

From Kenyan villager to international researcher

Rebekka Stredwick helped Francis Otieno tell his story



Francis Otieno / Diamond Light Source

Dr Francis Otieno from the University of the Witwatersrand (Wits) on a visit to the University of Oxford in the United Kingdom.

My name is Francis Otieno and I am telling this story to inspire school kids, emerging researchers, and everyone – your dreams are possible!

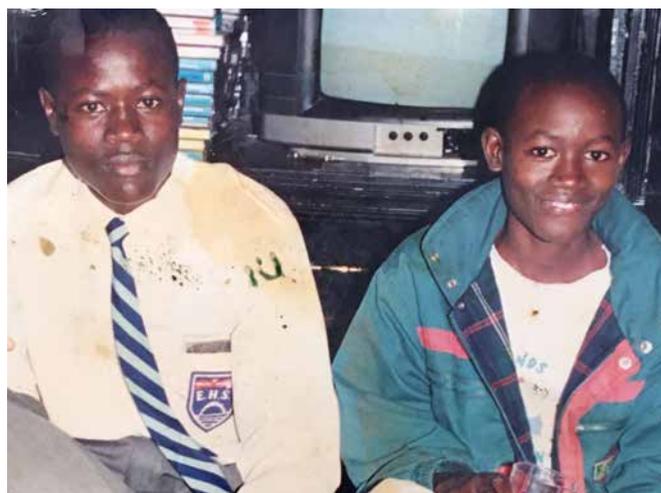
My story begins as I progressed into high school and experienced the heavy environmental pollution from the congested slums of Mathare in Nairobi, Kenya. Large numbers of smoking cars in the streets and continuous electricity blackouts were the norm, especially at the slightest onset of rains. When I look back, this was the start of my dream of making a difference to society and our communities, the start of a long journey in the quest for clean, sustainable renewable energy.

Today I am a GCRF START Postdoctoral Research Fellow in the field of solar energy research. I was born in a rural part of Kenya called Seme Kadero, in Kisumu County, to a big polygamous family of four mothers and 27 children. I

was number 20 in our family and my father, born in 1928, was quite passionate about his kids attending school but none before me made it to university. We were allowed to go to school in the mornings but had essential chores in the afternoons. We grew up grazing cattle barefoot and cultivating land in alternation with school hours – we couldn't even afford to buy shoes.

My father saved some money for me to attend high school but soon realised this was sufficient only to buy the school uniform and other items required for admission, but not school fees. I had to make do with a new school uniform, including long trousers and shoes for the first time, which I wore at home while waiting for my father to raise the fees. I didn't know what to read during those weeks, so after putting on my school uniform each day, I would go to the newspaper vendor and ask to read all the daily newspapers with him, and then go home in the evening.

My passion was to realise my father's dreams one day and return home with a title earned from studying. I wanted to be a teacher and contribute immensely to society. My physics teacher at Eastleigh High School in Nairobi really believed in me, which made a huge difference. He gave



Francis Otieno / Diamond Light Source

A childhood photo of Francis (left) with his brother Jacktone at home in Kenya.

The Global Challenges Research Fund's (GCRF) Synchrotron Techniques for African Research and Technology (START) project builds partnerships between world-leading scientists in Africa and the United Kingdom, working together on research using synchrotron science. The project develops research along two lines of scientific investigation: developing and characterising new energy materials (for example, in the development of solar cells or improving energy efficiency through novel catalysts), and structural biology to understand diseases and develop drug targets. For more information, see <https://start-project.org/home/about/>

me a project using angular inclination and the concept of rectilinear propagation of light to design a device that could be used to measure the height of any building or tree from a distance without having to climb it! This kickstarted my love of science and drove my research career ambition.

I competed through the district and province and became the second best in the National Science Congress. The fire for research was then fully ignited, fuelled by the fact that I didn't have a stable light source at night to study, in addition to the effects of environmental pollution. School and learning were vital. To avoid being mugged for our precious textbooks, we would walk the 6 km to and from school, rising early each morning and singing on the way back home to deter anyone from stealing our books to sell for drugs.

My father had long retired from active business, relying instead on peasant farming. Our tradition holds that our elder brothers help to cover school fees, which was a challenge as they were equally struggling to settle down in life. With all these hardships, my ambition was to improve performance at school, which had back then only a 2-5% pass rate to public university. As a group of high school learners, we managed to turn this around and many secured a place at our public university, where we could access government funding.

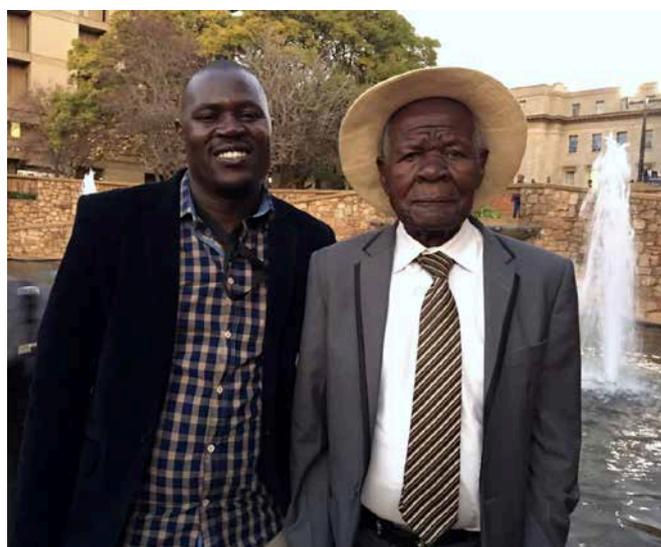
The best teacher teaches from the heart and not just the textbook, and this is what I intended when I chose a Bachelor of Education degree at Egerton University, almost 200 km north-west of Nairobi. I knew my heartfelt approach meant a lot to my father, who has always urged me to do well and surpass any problems on the way. When I got my first degree in education, teaching physics and mathematics, many of my pupils did well in my subjects. I am a proud teacher, having seen them move into good careers using the physics and mathematics they had been taught.

My next thought was that the combination of research and teaching would be more impactful to society, so I enrolled for an MSc in Physics at the University of the Witwatersrand (Wits) in South Africa. Getting accepted on the course wasn't easy, and I was rejected four times. Finally, in 2014, I joined Wits after resigning from my high school teaching job. This bold step would not have been possible without the encouragement of Prof. Daniel Wamwangi, Associate Professor in the School of Physics at Wits. I am forever grateful for the trust he had in me, the strong motivation he gave, and incredible guidance he has accorded me during my research journey at Wits.

Through his dedicated supervision I was able to successfully earn my MSc, within the time limit, and immediately enrol for a PhD, which I completed within a record time of 30 months together with an output of several publications. During my PhD journey, Prof. Daniel Wamwangi and Prof. Alex Quandt, Professor in Computational Physics in the School of Physics at Wits, formed the best team for supervision. From their immense expertise and with much hard work, I learnt so much within a record time and got exposure to advanced techniques, as well as collaborations within and beyond Africa.



Francis with his PhD supervisors, Professor Alex Quandt and Professor Daniel Wamwangi, at his graduation ceremony at Wits in 2018.



Francis with his father, Mzee Christopher Otieno Oluoch, at the graduation ceremony.

I invited my then 92-year-old father to my graduation, and tears of joy flowed freely when he landed in Johannesburg for this happy event, and throughout his three-week stay with me in South Africa. It was his first time owning a passport and boarding an aeroplane, and seeing his child graduate with the much-desired title of a Doctor of Philosophy. When my father returned to our village in Kenya, he would host sessions of storytelling about these experiences and remembers every tiny detail: his 20th child brought home his dream!



Daniel Wamwangi / Diamond Light Source



Diamond Light Source

Francis tours beamline I07 at Diamond Light Source, the UK's national synchrotron situated on the Harwell Science and Innovation Campus in Oxfordshire.

I told myself that although I was the first in the family to climb to this height of education, I would not be the last. Through this inspiration, four of my younger siblings have now earned their first degrees, and former students, friends and relatives have followed suit in South Africa and Kenya.

GCRF START Postdoctoral Research Fellowship

Through hard work with good output, I was approached by my current host, Prof. Dave Billing in the Department of Chemistry at Wits, and he suggested that I apply for a postdoc position funded by the GCRF START grant, even before my PhD thesis examination results were back. I was highly convinced that this was the best news ever, and indeed, being accepted by START would help my career and personal growth, because I needed exposure outside of Africa as well as within to move my research forward.

START was a real blessing at the right time when I truly needed it. The GCRF START grant funded my Postdoctoral Fellowship at Wits for two and a half years. With START, I have been able to obtain lots of data results that have enabled me to publish in reputable journals. Being part of the START network has given me opportunities to collaborate with like-minded researchers at the UK's University of Oxford, the University of Sheffield and the UK's world-renowned national synchrotron – Diamond Light Source (Diamond). Through these interactions, I have learnt many new skills and exchanged knowledge and various perspectives.

In addition, back in South Africa and with support from the GCRF START grant to purchase the necessary kits, I participated in several community outreach programmes, including hosting an awareness and outreach activity at Wits for the 69th Lindau Nobel Laureate Meeting in 2019, which I attended in Germany. This was funded by the Academy of Science of South Africa (ASSAf), in partnership with the then Department of Science and Technology (now DSI). The 2019 meeting – known by its Twitter hashtag #LINO19 – was dedicated to physics and was attended by 39 Nobel laureates and 580 young scientists from 89 countries. It was particularly meaningful for our South African contingent because South Africa hosted the International Day that year. I also participated in the Wits Yebo Gogga Exhibition and Focus Day, which assists young learners who need guidance on future careers, such as in physics.

Cleaner, cheaper energy sources

Finding alternative, cheaper energy sources using locally available materials, such as organic polymers, is the basis of my research. To provide clean renewable energy sources, the current market is dominated by silicon-based solar cells, which are high cost because of the expense of extracting silicon from its raw materials (sand), and they also have lower efficiency. Thin-film solar cells are known as second-generation solar cell fabrication technologies to produce electrical energy.



Patrick Kunkel/Lindau Nobel Laureate Meetings

Francis (back row, 3rd from right) was one of 20 young scientists selected by ASSAf to attend the 2019 Lindau Nobel Laureate Meeting in Germany.

I focus on using nanoparticle technology such as plasmonics to find alternatives to silicon solar cells. My research interests are renewable energy, energy policy and emerging solar technologies, with my focus under the GCRF START grant on materials' characterisation, device fabrication and testing of thin-film solar cells such as Organic Solar Cells (OSCs), perovskites, and dye-sensitised solar cells. My project also explores ways to enhance the performance of these thin-film devices through incorporation of nanoparticle technology and spectral conversion thin films, with the ultimate goal of realising an efficient, cheaper source of solar energy and device-making for local and global markets.

The GCRF START grant facilitated buying my research materials, and made and strengthened Africa-UK collaborations,

Francis Otiemo / Diamond Light Source



Francis in the laboratory at the Wits School of Chemistry, undertaking D10 Grazing Incidence X-ray diffraction. This technique is used to determine the phases of thin films at the sample surface and multi-layer films.

with lab visits to the UK. This gave me exposure to cutting-edge opportunities and joint proposals to perform advanced materials characterisation such as Grazing Incidence Wide Angle X-ray Scattering (GIWAXs) at Diamond, and access to UK laboratories in the Materials Physics Group at the University of Sheffield with GCRF START Co-I, Prof. David Lidzey, and to the Advanced Functional Materials and Devices Group (AFMD) with GCRF START Co-I, Prof. Moritz Riede at the University of Oxford.

The newly acquired National Thin-Film Cluster Facility for Advanced Functional Materials based at the University of Oxford is capable of being an epicentre for novel thin-

Irfan Habib / Diamond Light Source



Francis (front left) with members of the START network from Wits on a visit to the University of Oxford. Left to right: Professor Daniel Wamwangi, Professor Dave Billing, Adam Shnier, Dr Ramesh Pandian and Professor Yasien Sayed.

film development within the UK and beyond. This facility certainly places the UK at the centre of the development of next-generation materials and devices for applications in energy, photonics and electronics. Access to this facility through my ongoing collaboration with Oxford will certainly revolutionise my research prospects, with increased potential of producing publications in collaboration with the AFMD group, namely Dr Pascal Kaienburg and Irfan Habib.

In the Materials Physics Group at Sheffield University, Rachel Kilbride and Dr Joel Smith assisted me with carrying out GIWAXs on organic thin films. At Diamond, Dr Thomas Derrien guided me with joint beam time proposals enabling us to do measurements both at Diamond and the European Synchrotron Radiation Facility (ESRF).

These collaborations and networks I aim to continue being involved in, and were made possible by Prof. Billing, who has much expertise in powder diffraction and energy materials across research networks within and beyond Africa. I am always grateful for the faith he had to appoint me as a Postdoctoral Research Fellow, and I have valued his immense support. Also key is Prof. Wamwangi, who has been a great mentor in my research journey, from experimental techniques to manuscript preparation. As a result, I have contributed to several papers looking at solar cell materials and device-making instrumental to industries working on improving the performance of solar cell devices, highly needed in the global market.

We believe that the future of all technologies is 'smart', and Organic Solar Cells (OSCs) research is critical to realise efficient energy sources with advantages over current silicon solar cells, due to the abundance of materials and ability for scalable production processes that OSCs offer. Our aim is to contribute to the Sustainable Development Goals 7 (energy) and 3 (climate) and the growing global demand for innovative, world-class solar energy. Also, our research findings form the basis for teaching solar cell technology to undergraduate and postgraduate students, as well as other Research Fellows back home.

Inspiring hope, enabling others to dream

Although the journey is a long one, I am excited to have embarked on making a difference in society through our research, and I am proud that my dream of impacting young people from rural areas like my own was realised when I became a teacher. To continue investing in developing others, I have started mentoring undergraduate and postgraduate students at Wits and now at Maseno University, Kenya, where I have been offered a job as a lecturer.

The GCRF START grant exposed me to new skills and advanced equipment, and through my successes and links to START, I was able to receive the British Council Newton Travel Grant, which will enable me to visit Oxford for a period of six weeks. This exposure, together with much sought-after skills and strong collaborations, will be very useful to me as a young researcher looking forward to supervising postgraduate students back in Kenya, upon the completion of my Postdoctoral Fellowship.

This article was republished from the Wits website, but was originally published on the GCRF START website.

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A. Academy of Science of South Africa (ASSAf) Publications

D. Quest: Science for South Africa

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