellow, New York Academy of Sciences
2001 Henry Shaw Medal, Missouri Botanical Garden
2005 Foreign Associate, US National Academy of Sciences
2005 Fellow, World Academy of Sciences, Italy
2006 Fellow, African Academy of Sciences, Kenya
2006 Fellow, Royal Society of London
2006 Order of the Elder of the Burning Spear, President of the Republic of Kenya
2006 Doctor of Science (honorary), University of Sussex, UK
2007 Doctor of Science (honorary), University of Education, Winneba, Ghana
2007 Honorary Fellow, Royal Academy of Engineering, London
2012 Doctor of Science (honorary), Jomo Kenyatta University of Agriculture and Technology, Kenya
2012 Fiftieth Anniversary Fellow, University of Sussex, UK
2013 Doctor of Science (honorary), McGill University, Canada
2017 Breakthrough Paradigm Award, Breakthrough Institute, Oakland, California, USA

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The portrait photograph was taken in 2006 by Prudence Cuming Associates and is © The Royal Society.

AUTHOR PROFILE

Norman Clark

Norman Clark was awarded his PhD from the Department of Economics at the University of Edinburgh in 1971. After a period as a post-doctoral fellow at the Science Policy Research Unit (SPRU), University of Sussex, he spent seven years as a lecturer in international economic studies at the University of Glasgow before re-joining SPRU as its founding director of graduate studies in 1980. In 1996 he was appointed professor of environmental studies and director at the Graduate School of Environmental Studies, University of Strathclyde, before taking up the position of vice chancellor at Kabarak University in Kenya in 2004. He subsequently spent a period as research professor in innovation systems and development at The Open University’s Arts and Social Science Faculty, before retiring in 2013. He holds emeritus professorial positions at The Open University and the University of Strathclyde. His research interests include science and technology development in Africa and South Asia, a field in which he has acted also as an adviser to relevant agencies including the World Bank, UNCTAD, UNDP, DFID, NEPAD and the CGIAR. He continues to serve on the Governing Council of the African Centre for Technology Studies, Nairobi, Kenya.

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