

THE **FUTURE AFRICA** EARLY CAREER RESEARCH LEADER FELLOWSHIP

A reflection on the early career research leaders for Africa's future



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA





The Early Career Research Leader Fellowship:

Developing African centres of research excellence ... one research leader at a time

This publication was made possible by a grant from Carnegie Corporation of New York. The statements made and views expressed are solely the responsibility of the author.

This publication provides an overview of the Future Africa Early Career Research Leader Fellowship (ECRLF).

Publisher: Future Africa Institute, University of Pretoria
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Text: Janine Smit
Design and layout: Typeset Pty (Ltd)
Printing: BusinessPrint

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Transforming the world through
African research excellence

FOREWORD

MESSAGE FROM THE VICE-CHANCELLOR AND PRINCIPAL, UNIVERSITY OF PRETORIA

Prof Tawana Kupe

“

As a leading academic institution in Africa, the University of Pretoria (UP) is committed to finding solutions to the challenges that threaten the sustainable development of our continent and its people. Its dedication to expanding research capacity in Africa is at the core of its support and development of early career researchers, not just from within its own ranks, but from institutions across the continent.

”



It is with great appreciation that the University recognises the support of the Carnegie Corporation of New York (CCNY). Through the Early Career Research Leader Fellowship (ECRLF), it provided a nurturing opportunity to twelve promising early career researchers from ten tertiary institutions in six countries across East, West and Southern Africa, as well as the Indian Ocean island country of Mauritius, over the past three years.

This publication showcases the success stories of each of these postdoctoral fellows, and subsequently the successful interventions of their UP mentors, facilitated through Future Africa, to fill a critical gap in the African research capacity development ecosystem.

What will soon become evident is that this programme was not aimed at developing a mere dozen postdoctoral researchers in isolation. Each of these early career researchers came to the programme with a unique developmental challenge that they wished to solve – not only for their individual countries, but for the continent as a whole. Through their engagement with the other fellows on the programme, and the transformation-minded research leaders at the University of Pretoria, they came to realise the importance of integrating perspectives across academic disciplines in the form of transdisciplinary research.

Once they had reached the point in their postdoctoral journeys where they believed they had achieved what they had set out to achieve, their actual transformation into research leaders *in Africa for Africa* was only beginning.

This took place through the presentation of a series of dissemination workshops, where the fellows took their research and their experience as a participant in the ECRLF programme back to their home countries. Organised by the fellows themselves, prominent researchers, as well as members of the public and individuals from the private sector, were invited to deliver presentations related to the fellows' fields of research. Some of the workshops turned into full-fledged international conferences with up to 200 participants, which the respective universities plan on presenting annually. Many of these workshops were presented in a hybrid format to reach an online audience as well.

Even this did not signal the end of the impact of the ECRLF programme. During their dissemination workshops and conferences, many of the fellows identified a need for the further communication of the research outputs that were presented. The general feeling was that the presented information should not be restricted to academia and research journals.

It needed to be relayed to the communities who were affected by it. This led to a final round of interventions, for which the CCNY graciously provided extended funding.

These community engagement activities took on various forms: from field training sessions to community dialogues. Some were aimed at revising policy, and one even gave rise to an edited book that will be published internationally.

Reflecting on the successful implementation of the ECRLF programme, I would be remiss if I did not acknowledge the role played by UP's Future Africa Institute. As the University's vehicle to address complex challenges that face Africa, and indeed the world, it made a significant contribution to creating the next generation of research leaders that will ensure research sustainability and continuity.

Future Africa not only liaised with CCNY regarding the practical implementation of the programme, but also dealt with the programme's logistical and financial arrangements. It furthermore facilitated an orientation programme for the fellows, in which it introduced them to the concept of transdisciplinarity, as well as diversity and transformation, as crucial elements of the research agenda. The training it provided the fellows in science communication and proposal writing would benefit them beyond the duration of the fellowship.

As we reach the conclusion of this three-year journey with CCNY, I would like to acknowledge the contribution of each fellow and mentor who made the most of this opportunity to find solutions for Africa's challenges. I also wish to express my thanks to each fellow's host institution, which was prepared to release the fellow from some of their teaching and administrative obligations for the duration of the fellowship, cognisant of the benefit that it would have, not just for their country, but for the continent as a whole.

Finally, I wish to express my gratitude to the officials involved in the CCNY's Higher Education and Research in Africa programme, Andrea Johnson and Alloya Elwadie, and to the programme managers at Future Africa, Prof Wanda Markotter and Rachel Fischer, for their commitment to ensuring the success of this programme.

May we continue to develop African centres of research excellence, one research leader at a time. ○

Prof Tawana Kujee

Vice-Chancellor and Principal
University of Pretoria

“ Developing research leaders in Africa for Africa. ”

MESSAGE FROM THE CARNEGIE CORPORATION OF NEW YORK

Andrea Johnson
Alloya Elwadie

The Future Africa Institute of the University of Pretoria partnered with the Carnegie Corporation of New York (CCNY) to develop a unique advanced postdoctoral fellowship opportunity, the Early Career Research Leader Fellowship (ECRLF).

The ECRLF was aimed at helping to fill a critical gap in the African research capacity development ecosystem. Specifically, the fellowship aimed to enhance transdisciplinarity and the societal orientation and impact of research, while at the same time advancing science development through the empowerment and support of African early career researchers. Between 2019 and 2022, the programme sought to develop research leaders to focus on some of Africa's most urgent development challenges and opportunities.

The complexity and scale of the development challenge, as captured by the targets of the United Nations' Sustainable Development Goals (SDGs) and the African Union's Agenda 2063, require a radically different and disruptive approach to scientific discovery and innovation. The ECRLF proposed a more goal-oriented and interconnected approach, focusing on a model of research transdisciplinarity that connects the array of disciplines and sectors affected by or engaged in critical development issues.

Future Africa's interpretation of transdisciplinary research is a demand-driven and problem-oriented form of research. It combines interdisciplinarity with the participation of extra-scientific actors to create mutual learning across different scientific fields and society through joint problem solving, with the goal of creating sustainable solutions in a real-world context. Transdisciplinarity proposes a new model for research leadership training in Africa at the intersection of disciplines, industry, government and civil society, within collaborations linked to global research networks. In the case of the ECRLF, research was devoted to developing a sustainable and inclusive bioresource-based economy, including the governance, social transformation, energy and information needs for its development.

Future Africa recognised that traditional definitions of research excellence and training have not led to the resolution of the complex problems facing the future of society and the planet. In considering how research can effectively contribute to building a peaceful, equitable and sustainable Africa, it has become abundantly clear that transdisciplinarity holds promise for integrating perspectives across academic disciplines, societies and sectors. Linear thinking will not create the most effective solutions to global challenges.

The ECRLF actively implemented a future-oriented perspective on skills development to produce a new generation of transformation-minded research leaders by creating capacity to develop interdisciplinary research teams. Together with societal structures beyond academia, these researchers will continue to engage in impactful and responsible research that defies geographic borders and traditional narrow academic disciplines, developing new knowledge to respond more effectively to the risks and opportunities of global environmental change.

The CCNY-supported ECRLF has been one of Future Africa's flagship programmes and presents a new model for the continent. Albeit not without challenges, especially in the face of the coronavirus pandemic, striking success stories have certainly come to the fore. Seeking to overcome these challenges not only displays creative and critical thinking, but also resilience in a time of severe uncertainty. ○



Andrea Johnson
Programme Officer (retired)
Higher Education and Research in Africa
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Carnegie Corporation of New York



Alloya Elwadie
Programme Analyst
Higher Education and Research in Africa
Carnegie Corporation of New York

MESSAGE FROM THE FUTURE AFRICA EXECUTIVE

Dr Heide Hackmann
Dr Neeraj Mistry

As the University of Pretoria's pan-African platform for research and innovation that span disciplinary fields, sectoral and geo-political boundaries, it was a privilege for Future Africa to partner with the Carnegie Corporation of New York (CCNY) on the Early Career Research Leader Fellowship (ECRLF) programme.

Launched in January 2019, the programme's primary purpose was to develop African academics in terms of thought leadership, team development, stakeholder engagement and collaboration. In the process, the programme sought to stimulate the emergence of centres of research excellence to solve complex problems that face Africa and the world.

The mission of developing early career research leaders in Africa for Africa is essential to build critical mass for the next generation. The younger generation of postdoctoral researchers are agents of change, with the energy and initiative to challenge existing practices in both science and society. This momentum is necessary to develop new knowledge on the interactions between ecological and social systems, and to apply such knowledge to the challenge of sustainable development.

The ECRLF programme supports Future Africa's goal of fostering transformative research and scholarship; finding concrete solutions to real-world problems. The challenges that each of the postdoctoral fellows identified in their countries of origin – from Ghana in the west to Kenya in the east – covered topics such as the spread of zoonotic diseases, water quality assessment, the anticancer activity of medicinal plants, and raising the awareness of climate change and environmental sustainability. These topics are aligned to Future Africa's ambition of ensuring that science contributes to Africa's socioeconomic development and serves as an example to the rest of the world.

The solutions suggested by the fellows participating in the programme were centred in approaches that transcend traditional boundaries and embrace the concept of transdisciplinarity.

In addition to recognising the generous financial support of the CCNY, Future Africa also acknowledges the important role played by Prof Cheikh Mbow, Future Africa's former Director, as well as Prof Bernard Slippers, Director of the University of Pretoria's Innovation Africa @UP Campus, who were involved in the design and launch of the programme.

We look forward to the continued support of CCNY in developing research leadership in Africa through the newly launched Future Africa Research Leadership Fellowship (FAR-Leaf) programme, which will focus on the nexus between wellbeing and the social, economic and natural environment.

Through initiatives such as this, we believe that Future Africa and its collaborators will succeed in their ambition to help transform the world through African research excellence. ○



Dr Heide Hackmann
Interim Director: Future Africa



Dr Neeraj Mistry
Deputy Director: Future Africa



Prof Bernard Slippers, Director: Innovation Africa @UP Campus (left)
Prof Cheikh Mbow, former Director: Future Africa

FELLOWSHIP

THE EARLY CAREER RESEARCH LEADER FELLOWSHIP

The Early Career Research Leader Fellowship (ECRLF) is an initiative of the Future Africa Institute at the University of Pretoria (UP), funded by the Carnegie Corporation of New York (CCNY). It serves early career research leaders in basic and applied sciences, engineering, social sciences, the humanities and the arts.

The fellowship was launched in January 2019 with the aim of growing African academics in their thought leadership, team development, stakeholder engagement and collaboration, with the intention to stimulate the emergence of centres of research excellence to solve complex problems that face Africa and the world.

The overarching purpose of a postdoctoral fellowship is to provide the necessary training for postdoctoral scholars to achieve intellectual and professional independence and success. Postdoctoral training opportunities are among the principal requirements for developing future leading scientists who will contribute to the advancement of research. A postdoctoral fellowship thus presents opportunities for new or advanced skills.

The aim of the Future Africa ECRLF postdoctoral programme was to develop research leaders to fill a critical gap in the African research capacity ecosystem. It was designed to equip postdoctoral fellows with the skills needed to address Africa's most urgent challenges and to provide opportunities to develop a sustainable and inclusive bioresource-based economy.

It had the following objectives:

- Stimulate new thinking on the perceived frontiers of science so as to produce theoretical frameworks for transformation
- Develop novel questions and/or approaches to existing and emerging questions with a focus on adaptability, resilience, and the co-design of systems for sustainable and equitable development in Africa.
- Function in a twinned, split-site approach with the home institution in Africa to strengthen the fellows' research at both their home institution and the hosting institution
- Use the project as a basis to advance the development of a research programme at the fellows' home institutions
- Promote interaction between researchers at UP and at the fellows' home institutions
- Assist fellows to develop their project proposals to increase transdisciplinarity, focus and quality, as well as alignment with the expertise of the local supervisor
- Connect disciplines within the natural and social sciences, and the humanities that are affected by or engage with specific goals shared by scholars, practitioners in industry and non-governmental organisations, and policy makers through transdisciplinarity
- Encourage mutual learning and joint problem solving to create sustainable solutions in a real-world context
- Expose fellows to a structured skills development programme using a highly interactive approach to training
- Integrate the fellows into a pan-African network of researchers who are geared towards advancing a new paradigm for African science

Following a call for proposals, fellows were elected from institutions in Ghana, Kenya, Malawi, Mauritius, Nigeria, Uganda and Zimbabwe. They would be mentored by established researchers in an associated specialised area at the University of Pretoria.

The postdoctoral fellowship funded the following components:

- A monthly stipend of R10 055 paid into a South African bank account
- Accommodation to the value of R5 800 per month in a standard single room
- One return flight ticket per annum to and from Johannesburg and the fellow's nearest home airport
- Support to the value of R32 000 per annum to attend conferences
- Seed funding to the value of R120 000 per annum for research administered by UP
- An allowance of R35 000 for the host mentor to visit the fellow's home institution
- A meal allowance of R4 700 paid into the fellow's student account



ECRLF PROGRAMME MANAGERS
Prof Wanda Markotter (right) and Rachel Fischer (left)



THE UNIVERSITY OF PRETORIA



The University of Pretoria is one of the largest research universities in South Africa. It boasts a dynamic community of staff and students who come from a range of diverse backgrounds and cultures, showcasing South African and global societies.

The University was born from a vision to create a space for quality education and new ideas to flourish. Over the course of its existence, and through different phases of political power and social change, it has been resilient in its commitment to academic quality. This has allowed it to establish a presence among the top 1.9% of universities worldwide.

Its vision has always been to look forward, provide the best possible education for its students, and encourage them to go on to do great things. It is continuously transforming the corporate and research landscape through innovative thinking and the high calibre of its graduates.

Vision

To be a leading research-intensive university in Africa, recognised internationally for its quality, relevance and impact, as well as for developing people, creating knowledge and making a difference locally and globally.

Mission

In pursuing recognition and excellence in its core functions of research, teaching and learning, and integrating engagement with society and communities into these, the University of Pretoria will use quality, relevance, diversity and sustainability as its navigational markers.

The University of Pretoria is built on a foundation of excellence and change. Its strength lies in working together to transform the futures of our country, continent and the world.

Key strategic goals

- Enhance access and successful student learning
- Strengthen the University's research and international profile
- Foster and sustain a transformed, inclusive and equitable university community
- Optimise resources and enhance institutional sustainability
- Strengthen the University's social consciousness and its impact on society

Academic offering


The University of Pretoria offers academic and research programmes in nine faculties and one business school:

- Faculty of Education
- Faculty of Economic and Management Sciences
- Faculty of Engineering, Built Environment and Information Technology
- Faculty of Health Sciences
- Faculty of Humanities
- Faculty of Law
- Faculty of Natural and Agricultural Sciences
- Faculty of Theology and Religion
- Faculty of Veterinary Science
- Gordon Institute of Business Science (GIBS)

The University produces the highest number of research outputs locally, as recorded by the Department of Higher Education and Training. It will continue to improve on the quality of its research. It is one of the biggest contributors of qualified professionals and research students in the country. As a result, it is already known internationally as a research-intensive university.

Prominent research focus areas include agriculture and sustainable food systems, climate change and the environment, economic development and sustainable futures, energy, heritage studies, inequalities, social justice and human rights, One Health, smart infrastructure and innovation, and water.

The University of Pretoria is recognised for transdisciplinary research and partnerships. It addresses the world's challenges through collaboration, transdisciplinary approaches and exciting new platforms to co-create knowledge that translates into solutions. One such platform is Future Africa, the first of its kind on the continent to function as a space for transdisciplinary research. Issues of critical relevance to Africa are tackled by researchers from multiple disciplines across all the University's faculties. These issues include everything from sustainable development and good governance, citizen participation and human rights, to advancing innovation for the bioresource economy. Future Africa contributes to addressing complex challenges that face Africa and the world. It is committed to creating the next generation of researchers and research leaders required to ensure research sustainability and continuity.

The Times Higher Education Impact Rankings have ranked UP among the top 100 universities in the world in five categories based on the following Sustainable Development Goals: SDG 3 (Good health and wellbeing), SDG 4 (Quality education), SDG 9 (Industry innovation and infrastructure), SDG 16 (Peace, justice and strong institutions) and SDG 17 (Partnerships for the goals). 

FUTURE AFRICA

The University of Pretoria has recognised the need for inter- and transdisciplinary research. Over time, it has invested in the creation of many inter- and transdisciplinary research collaborations in the form of cross-cutting research themes, institutes, centres and programmes.

Future Africa is an initiative of the University of Pretoria that develops innovative transdisciplinary skills transfer programmes to address Africa's growth and development challenges. This major investment from the University provides advanced facilities and capacity for developing problem-oriented, interconnected, pan-African research networks for innovation. The partnership with the Carnegie Corporation of New York (CCNY) on the Early Career Research Leader Fellowship (ECRLF) is an example of such a collaborative pan-African project.

The University of Pretoria is one of the 15 founding universities of the African Research Universities' Alliance (ARUA). An integral part of its research and international strategies has been the growth of the institution's postdoctoral cohort. The University's capacity includes a large number of National Research Foundation (NRF)-rated researchers, who are internationally recognised in their disciplinary field, across nine faculties. These researchers can contribute to the implementation of the programme, while being appropriately paired as mentors to the fellows. During 2016, UP's academics and researchers mentored some 237 international postdoctoral fellows and produced the largest volume of quality peer-reviewed research outputs of any university in South Africa.

The University of Pretoria is particularly well positioned to play a leading role in the development of science leaders in Africa. Specifically, Future Africa is a research institute and pan-African platform at the University of Pretoria that makes fundamentally new approaches to research and innovation that span disciplinary fields and geo-political boundaries possible. More specifically, through the efforts of a growing network of leading scientists and exceptional young talent, Future Africa is set to inspire science excellence to transform Africa and the world.

Many complex challenges face Africa and the global community. These include diverse issues such as climate change, food security, poverty, human rights, health and wellbeing, and biodiversity loss. We know that traditional linear and singular approaches to science are no longer appropriate, and that searching for solutions will require the scientific community to operate in fundamentally new ways. It also requires transformation-minded researchers and science leaders to drive equitable and sustainable development.

In a nutshell, Future Africa:

- Takes a future-oriented perspective on skills
- Promotes development for a new generation of science leaders in Africa
- Actively builds networks between leaders of science across Africa and the rest of the world
- Develops interdisciplinary and multinational research teams who, together with societal structures, can engage in impactful research to find solutions to complex problems
- Places equity and sustainability at the centre of its research and engagement related to African challenges



The work at Future Africa is anchored by its commitment to the African continent, the belief that knowledge generation will be the foundation of development, and the recognition that this cannot be done in isolation. To have substantive impact on the pressing issues facing society, Future Africa's value proposition is to strengthen networks, and mobilise human capital and talent to generate integrated knowledge that matters for Africa.

Earlier research supported by the CCNY provided an analysis of the challenges facing early career researchers at African universities. It identified the key areas in which further support should be provided, and suggested ways in which new collaborative mechanisms might be designed in order to do this. These included the following:

- Opportunities to stay connected to peers locally, regionally and internationally through networks and conferences, and by participating in the respective research communities
- Guidance and support to enable the development of PhD work into a publishable form and to secure postdoctoral researchers' first peer-reviewed articles
- Time and assistance to define a research agenda, design new projects and secure funding to enable the research
- Gain access to seed funding to build on doctoral work or explore new ideas
- The ability of mentors to supervise doctoral students of their own so as to contribute to the research base of their departments
- A supportive institutional context, where the institution and its senior academics seek to enable progression, encourage research, and foster collegiality and mentorship

The Future Africa ECRLF responded to this list of challenges in a structured way and provided support to achieve the objectives for the development of early career researchers. ○



PROGRESS REPORT

DEVELOPING AFRICAN CENTRES OF RESEARCH EXCELLENCE ... ONE RESEARCH LEADER AT A TIME

The ECRLF programme supports early career researchers who are previous recipients of funding from the CCNY. These fellows are from different African countries and represent a diversity of cultures, genders, ages and disciplines. The fellowship encourages transdisciplinary approaches to developing a deep understanding of the African bio-economy to address various challenges. It connects disciplines from, but not limited to, the humanities, social sciences and natural sciences to develop research projects on the broad topic of inclusive and equitable growth, through the bioresource economy, relevant to Africa's development.

The overall aim of the programme is to develop the next breed of African academics and researchers who will lead Africa's higher education sector. The fellows benefit from interactive mentorship and leadership training. This is done to prepare future academic leaders who are equipped with the necessary soft skills to lead teams for innovation and success. It also trains them to become key stakeholders in their ability to influence policy, as well as actors and experts in their disciplines to stimulate centres of research excellence that can solve complex sustainability challenges in Africa. Fellows were expected to benefit from the experience they gained and help increase the impact of their research, share knowledge and build capacity.

Composition of the programme

Initially, 16 fellows were expected to complete the postdoctoral fellowship while maintaining their home academic function. However, out of 600 applicants, only 12 fellows were accepted into the postdoctoral programme. Nine fellows were male and six were female. One fellow was not employed at an institution with an academic function. One fellow resigned from her place of employment during the course of the fellowship and is still without formal employment. Two fellows received new appointments with other institutions. Three fellows had to be let go during the two-year period. When the programme started in January 2019, eight fellows were able to arrive on time. The rest joined later in March, with the last one arriving in May 2019. By the end of 2020, nine fellows came to the end of their fellowship. Three fellows continued with their fellowship in 2021.

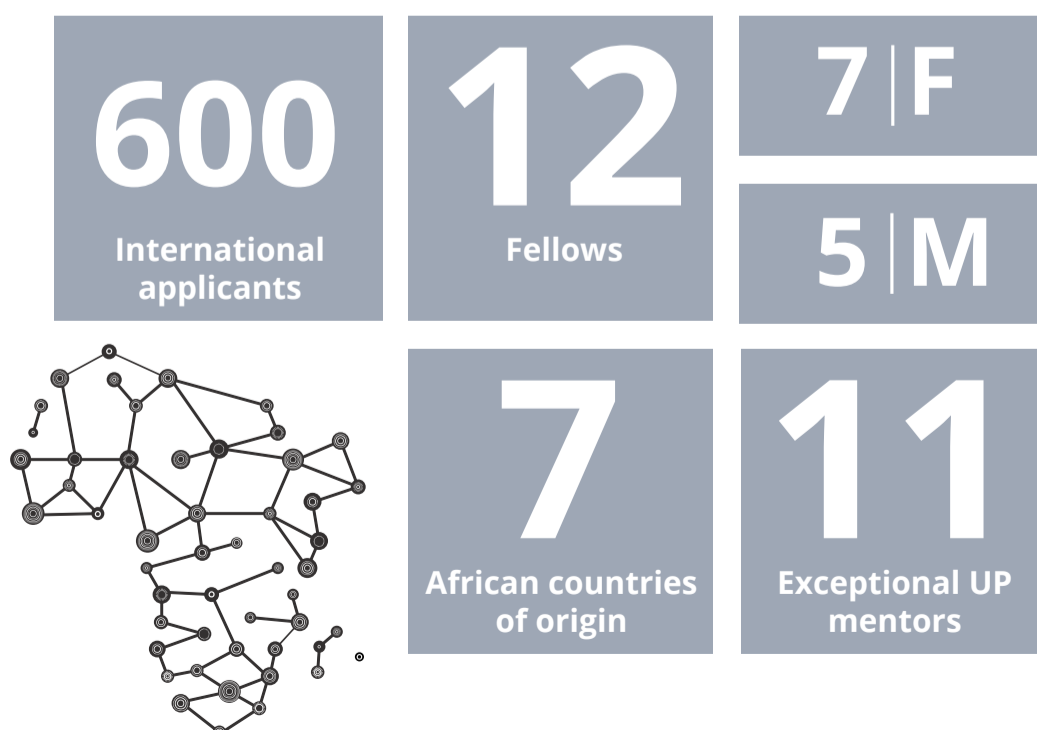
All the fellows managed to start work on their projects in 2019. The intention was to produce 16 well-designed transdisciplinary research projects with follow-on research continued at the home institution.

Unfortunately, with the sudden outbreak of the COVID-19 pandemic in March 2020, several of the fellows had their work disrupted and could not proceed as expected. The fellows tried to review their plans. This included reducing the scope to focus on the data they had available when the pandemic hit. Another common strategy implemented by a number of fellows was to increase collaborations with groups that had available data. Others were able to resume work when the restrictions started easing.

The design of the programme entailed research supervisors from the University of Pretoria actively engaging with the fellows' home institution, adding value to the sustainability of the respective projects at the home institution. The mentors with which the fellows were paired were all helpful and actively involved. Two of the 12 mentors were able to travel to the fellows' home institution and establish partnerships in that country. However, due to the COVID-19 pandemic, the visits planned for 2020 had to be suspended.

Although the initial intention was to have a cohort comprising eight male and eight female researchers sourced from different disciplines comparable to the University of Pretoria's centres of research excellence, the eventual cohort comprised seven male and five female researchers. They came from Ghana, Kenya, Malawi, Mauritius, Nigeria, Uganda and Zimbabwe.

The disciplines included animal production and nutrition, population studies, bioprocessing, African literature, cultural studies, epidemiology, plant chemistry, history, microbiology, food science and agricultural economics.



“ The design of the programme entailed research supervisors from the University of Pretoria actively engaging with the fellows’ home institution, adding value to the sustainability of the respective projects at the home institution. The mentors with which the fellows were paired were all helpful and actively involved. ”

Expected outcomes

Among the expected outcomes of the fellowship was that the fellows would be integrated into and remain active in the existing and growing pan-African network of science and research leaders. This would be done by ensuring that fellows from different countries, universities and historical backgrounds were placed in research institutions within the African universities’ network so that they could expand the quality of research needed in the African bioeconomy. The fellows were able to network and collaborate with other researchers on the continent using Future Africa’s ConnectUs initiative. The aim of this initiative is to connect African scholars and their institutions, with the aim of creating a platform for them to work together to reshape research in Africa.

The funders expected the following from both the fellows and the host institution upon conclusion of the fellowship:

- Continued support and mentorship from UP while fostering a long-term partnership between UP and the home institution
- The opportunity for fellows to gain experience in mentoring graduate students
- The continued involvement of UP, supported by the home mentor, to guide the early career researchers to establish themselves and launch research groups, branching out from their projects and experiences on the fellowship
- Training the fellows in grant applications so that they could successfully apply for and receive additional grants to fund their projects
- Expanding the research network through new collaborations and partnerships formed during the fellowship

In addition, the fellowship brought elements that only a few fellowships are able to offer, especially in Africa. These included focus on extra support that some PhD holders from some institutions in Africa do not get during training: leadership training, with a special focus on research leadership that fosters transdisciplinary engagement and collective leadership, and exposure to other offerings at Future Africa; and opportunities to network, collaborate and find new opportunities for regional and international development in all disciplines. The fellowship was able to extend the opportunity to all qualifying early career researchers in Africa with the desire to advance as researchers. It has helped some of the fellows improve their research skills, while equipping them with the leadership skills they need in academia.

Finally, the fellowship provided a platform where researchers from different fields could meet, work together, exchange ideas and develop new research projects that are aimed at addressing the challenges that hamper transformation towards a prosperous, equitable and sustainable future for Africa.

The programme also included a strong focus on developing science communication skills, and participating in Future Africa dialogues, seminars, workshops and networking engagements with international and government officials on key issues.

Assessment of fellows’ progress

The evaluation of the fellows’ progress took place as follows:

- Continuous evaluation on a daily or weekly basis by individual supervisors as part of the supervisory experience, depending on the agreed-upon engagements
- Monthly discussions among the mentor or supervisor and the fellow and teams involved to discuss progress
- A written formative evaluation in the form of a progress report that the fellow typically completes in the middle and at the end of the year, which must be approved by the mentor
- A final evaluation that involves the dissemination of the project’s conclusions, including a measurement of the postdoctoral researcher’s success, and as a professional, especially from an academic viewpoint.

This assessment focused on several core competencies for postdoctoral training and professional development, including capacity development, research skills development, communication skills, leadership development and targeting younger scholars. Each fellow was expected to conclude the fellowship with the presentation of a workshop or conference as evidence of the development of these core competencies.

The first year of the programme focused on ensuring that the fellows were able to finalise their research projects by surveying the research landscape and establishing transdisciplinary collaborations. The fellows received ongoing mentorship and skills development during this preparatory phase.

The second year was intended to focus on delivering outputs from the fellows’ proposed research activities. This included publishing their research in accredited journals, peer-reviewed books or chapters in books, op-eds, policies and peer-reviewed published conference proceedings that met the criteria of the South African Department of Higher Education and Training.

The impact of COVID-19

When the programme was launched at the beginning of 2019, no-one could anticipate the impact of a global health pandemic on the academic and research sector. The University of Pretoria was subjected to a nationwide lockdown in March 2020, in accordance with the President's risk-adjusted strategy to deal with the pandemic.

By that time, the fellows had achieved various outputs along the way to meeting their final deliverables. Although some were able to remain in South Africa, accommodated at the Future Africa residence facility, others had to return to their home countries due to personal and family commitments. The subsequent travel restrictions that were imposed also hampered the conclusion of some important activities that were supposed to take place face to face. This included the visits of the mentors to their fellows' home countries to network and collaborate with researchers in these countries, and to observe the challenges on the ground that their fellows were intent on resolving through their research.

In an effort to mitigate this situation, Future Africa proposed an alternate engagement process to increase the impact of the projects in the fellows' respective countries. It therefore decided to channel part of the remaining funding to support mentors and fellows to organise a series of national activities. These were mostly workshops, but included outreach and collaboration activities with other research groups in similar disciplines. The purpose of these activities was to share the results of the fellows' research, identify future opportunities and consolidate leadership training.

The proposed workshops would be organised by the fellow, together with the host mentor, at the fellow's home institution. This had the added benefit of giving mentors who had been unable to visit their fellows' home countries the opportunity to foster partnerships with their fellows' home institutions to develop sustainability, and expand and enhance the quality of the research done in Africa, while deepening partnerships.

Due to the challenges presented by COVID-19 and the option to present dissemination workshops to replace some of the programme's initial deliverables, Future Africa submitted a request to CCNY for a no-cost extension until 1 January 2022, which was approved.

The workshops were complemented by a final phase of activities at each of the fellows' home institutions. Each fellow had to submit a proposal and a budget for the activity; albeit a continuation of the previous event, or the development of a knowledge product (publication) inspired by the fellowship and/or previous event. Future Africa also hosted a Transdisciplinary Symposium to reflect on the ECRLF. Each of the fellows made a presentation at this symposium. This also served as a transition into the CCNY-funded Future Africa Research Leader Fellowship (FAR-LEAF) programme.

The twelve fellows that remained in the programme until the end of 2021, together with their host and home institution departments, mentors, research topics, countries of origin and home institutions, are presented in Table 1.

TABLE 1: DEPARTMENTS AND MENTORS COLLABORATING WITH FUTURE AFRICA AS HOSTS TO ECRLF FELLOWS

Country	Name, position and gender	Institution	University of Pretoria mentor	Discipline
Ghana	Dr Sherry Johnson: Lecturer F	University of Ghana: Department of Veterinary Medicine	Prof Peter Thompson: Department of Production Animal Studies	Veterinary epidemiology
Kenya	Dr Florence Opondo: Lecturer F	Laikipia University: Department of Agribusiness	Prof André Louw: Department of Agricultural Economics, Extension and Rural Development	Agribusiness value chain analysis, and enterprise development in Africa
Malawi	Dr Emmanuel Vellemu: Lecturer M	Malawi University of Science and Technology: Department of Water Resources Management	Prof Fanus Venter: Department of Biochemistry, Genetics and Microbiology	Ecosystem services, ecotoxicology and biomonitoring
	Dr Kumbukani Nyirenda: Lecturer M	Kamuzu University of Health Sciences: Department of Pharmaceutical Chemistry	Prof Namrita Lall: Department of Plant and Soil Sciences	Applied and pharmaceutical chemistry
Mauritius	Dr Carene Picot-Allain: Research assistant F	University of Mauritius: Department of Agricultural Production and Systems	Prof Naushad Emmambux: Department of Consumer and Food Sciences	Food science and food biopolymers
Nigeria	Dr Oluwole Coker: Lecturer M	Obafemi Awolowo University, Ile-Ife: Department of English	Prof Corinne Sandwith: Department of English	African literature and cultural studies
	Dr Festus Adejoro: Lecturer M	Federal University Oye-Ekiti: Department of Animal Production and Health	Prof Abubeker Hassen: Department of Animal Sciences	Animal production and health
	Dr Ifeanyi Onwuzuruigbo: Lecturer M	University of Ibadan: Department of Sociology	Prof Cori Wielenga: Department of Political Science	Political and development sociology, and conflict studies
Uganda	Dr John Mushomi: Lecturer M	Makerere University: Department of Statistics and Planning	Prof Cori Wielenga: Department of Political Science	Statistics and population studies
	Dr Alice Nabatanzi: Lecturer F	Makerere University: Department of Plant Sciences, Microbiology and Biotechnology	Prof Lyndy McGaw: Department of Paraclinical Sciences	Natural products technology and value chains
	Dr Nicholas Kagimu M	N/A	Prof Brett Hurley: Forestry and Agricultural Biotechnology Institute	Nematology
Zimbabwe	Dr Eness Mutsvangwa- Sammie: Postdoctoral Fellow F	Food Systems Research Network for Africa (FSNet-Africa)	Prof Sheryl Hendriks: Department of Agricultural Economics, Extension and Rural Development	Agricultural economics, climate change and agricultural innovation

Dissemination of outputs

The dissemination of findings and experiences assesses whether the fellows were able to achieve what they had set out to achieve on the fellowship programme. Based on the unique nature of the programme, the fellows, together with their mentors, participated in co-creation. Initially, the only form of dissemination of the outcomes was in the form of peer-reviewed publications. While this may be effective, more impact and visibility can be achieved through organised workshops where fellows and mentors can share their knowledge and engage with stakeholders. In the spirit of continuous improvement, these presentations also helped assess the impact of the programme, and how one can improve it for future cohorts.

Workshops serve as an ideal mechanism to gather the wider project audience, community or interested parties together around a particular topic. In addition to the presentation and written report that the fellows delivered at the end of the fellowship, a few more activities were proposed that would promote the fellow, not only as a recipient of the fellowship, but also as a benefactor, in their own institutions.

The workshops, which were to be hosted at each of the fellows' home institutions, were designed to include a variety of academic stakeholders and to recognise the academic life cycle: from postgraduate student to established senior researcher. Remaining cognisant of COVID-19, the workshops were planned as multi-modal events, and included real-life

engagements, virtual presentations, publicly displayed posters and printed publications.

The workshops addressed the following primary objectives of the postdoctoral programme:

- Connect disciplines within the natural and social sciences and the humanities that are affected by, or engage with, specific goals shared by scholars, practitioners in industry and non-governmental organisations, and policy makers through transdisciplinarity
- Encourage mutual learning and joint problem solving to create sustainable solutions in a real-world context
- Integrate the fellow into a pan-African network of researchers that is geared towards advancing a new paradigm for African science
- Strengthen the fellow's research at both their home institution and the host institution
- Use the project as a basis to launch or advance the development of a research programme at the fellow's home institution
- Promote interaction between a researcher at UP and academic leaders at the fellows' home institutions

Table 2 provides a summary of the workshops presented.

TABLE 2: DISSEMINATION WORKSHOPS PRESENTED AS PART OF THE ECRLF

Country	Host	Date	Organiser	Title
Ghana	University of Ghana	27–28 September 2021	Dr Sherry Johnson	One Health Conference: Zoonoses in Ghana
Kenya	Laikipia University, Kenya	6–8 July 2021	Dr Florence Opondo	Promoting Multidisciplinary Research Approaches for Sustainable Agricultural Development
Malawi	Malawi University of Science and Technology and Kamuzu University of Health Sciences, Malawi	20–22 July 2021	Dr Emmanuel Vellemu and Dr Kumbukani Nyirenda	Biodiversity for Malawi 2063 (joint workshop)
Nigeria	Federal University Oye-Ekiti and University of Ibadan, Nigeria	22–24 June 2021	Dr Festus Adejoro	Climate-smart Livestock Production in Africa Conference 2021
Uganda	Makerere University, Uganda	5–7 July 2021	Dr Alice Nabatanzi	Advancing Africa's Natural Products Industry through Transdisciplinarity and Sustainable Innovations
		14 September 2021	Dr John Mushomi	History Meets Demography: Resource Contestations, Mobility, Citizenship and Conflict in Uganda's Albertine Region and Beyond
		8–9 November 2021	Dr Nicholas Kagimu	Impact of Pathogens on Agricultural Production Workshop 2021

Fellows not included above, representing Mauritius, Nigeria and Zimbabwe, were unable to organise events due to logistical impediments..

Outreach and transdisciplinary engagement with other institutions and scholars

Based on consultations with mentors and fellows, it was suggested that the dissemination of scientific products to wider scholarship platforms should be encouraged. This would have the dual intent to extend the network and to learn from similar initiatives in other countries. Future Africa therefore decided to host a two-day in-person symposium in Pretoria with fellows and mentees residing in South Africa to discuss transdisciplinarity going forward. This symposium, which took place on 26 January 2022, involved a broader UP audience, and served as a mechanism to gather the wider community and expertise around the respective research areas.

In addition to the report that the fellows delivered at the end of their fellowship, the Transdisciplinary Symposium sought to deliver on several additional outreach activities, develop skills to implement an inclusive approach, and recognise the value of engagement with stakeholders.

The extended activities and symposium explored and designed transdisciplinary definitions and approaches that cut across universities and academic research, intergovernmental projects, non-governmental organisations (NGOs) and civil society collaboration.

Nine extended activities by fellows have been or are in the process of being organised to achieve the final phase of the no-cost extension requirements.

These include the following:

- Dr Alice Nabatanzi organised the First Natural Products Industry Advancement Network (NAPIANA) Symposium on reconceiving indigenous knowledge health systems to bridge the gap between science, societal needs and global

challenges at Makerere University, Ghana, on 17 January 2022.

- Dr Emmanuel Vellemu organised a Water Quality Management Policy Dialogue and training event in Malawi from 18 to 21 January 2022.
- Dr John Mushomi organised an ECRLF pre-publication workshop for an edited book project at Makerere University, Uganda, on 27 January 2022. This arose from the presentations delivered at his dissemination workshop, "History meets demography: Resource contestations, mobility, citizenship and conflict in Uganda's Albertine region and beyond". His mentor, Prof Cori Wielenga, serves as joint editor.
- Dr Kumbukani Nyirenda organised a three-day writing retreat in Malawi from 11 to 13 February 2022.
- Dr Sherry Johnson organised a community dissemination event on animal diseases that affect humans, with the theme "Preventing animal diseases, protecting human life", in collaboration with Ghana Veterinary Services, from 17 to 19 February 2022.
- Dr Festus Adejoro organised a technical workshop on scalable animal nutrition methodologies, hosted by the Federal University Oye-Ekiti from 14 to 15 March 2022.
- Dr Florence Opondo organised a training workshop for the publication of research outcomes in Kenya in March 2022.
- Dr Carene Picot-Allain spent an additional three months in 2022 at the Biopharmaceutical Unit at the University of Mauritius's Centre for Biomedical and Biomaterials Research to finalise her research and assess the anticancer activity of pectin recovered from citrus peel waste.
- Dr Nicholas Kagimu is delivering a presentation at the Seventh International Congress of Nematology, to be held at Antibes Juan-les-Pins, France, from 1 to 6 May 2022. ○

“ The fellowship brought elements that few are able to offer, especially in Africa. These included focus on extra support that some PhD holders from some institutions in Africa do not get during training: leadership training, with a special focus on research leadership that fosters transdisciplinary engagement and collective leadership, and exposure to other offerings at Future Africa; and opportunities to network, collaborate and find new opportunities for regional and international development in all disciplines.

”

RESEARCH OUTPUTS

Journal publications

The following publications emanated from the research that formed part of the fellowship:

- Adejoro F., Hassen A., Akanmu A., Morgavi D. (2019). Replacing urea with nitrate as a non-protein nitrogen source increases lamb growth and reduces methane production, whereas mimosa tannin has no effect. *Animal Feed Science and Technology*, 259, 114360.
- Akanmu AM, Hassen A, & Adejoro FA. (2020). Haematology and Serum Biochemical Indices of Lambs Supplemented with Moringa oleifera, Jatropha curcas and Aloe vera Leaf Extract as Anti-Methanogenic Additives. *Antibiotics* 9(9), 601
- Akanmu AM, Hassen A, & Adejoro FA. 2020. Gas production, digestibility and efficacy of stored or fresh plant extracts to reduce methane production on different substrates. *Animals*. 10(1):146.
- Cloete L., Picot-Allain C., Ramasawmy B., Neetoo H., Ramful-Baboolall D., Emmambux M. (2022). Drivers and barriers for commercial uptake of edible coatings for fresh fruits and vegetables industry – a review. *Food Reviews International*, 1–34.
- Johnson S., Kaneene J., Asare-Dompreh K., Tasiame W., Mensah I., Afakye K., Simpson V., & Addo K. (2019). Seroprevalence of Q fever in cattle, sheep and goats in Volta region of Ghana. *Veterinary Medicine and Science*, 5(3), 402–411.
- Kagimu N., Malan A. (2019). Formulation of South African entomopathogenic nematodes using alginate beads and diatomaceous earth. *BioControl*, 64, 413–422.
- Mutsvangwa-Sammie, E. (2020). Impact narratives of agricultural innovations and their implication on rural livelihoods in southwest Zimbabwe. *Outlook on Agriculture*. September 2020.
- Nabatanzi, A., Nkadimeng, S.M., Lall, N., Kabasa, J.D., & McGaw, L.J. (2020). Antioxidant and anti-inflammatory activities of *Kigelia africana* (Lam.) Benth. *Evidence-based Complementary and Alternative Medicine* (1):1–11.
- Nabatanzi, A., Nkadimeng, S.M., Lall, N., Kabasa, J.D., & McGaw, L.J. (2020). Ethnobotany, phytochemistry and pharmacological activity of *Kigelia africana* (Lam.) Benth. (Bignoniaceae). *Plants*, 9, 753;
- Nel TC, Hassen A, Akanmu AM, & Adejoro FA. (2020). The use of essential oil in combination with fibrolytic enzymes to reduce in vitro ruminal methane production. *South African Journal of Animal Science*. 50(5): 679–686.
- Nkadimeng, S., Nabatanzi, A. Steinmann, C. & Eloff, J. (2020). Phytochemical, Cytotoxicity, Antioxidant and Anti-Inflammatory Effects of *Psilocybe natalensis* Magic Mushroom. *Plants*, 9(9), 1127
- Nyirenda K., Saka J., Lall N. (2021). Nutraceutical potential of *Fadogia aencylantha*, indigenous knowledge and intellectual property rights. *Planta Med*, 87(15), 1255.
- Onwuzuruigbo, I. (2019). Land grab and conflicts in colonial Southeastern Nigeria,(1830-1960). *Ubuntu: Journal of Conflict Transformation*, 8(1), 137–160.
- Onwuzuruigbo, I. (2020). Enclaves of Banditry: Ungoverned Forest Spaces and Cattle Rustling in Northern Nigeria. *African Studies Review*, 1–24.
- Opondo, F., Owuor, G., Mshenga, P., Louw, Andre. & Jordan, D. (2020). Estimation of the effect of cassava commercialization on different household income measurements in Kilifi County, Kenya. *Journal of Sustainable Development*, 13 (1); 44–58.
- Picot-Allain C., Amiri-Rigi A., Abdoun-Ouallouche K., Aberkane L., Djefal-Kerrar A., Mahomoodally M., Emmambux M. (2022). Assessing the bioactivity, cytotoxicity, and rheological properties of pectin recovered from citrus peels. *Food Bioscience*, 46, 101550.
- Picot-Allain, MCN., Ramasawmy, B., & Emmambux, M. N. (2020). Extraction, Characterisation, and Application of Pectin from Tropical and Sub-Tropical Fruits: A Review. *Food Reviews International*, 1-31.
- Picot-Allain C., Mahomoodally M., Ak G., Zengin, G. (2021). Conventional versus green extraction techniques – a comparative perspective. *Current Opinion in Food Science*, 40, 144–156.
- Picot-Allain C., Emmambux M. (2021). Isolation, characterisation and application of nanocellulose from agro-industrial by-products: A review. *Food Reviews International*, 1(29).
- Vellemu E., Katonda V., Yapuwa H., Msuku G., Nkhoma S., Makwakwa C., Safuya K., Maluwa, A. (2021). Using the Mavic 2 Pro drone for basic water quality assessments. *Scientific African Journal*, 14, e00979.
- Vilakazi N., Nyirenda K. & Vellemu, E. (2019). Unlocking water issues towards food security: An African context. *Food Security in Africa*. *Intech Open*.

Other publications

- Kakuba, C., Golaz, V., Nankinga, O., Mushomi, J. Chapter 5: Measuring illiteracy in Uganda over the past decades: A reflection on available National Demographic Data and Indicators: Book to commemorate the 8th APC in Entebbe, Uganda
- Nankinga, O., Kakuba, C., Golaz, V., Mushomi, J. Chapter 7: Out-of-school children in Uganda over the past decades: A reflection on available National Demographic Data and Indicators: Book to commemorate the 8th APC in Entebbe, Uganda
- Mushomi, J.A., Mirembe, S. Chapter 10: Determinants of receipt of migrant remittances in households: Evidence from Uganda's population and housing census: Book to commemorate the 8th APC in Entebbe, Uganda
- Mutsvangwa-Sammie, E. (October 2020). Why a Zimbabwean farming project failed: lessons for rural innovation. *The Conversation Africa*.
- Nyirenda K. (2020). In Erkekoglu P., Ogawa, T. (eds) *Medical toxicology: Toxicity potential of cyanogenic glycosides in edible plants*, Intech Open.
- Onwuzuruigbo, I. (April 2019). Why Nigeria's insecure forests are fertile ground for cattle rustlers. *The Conversation Africa*.

Conferences

- Eighth International Scientific Conference on Global Health Security, Makerere University, Uganda, 28–29 June 2019.
- Eighth International Congress on Sustainability Science and Engineering (ICOSSE '19). Kuala Lumpur, Malaysia. 1–3 July 2019
- Global Forum on Women in Scientific Research. Senegal, 18–19 July 2019.
- Twenty-third Biennial International Congress and Exhibition: Food Science and Technology for the 21st Century. Johannesburg, South Africa. 1–4 September 2019
- Eighth European Conference of African Studies Edinburgh, United Kingdom. 11–14 June 2019.
- Second Annual Sustainability and Development Conference Michigan, USA. 11–14 October 2019
- Sixty-second ISI World Statistics Congress 2019 (ISI WSC 2019). Kuala Lumpur, Malaysia. 18–23 August 2019
- Fifty-eighth Annual Meeting of the Society of Nematologists. North Carolina. USA. 7–10 July 2019
- The African Research Universities Alliance (ARUA), International Conference University of Nairobi, Kenya. 18–20 November, 2019
- Fifth International Conference on Agricultural and Biological Sciences (ABS 2019). Macau, China. 21–24 July 2019
- Annual International Southern Africa Social Protection Expert Network (SASPEN) Conference, Johannesburg, South Africa. 14–15 August 2019
- Third International Conference on Traditional Medicine, Phytochemistry and Medicinal Plants. 2–4 November 2020
- 69th International Congress and Annual Meeting of the Society for Medicinal Plant and Natural Plant and Natural Product Research (GA), Bonn, Germany, 5–8 September 2021.

Grants awarded

- Fleming Fund (Ending Pandemics) grant for joint research between Tel Aviv University and the University of Ghana. Project: One Health surveillance of antimicrobial resistance in non-typhoidal *Salmonella*, *Klebsiella pneumoniae*, and other gram-negative bacteria (pilot implementation in Ghana) (2021)
- Fleming First Country Grant on Antimicrobial Resistance Surveillance. Animal Health Team of the University of Ghana (2019–2020)
- Government of Uganda through Makerere University, Kampala. Mapping the mobility patterns, perceptions, preparedness and response mechanisms towards COVID-19 for Uganda's border communities (2020)
- Government of Uganda through Makerere University, Kampala. Development of value-added phytogenic feed additives to replace conventional antibiotics in chicken feeds (2020)
- Government of Uganda through Makerere University, Kampala. Developing an integrated framework for addressing population, health and environment for refugees and host communities in Uganda (2019)
- Government of Uganda through Makerere University, Kampala. Developing multipurpose phytonutraceuticals from indigenous wild edible fruits and vegetables for Mitigating Malnutrition among pregnant women and school-going children (2019)
- Government of Uganda through Makerere University, Kampala. Development of a safe and efficacious anti-malarial drug from traditional medicine (DESAT) (2019)
- Grant application to attend the DAAD-Alumni Seminar at Witzenhausen, University of Kassel 10–21 September.
- Access to credit by smallholder farmers to finance climate smart Agriculture – TIMPS through Rural Finance Markets in Kenya.
- Funding for the integration of small-scale fisheries into the tourism value chain by the South African Local Government Sector Education Training Authority (LGSETA)

SYMPOSIUM

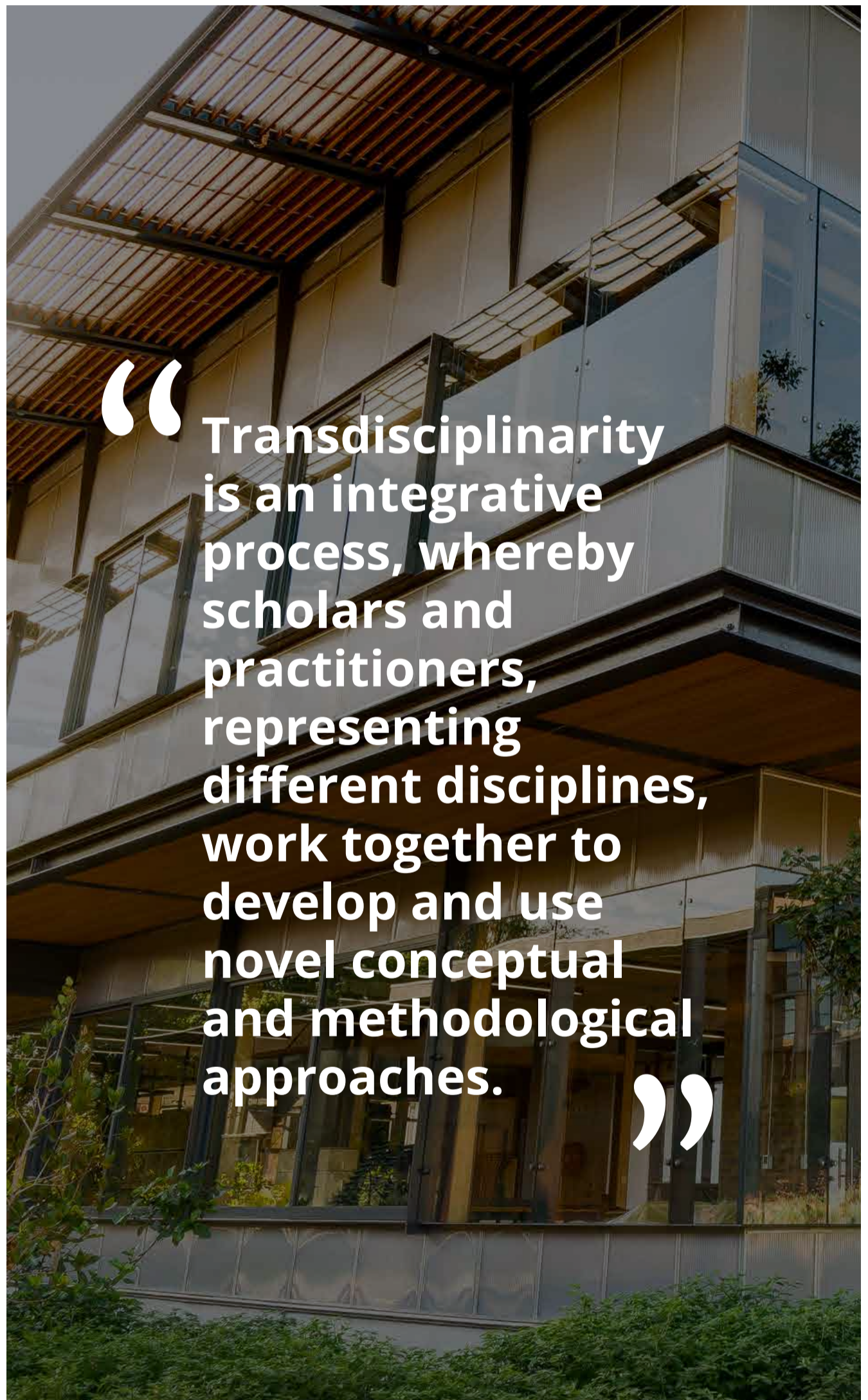
TRANSDISCIPLINARY SYMPOSIUM GATHERS THE BROADER COMMUNITY AROUND FELLOWS' RESEARCH

On 26 January 2022, Future Africa hosted a two-day in-person Transdisciplinary Symposium in Pretoria with fellows and mentees who resided in South Africa to discuss transdisciplinarity going forward. This symposium involved a broader UP audience and served as a mechanism to gather the wider community and expertise around the research areas investigated as part of the Early Career Research Leader Fellowship (ECRLF).

The symposium sought to deliver on several outreach activities, develop skills to implement an inclusive approach, and recognise the value of stakeholder engagement. It explored and designed transdisciplinary definitions and approaches that cut across universities and academic research, intergovernmental projects, non-governmental organisations (NGOs) and civil society collaboration.

It addressed the following primary objectives:

- Connect disciplines within the natural and social sciences and the humanities, and engage with researchers, specialists, policy makers and practitioners in industry, government, intergovernmental organisations and NGOs engaging with transdisciplinarity
- Explore transdisciplinarity by encouraging mutual learning and joint problem solving to create sustainable solutions in a real-world context
- Consider the type of training needed by communities, the current capacity at UP and elsewhere, and identify various target audiences
- Integrate the definition of transdisciplinarity into a pan-African network of researchers who are geared towards advancing a new paradigm for African science
- Engage with other partners about ways they apply transdisciplinarity and share experience through transdisciplinary platforms. Collaborative partnerships include the Carnegie Corporation of New York (CCNY), the United Nations Children's Fund (UNICEF), Climate, Land, Agriculture and Biodiversity (CLAB) experts at Future Africa, the Centre for the Advancement of Scholarship at the University of Pretoria, as well as UP's transdisciplinary platforms Innovation Africa, Javett Arts and Engineering 4.0
- Strengthen the fellows' research at both their home institution and the host institution



“ Transdisciplinarity is an integrative process, whereby scholars and practitioners, representing different disciplines, work together to develop and use novel conceptual and methodological approaches. ”

The symposium was attended by 147 individual participants, with attendees from West Africa, East Africa and southern Africa. Dr Neeraj Mistry, Deputy-Director of Future Africa, welcomed delegates to the event, which was made possible with the support of CCNY. Prof Wanda Markotter, Research Chair at Future Africa, introduced the symposium programme, expressing her enthusiasm for this opportunity to learn from the fellows about their experiences on the postdoctoral programme.

Prof Stephanie Burton, the University's former Vice-Principal: Research and Postgraduate Education and a member of Future Africa's management team, expressed the fact that African research excellence, such as that developed through Future Africa, depends on programmes such as CCNY's ECRLF programme. It is through such initiatives that Future Africa's aspirations for African research leadership can be achieved.

She introduced the delegates to the Future Africa Research Leader Fellowship (FAR-LeaF), to be launched on 1 February 2022. This would extend the achievements of the ECRLF, focusing on transdisciplinary work related to the nexus of wellbeing and the environment in Africa (including the social and economic environment). "We are excited to encourage projects in Africa for Africa to enhance the continent's wellbeing," she concluded.

This was followed by an introductory message on transdisciplinarity by Prof Barend Erasmus, the University's Dean in the Faculty of Natural and Agricultural Sciences. He emphasised the fact that transdisciplinarity is as much an attitude and approach as it is a tool to conduct complementary research. This was corroborated by Dr George Lueddeke, leader of the international One Health for One Planet Education initiative, who stressed the relevance of transdisciplinarity and encouraged greater collaboration across all sectors of society and academic disciplines.

Finally, nine of the ECRLF postdoctoral fellows had the opportunity to present their research, their experiences of the fellowship, and how these related to transdisciplinarity. According to Rachel Fischer, the programme coordinator, it was evident that the fellows had benefitted a great deal from the programme. "Most striking was their level of engagement with the local communities in their home countries", she remarked.

All the projects reported on collaboration with grassroots entities, ensuring a bottom-up approach, complemented by top-down efforts in terms of academic research and policy development.

The presentations by the fellows were as follows:

- Dr Alice Nabatanzi, Makerere University, Uganda: "Anticancer activity and anticancer mechanisms of action of *Kigelia africana*"
- Dr Festus Adejoro, Federal University Oye-Ekiti, Nigeria: "Effect of encapsulated tannin extract on rumen microbiome, microbial protein synthesis and nitrogen balance in growing merino lambs"
- Dr Kumbukani Nyirenda, Kamuzu University of Health Sciences, Malawi: "Physicochemical properties and applications of nanomaterials from Malawian underutilised plant species"
- Dr John Mushomi, Makerere University, Uganda: "Emerging rural capitalism and insecurities in Uganda's oil district"
- Dr Florence Opondo, Laikipia University, Kenya: "Investigating drivers of cassava value chain commercialisation and upgrading as a poverty reduction strategy in Kenya and Nigeria"
- Dr Sherry Johnson, University of Ghana: "Rift Valley fever, brucellosis and Q fever at the livestock-human interface in southern Ghana"
- Dr Carene Picot-Allain, University of Mauritius: "Extraction and characterisation of pectin, micro and nanocellulose from grape pomace and grapefruit peel"
- Dr Emmanuel Vellemu, Malawi University of Science and Technology: "Development of an aquatic biodiversity information system for a sediment impact river"
- Dr Nicholas Kagimu, Makerere University, Uganda: "Biocontrol potential of metabolites from *Xenorhabdus* and *Photorhabdus* bacteria for agricultural application"

The symposium was concluded with a 40-minute question-and-answer session, which elicited a robust discussion on transdisciplinarity. It became clear that more events of this nature needed to be hosted to foster continuous collaboration and strengthen networks across Africa. ○

What is transdisciplinarity?

Transdisciplinarity is an integrative process, whereby scholars and practitioners, representing different disciplines, work together to develop and use novel conceptual and methodological approaches. Stakeholders bring the wealth of knowledge about their disciplines into a new arena, which transcends disciplinary boundaries.

Transdisciplinary research is an approach to problem-solving that coordinates a variety of scientific and non-scientific actors, including stakeholders, to integrate diverse types of knowledge, consider the risks and consequences of possible solutions, and generate practical solutions that may be implemented.

GHANA



UNIVERSITY OF GHANA



The University of Ghana is the premier and largest university in Ghana. It was founded as the University College of the Gold Coast by Ordinance on 11 August 1948 for the purpose of providing and promoting university education, learning and research. The University's vision is to become a world-class research-intensive institution over the next decade.

As part of this vision, the University of Ghana has identified four priority areas to promote international collaboration in research initiatives. These comprise malaria research, transdisciplinary research into climate change adaptation, enhancing food production and processing, and development policy and poverty monitoring and evaluation.

The University aims to produce the next generation of thought leaders to drive national development. In this way, it seeks to create an enabling environment to elevate its relevance to national and global development through cutting-edge research and high-quality teaching and learning.

The University of Ghana has several research institutions and centres for learning and research, including the Noguchi Memorial Institute for Medical Research, the Centre for Tropical, Clinical Pharmacology and Therapeutics, the Regional Institute for Population Studies, the Institute for Environmental and Sanitation Studies and the Institute for Statistical, Social and Economic Research.

Webometrics Rankings place the University of Ghana in 11th position in sub-Saharan Africa and in 1 121st position in the world. ○

No. 1 University in Ghana



DR SHERRY JOHNSON

Dr Sherry Johnson is a senior lecturer in the School of Veterinary Medicine at the University of Ghana's College of Basic and Applied Sciences in Accra. She obtained her PhD in Veterinary Clinical Studies from the University of Nairobi in Kenya in 2015. The focus of her postdoctoral studies is Rift Valley fever, brucellosis and Q fever at the livestock and human interface in Southern Ghana.

With a background in applied epidemiology, her research focus has been on neglected zoonotic diseases (either in livestock or companion animals) and the One Health approach to tackling these diseases. Some diseases that she has worked on include rabies, Q fever and Rift Valley fever. She believes that researching and controlling diseases that can be passed from animals to humans ultimately saves lives.

Her research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Rift Valley Fever, brucellosis and Q fever at the livestock-human interface in southern Ghana



FELLOW'S RESEARCH HIGHLIGHTS

Other postdoctoral fellowships

United States Department of Agriculture (USDA) Food and Agriculture Service Faculty Exchange Programme, Michigan State University, USA (August to December 2016)

Grants

Fleming Fund (Ending Pandemics) grant for joint research between Tel Aviv University and the University of Ghana. Project: One Health surveillance of antimicrobial resistance in non-typhoidal *Salmonella*, *Klebsiella pneumoniae*, and other gram-negative bacteria (pilot implementation in Ghana) (2021)

Fleming First Country Grant on Antimicrobial Resistance Surveillance. Animal Health team of the University of Ghana (2019–2020)

Arthropod-borne Infectious Disease Surveillance Project. Sponsored by the African Small Animal Network (AFSCAN), a project of the World Small Animal Veterinary Association (WSAVA) (2018–2020).

BANGA-Africa Seed Grant, funded by Carnegie Corporation of New York (2018–2019)

University of Ghana Staff PhD Grant (2014)

University of Ghana/Next Generation of Academics in Africa (2013)

Conference Grant to the Training Programmes in Epidemiology and Public Health Interventions Network (TEPHINET) Conference in South Africa (2010)

Publications

Heylen D., Day M., Schunack B., Fourie J., Labuschange M., Johnson S., Githigia S., Akande F., Nzalawahe J., Tayebwa D., Aschenborn O., Marcondes M., Madder M. (2021). A community approach of pathogens and their arthropod vectors (ticks and fleas) in dogs of African sub-Saharan. *Parasites Vectors*, 14, 57.

Tasiame W., Johnson S., Burimuah V., Akyereko E., El-Duah P., Amemor E., Owiredu E. (2020). Outbreak of highly pathogenic avian influenza in Ghana, 2015: Degree of losses and outcomes of time-course outbreak management. *Epidemiology and Infection*, 148, E45.

Johnson S., Kaneene J., Asare-Dompreh K., Tasiame W., Mensah I., Afakye K., Simpson V., Addo K. (2019). Seroprevalence of Q fever in cattle, sheep and goats in Volta region of Ghana. *Veterinary Medicine and Science*, 5(3), 402–411.

Tasiame W., Johnson S., Burimuah V., Akyereko E., Amemor E. (2019). Dog population structure in Kumasi, Ghana: A missing link towards rabies control. *Pan-African Medical Journal*, 33.

Johnson S., Bugyei K., Nortey P., Tasiame W. (2017). Antimicrobial drug usage and poultry production: Case study in Ghana. *Animal Production Science*, 59(1), 177–182.

Johnson S., Gakuya D., Mbuthia P., Mande J., Afakye K., Maingi N. (2016). Myiasis in dogs in the Greater Accra region of Ghana. *Vector-Borne and Zoonotic Diseases*, 16, 54–57.

Tasiame W., Emikpe O., Folitse D., Fofie C., Burimuah V., Johnson S., Awuni A., Afari E., Yebuah N., Wurapa F. (2016). The prevalence of brucellosis in cattle and their handlers in North Tongu district of Volta region, Ghana. *African Journal of Infectious Diseases*, 10, 111–117

Afakye K., Kenu E., Nyarko K., Johnson S., Wongnaah F., Bonsu M. (2016). Household exposure and animal-bite surveillance following human rabies detection in Southern Ghana. *The Pan African Medical Journal*, 25 (Supp 1), 12

Tasiame W., Emikpe B., Folitse R., Fofie C., Johnson S., Burimuah V., Atawalna J., Boateng E., Amemor E. (2016). Foetal wastage in sheep and goats at the Kumasi Abattoir in Ghana: A cross-sectional study. *Archives of Basic and Applied Medicine*, 4, 95–98

Johnson S., Gakuya D., Mbuthia P., Mande J., Maingi N. (2015). Prevalence of gastrointestinal helminths and management practices for dogs in the Greater Accra region of Ghana. *Heliyon* 1(1), e00023.



Mentor profile

PROF PETER THOMPSON

Peter Thompson is a professor in Veterinary Epidemiology in the Department of Production Animal Studies in the University of Pretoria's Faculty of Veterinary Science at Onderstepoort. He obtained both his BVSc and his MMedVet (cum laude) from the University of Pretoria, and his PhD from Utrecht University in The Netherlands. He joined the Faculty as a senior lecturer in 1992 and was promoted to a full professor in 2014.

He has a C1 rating from the National Research Foundation, which classifies him as an established researcher with a sustained recent record of productivity in the field, who is recognised by his peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

His research expertise lies in the epidemiology of infectious diseases, particularly transboundary, emerging and zoonotic diseases at the wildlife-livestock-human interface, such as Rift Valley fever, foot-and-mouth disease, Newcastle disease and brucellosis, and pathogens of food safety concern such as *E. coli* and *Salmonella*. He is also interested in the risk factors and impacts of disease in commercial livestock production systems.

His interest in this research sub-theme stems from the fact that a large number of infectious agents are able to infect multiple species, including wildlife, domestic animals and/or humans. Indeed, the majority of infectious diseases in humans originally come from wildlife. Currently, with increasing human population pressure and the fragmentation of ecosystems, interfaces are becoming more complex and the potential for the transmission of diseases between compartments is greater than ever. A better understanding of the occurrence, distribution and dynamics of such diseases is necessary to better control them and reduce their impact, thereby protecting the health of wildlife populations, domestic species and humans alike. ○

CURRENT RESEARCH PROJECTS

- The epidemiology of Rift Valley fever in livestock, humans and wildlife in the Free State, Northern Cape, North West, Limpopo and KwaZulu-Natal provinces of South Africa
- Studies on mosquito populations in wildlife-livestock interface areas, with reference to the transmission of arboviruses
- Studies on the epidemiology of Q fever, brucellosis and other infectious and zoonotic diseases

RIFT VALLEY FEVER, BRUCELLOSIS AND Q FEVER AT THE LIVESTOCK-HUMAN INTERFACE IN SOUTHERN GHANA

Postdoctoral fellow: Dr Sherry Johnson
Mentor: Prof Peter Thompson

When a livestock farmer or herder, in a bid to raise animals to feed their family and the nation, succumbs to a disease that is acquired from their livestock, that calls for reflection and action. This was the driver of Dr Sherry Johnson's research on transmissible diseases from animals to humans, both from companion animals and animals bred for human consumption.

Zoonotic diseases are diseases that are transmissible from animals to humans. According to the Centre for Disease Control (CDC), over 60% of infectious diseases in humans are zoonotic, and three out of every four new or emerging infectious diseases in people come from animals. Most of these diseases are preventable or can be better managed when more information is known about them in a given geographic area.

"I have seen people die due to zoonotic diseases like rabies, and one death to a zoonotic disease is one too many,"
remarks Prof Johnson.

Rift Valley fever (RVF), brucellosis and Q fever are re-emerging zoonotic diseases of sheep, goat and cattle, which cause abortion storms in livestock and fever-like symptoms in humans. Although Ghana had not yet identified cases of these diseases, it is a priority disease in some of its neighbouring countries, such as Cote d'Ivoire, Burkino Faso and Togo. It therefore has the potential to have a huge economic and public health impact in countries in West Africa.

With a background in veterinary medicine, Dr Johnson identified the occurrence of RVF in Ghana as a research topic that she could investigate to improve the health and welfare of both man and animal on the continent.

The aim of her study was to survey the seroprevalence of RVF in cattle, sheep, goats and livestock herders in the southern part of Ghana and assess risk factors for occurrence. She assessed demographic data of livestock, farm characteristics, flock health history and risk factors using a structured questionnaire.

Her fieldwork, which entailed a survey of 165 livestock farms in the Ga South (Greater Accra region) and Kwahu East (Eastern region) of southern Ghana, delivered serum samples of 253 goats, 253 sheep, 213 cattle and 155 herdsmen. These samples were tested to detect IgG and LgM antibodies against RVF virus in livestock and humans.

She discovered that abortions on farms and while assisting in delivery were significantly associated with RVF virus in the livestock herders. The disease was also more prevalent in male herders than in female members of the community.

Although she was able to process the animal samples in her home country, she benefitted from contacts that she established with the South African National Institute for Communicable Diseases (NICD), where the human samples could be processed.

The findings of her research revealed that, although RVF had not yet been identified as a priority disease in her home country of Ghana, there were indeed cases of the disease. Ongoing stakeholder engagement should lead to its inclusion as a disease of concern at the livestock-human interface in this country.

In a first report of its kind, Dr Johnson noted that RVF virus was shown to have been circulating in southern Ghana. She suggests a One Health approach to understand, prevent and control future outbreaks.

Challenges Dr Johnson experienced during her fellowship related to the delay in obtaining ethical clearance and the impact of the COVID-19 pandemic, which affected the delivery of laboratory reagents and kits to Ghana for testing. However, with the support she received from her mentor and other collaborators, she was able to successfully complete her study.

Reflecting on the fellowship, Dr Johnson feels that it has added value to her research. She is particularly grateful that her mentor encouraged her to expand her initial research proposal, in which she had planned to only examine Q fever, to include RVF and brucellosis as well. As Prof Thompson had worked extensively with RVF, he was able to provide her with expert guidance, and also to put her into contact with specialists at the NICD who could assist her in finalising her research.

According to Prof Thompson, most of the work on RVF in Africa has been conducted in East and southern Africa, with little research having been conducted to date in the humid coastal areas of West Africa. He was therefore excited about the opportunity to be involved in research in a part of the continent in which little work had previously been done, and where there were many gaps in terms of the prevalence of the disease.

During the course of her fellowship, Dr Johnson was also able to work on completing two manuscripts for publication: "Evidence of endemic Rift Valley fever virus circulation in southern Ghana" and "Brucellosis at the human-livestock interface in southern Ghana".

As an academic, the impact of the fellowship was observed by her home institution, where she was promoted from lecturer to senior lecturer. She attributes this to the capacity building activities she undertook at Future Africa. The fellowship also gave her a better idea of the meaning of transdisciplinary research. "The ECRLF programme provided me with the skills and opportunity to work in a transdisciplinary manner to solve problems that would have been difficult to solve through a one-discipline approach. I learnt what it meant to collaborate with other researchers and to leverage on each other's strengths." She particularly appreciated the way that the fellows on the programme were able to work together in a non-threatening way so that everyone could contribute something.

To enhance awareness of zoonoses in Ghana, particularly within the context of the One Health concept, Dr Johnson organised the One Health Conference at the University of Ghana in September 2021.

In addition to disseminating the findings of her own research, she was able to provide a platform for other researchers concerned about the transmission of diseases between humans and animals in Ghana. "I particularly hoped to create an awareness of zoonotic diseases in my country, and to provide the opportunity for discussion."

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The findings of her research revealed that, although Rift Valley fever had not been identified as a priority disease in her home country of Ghana, there were indeed cases of the disease. Ongoing stakeholder engagement should lead to its inclusion as a disease of concern at the livestock-human interface in this country.

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She also organised a community dissemination event in two communities in Kwahu East in February 2022. The purpose of this event, presented to the Sempoa and Hyewohoden communities, was to educate the community members and create awareness of zoonotic diseases in this area. The event, with the theme: “Preventing animal diseases, protecting human life”, was presented in collaboration with the Veterinary Services Directorate of the Ghana Health Service in the Ministry of Food and Agriculture.

Further outcomes of her fellowship include her participation, in 2021, in a joint research project between Tel Aviv University and the University of Ghana. The project, titled “One Health surveillance of antimicrobial resistance in non-typhoidal *Salmonella*, *Klebsiella pneumoniae* and other gram-negative bacteria (pilot implementation in Ghana)”, was funded by Ending Pandemics, under the Fleming Fund, located in San Francisco, California.

The experience of being mentored by a specialist in the field of veterinary epidemiology has enabled her to act as a supervisor to a PhD student at the University of Bonn in Germany, who is working on a research project focused on the One Health approach.

The proposal-writing skills she acquired have enabled her to join a team of researchers from Ghana, Uganda, Tanzania, Zambia and the Norway University of Life Sciences to apply for a grant from the Research Council of Norway on a collaborative knowledge-building project to promote the sustainability of antimicrobial resistance preparedness in sub-Saharan African countries. Preliminary approval has been obtained; the team is awaiting the outcome of the full proposal.

She gives a huge thanks to Future Africa and the University of Pretoria for providing the serene atmosphere, appropriate resources and the right mentorship programme to develop her research career and collaborate with other scientists from the African continent.

“The thought leadership, team building and engagement training at Future Africa prepares any fellow who goes through the programme with the tools necessary for looking beyond individual disciplines to a transdisciplinary approach to solve African problems in an African way,” she concludes. ○



RIFT VALLEY FEVER KEY FACTS

- Rift Valley fever is a viral mosquito-borne zoonotic disease caused by the Rift Valley fever virus that primarily affects animals, but can also infect humans.
- Rift Valley fever is most common in domesticated animals in sub-Saharan Africa, such as cattle, buffalo, sheep, goats and camels.
- Outbreaks of Rift Valley fever in animals can be prevented by a sustained programme of animal vaccination.
- The incubation period from infection to the onset of symptoms varies from two to six days.
- Human infections may result through contact with blood, body fluids or tissue from infected animals during slaughtering or butchering, assisting with animal births, conducting veterinary procedures or from the disposal of carcasses or foetuses. It can also be transmitted through bites from infected mosquitoes.
- It is a reportable disease that is listed by the World Organisation for Animal Health (OIE)

ONE HEALTH CONFERENCE

The theme of the One Health Conference, presented at the Centre for African Wetlands at the University of Ghana on 27 and 28 September 2021, was: “Zoonoses in Ghana: Focusing on the One Health Concept”. The conference was organised by postdoctoral fellow Dr Sherry Johnson from the University of Ghana, and attracted 133 participants across various disciplines from academia, industry and government institutions. They attended the congress physically or virtually.

Research collaborations between the fellow and the conference participants have been developed. She is currently working on a research collaboration on COVID-19 in companion animals in Ghana with one of the participants from the University of Health and Allied Sciences and others from Ghana’s Veterinary Services and the University of Ghana.

The conference had the following objectives:

- Encourage transdisciplinary participation
- Share the fellow’s findings with scholars, practitioners in industry, non-governmental organisations and policy makers
- Strengthen her research base
- Promote interaction between the University of Pretoria and the University of Ghana
- Encourage mutual learning and joint problem solving to create sustainable solutions in a real-world context

The following presentations were delivered:

- “Rift Valley fever, brucellosis and Q fever in the livestock-human interface in Ghana” – Dr Sherry Johnson, School of Veterinary Medicine, University of Ghana
- “Research and training needs in One Health: Necessary step for emergency preparedness and response to outbreaks in Ghana” – Ben Emikpe, School of Veterinary Medicine, Kwame Nkrumah University of Science and Technology, Ghana
- “Ghana’s COVID-19 pandemic response” – Ernest Konado Asiedu, Quality Management Unit, Ghana Ministry of Health
- “Detection of potential zoonotic viruses in bats and rodents in an agricultural settlement in Ghana” – Dr Richard Suu Ire, School of Veterinary Medicine, University of Ghana
- “Dynamics of avian influenza virus in poultry in the Greater Accra region of Ghana amongst the production levels” – Theophilus Odoom, Accra Veterinary Laboratory, Ghana Veterinary Services Department
- “High prevalence of human balantidiasis in two farming communities in Ga West Municipality, Ghana” – Enoch Aninagyei, University of Health and Allied Sciences
- “Rabies virus in slaughtered dogs for meat consumption in Ghana: A potential risk for rabies transmission” – Dr William Tasiame, School of Veterinary Medicine, Kwame Nkrumah University of Science and Technology
- “Rabies and dog bite cases in the Tema Enclave: A 12-month record review” – Emmanuel Peku, Veterinary Services, Tema
- “Gastrointestinal parasites among farm workers and livestock in selected areas in Accra, Ghana” – Richard Asmah, University of Health and Allied Sciences
- “Prevalence of zoonotic diseases detected in some captive wildlife management facilities in Ghana” – YM Ziekah, Kumasi Zoological Gardens
- “The role of digital/smart surveillance during outbreaks: The Ghana experience in COVID-19 response” – Isaac Owusu, Disease Surveillance Department, Ghana Health Service
- “*Campylobacter* spp. and *Lactobacillus* spp. in cattle kraal and milk” – Suraj Mohammed Alhassan, Department of Veterinary Sciences, University for Development Studies
- “Occurrence of multidrug resistant bacteria in meat sold in Accra” – Derick Asinor
- “Avian influenza outbreak among poultry birds in some poultry farms in Greater Accra region, Ghana” – Abdul Gafaru Mohammed, Ghana Field Epidemiology and Laboratory Training, School of Public Health, University of Ghana
- “Survey of toxoplasma in pigs in selected districts of Greater Accra” – Frank Doku, University of Ghana
- “Zoonotic microbes (*E. coli* and *Salmonella* spp.) in locally produced fruit juice” – Firdaus Iddrisu Jimma, University for Development Studies
- “Profile of *Escherichia coli* isolated from nose and ear of dogs” – Abudu Gafaru, University for Development Studies
- “Survey of Q fever in sheep in the Kwahu West Municipality, Eastern region, Ghana” – Richard K Abbiw



Presenters at the dissemination conference in Accra, Ghana

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Dr Johnson suggests that further studies are required to determine the seroconversion rate and the lineage of RVF virus. Risk mapping to predict and prevent future outbreaks is also needed.

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Sharing the research findings in two communities in Kwahu East



Dr Sherry Johnson presenting her research at the dissemination workshop





RAISING AWARENESS OF ZONOTIC DISEASES IN RURAL GHANA

Dr Sherry Johnson was able to successfully conclude her fellowship by disseminating her research findings in two communities in her study sites in southern Ghana. The communities, Sempoa and Hyewohoden, are two deprived farming communities in the Kwahu East region, which both recorded a high prevalence of Rift Valley fever, brucellosis and Q fever, which she investigated as part of her research.

These three diseases, which were identified in the study area, are transmissible from animals to humans. Their control in the affected communities requires a multi-sectoral approach, involving the Veterinary Services Directorate of the Ministry of Food and Agriculture, Ghana Health Services, the Environmental Protection Agency and Social Services. The theme of the event was: "Preventing animal diseases, protecting human life".

As part of her dissemination initiative, she engaged several key stakeholders on 17 February 2020. These stakeholders included the District Director of Health, the District Director of Agriculture, veterinary staff, and chiefs and other members of the District Assembly.

The aim of the dissemination event was to present her research findings and their implications, and to ensure that these three

diseases were kept on the radar of the health authorities. It was evident that Rift Valley fever virus had never been considered as a disease condition presented at the district's hospital and veterinary clinics. Creating awareness of the prevalence of this disease thus proved to be useful.

Following the stakeholder engagement, she organised two community durbars: in Hyewohoden on 18 February and in Sempoa on 19 February. These events were attended by livestock farmers, community leaders, veterinary staff and the Disease Control Officer (DCO) for Kwahu East. As she educated the farmers on the three diseases, the DCO focused on educating the people on the need to report promptly for medical attention.

During the durbars, the farmers confirmed that they were recording a lot of abortions in their livestock, but did not know much about the three diseases. There were extensive discussions on the diseases and the community agreed to implement biosecurity measures on their farms to protect themselves and their livestock. They expressed profound gratitude for the education they received, as this was the first time they had been briefed by a researcher in those areas. They requested more such engagements to bring new knowledge on livestock farming. The farmers were also provided with anti-parasitic drugs for their livestock.

These engagements were very important to the communities and the other stakeholders as the only health facility in each of the communities was a Community-based Health Planning and Services compound. Such compounds are health outlets to handle sick patients in far-to-reach areas in Ghana. These two communities, in particular, have poor road access and are difficult to reach during the rainy season.

A challenge that was identified in both communities was access to animal health care as the communities did not have a veterinary post. This, coupled with poor road access, made them struggle when veterinary services were required.

It was suggested that the communities arrange for a group approach to animal care services to enable the veterinary staff to move into the community to attend to more than one kraal at a time. In Sempoa, the community complained about the lack of potable water, which resulted in both humans and livestock drinking from the same river. This is a risk factor for the occurrence of zoonotic diseases.

Dr Johnson believes that the community event succeeded in raising the awareness of community members of the causes and symptoms of zoonotic diseases, and what they can do to prevent and treat them. ○

“ Reflecting on the fellowship, Dr Johnson feels that it has added value to her research. ”



KENYA



LAIKIPIA UNIVERSITY



Laikipia University is located in Nyahururu, Kenya. The University has a unique history that has evolved through different educational phases. It was initially established as a campus of Egerton University in 1990. In 2011, the institution became a constituent university college of Egerton University until 2013, when it became a fully fledged university.

The University is developing its infrastructure and human resource capacity. Currently, academic programmes are organised into four major areas: the School of Education, the School of Humanities and Development Studies, the School of Science and Applied Technology, and the School of Business and Economics.

Laikipia University is endowed with a number of resources. These include the 927 acres on which the main campus sits, 200 acres in Rumuruti, and another 100 acres in Maralal town. Currently, the University undertakes dairy, crop and horticulture production. In addition, the University is in the process of establishing a demonstration farm that will benefit both students and society.

The University also organises research and innovation forums, which cover a broad range of themes. While the University recognises the vital contribution made by researchers working on their own, teams and multidisciplinary groups are encouraged.

Laikipia University is committed to becoming a reputable research-intensive destination that drives creativity and discovery with its community of researchers by providing a conducive environment. Through the work of its researchers, the institution is dedicated to innovation and intellectual discovery. ○



DR FLORENCE OPONDO

Dr Florence Opondo is a lecturer, researcher and consultant in Agribusiness Management at Laikipia University, Kenya. She obtained her PhD in Agribusiness Management from Egerton University, Njoro, Kenya, in 2018. The focus of her postdoctoral studies is the value chain commercialisation of an orphan crop as a means to alleviate poverty in East Africa.

With a background in agribusiness management, her research focus has been on agribusiness value chain analysis, especially of underutilised crops. She has published widely and has attended conferences both nationally and abroad. She has also participated in a number of panel discussions on various topics, including entrepreneurship and agricultural enterprise development in Africa (especially among women and the youth), sustainable agriculture for food security, improved nutrition and the eradication of hunger, and social networks and agricultural technology in comparing social protection strategies, practices and knowledge to develop rural areas.

Her research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Investigating the drivers of cassava value chain commercialisation and upgrading as a poverty-reduction strategy in Kenya and Nigeria



CONTACT: opondoflorence@gmail.com

FELLOW'S RESEARCH HIGHLIGHTS

Publications

- Opondo F., Owuor G., Mshenga P., Louw A., Jordan D. (2020).** Estimation of the effect of cassava commercialisation on different household income measurements in Kilifi County, Kenya. *Journal of Sustainable Development*, 13(1), 44–58.
- Opondo F., Dannenberg P., Willkomm M. (2017).** Characterisation of the levels of cassava commercialisation among smallholder farmers in Kenya: A multinomial regression approach. *African Journal of Agricultural Research*, 12(4), 3024–3036.
- Opondo F., Owuor G., Mshenga P. (2017).** Is cassava commercialisation a strategy for improving household income of smallholder farmers in Kenya? Endogenous Switching Model approach. *Journal of Economics and Sustainable Development*, 8(20), 107–117.
- Rotich K., Ochieng I., Bett C., Opondo F. (2014).** The effect of performance contract implementation on service delivery in provincial administration. *European Journal of Business and Management*, 6(15), 6–12.
- Opondo F., Ochieng' I., Jerop R. (2014).** Effect of talent development strategies on competitive advantage. *Canadian Open Agricultural Economics and Finance Journal*, 1(1), 1–11.
- Opondo F., Odida A., Njanja L. (2014).** The effect of strategic talent identification and acquisition on competitive advantage in commercial banks. *Asian Journal of Business and Management*, 2(3), 176–183.
- Jerop R., Kosgey I., Ogola T., Opondo F. (2014).** Consumers' perceptions towards goat's milk: Exploring the attitude amongst consumers and its implication for a dairy goat breeding programme in Siaya County, Kenya. *European Journal of Business and Management*, 6(28), 221–229.

Conference papers

- October 2021:**
Forecasting models for the performance of selected orphan crops. Presented at the Conference on the Role of Basic Sciences on National Policies and Global Trends, Kabarak University, Kenya.
- July 2021:**
Forecasting models for the area of production, yield and production levels for maize and potato agricultural crops in Kenya. Presented at the 1st Early Career Research Leadership Conference, Laikipia University, Kenya.
- October 2019:**
Drivers of cassava value chain for commercialisation of cassava: Systematic review of the Kenya and Nigeria cases. Presented at the 2nd Conference on Sustainability and Development 2019, Michigan University, Ann Arbor, MI, USA.
- September 2019:**
Status of cassava value chains and commercialisation in Africa: A systematic review of Nigeria and Kenya. Presented at the Tropentag 2019 Conference, University of Kassel, Kassel, Germany.
- July 2018:**
Does value addition or market participation significantly affect cassava commercialisation in arid and semi-arid land areas? A case of Siaya County, Kenya. Presented at the 5th Global Conference on Economic Geography 2018, Cologne, Germany.
- July 2018:**
The effect of cassava commercialisation on household income of smallholder farmers in arid and semi-arid land. A case of Kilifi County. Presented at the 30th International Conference of Agricultural Economists, Vancouver, Canada.
- September 2018:**
Can commercialisation of orphan crops be a solution to the perennial food insecurity in sub-Saharan Africa? A case of cassava crop. presented at the 1st Cologne Conference on Food for Future, Cologne, Germany.

Panel discussions

- December 2021:**
Research webinar series on the role of local government in repositioning the role of inland small-scale fisheries with regard to food production and economic development: In response to COVID-19.
- September 2018:**
Panel discussion on universities, entrepreneurship and enterprise development in Africa organised by Bonn-Rhein-Sieg University of Applied Sciences in Sankt Augustin, Germany.
- October 2018:**
Panel discussion on social networks and agricultural technology: Comparing social protection strategies, practices and knowledge to develop rural areas in Rwanda. A case of dairy cooperatives in Kenya.
- November 2018:**
SIANI members' forum discussion on sustainable agriculture for food security, improved nutrition and eradication of hunger at ICRAF, Nairobi, Kenya.

Seminars and workshops

- November 2021:**
Bio-Africa project ODL-training course.
- November 2021:**
DAAD Alumni training event:
Climate change research: Theory and practice of getting the numbers right on greenhouse gas emissions from livestock in sub-Saharan Africa – case of East Africa.
- September 2019:**
DAAD Alumni Seminar 2019 on technical and social innovations for sustainable agri-value chains and job creation in rural areas in Witzenhausen, Germany.
- May 2019:**
Centre for Environmental Economics and Policy in Africa (CEEPA) training course on theory and econometrics of individual and collective choice analysis: Choice and controlled experiments, University of Pretoria, South Africa.
- March 2019:**
Transdisciplinary science leadership workshop, University of Pretoria, South Africa
- June 2018:**
5th Humboldt Kolleg in Kenya 2018 on the role of alumni networks in mentorship and collaboration in multidisciplinary research.
- March 2018:**
Entrepreneurship in agribusiness training the trainer programme organised by Agripreneurship Alliance in Nairobi, Kenya.
- May 2017:**
Lecture series on evaluation and evidence-based policy-making in Germany, organised by University of Bonn, Germany.
- September 2015:**
Electronic resources training workshop for DAAD scholars, organised by DAAD and ITOCA in Nairobi, Kenya.
- September 2014:**
Capacity building of lecturing staff of Laikipia University on technology transfer in the dairy value chain in Naivasha, Kenya.
- March 2014:**
Trilateral partnership for food security through sound business plan development, organised by USINKEN in Nakuru, Kenya.



Mentor profile

PROF ANDRÉ LOUW

Prof André Louw is the former director of the Absa Chair in Agribusiness Management in the University of Pretoria's Department of Agricultural Economics, Extension and Rural Development. He joined the University in 2003 after he had spent more than 20 years in a senior position as an agribusiness specialist in the private sector.

Prior to his retirement in 2020, he had a C2 rating from the National Research Foundation, which classified him as an established researcher with a sustained recent record of productivity in the field, who was recognised by his peers as having produced a body of quality work, the core of which had coherence and attested to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

His research interest is in value chain analysis for several commodities in South Africa and the Southern African Development Community (SADC) region, value chain financing in South Africa and Africa, the formulation of strategies for agro-processing, policy issues regarding land restitution, risk management and capacity building for commercial banks in Africa.

He is involved in teaching and research in various fields of agribusiness, as well as consultancy activities, such as strategy and business planning, value and supply chain management, finance, risk, marketing and project management. He has also been involved in various local and international research projects on retail markets, Africa, agro-processing strategies, business planning, curriculum development, insurance, credit policies and risk management, and business planning.

During his career, he has been exposed to several diverse and multi-disciplinary projects. From a credit and risk management point of view, in-depth financial and risk analysis of agribusinesses from a banking, credit and audit committee environment gave him vast experience in this field. He also conducted due diligence projects for agribusinesses, land reform audits, and in-depth quantum analyses for the State Attorney and agribusinesses. Projects focusing on value and supply chain analysis include a project on the beef value chain for the Industrial Development Corporation and a project on the dairy value chain for the Department of Trade, Industry and Competition. These analyses are important to understand the flow of goods and funds in an industry, as well as the interdependencies between stakeholders.

He has written several peer-reviewed and popular articles on his fields of expertise, and published the 6th edition of *Finance and Farm Management* in 2017, which is prescribed by at least four universities in South Africa. ○



“ Dr Opondo made a positive contribution to the Department of Agricultural Economics, Extension and Rural Development as a postdoctoral scholar. ”

INVESTIGATING DRIVERS OF CASSAVA VALUE CHAIN COMMERCIALISATION AND UPGRADING AS A POVERTY-REDUCTION STRATEGY IN KENYA AND NIGERIA

Postdoctoral fellow: Dr Florence Opondo
Mentor: Prof André Louw

Sub-Saharan Africa has experienced tremendous changes in the demand for and supply of food over the last few years, which have impacted on food security. This is not only a problem encountered in the East African countries of Kenya and Nigeria, but is a challenge across the entire subcontinent.

On the demand side, there is an increase in population, which has contributed to the migration of people from rural to urban dwellings, as well as diminishing land for agricultural production. This has exerted pressure on the demand for food. Consumer tastes and preferences have also changed over time, with consumers demanding healthier and more nutritious food. On the supply side, climate change has led to a lower yield, and farmers are becoming more reliant on rain-fed agriculture. This has increased poverty and food insecurity.

Research conducted by Dr Opondo since 2017 has focused on the production of cassava by smallholder farmers in Kenya. Her interest was motivated by the fact that many underutilised crops thrive well under harsh climatic conditions, and have the potential to reduce poverty in rural areas.

The study that formed part of her postdoctoral research expanded on previous research she had conducted by comparing the production of cassava in Kenya to Nigeria. Upon the recommendation of her mentor, Prof André Louw, and following interactions with researchers from different disciplines who were focused on solutions to Africa's food security challenges, Dr Opondo decided to expand her research from household use to commercialisation. Although the production and commercialisation of cassava in Africa is still low, Nigeria leads the production of this commodity in Africa, supplying cassava on an industrial scale. She therefore decided to compare the cassava value chain in Kenya to that in Nigeria to establish whether the commercialisation of cassava could be upgraded to improve food security in Africa.

As partnerships and collaborations are important for the development of sustainable food value chains, she saw the fellowship as a chance to collaborate with researchers from various disciplines and from different backgrounds. She also saw this as an opportunity to support enabling policy and the regulatory environment that promotes the commercialisation and competitiveness of crops in Africa.

An initial literature study revealed that very little had been achieved regarding the commercialisation of cassava in Africa, and many countries were intensifying their efforts to rediscover the crop's potential. She therefore decided to focus on the following aspects:

- Describe the outlook of cassava commercialisation in Kenya and Nigeria
- Establish whether policy interventions meet the needs of value chain actors in Kenya
- Identify and characterise the drivers of cassava value chains for upgrading commercialisation in Kenya and Nigeria

Dr Opondo commenced her fellowship by developing a protocol that would guide her research activities for the duration of her postdoctoral programme. This entailed conducting a systematic review of literature, reports, policies and legislation, and stakeholder engagement with cassava farmers, group representatives, extension and development officers and agricultural officers of sub-counties. This included her attendance of the Siaya public participation forum as a stakeholder in the cassava value chain, and discussions with both the Siaya County Minister and the Director of Agriculture on a climate-smart project and how to integrate the various actors along the cassava value chain. The final step in her research was the qualitative analysis of the data using ATLAS.ti. She had initially only planned to conduct a survey, but after consulting with the programme coordinator, changed her research methodology to include key informant interviews and group discussions.

The findings of her research revealed that the production of cassava is still low in Africa, although expansion is witnessed in some parts of Kenya and Nigeria. There is a strong partnership between development organisations and the government of Nigeria to boost cassava production. In Nigeria, there are markets for different cassava products, although marketers have not explored the emerging markets for dried cassava chips and starch. There is limited diversity of cassava value-added products in Kenya compared to Nigeria. Although there are potential market opportunities for industrial products in both local and international markets, participation by both countries is low. Reasons for this include the poor quality of cassava products, the high cost of processing, undeveloped technologies, and inadequate support services such as infrastructure, credit facilities and information.

She furthermore found that the awareness of cassava feed utilisation among livestock farmers in Kenya is low. There is limited information about the cassava trade in Kenya because of undocumented reports and informal transactions. Many initiatives have contributed to the improved development of cassava in Nigeria, as opposed to Kenya.

There is weak integration between small-scale cassava farmers and development organisations in Kenya. Most farmer groups are just entities sampled together because most development organisations use them as entry points. Trust between group members and partner organisations is a driving force in the partnerships. There are also limited policies that regulate quality standards, pricing and grading structures. Commercialisation interventions are focused on the production and processing nodes.

Based on this research, she concluded that the cassava value chain for Nigeria is more competitive than for Kenya. The cassava value chains are not developed to support industrialisation and internationalisation. Consumer preferences and demand for various cassava products also vary between the two countries. She therefore suggests that various actors should consider the commercialisation of industrial products, and policies should be developed for pricing, quality standards and grading to strengthen the value chains and enhance commercialisation. She also recommends organising farmer groups into economic entities.

Dr Opondo succeeded in publishing an article on one aspect of her research, an estimation of the effect of cassava commercialisation on different household income measurements in Kilifi County, Kenya, in the peer-reviewed *Journal of Sustainable Development* in February 2020. She also submitted an article on the status of cassava value chains and commercialisation in sub-Saharan countries, focusing on Kenya and Nigeria, to *Food Reviews International Journal*, which has been accepted for publication.

According to her mentor, not only her research writing skills, but also her proposal writing skills developed remarkably during her time at Future Africa. She submitted several abstracts for local and international conferences. Some of these resulted in presentations at the respective conferences. These included a paper presented at the African Conference for Agricultural Economists (ACAE) in Abuja, Nigeria, in September 2019; a poster presented at the Tropentag 2019 Conference at the University of Kassel, Germany, in September 2019; a poster presented at the 2019 Conference on Sustainability and Development at the University of Michigan, USA, in October 2019; and a paper presented at the Conference on the Role of Basic Sciences on National Policies and Global Trends at Kabarak University, Kenya, in October 2021. She will also be presenting her research at the International Consortium on Applied Bioeconomy Research's 2022 conference to be held in Bologna, Italy, in July 2022.

Dr Opondo teamed up with other research fellows to develop several grant proposals. A proposal on breaking systemic barriers to women's participation in science was submitted to the International Development Research Centre in Canada. A collaborative research grant on access to credit by smallholder farmers to finance climate-smart agricultural technologies, innovations and management practices through rural finance markets in Kenya was accepted for funding. She also participated in writing a proposal for a grant for enhancing sustainable community-based ecosystems through an integrated framework of population, health and the environment. Another proposal, to attend the University of Kassel's international German Academic Exchange Service (DAAD) Alumni Seminar, resulted in a fully funded grant to participate in this seminar in Witzenhausen, Germany, in September 2019.

She undertook several career-enhancing activities at the University of Pretoria during her fellowship. This included training organised by the Centre for Environmental Economics and Policy in Africa in May 2019 on the theory and econometrics of individual and collective choice analysis, and training on ATLAS.ti in August 2019. This training was necessary for her to learn to use this program to review her research findings and for data analysis.

While in South Africa, she was also appointed as the principal investigator of a research project commissioned by Enterprises University of Pretoria for the South African Local Government Sector Education and Training Authority (LGSETA). This examined the integration of small-scale fisheries into the tourism value chain. According to Prof Louw, she made a positive contribution to the Department of Agricultural Economics, Extension and Rural Development as a postdoctoral scholar. "Both parties benefitted from this synergistic relationship, and there is certainly merit in engaging in more partnerships of this nature in the future," he remarked.



To share approaches for sustainable agricultural development in Africa, and Kenya, in particular, Dr Opondo organised the Conference on Promoting Multidisciplinary Research Approaches for Sustainable Agricultural Development at Laikipia University in July 2021. "This conference was based on the premise that Africa is an embodiment of African researchers and academics who should provide leadership aimed at making the continent better for her people," she explained. In addition to disseminating the findings of her own research, she was able to provide a platform for other researchers with diverse knowledge on food systems to share their expertise. In his opening address, the Vice-Chancellor of Laikipia University, Prof Joseph K. Rotich, stated that he hoped this was the first of many similar partnerships and collaborations.

Dr Opondo considered the conference to have created a golden opportunity for early career researchers to interact and share their research results and innovations. From the presentations, it emerged that factors affecting food security in Africa emanate from culture or traditions, science, post-harvest losses, minimal value addition and fortification, lack of a market for farm produce, and the failure to grow organic foods. Food sovereignty has been derailed by ecological disasters in Africa, shocks such as COVID-19, and occurrences such as locust plagues and flooding.

Most of the presentations made at the conference were from postgraduate students from Laikipia University, with some by senior researchers and industry specialists. There were also four keynote addresses by distinguished scholars in the agricultural value chain across the globe. None of the research described in these presentations has been published in peer-reviewed journals. Dr Opondo identified this as an opportunity for further research dissemination. She therefore proposed that the last tranch of her research funding be utilised for the development of the conference's research outcomes. This would motivate early career researchers to engage in further research activities, and enhance the use of this knowledge to formulate policy, particularly as it relates to the transformation of food systems in Africa. She therefore concluded her fellowship by organising a two-day training workshop in Kenya in March 2022 for the development of quality articles based on the conference's research outcomes.

Reflecting on her mentorship journey, Dr Opondo has great appreciation for the staff members of Future Africa and the academics in the Department in which she was mentored. "This was a very conducive environment for research," she says. She believes that teaching and research are inseparable, and her experience on the fellowship has elevated both her teaching and her research to a different level in terms of the opportunities she had to engage with stakeholders and participate in transdisciplinary networks. "I can now engage in collaborative research with confidence."

She also comments that the training she received in writing and presentation skills shifted her abilities into another dimension. She describes the experience as "excellent", particularly the degree to which she was able to network with other researchers, and form transdisciplinary teams to jointly respond to calls for proposals.

Dr Opondo was introduced to the concept of transdisciplinarity during an orientation workshop held at the beginning of the fellowship, and immediately recognised that solutions to the challenges of Africa cut across disciplinary boundaries.

"My research on promoting the commercialisation of cassava brought together crop scientists, horticulturalists, agricultural economists, agribusiness specialists, statisticians, sociologists, information and communication technology experts, farmers and the media." In the process, a wealth of knowledge could be combined that transcended disciplinary boundaries to generate practical solutions for Africa. ○

THE COMMERCIALISATION OF CASSAVA PRODUCTION IS IMPORTANT FOR FOOD SECURITY IN AFRICA

The agricultural sector is one of the drivers of the Kenyan economy. Some 75% of the rural population depends on agriculture to make a living on the arid and semi-arid soils. A significant proportion of Kenya is characterised by low rainfall and high temperature. The adverse effect of the country's arid climate and the effects of climate change mean that major crops, such as maize and beans, tend to perform poorly. Over the years, the effects of these adverse climatic conditions have increased poverty and food insecurity in Kenya.

As the second most widely grown root crop in Kenya, cassava (*Manihot esculenta* Crantz) has an important role to play in addressing food insecurity. However, the cassava industry has not yet realised its full growth potential in terms of commercialisation and utilisation due to a lack of resources available to local farmers.

In an article published in the *Canadian Journal of Sustainable Development*, Dr Florence Opondo states that the transformation of agricultural production from subsistence to commercially oriented outcomes is a topical subject in many rural and socio-economic development discussions. She recognised the fact that there are many underutilised crops in Africa with low production and commercialisation, which can thrive under harsh climatic conditions and have the potential to reduce poverty in rural areas on the continent.

For many years, cassava has been promoted as a crop that can improve food security because of its potential to tolerate harsh conditions. However, a literature study revealed that very little is being done to commercialise cassava. She suggests that this is an ideal crop to consider for commercialisation, especially in rural areas.

As a tuber crop, cassava has the potential to improve household food security and income. She pointed out that, in Kenya, a number of interventions have been directed towards commercialising cassava, but the effect of commercialisation on household income has not been established.

Her study aimed to estimate the effect of cassava commercialisation on three different income measures: per-capita, annual and per-hectare revenue. She conducted a household survey in Kilifi County, Kenya, where 200 respondents were randomly selected. Data was collected using a structured questionnaire, and a two-stage endogenous switching regression model was fitted to determine the effect of commercialisation on the different income measures.

According to the information gathered, some 69% of households have commercialised cassava production in some form, while the remaining 31% have not. The study found that a majority of the households marketed cassava products with little or no value-addition.

The results also revealed that farmers who engaged in commercial cassava production realised a higher income than their counterparts. Off-farm income, age of the household head and distance to market had a significant negative impact in all the income estimates.

Group membership was only significant for per-acre income, while household size was negative and statistically significant in both per-acre and per-capita incomes. These findings accentuated the importance of promoting policies that will enhance the commercialisation of cassava production.

Dr Opondo recommends that farmers should market high-value cassava products to increase the crop's economic opportunities. Governments should also offer support mechanisms to enhance market competitiveness through cassava commercialisation. These measures include improving infrastructure, especially road networks, to facilitate easy access to markets and training so that farmers can understand the importance of collective actions through extension services. She also recommends undertaking an additional comprehensive study to determine the extent to which off-farm activities affect cassava commercialisation. ○

What is cassava?

Cassava (*Manihot esculenta* Crantz) is a root vegetable that grows in diverse agro-ecological zones. It has gained prominence in Africa because of its economic importance in addressing food security. In Kenya, it is widely cultivated in the western and coastal regions. Most of the cassava produced in Kenya is used in its raw form for human consumption or as traditional processed products through fermentation, drying and cooking. It is mainly grown for food and nutrition security, and excess roots are sold to generate an income for farm households. It is a calorie-rich vegetable that contains plenty of carbohydrates and key vitamins and minerals. It is a good source of Vitamin C, and the leaves can contain up to 25% of protein if cooked and dried in the sun. It is known as an orphan crop, as it is not traded internationally, and therefore tends to get less attention in terms of agricultural training and extension. However, it plays a vital role in the food security and livelihoods of resource-poor farmers and consumers.



“ Dr Opondo's findings accentuated the importance of promoting policies that will enhance the commercialisation of cassava production. ”

CONFERENCE ON PROMOTING MULTIDISCIPLINARY RESEARCH APPROACHES FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT

The conference organised by postdoctoral fellow, Dr Florence Opondo from Laikipia University, Kenya, was focused on promoting multidisciplinary research approaches for sustainable agricultural development. It took place from 6 to 8 July 2021 and attracted almost 150 participants daily, as well as 30 online delegates. It was a powerful collaboration among universities and research institutions in Kenya, Africa and the world.

The objective of the workshop was to enhance collaboration among young scholars and researchers on a global basis. It offered a unique platform for sharing and discussing research topics with key opinion leaders across academia and practitioners. Africa has many researchers and academics who should and are able to provide leadership to improve the lives of people on the continent, and this conference provided the opportunity to do so.

The three-day conference comprised eight parallel sessions, during which oral paper presentations were delivered and pre-recorded videos were presented. Each day also featured a plenary session, at which a keynote speaker delivered an address.

The keynote addresses were the following:

- “The reality of COVID-19 pandemic on food systems” – Dr John Olwande, Tegemeo Institute
- “The food system in Africa: Trends and opportunities” – Dr Anne Roulin, Agripreneurship Alliance
- “Infrastructure development and global value chain integration in agriculture: The case of Southern Agricultural Growth Corridor of Tanzania” – Prof Peter Dannenberg, University of Cologne, Germany
- “Strategies for promoting sustainable agriculture and food security in times of pandemics. Innovation, investment and policy priorities” – Dr Oliver Kirui, Centre for Development Research, University of Bonn, Germany



Participants at the dissemination conference

The following oral paper presentations were delivered during the parallel sessions:

- “Potential utilisation of insects as alternative protein sources in diets of farmed fish: Acceptance of black soldier fly (*Hermetia illucens*) larvae meal in Kenya” – Kevin O Ouko, Jaramogi Oginga Odinga University of Science and Technology, Kenya
- “Kenya factors influencing leadership styles used by farmer organisations in Uganda” – Racheal Nangobi, Egerton University, Kenya
- “Factors influencing the extent of crop diversification among smallholder farmers in Kisumu County, Kenya” – Hezbon Awiti, Egerton University, Kenya
- “Effect of sorghum (*Sorghum Bicolor L. Moench*) grain conditions on occurrence of mycotoxin-producing fungi” – Alex Machio, Bomet University College, Kenya
- “Quality assessment of three water hyacinth (*Eichhornia Crassipes*) compost types in Lake Victoria Basin, Kenya” – Kevin O. Obondo, Egerton University, Kenya
- “Effects of black shade net on water use efficiency for Chinese cabbage production within Kilifi County, Kenya” – Kengere Atambo Daniel, Pwani University, Kenya
- “Agro-dealers knowledge, perception, and willingness to stock a fungal-based biopesticide (ICIPE 20) for management of *Tuta Absoluta* in Kenya” – Francis Ogutu, Egerton University, Kenya
- “Can bioslurry be an alternative to inorganic fertilizers in increasing soil fertility?” – Mercy Rewe, Pwani University
- “Kenya effect of process parameters and feedstocks on selected briquette properties” – Okwara Mayabi Wilberforce, Egerton University
- “Kenya screening of maize (*Zea Mays L.*) inbred lines for resistance to grey leaf spot (*Cercospora Zeae-Maydis*) in Kenya” – Lagat Nicholas, Egerton University
- “Performance of selected sorghum varieties on titanium-mined soils in Kwale County, Kenya” – Kazungu Florence, Pwani University
- “Probiotic properties and safety profiling of *Lactobacillus Plantarum* isolated from spontaneously fermented milk, Amabere Amaruranu” – Mercy M. Katiku, Egerton University, Kenya
- “Genetic analysis of hybridisation pattern in goat genotypes from East Africa” – Theodora Chikoko, Egerton University, Kenya
- “Performance of selected green grams varieties on titanium-mined soils in Kwale County” – Muchomba Mercy Kiende, Pwani University
- “Coconut rhinoceros beetle (*Oryctes rhinoceros*) production as a farm enterprise for food security” – Dennis Ong’or, Jaramogi Oginga Odinga University of Science and Technology
- “A multimodal critical discourse analysis of media construction of agriculture in selected Kenyan newspapers” – Nancy Langat, Laikipia University
- “The integration of small-scale fishers into the tourism value chain in South Africa” – Dr Clarietta Chagwiza, University of Pretoria
- “Effect of utilisation of social media platforms on youth participation in agriculture in Njoro Subcounty, Kenya” – Dr Khumoetsile O. Sebotsa, Egerton University, Kenya
- “The nexus between levels of education and food production practices among farmers in South Nyanza Region, Kenya” – Dr Benjack Ochieng, Laikipia University
- “A baseline case study of agriculture teacher gaps affecting the training of quality human resource for sustainable agricultural development in secondary schools in Nakuru County” – Dr Miriam N. Kyule, Egerton University
- “Drivers of cassava value chain commercialisation” – Dr Florence Opondo, Laikipia University
- “Influence of tillage, lime and phosphorus on maize growth in acid soils” – Dr Esther Mwendu Muindi, Pwani University
- “Effectiveness of desert locust control methods: A case of small-scale farmers in Meru County, Kenya” – Dr Ronald Nyamwamu, Laikipia University
- “The discursive construction of the climate change agenda in Kenya” – Dr Justus Chimoni, Pwani University
- “Performance of bulb onions in titanium-mined soils” – Dr Esther Mwendu Muindi, Pwani University
- “Impact of agribusiness support services on milk productivity and Income: Evidence from Kenya’s dairy sector” – Dr Dickson Otieno, Egerton University
- “The response of the COVID-19 pandemic on the indigenous communities: Case of access to emergency health care among the Ogiek of Kenya” – Dr Babere Kerata Chacha, Laikipia University
- “Informal food supply chain response to COVID-19 pandemic; A case study of Nairobi, Kenya” – Dr Beatrice Muriithi, ICIPE, Nairobi
- “Making youth a leading force for promoting agri-food systems, a case of rural Nakuru, Kenya” – Dr John Mathenge King’au, Laikipia University
- “Financing agricultural SMEs’ value chains through capital markets in Kenya” – Dr Samuel Onyuma, Laikipia University
- “Economic efficiency of cricket production reared under improvised cage system” – Charles. A. Ngóngá, Jaramogi Oginga Odinga University of Science and Technology
- “Food sovereignty in times of recovery: Building back better through mainstreaming social justice and leveraging agro-ecology in Africa” – Dennis Kyalo, Jesuit Justice and Ecology Network-Africa (JENA)
- “Forecasting models for area of production, yield and production levels for maize and potatoes agricultural crops in Kenya” – Dr PA Owili, Laikipia University



MALAWI



MALAWI UNIVERSITY OF SCIENCE AND TECHNOLOGY



The Malawi University of Science and Technology (MUST) was established in 2012 with the aim of promoting the development, adaptation, transfer and application of science, technology and innovation for the macro- and micro-economic development of Malawi. Its vision is to be a world-class centre of science and technology education, research and entrepreneurship, which is being realised through the provision of an environment conducive to the provision of quality education, training, research, and entrepreneurship and outreach activities.

MUST has four operational schools: The Malawi Institute of Technology, the Ndata School of Climate and Earth Sciences, the Academy of Medical Sciences and the Bingu School of Culture and Heritage. The institution offers programmes in engineering, computer and information technology, innovation and entrepreneurship, earth science, climate science, sustainable energy, water resources, sports science, African musicology, and indigenous knowledge systems and practice. Its medical school offers programmes in medical imaging, immunology and medical microbiology. The medical school also houses the University's teaching hospital, which runs a fully fledged private clinic and acts as a state-of-the-art diagnostics centre; apart from carrying out research activities, especially on non-communicable diseases.

MUST also hosts a Technology and Innovation Support Centre, with the objective of assisting researchers in Malawi to access information on prior art in different technological fields. The University boasts a research centre, called the Industrial Research Centre, which has been involved in industrial research, technology development and transfer programmes for over 20 years. Plans are underway to reposition the Industrial Research Centre as the first centre of excellence at MUST. ○



DR EMMANUEL VELLEMU

Dr Emmanuel Vellemu is a lecturer in the Department of Water Resources Management of the Malawi University of Science and Technology. He obtained his PhD in Water Resources Science from Rhodes University, South Africa, in 2018. The focus of his postdoctoral studies was to develop an aquatic biodiversity information system for a sediment-impacted river. He is a professional member of the Water Institute of Southern Africa, the Society for Environmental Toxicology and Chemistry, and South African Young Water Professionals. He is also Managing Director of Eco-Health Limited, Lilongwe, Malawi.



He is passionate about solving freshwater quality threats brought about by anthropogenic activities. He uses drone technology for ecosystem mapping and to gather large water quality datasets for monitoring ecosystems to protect humans and the environment. He has developed and published salinity and acid mine drainage water quality guidelines using risk-based approaches. His research also straddles trait-based approaches in water quality management. His current research focuses on the impacts of water pollution on ecosystem services.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Development of an aquatic biodiversity information system for a sediment-impacted river



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FELLOW'S RESEARCH HIGHLIGHTS

Publications

Vellemu E., Katonda V., Yapuwa H., Msuku G., Nkhoma S., Makwakwa C., Safuya K., Maluwa, A. (2021). Using the Mavic 2 Pro drone for basic water quality assessments. *Scientific African Journal*, 14, e00979.

Vellemu E., Mensah P., Griffin N., Odume O., Palmer C., Dowse R. (2018). Using a risk-based approach for derivation of water quality guidelines for sulphate. *Mine Water and the Environment*, 37(1), 166–173.

Vellemu E., Mensah P., Griffin N., Odume O. (2018). The derivation of water quality guidelines for acid mine drainage using a risk-based approach. *African Journal of Aquatic Science*, 43(1), 51–58.

Vellemu E., Mensah P., Griffin, G., Odume, O. (2017). Sensitivity of the mayfly nymph (*Adenophlebia auriculata*) Leptophlebiidae to $MgSO_4$ and Na_2SO_4 . *Physics and Chemistry of the Earth*, 100, 81–85.

Vellemu E., Omoregie E. (2014). Lead pollution: A growing concern along the Namibian coastal waters. *International Science and Technology Journal of Namibia*, 3, 15–28

Omorie E., Vellemu, E., Nashima F., Mudumbi S., Liswaniso G., Shimooshili K. (2019). Assessment of copper levels along the Namibian marine coastline. *GSC Biological and Pharmaceutical Sciences*, 7(3), 48–55.

Book chapters

Vilakazi, N., Nyirenda, K., Vellemu, E. (2019). Unlocking water issues towards food security in Africa. In: Mahmoud, B. (ed) *Food security in Africa*. IntechOpen.

Umejesi I., Thompson M., Marcello M., Vellemu E. (2018). Extract of Africa: Towards the equitable and ecologically sound governance of mining and drilling. In: Mensah P., Katerere D., Hachigonta S., Roodt A. (eds) *Systems analysis approach for complex global challenges*, Springer.

Technical reports

Griffin N., Palmer C., Retief D., Mensah P., Joubert A., Du Toit D., Munnik V., Thomson G., Weaver M., Sahula A., Vellemu, E. (2016). Resilim-O water quality final summary report. Report to the Association for Water and Rural Development (AWARD)/USAID – Unilever Centre for Environmental Water Quality, Institute for Water Research, Rhodes University, Grahamstown.

Palmer C., Du Toit D., Munnik A., Thomson G., Weaver M., Sahula A., Vellemu E., Griffin N. (2015). Activities that affect water quality in the Olifants River Basin with a particular focus on mining. Report submitted to USAID: Resilience in the Limpopo Basin Program (RESILIM) Olifants (O) programme implemented by the Association for Water and Rural Development (AWARD), Hoedspruit.

Conferences

Vellemu E., Umejesi, I. (2015). Fighting Elephants, Suffering Grass: Towards a clumsy solution to solving acid mine drainage in South Africa. Poster presented at the 4th YWP ZA Biennial and 1st African Young Water Professionals (YWP) Conference, Pretoria, South Africa.

Vellemu E., Mensah P., Palmer C. (2015). Sensitivity of the mayfly nymph (*Adenophlebia auriculata*) Leptophlebiidae to $MgSO_4$ and Na_2SO_4 . Paper presented at the 16th WaterNet/WARFSA/GWP-SA Symposium, Île Maurice, Mauritius.

Vellemu E., Mensah P., Palmer C. (2015). Tolerance of juvenile and adult freshwater shrimps (*Caridina nilotica*) to $MgSO_4$ and Na_2SO_4 . Paper presented at the Society of Environmental Toxicology and Chemistry (SETAC) Europe 25th Annual Meeting, Barcelona, Catalonia.

Vellemu E., Mensah P., Palmer C. (2014). The toxicity of two magnesium salts to adult and juvenile freshwater shrimp *Caridina nilotica*. Poster presented at the 15th WaterNet/WARFSA/GWP-SA Symposium, Lilongwe, Malawi.



Mentor profile

PROF FANUS VENTER

Fanus Venter is a professor in the Department of Biochemistry, Genetics and Microbiology in the Faculty of Natural and Agricultural Sciences. He has been Deputy Director of the University's world-renowned Forestry and Agricultural Biotechnology Institute (FABI) since 2018, prior to which he held the Rand Water Chair in Water Microbiology.

He obtained his PhD in Water Resource Management at the University of Pretoria in 2002. Prior to joining the University as a lecturer in 1997, he was associated with the Division of Water Technology and the Division of Water, Environment and Forestry Technology at the South African Council for Scientific and Industrial Research (CSIR).

The main focus of his research is bacterial evolution, systematics and diversity. Through the use of comparative genomics, his research attempts to understand the functions, biology and evolution of bacteria associated with plants and aquatic environments. His main focus related to bacterial systematics is on the plant pathogenic *Enterobacteriaceae*, including the genus *Pantoea*, as well as nitrogen-fixing *Burkholderia* and *Bradyrhizobium* species isolated from indigenous legumes in South Africa. His research group has already described several new species belonging to this genera.

His research for Rand Water focused on the bacterial ecosystem present within drinking water distribution networks. With this research, he was able to monitor the presence and abundance of bacterial species within the network, and demonstrate how the bacterial community changes in response to external factors such as water treatment, temperature and seasonality.

He has a B2 rating from the National Research Foundation, which classifies him as a researcher who enjoys considerable international recognition by his peers for the high quality and impact of his recent research outputs.

In addition to his research interests, Prof Venter is a member of several national and international scientific associations, including the International Water Association, the Water Institute of South Africa and the International Society for Microbial Ecology. He is a Council member of the Southern African Society for Systematic Biology and a member of the International Committee on Systematics of Prokaryotes, where he served on the Executive Board.

He acts as a reviewer for several international peer-reviewed journals, such as *Frontiers in Microbiology*, *Water Research* and *PLOS One*. He is also associate editor of both the *International Journal of Systematic and Evolutionary Microbiology* and *Systematics and Applied Microbiology*. ○



DEVELOPING AN AQUATIC BIODIVERSITY INFORMATION SYSTEM FOR A SEDIMENT-IMPACTED RIVER

Postdoctoral fellow: Dr Emmanuel Vellemu
Mentor: Prof Fanus Venter

Pollution through human activities is an increasing threat facing rivers in southern Africa. In developing countries like Malawi, sand mining and sediment loads in rivers are increasing water quality challenges. Coupled with inadequate data, these challenges impede the realisation of the Sustainable Development Goal of clean water and life below water.

The various anthropogenic activities in river catchments impact on aquatic biodiversity through changes in ecosystem structure, such as habitat loss and altered river flows. However, despite increasing pollution levels in rivers, humans derive many benefits from these ecosystems, including flood control, spiritual services, food, medicine and recreational benefits such as fishing and swimming.

Dr Emmanuel Vellemu's doctoral research examined water effluent emanating from South Africa's coal and gold mines – known as acid mine drainage. When he was accepted onto the ECRLF programme, he decided to expand his research to study the organisms that reside in the sediment found in polluted water bodies in Malawi, with the objective of developing an aquatic biodiversity information system to manage the water quality of sediment-impacted rivers. The funding he received from the Carnegie Corporation of New York also enabled him to set up a water quality laboratory at his home institution, the Malawi University of Science and Technology (MUST).

His research focused specifically on the Mudi River in southern Malawi. This is an urban river situated in the city of Blantyre. For many years, its water has been unsuitable for human use due to excess sediment caused by top soil being washed into the river following flooding in the area. This not only has detrimental environmental effects, but contributes to health problems for the people using the river for drinking and washing, as well as informal traders who rinse their merchandise, such as fruit and vegetables, in the river.

Management efforts for the Mudi River have been aimed at service delivery, catchment restoration and conserving the full extent of the river ecosystem. However, no one-stop reputable and easily accessible bioinformatics system exists for the catchment, making the full integration of biodiversity information in decision making difficult. Baseline data and biodiversity assessment tools are needed to plan and evaluate the successes of conservation and rehabilitation efforts.

Dr Vellemu's research was therefore aimed at linking aquatic biodiversity to the benefits that people derive from rivers, clearly unlocking pathways through which biodiversity plays an ecological role so that humans can enjoy these benefits. As an added element in his research, Dr Vellemu employed drone technology to collect large water quality datasets in areas that were hard to reach for improved water quality assessment and monitoring.

The objectives of his research were as follows:

- Convene catchment stakeholders to develop a shared vision of a bioinformatics system that supports research, management and development infrastructure projects
- Collect and collate available aquatic biodiversity information (primarily on macroinvertebrates) on the Mudi River and its tributaries
- Develop a reputable and easily accessible bioinformatics system, and build bioinformatics capacity for smart communities
- Develop a monitoring tool for assessing the sediment impacts on biodiversity for smart communities
- Link aquatic biodiversity to sand mining as an ecosystem service
- Undertake a biodiversity gap analysis and field collection of biodiversity data in critical and vulnerable understudied hotspots in the catchment areas
- Use artificial intelligence (drone technology) in water quality assessments and monitoring (ecosystem mapping and water sampling)
- Promote citizen science in the study areas

Dr Vellemu explains that many organisms reside in the sediment that results from waste dumped in the rivers. "I was interested in balancing the use of the river by people for different ecosystem services, and the benefit to be gained from the river itself." The many organisms that are found in the sediment play different ecological roles, which are not necessarily compatible with the purposes for which residents were using the river.

"The river was not only being used for household and recreational purposes, it was also being used by people collecting sand for construction, who would dredge the river for sediment." Once the ecosystem structure is disturbed, the ecological functions are also affected. "I was interested in protecting the organisms in the sediment by formulating a decision support tool that the city council could use to manage the resources within the river," he concluded.

As a specialist in water resources management, Dr Vellemu found that his pairing with his mentor, Prof Fanus Venter, a specialist in biochemistry and microbiology, added value to his research, as it enabled him to reflect on several transdisciplinary elements related to ecosystem services, ecotoxicology and biomonitoring, which he would not otherwise have considered.

Prof Venter introduced him to water quality experts at the South African Council for Scientific and Industrial Research (CSIR), where he engaged with several transdisciplinary elements of the topic. This gave him a wider exposure to new trends in the field of water quality management. "I also benefitted from the soft skills that I acquired as part of the programme's orientation, as well as the interaction with the other fellows, and the students and staff of the University's Department of Biochemistry".

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Reflecting on the fellowship, Dr Vellemu has great appreciation for the flexibility of the programme, as it enabled him to travel between South Africa and Malawi to honour his teaching commitments at the Malawi University of Science and Technology and to do fieldwork. During the nationwide lockdown imposed by the COVID-19 pandemic, he was able to spend 10 months at Future Africa, where he could perform ecotoxicology experiments in the laboratory, and work on his data analysis and publications under the guidance of his mentor. "Prof Venter was more than just a supervisor – he was an excellent mentor, and I am grateful for this opportunity to be guided by him." An added benefit was the research connections that could be established between the two institutions.

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An output of his fellowship was the publication of an article in *Scientific African*, a peer-reviewed Elsevier journal, published on behalf of the African Institute of Mathematical Sciences, in which he assessed the capability of the Mavic 2 Pro drone for the collection and delivery of river water samples for basic water quality assessments.

To enhance awareness of the need to address Africa's most urgent challenges and provide an opportunity to develop a sustainable and inclusive bioresource-based economy, Dr Vellemu joined his fellow countryman, Dr Kumbukani Nyirenda (another ECRLF postdoctoral scholar) to organise the Biodiversity for Malawi Conference in July 2021. It was jointly hosted by the Malawi University of Science and Technology and the Kamuzu University of Health Sciences. The theme of the conference was consistent with the Malawi Vision 2063, which has identified environmental sustainability as one of the seven enablers for Malawi's inclusive economic growth. Dr Vellemu's conference presentation was related to the theme of water resources management, and addressed the mapping of the water quality of the Lichenza River using geographical information systems.

During this conference, participants expressed great interest in engaging key policy and decision makers on the contributions of postdoctoral fellows in academia and the country at large. A key observation was that postdoctoral research is not recognised as being part of an academic career in Malawi, with most higher education institutions being reluctant to absorb such researchers into the system. "This often leads to shifting focus from research to teaching," says Dr Vellemu, "in addition to other challenges such as a lack of resources". Another observation was that the conference did not include the participation of local communities in the scientific dissemination due to limited resources and time constraints; yet, these citizens play a crucial role in the management of water resources across Malawi.

Dr Vellemu therefore proposed cementing the outcomes of the conference by conducting a one-day Water Quality Management Policy Dialogue, involving key policy and decision makers on the contributions of postdoctoral fellows. This took place on 18 January 2022. This was followed by a three-day field training workshop to introduce government, industry, local communities and academia to the river health biomonitoring approach, using lessons learnt from the South African scoring system (SASS), to be incorporated into river health monitoring and assessment initiatives across Malawi. Finally, he proposed mentoring the youth and students on water resources monitoring and assessment as part of capacity building. This would serve as a link to ensure impact between early career researchers and the public at large on water quality management issues in Malawi. An intended output of this initiative would be a draft protocol for conducting river health assessments in Malawi, and a draft paper on baseline data involving river health biomonitoring across Malawi.

Through his exposure on the ECRLF programme, Dr Vellemu managed to secure several prestigious research assignments. With his colleagues, they won the USA-based JRS Biodiversity Foundation Grant, where they developed and are running an MSc in Biodiversity Informatics at MUST. This appointment is also important to understand the significance of agro-ecological interventions in Malawi. The Norwegian Programme for Capacity Development in Higher Education and Research for Development appointed him on a five-year project to develop and run postgraduate programmes in the higher education sector in Malawi, particularly at MUST. The World Bank appointed him to coordinate the freshwater component of the Malawi National Redlisting Project. The Global Environmental Facility engaged him in the Pathways Risk Analysis for Invasive Alien Species Management in Malawi Project.

He admits that none of this would have been possible without the development opportunities granted to him through the Future Africa ECRLF programme, which not only benefitted him as a researcher, but also benefitted the recipients of the outcome of future research on water quality management in Africa. "It was a game-changer, which has enabled me to continue with research to the advantage of the continent and its natural resources." ○

DRONES PROVE USEFUL IN COLLECTING WATER SAMPLES

Freshwater ecosystems continue to be impacted on by pollution due to anthropogenic activities such as mining, industrial effluent, poor agricultural practices and pharmaceutical-related waste. In middle- and low-income countries, it is often difficult to quantify the extent of pollution due to inadequate expertise to collect data, unfavourable policies guiding the protection and management of ecosystems, and the high capital and running costs of data collection.

The lack of adequate data affects the design and implementation of appropriate ecosystem monitoring programmes. In river ecosystem studies, understanding the status of water quality is necessary to periodically characterise and identify its variations and trends over time. The ability to use artificial intelligence knowledge and techniques in water sampling can save costs and time.

In a study conducted by Dr Emmanuel Vellemu, he assessed the capability of the Da-Jiang Innovations Mavic 2 Pro drone for the collection and delivery of river water samples for basic water quality assessments. The primary objective was to evaluate how this unmanned aerial vehicle (UAV) could help generate large water quality datasets in the

developing world to assist in the design and implementation of water quality monitoring and assessment programmes.

He hypothesised that the traditional approach, where portable hand meters are used to measure *in-situ* water parameters, including pH, dissolved oxygen, electrical conductivity and turbidity, could not yield significant water quality data variations from those collected by the Mavic 2 Pro. A paired t-test was performed to determine the parameter differences between the two approaches.

He concluded that, given similar physical environmental conditions and plot experience, the Mavic 2 Pro could generate large and much more reliable datasets at faster rates than the traditional approach. The drone also avoided obstacles with ease, which made it the perfect technology to use in rural rivers.

However, pilot efficiency and precision require further investigation, considering their potential parameter influences.

Similar future tests should investigate the performance of this drone model and data reliability over a long river course to ascertain its capability and sustainability in various conditions in ecological applications.

The use of drones in generating water quality data would greatly ease human efforts and reduce field costs, particularly in middle- and low-income countries where finances are usually a conservation issue.

The present study demonstrated that the Mavic 2 Pro can collect and deliver ecological samples, including running river water. It has been proven that the samples taken with the UAV were more reliable in terms of quality than those collected using a traditional hand-held meter.

It also saved a considerable amount of time by collecting and delivering samples at a much faster pace, which could not be compared to humans walking through the terrain or topography of the river in this study.

He acknowledges that drone technology is still in its infancy, and suggests that future UAV studies should focus on sampling *in-situ* river samples by mounting multi-probe sensors to the aircraft. The Mavic 2 Pro still needs to be tested under different weather conditions such as differing wind speeds and visibility, and with several pilots. ○



Participants engaged in fieldwork

BIODIVERSITY FOR MALAWI 2063

Postdoctoral fellows Dr Emmanuel Vellemu from the Malawi University of Science and Technology and Dr Kumbukani Nyirenda from the Kamuzu University of Health Sciences in Malawi presented a joint conference, Biodiversity 2063. It took place from 20 to 22 July 2021 and attracted just over 150 delegates either on-site or virtually via Zoom and WhatsApp. The theme of the conference was aligned to Malawi 2063, which identified environmental sustainability as one of the seven enablers for Malawi's inclusive economic growth.

The main aim of the conference was to integrate various research disciplines through the sharing of scholarly findings and the engagement of practitioners in industry and non-governmental organisations, as well as policy makers.

It promoted transdisciplinary research among early career researchers through the sharing of new research findings to inform policy and best practices. It enhanced collaboration among researchers, academia, government and industry to create sustainable research programmes in synergy with other health and water development sectors. Furthermore, it highlighted the technological application, experiences and solutions for health, artificial intelligence and machine learning, and water resource management for improved livelihoods.

The conference succeeded in bringing together policy makers, industry specialists and other stakeholders from academia and government to find solutions to common problems experienced in southern Africa. It addressed three sub-themes: water resources management, natural products and health, and machine learning for biodiversity.

The conference presentations included the following:

Water resources management

- "Postdoctoral experiences, opportunities and challenges" – Dr Emmanuel Vellemu
- "Mapping water quality of Lichenza River using geographical information system" – Annie Kanyada and Dr Emmanuel Vellemu, Malawi University of Science and Technology
- "Assessment of human activities impacts on water quality in Nasolo River, Blantyre, Malawi" – Blessings Mtchuka and Francis Chauluka, Malawi University of Science and Technology
- "Dire state of the environment in urban communities: Opportunities and challenges for community youth groups" – Patrick Ken Kalonde, Treasurer Mandevu and Alick Chisale Austin, St Cloud State University
- "Assessing the river health condition of Mulanje rivers using a biomonitoring approach" – Jessy Baloyi, Malawi University of Science and Technology
- "Determination of the assimilative capacity of Mudi and Nasolo river branches, Blantyre City" – George Chinoko, Cleopatra Chimanya and Maria Makocha, Malawi University of Science and Technology



- "Ecotoxicological impacts of wastewater pollution in Mudi River" – Rodney Jegere, Malawi University of Science and Technology
- "Geospatial assessment on groundwater quality and suitability for drinking: A case study of TA Somba in Blantyre, Malawi" – Cleopatra Chimanya, George Chinoko and Maria Makocha
- "Water quality assessment of an industrial effluent-receiving urban river using basic water quality variables: A preliminary assessment of Chirimba River, Blantyre, Malawi" – Harold Yapuwa, Thoko Mtewa and Esther Mabedi, Malawi University of Science and Technology
- "Baseflow analysis for Thuchila River" – Esther Chifuniro Mabedi and Francis Chauluka, Malawi University of Science and Technology
- "Assessment of land use and land cover changes in the Thuchila catchment area, southern Malawi" – Francis Chauluka, Shruti Singh, Rajesh Kumar, Harlod Yapuwa, Thoko Mtewa and Esther Mabedi, Malawi University of Science and Technology
- "Eutrophication of Lake Malawi and its associated impacts on aquatic life, fish diversity and humans" – Daniel Vellemu, Malawi University of Science and Technology
- "Ecotoxicological impacts of wastewater pollution in Mudi River" – Rodney Jegere, Malawi University of Science and Technology
- "Structure-based screening and pharmacokinetic analysis of potential anti-breast cancer compounds from Africa" – Jonathan T. Bvunzawabaya, Kamuzu University of Health Sciences
- "Molecular docking of plant-isolated Octadeca-9,12-dienoic Acid with β -ketoacyl-ACP synthase in tuberculosis drug designing" – Andrew G. Mtewa, Jonathan T. Bvunzawabaya, Davies Mweta and Fanuel Lampiao, Malawi University of Science and Technology
- "Phytochemical and nutritional composition of two indigenous vegetables: *Hibiscus sabdariffa* L (Chidede) and *Solanum nigrum* L (Msaka)" – Felix Daire Kumwenda, John D.K. Saka and Timothy N. Ngwira, Lilongwe University of Agriculture and Natural Resources
- "Effect of herbal aphrodisiac, *Dioscorea bulbifera* on sperm parameters, serum hormonal levels and testicular histology of Wistar rats" – Thomson Msiska, Anthony Mwakikunga, Fanuel Lampiao and David Tembo, Malawi University of Science and Technology
- "Assessing impacts of natural remedies on health of people" – Mayamiko Phiri, Malawi Institute of Education
- "Acetylcholinesterase nerve agent antidote development potential in Africa: The natural gift from plant biodiversity" – Andrew G. Mtewa, Jonathan T. Bvunzawabaya, Davies Mweta and Fanuel Lampiao, Chinhoyi University, Zimbabwe

Natural products and health

- "Aflatoxin and microbiological evaluation of traditional cereal-based weaning foods in Malawi" – Dr Kumbukani Nyirenda, Kamuzu University of Health Sciences
- "Soybean fiber and maize blend complementary food improves weight and reduces diarrhoea-type stools in Malawian children aged 6–36 months" – Dr Edda Lungu and Wendy Dahl, Malawi University of Science and Technology
- "Anti-plasmodial activity, toxicity and phytochemistry of the extracts of the *Clerodendrum rotundifolium* plant species in Uganda" – Dr Madina Mohamed Adia, James G. Ndukuib, Akala Hoseac, Robert Byamukamaa, Ulf Göransson, Lauri Toome, Anna-Karin Borg-Karlson, Makerere University, Uganda
- "Chemical space and diversity profiling of drug-like compounds from African natural product databases for fragment-based drug discovery"

Machine learning for biodiversity

- "An acoustic approach to assessing bird species status on Mulanje Mountain Forest Reserve" – Moses Samalani, Lilongwe University of Agriculture and Natural Resources
- "Implementation of machine learning technique for forest conservation" – Dawnwell Chiwanda, Malawi University of Science and Technology
- "On the diversity of cultivars from the same plant species" – Kondwani Magamba, Malawi University of Science and Technology
- "Remotely sensed multitemporal change detection analysis of urban green spaces in Blantyre City: A machine learning approach" – Emmanuel Chinkaka, Malawi University of Science and Technology

ENVIRONMENTAL WATER QUALITY POLICY DIALOGUE

Dr Emmanuel Vellemu concluded his participation in the ECRLF programme with the presentation of an environmental water quality policy dialogue and a series of field training sessions on novel water quality management approaches that can be adopted in Malawi.

The policy dialogue took place at the Nalipiri Eco Resort in Malawi's Mulanje district on 18 January 2022. This was followed by in-country field training on river health biomonitoring and assessment at three sites in the vicinity of local rivers: Mulanje district in the south, Salima district in central Malawi and Karonga district in the north. Participants included government technicians, representatives of non-government organisations, students and local community members.

The purpose of the dialogue was to promote novel river health monitoring and assessment approaches among various stakeholders, such as academia, policy makers and communities in Malawi. It also aimed to highlight data gaps in research and practice, and to balance resource protection and use. Through this community engagement activity, Dr Vellemu hoped to increase the impact of water management research to a wider audience through dissemination and outreach activities. He succeeded in engaging policy and decision makers in Malawi and introducing participants to unique new river health monitoring and assessment techniques to promote water quality management in the country.

During the Biodiversity for Malawi 2063 Conference, participants had indicated the need to engage policy and decision makers in a round table discussion around key issues and gaps that were impeding progress in water management in Malawi. These included the need to develop novel strategies and approaches to the monitoring and assessment of environmental resources for the country's development. The participants also expressed the need for policy makers to create a conducive environment for practitioners from both industry and academia to practice some of the issues that were raised.

The policy dialogue served as a knowledge exchange platform for water quality management and practice by various stakeholders in Malawi. Participants were provided with an overview of water quality management in Malawi, and had the opportunity to discuss policy issues around water quality management. They were introduced to common environmental water quality management approaches, such as physico-chemical, biomonitoring and ecotoxicology approaches. The dialogue was concluded with a debate on the way forward for Malawi.

As biomonitoring techniques are not practiced in Malawi, the South African scoring system (SASS) formed the centre of the discussion and field training. This is one of the key biological approaches to water quality management. Dr Vellemu introduced delegates to this technique, as well as its advantages over other approaches. This includes the fact that it is inexpensive as little equipment is needed, the techniques are simple and easy to apply, it is easy to learn to identify macroinvertebrates, and it is a rapid technique to assess riverine health.

Other topics related to the implementation of the SASS that were discussed included the standard tools and basic equipment used in the SASS, site selection criteria, protective equipment, the basic production of SASS tools using locally available resources, the sampling and identification of macroinvertebrates, the interpretation of the data, determining a river's condition, and the accreditation and certification of SASS practitioners.

The SASS is a rapid biomonitoring technique that is used to collect important biodiversity data in rivers and streams. It is based on assessing the benthic macroinvertebrates in river ecosystems. The value of these organisms for bioassessment is largely due to their visibility to the naked eye, their ease of identification, their rapid life cycle and their largely sedentary habits. Each taxon is assigned a sensitivity score, which is used to calculate the average score per taxon. This, in turn, provides an assessment of the quality of the river as good, poor, fair or natural.

Field training

The importance of the field training lies in the fact that it highlighted gaps and data needs regarding water resources monitoring and assessment in Malawi. Participants were exposed to various types of safety equipment, as well as a macroinvertebrate identification field book and the SASS score sheet, which could be used to assess the health of the river.

The first day of field training took place in Mulanje. It included a demonstration of macroinvertebrate sampling. Participants were shown how to sample three biotopes: stone, vegetation, and gravel, sand and mud. The sampled macroinvertebrates were then placed in

three different trays, each containing a single biotope. Participants had to identify the benthos found in each tray. The organisms were identified using the field guidebook for macroinvertebrates in southern Africa. A sensitivity score was then determined for each taxon to interpret the state of the river.

The second day of field training took place in Salima. It entailed an introduction of the SASS technique and its key contributions to the country at large in river health assessment initiatives. Participants learnt that the technique can be practiced by non-specialists, as well as local communities. They also received training on the sampling and identification of macroinvertebrates, and how to determine the condition of a river using the SASS score sheet.

The final day of field training took place in Karonga. The participants included a number of secondary school learners with their teachers. This was crucial to ensure that the message of river health monitoring reaches home. They were also introduced to the SASS technique. The session that followed was interactive to ensure impact among the learners. They were asked to identify five macroinvertebrates, determine their sensitivity scores using the SASS technique and determine the condition of the river.

The major outcome of the dialogue and field training was an agreement by participants that Malawi's Department of Water Resources needed to adopt the SASS in its water quality monitoring and assessment programmes. Dr Vellemu believes that the activity achieved its intended objectives as the participants showed an appreciation of the novel SASS technique, and expressed an interest in further training sessions. ○





KAMUZU UNIVERSITY OF HEALTH SCIENCES



Kamuzu University of Health Sciences (KUHeS) is a public-owned university, established in 2019 through the merger of Kamuzu College of Nursing (established in 1979) and College of Medicine (established in 1991). It is a comprehensive health and allied sciences higher learning institution, with the primary function of training health workers under one roof in order to increase efficiency and promote inter-profession collaboration, team building and teamwork from the early days of their training. KUHeS continues to train more and competent health professionals, including nurses, midwives, medical doctors, laboratory technologists, pharmacists and physiotherapists who are globally competent and locally relevant. The belief is that health service should be responsive to global trends and relevant to the local needs of individuals and communities.

As a key government partner, the University continues to serve the Malawi nation by providing quality education and innovation through research as key to the health welfare of Malawi, the region and beyond. Through research, the University generates evidence that informs government policies and practice in the health sector. Its operations are informed by a holistic approach to human health.

The University's main campus is in Blantyre, with other campuses in Lilongwe and Mangochi. KUHeS is internationally recognised, and a qualification from this institution can be used across the globe for either practice or further training.

The institution's vision is to be a world-class, innovative university committed to scholarly and professional excellence in the provision of health education, research and services in Malawi and globally. ○

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DR KUMBUKANI NYIRENDA

Dr Kumbukani Nyirenda is a senior lecturer in the Pharmacy Department of the Kamuzu University of Health Sciences in Blantyre, Malawi (formerly the College of Medicine at the University of Malawi). He obtained his PhD in Chemistry from the University of Malawi in 2019. The focus of his postdoctoral studies was to unravel the physicochemical properties of nanomaterials from Malawian underutilised plant species. He is interested in transdisciplinary research that could enhance the contribution of Africa's natural resources to the global economy.

With a background in applied and pharmaceutical chemistry, his research focus has been on investigating bioactive compounds from four Malawian plants traditionally used for the management of diabetes and human immunodeficiency virus (HIV) opportunistic infections. This work generated active novel chemical compounds that could help improve the nutritional and health status of Malawian society.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Physicochemical properties and applications of nanomaterials from Malawian underutilised plant species



FELLOW'S RESEARCH HIGHLIGHTS

Awards

- Semi-finalist in the Africa-wide Young Professionals in Science Competition (2012)
- Recipient of the World Bank's Robert S. McNamara Fellowship (2001)

Publications

Nyirenda K., Saka J., Lall N. (2021). Nutraceutical potential of *Fadogia aencylantha*, indigenous knowledge and intellectual property rights. *Planta Med*, 87(15), 1255.

Nyirenda K., Saka J. (2014). Antidiabetic and antioxidant activities of phytoconstituents from *Fadogia aencylantha*. *Pharma Nutrition*, 2(3), 84–86.

Nyirenda K. (2013). Nutraceutical potential of antidiabetic metabolites from herbal tea for improving African rural livelihoods. *Metabolomics*, 2(7).

Nyirenda K., Saka J., Naidoo D., Maharaj V., Muller C. (2012). Antidiabetic, antioxidant and antimicrobial activities of *Fadogia aencylantha* extracts from Malawi. *Journal of Ethnopharmacology*, 143, 372–376.

Saka J., Nyirenda K. (2012). Effect of two ethnic processing technologies on reduction and composition of total and non-glucosidic cyanogens in cassava. *Food Chemistry*, 130: 605–609.

Book chapters

Nyirenda K. (2020). In Erkekoglu P., Ogawa, T. (eds) *Medical toxicology: Toxicity potential of cyanogenic glycosides in edible plants*, Intech Open.

Vilakazi N., Nyirenda K., Vellemu E. (2019). In Nyila M. (ed) *Food security in Africa: Unlocking water issues towards food security in Africa*, Intech Open.

Nyirenda K. (2011). An analysis of the impact of appropriate technologies commonly used by smallholder farmers. In Mkandawire F., Mmaduabuchukwu M. (eds) *Low-input agricultural technologies for sub-Saharan Africa*, Peter Lang GmbH, Frankfurt, Volume 4, 108–120.

Conference proceedings

Nyirenda K., Lall N., McGaw L.J. (2019). Harnessing the potential of nanomaterials from African biodiversity for biomedical applications. Paper submitted for oral presentation at the ARUA International Conference, Nairobi, Kenya.

Nyirenda K., Mwekinda I., Nkhambule H., Mwakikunga A. (2019). Morphological and physicochemical properties of Malawian native cassava starch as potential polymer additives. Paper presented at the 5th International Conference on Agricultural and Biological Sciences (ABS 2019), Macau, China.

Nyirenda K., Dzimbiri I., Chikometsa M., Sinoya L., Ikwanga L. (2015). Effect of agro-ecological zones on the nutrient contents of *Moringa oleifera* leaves from four districts of Southern Malawi. An abstract of the paper presented at the International Food and Nutrition Research Dissemination Conference, Lilongwe, Malawi.



Mentor profile*

PROF NAMRITA LALL

Namrita Lall is a professor in the Department of Plant and Soil Sciences in the University of Pretoria's Faculty of Natural and Agricultural Sciences. She holds the National Research Foundation (NRF)/ Department of Science and Innovation (DSI) Chair in Plant Health Products from Indigenous Knowledge Systems. She also leads the Department's Medicinal Plant Science Programme.

The main vision of her research is to use medicinal plants for the benefit of people. The Medicinal Plant Science Programme investigates medicinal plants for tuberculosis, cancer and skin-related diseases. The hepatoprotective and immunomodulatory effects of plants are also evaluated. The aim is therefore not only the isolation and purification of pharmacologically relevant phytochemicals as new lead compounds, but also the investigation of complex extracts and semi-pure fractions to use in the medicinal plant industry related to the primary health care of people. Prof Lall works closely with industry partners, as well as traditional health practitioners for the commercialisation of new plant-based herbal products. Bioprospecting, ethical issues, intellectual property rights and benefit-sharing related to this process are some of the tasks of high priority.

Prof Lall obtained her PhD at the University of Pretoria in 2001. She joined the University as a senior research assistant in 1997, moving up the ranks as a lecturer, senior lecturer and assistant professor, and was promoted to the position of full professor in 2016. She has a C2 rating from the National Research Foundation, which classifies her as an established researcher with a sustained recent record of productivity in the field, who is recognised by her peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

Among the awards she has received are the Unesco-L'Oreal Award for Women in Science (2002), the Order of Mapungubwe (2014) and the Biotech Fundi Lifetime Contribution Award by the Gauteng Department of Agriculture and Rural Development and the Innovation Hub (2017).

She has been placed in the top 1% of the Essential Science Indicators list for publication citations in the discipline of pharmacology and toxicology. She has also led the discovery of a number of medicinal plants with valuable biological activities, many of which have been patented. Sixteen prototype extracts prepared in her laboratory have undergone extensive research and development, and have been patented and licenced out to manufacturers. ○

*Dr Kumbukani Nyirenda was jointly supervised by Prof Namrita Lall and Prof Lyndy McGaw (see page 83)

PHYSICOCHEMICAL PROPERTIES AND APPLICATIONS OF NANOMATERIALS FROM UNDER-UTILISED MALAWIAN PLANT SPECIES

Postdoctoral fellow: Dr Kumbukani Nyirenda
Mentors: Prof Namrita Lall and Prof Lyndy McGaw

Medicinal plants play a key role in health care around the world, with about 80% of Africans depending on phytomedicine. It has a wide range of uses in the treatment of diseases, especially priority diseases of Africa such as HIV/AIDS, malaria, diabetes and tuberculosis. These plants have more beneficial effects than their synthetic counterparts and are reported to be safer, more affordable and more culturally compatible. Some African phytomedicines are well known in the international market, and provide an economic benefit for the producing countries.

In Malawi, wild plants have been collected for medicinal purposes for centuries. As the grandchild of renowned traditional medicine practitioners, Dr Nyirenda developed a passion for unconventional approaches to solving Africa's health challenges using interdisciplinary scientific methods. His doctoral thesis, completed as a Carnegie Regional Initiative in Science and Education (RISE) fellow, focused on investigating bioactive compounds from four Malawian plants traditionally used for the management of diabetes and HIV opportunistic infections. This work generated active novel chemical compounds that could help improve the nutritional and health status of Malawian society. His academic and research aspirations are to add value to Malawian biological resources through sustainable partnerships.

Dr Nyirenda's postdoctoral research was focused on expanding the focus of his doctoral work by including aspects of nanotechnology to bring together expertise from the fields of engineering, biosciences and physical sciences to address the problems affecting the continent. Through this work, he hopes to contribute to the sustainable economic, social and environmental development of Malawi.

The goal of his research was to investigate the physicochemical and functional properties of nanomaterials derived from Malawian plant species for improved healthcare. Specific objectives included the following:

- Determine the selected dermatological and pharmaceutical activities of two Malawian plant species
- Evaluate the physicochemical properties of starch-based nanomaterials
- Characterise the functional attributes of candidate products formulated from plant species

The study engaged the multidisciplinary involvement of botanists, preparative chemists, analytical chemists, toxicologists and biologists to assess the cosmetic, pharmaceutical and cytotoxicity activity of the two selected plants and formulations. The two plant species that were targeted as a source of active compounds were *Chenopodium ambrosioides* (commonly known as Mexican tea), a perennial herb that is found in Malawi and has been used as a natural pesticide, and *Jaterorhiza palmata* (known as the calumba), a perennial climbing plant endemic to East Africa that contains isoquinoline alkaloids and is known to treat anaemia.

The findings from the *J. palmata* extracts showed high potential for the isolation of lead compounds and the development of dermatological products for the treatment of conditions caused by acne bacteria. The preliminary results of essential oils extracted from *C. ambrosioides* revealed that it also displayed impressive repellent activity against the female *Anopheles* mosquito larvae.

Among the outputs of his research include two conference papers presented with his mentors, Prof Namrita Lall and Prof Lyndy McGaw: one at the International Conference on Agricultural and Biological Sciences for 2019 on the morphological and physicochemical properties of Malawian native cassava starch as potential polymer additives, and the other at the International Conference of the African Research Universities Alliance for 2019 on harnessing the potential of nanomaterials from African biodiversity.

He has another two manuscripts in preparation. He plans to submit an article on the phytochemical profile, antibacterial and anti-tyrosinase activities of various *J. palmata* root extracts to the Institute for Scientific Information (ISI)-rated journal *Plants*, and an article on the morphology and physicochemical properties of Malawian native cassava starch to the journal *Nanotechnology*. To finalise these papers, he proposed organising a three-day writing retreat in Malawi at the beginning of February 2022.

To enhance awareness of the need to address Africa's most urgent challenges and provide an opportunity to develop a sustainable and inclusive bioresource-based economy, Dr Nyirenda joined his fellow countryman, Dr Emmanuel Vellemu (another ECRLF postdoctoral scholar) to organise the Biodiversity for Malawi Conference in November 2021. It was jointly hosted by the Kamuzu University of Health Sciences and the Malawi University of Science and Technology. The theme of the conference was consistent with the Malawi Vision 2063, which has identified environmental sustainability as one of the seven enablers for Malawi's inclusive economic growth. Dr Nyirenda's conference presentation was related to the theme of natural products and health, and addressed the aflatoxin and microbiological evaluation of traditional cereal-based weaning foods in Malawi.

Reflecting on the value of the fellowship, Dr Nyirenda states that the mentorship he received from such exceptional specialists in their fields as Prof Lall and Prof McGaw made him a better scientist. He appreciates the skills he developed in proposal writing, which enabled him to be involved in the writing of three grant proposals. It also gave him insight into postdoctoral supervision, as well as the confidence to mentor postgraduate students in his own right as a researcher.

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Dr Nyirenda has great appreciation for the transdisciplinary platform that was provided by the ECRLF programme. He recommends exploring the possibility of graduating fellows of the programme to senior fellows who can support incoming fellows. He sees this as a way of ensuring the continuity and sustainability of the programme.

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He is currently supervising two master's and one doctoral candidate at his home institution. He will be continuing with his postdoctoral research under the mentorship of his home supervisor by extracting and isolating essential oils from *C. ambrosioides* plant biomass for further experimentation and data analysis.

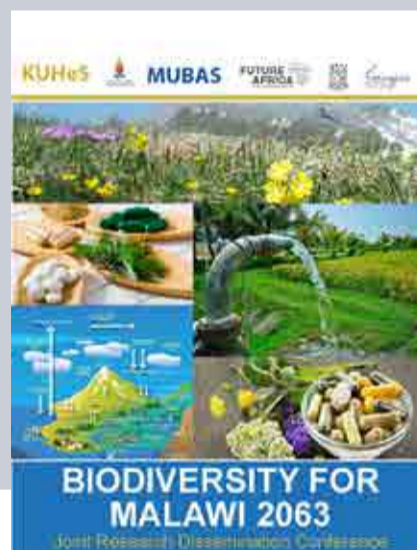
Benefits that he did not expect to receive from the fellowship included transdisciplinary collaboration with other researchers, and additional training in product development, food safety and analysis. Some of the postdoctoral networks that were formed on the fellowship extend beyond the programme. He has been appointed as principal investigator on a project funded by the American Health and Environmental Sciences Institute (HESI) to evaluate traditional and complementary medicines and conventional medicines used concurrently in non-communicable disease management, as well as on a project of the HESI's Botanical Safety Consortium on the phytochemistry and toxicity of *Aristolochia* sp. He has also been appointed as the co-principal investigator on a project funded by The World Academy of Sciences (TWAS) to synthesise and characterise betulinic acid derivatives.

Dr Nyirenda has great appreciation for the transdisciplinary platform that was provided by the ECRLF programme. He recommends exploring the possibility of graduating fellows of the programme to senior fellows who can support incoming fellows. He sees this as a way of ensuring the continuity and sustainability of the programme. ○

Dissemination conference

BIODIVERSITY FOR MALAWI 2063

Dr Kumbukani Nyirenda presented a conference in collaboration with Dr Emmanuel Vellemu from the Malawi University of Science and Technology, another postdoctoral fellow.. The joint conference, Biodiversity 2063, took place from 20 to 22 July 2021 and attracted just over 150 delegates either on-site or virtually via Zoom and WhatsApp. The theme of the conference was aligned to the Malawi Vision 2063, which identified environmental sustainability as one of the seven enablers for Malawi's inclusive economic growth. ○



See page 38 for conference details

Fellow's publication

SCIENTIFIC EVIDENCE FOR THE TRADITIONAL USE OF PLANTS FOR THE TREATMENT OF SKIN DISEASES

Skin diseases are classified as the fourth most common cause of human illness and affect almost 900 million people in the world at any time. People of all age groups are known to be affected by skin conditions, but the elderly and young children are disproportionately impacted. The known causes of skin disorders include microbial infection, inflammation, cancer and genetic or congenital factors. Infectious dermatoses are the most common skin disorders in Africa.

In developing countries, including several African countries, skin disorders are more prevalent in rural areas, where poor hygienic conditions prevail and access to health care is limited. Acne vulgaris or acne is a chronic skin condition, which is caused by different types of microbial populations. The gram-positive bacteria, *Cutibacterium acnes*, is the most predominant cause of the disease.

In his research, Dr Kumbukani Nyirenda investigated whether the extracts of *Jateorhiza palmata* have biological activities based on traditional applications of these species. He hypothesised that extracts derived from the *J. palmata* significantly inhibit the *in vitro* growth of acne-causing bacteria and tyrosinase enzyme activity, a key enzyme in melanin biosynthesis, and exhibit cytotoxicity against cervical cancer cells (HeLa).

This study explored the phytochemical profile, *in vitro* antibacterial and anti-tyrosinase activities of the crude extracts of the peel and parenchyma organs of *J. palmata* roots. The results of his study showed that the polar ethanolic extracts had a direct inhibitory effect on the growth and proliferation of *C. acnes* bacterial strains. This provided scientific evidence for the traditional use of the plant for the treatment of skin diseases.

The *J. palmata* extracts exhibited minimal anti-tyrosinase activities, which was consistent with other Menispermaceae plants that have shown little to no inhibition against tyrosinase. Of the eight *J. palmata* extracts that were tested for their cytotoxicity activity against HeLa cells, only two showed a toxic effect, while six did not show any inhibitory activity when tested at the highest concentration of 400 µg/ml. The ethanolic peel extracts from Thyolo and Neno exhibited an IC_{50} of 357.80 ± 28.23 µg/ml and 85.94 ± 0.92 µg/ml, respectively, indicating the concentrations of extract required to inhibit 50% of HeLa cell proliferation.

The findings of his present study suggest that future research directions should include the characterisation and identification of phytochemical constituents responsible for the observed anti-acne activities and further investigation of extracts for direct melanin production in a cell model. ○



INTEGRATING CAPACITY BUILDING IN BOTANICALS AND DISSEMINATION FOR COSMECEUTICAL APPLICATION

Upon conclusion of his postdoctoral fellowship, Dr Kumbukani Nyirenda obtained an extended grant from the Carnegie Corporation of New York, under the ECRLF programme. This would be utilised to undertake additional phytochemical analyses of *Chenopodium ambrosioides*, and to extract essential oils from this plant for possible cosmetic product formulation studies, as well as to finalise and publish an article on his research.

His postdoctoral research was aimed at exploiting biodiversity, science and traditional knowledge, and to make it accessible to the modern market by tapping into the rich pool of diversity for medicinal and cosmeceutical purposes. The *C. ambrosioides* was one of the plant species that formed part of his initial research. Preliminary results had shown that essential oils from this plant displayed impressive repellent activity against the female *Anopheles* mosquito larvae.

The target species was harvested from Soche Hill, Blantyre district in Malawi. It was scientifically identified by a taxonomist at the National Herbarium and Botanical Gardens of Malawi, dried under shed and weighed. Steam distillation and Soxhlet methods were used to extract

and isolate essential oils from the pre-weighed materials of the *C. ambrosioides* plant biomass. Cumulatively, a total volume of 20 ml of essential oil was obtained from 30 kg of fresh biomass.

The volatile oils that were extracted from the plant biomass are being refrigerated in amber bottles at 4 °C and are awaiting further phytochemical analysis by gas chromatography-mass spectrometry to determine its chemical composition. The oil samples have been shipped to the University of Pretoria's Phytomedicine laboratories where formulation study experiments will be conducted.

The second activity that formed part of his extended grant entailed a three-day scientific manuscript writing retreat. The workshop was held at the Sunbird Nkopola Lodge in Mangochi, Malawi from 11 to 13 February 2022. Participants were drawn from three universities in Malawi: Kamuzu University of Health Sciences, University of Malawi and Lilongwe University of Agriculture and Natural Resources.

The workshop was facilitated by Dr Peter Kumpalume, a former Minister of Health in Malawi, and Dr Baxter Kachingwe, a senior lecturer in the Pharmacology Department of the Kamuzu University of Health Sciences in Malawi. It was aimed at providing the participants with

an overview of scientific writing, peer-reviewed journals and the purpose of peer review. It would develop a sound understanding of the structure of scientific papers, and assist researchers in planning their writing in order to ensure publication in the targeted journals. Finally, it provided the participants with an opportunity to practice their writing skills and write a draft article for possible publication. The workshop involved lectures, question-and-answer sessions, individual and tutoring activities, and group presentations.

Outcomes of the workshop included the conclusion of a paper on the bioassay results of Dr Nyirenda's research on *Jaterorhiza palmata* extracts. This paper is ready for submission to the Multidisciplinary Digital Publishing Institute's peer-reviewed journal *Plants*. A second article was drafted on Dr Nyirenda's work on mosquito repellence and volatile oils from *C. ambrosioides*. This will be submitted to *Malaria* for publication. The workshop also contributed to the capacity building of four Bachelor of Pharmacy (Honours) students, three staff members, an MSc student and a PhD student in research and publication skills.

Dr Nyirenda is satisfied with the successful completion of these extended activities. ○



Dried plant material



Student extracting oil



C. ambrosioides extraction



Oil above water



Purified *C. ambrosioides* oil



MAURITIUS



UNIVERSITY OF MAURITIUS



The University of Mauritius is the national university of Mauritius. It is the oldest and largest university in the country in terms of student enrolment and curriculum offered. The public university's main campus is located at Réduit, Moka. The University of Mauritius was officially established by the University of Mauritius Ordinance in 1965, incorporating the existing School of Agriculture.

The institution houses the Faculty of Agriculture, the Faculty of Engineering, the Faculty of Information, Communication and Digital Technologies, the Faculty of Law and Management, the Faculty of Ocean Studies, the Faculty of Science and the Faculty of Social Studies and Humanities. In addition to the six faculties, the University of Mauritius also includes the Centre for Innovative Lifelong Learning, the Centre for Information Technology and Systems, and the Centre for Biomedical and Biomaterials Research.

The University's vision is to position itself as a research-engaged and entrepreneurial university. This guides the institution in its goal to play an active role in building the human, intellectual, business and social capital needed for this country to develop an innovation-based economy. To achieve this vision, the University of Mauritius has not only developed a tripartite relationship between itself, government and industry, but is also engaging closely with the community into what is coined a quadruple helix of innovation. To this end, the University collaborates with numerous local and foreign institutions through established agreements.

Its mission is to develop world-class learning, impactful and innovative research and an entrepreneurial culture, as well as to promote engagement with civil society. ○



DR CARENE PICOT-ALLAIN

Dr Carene Picot-Allain is currently an intern at the Biopharmaceutical Unit of the Centre for Biomedical and Biomaterials Research at the University of Mauritius. She obtained her PhD in Biochemistry from the University of Mauritius in 2018. The focus of her postdoctoral studies is the extraction and characterisation of natural biopolymers from agro-industrial waste.

With a background in biochemistry and natural product research, her current research is in the field of food biopolymers. Her focus is on the extraction and characterisation of pectin from waste products like lime, lemon and grapefruit peels and the assessment of its bioactivity and functional properties. She hopes that the development of valuable biomaterials from agro-industrial wastes will help mitigate environmental concerns related to waste disposal and pollution.

Her research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Extraction and characterisation of pectin from agro-industrial waste



CONTACT: picotcarene@gmail.com

FELLOW'S RESEARCH HIGHLIGHTS

Grants

TEC National Postgraduate Scholarship for full-time MPhil and PhD by Research. Awarded by the Tertiary Education Commission, Ministry of Education, Government of Mauritius.

Full sponsorship to attend the 11th edition of BIOVISION, the World Life Sciences Forum, held from April 13-14, 2016 at Lyon, Congress Center, Cite Internationale.

Publications

- Picot-Allain C., Amiri-Rigi A., Abdoun-Ouallouche K., Aberkane L., Djefal-Kerrar A., Mahomoodally M., Emmambux M. (2022). Assessing the bioactivity, cytotoxicity, and rheological properties of pectin recovered from citrus peels. *Food Bioscience*, 46, 101550.
- Cloete L., Picot-Allain C., Ramasawmy B., Neetoo H., Ramful-Baboolall D., Emmambux M. (2022). Drivers and barriers for commercial uptake of edible coatings for fresh fruits and vegetables industry – a review. *Food Reviews International*, 1–34.
- Picot-Allain C., Mahomoodally M., Ak G., Zengin G. (2021). Conventional versus green extraction techniques – a comparative perspective. *Current Opinion in Food Science*, 40, 144–156.
- Picot-Allain C., Emmambux M. (2021). Isolation, characterisation and application of nanocellulose from agro-industrial by-products: A review. *Food Reviews International*, 1(29).
- Mahomoodally M., Picot-Allain C., Zengin G., Llorent-Martinez E.J., Stefanucci A., Ak G., Senkardes I., Tomczyk M., Mollica, A. (2021). Chemical profiles and biological potential of tuber extracts from *Cyclamen coum* Mill. *Biocatalysis and Agricultural Biotechnology*, 33, 102008.
- Zengin G., Mahomoodally M., Picot-Allain C., Sinan K., Ak G., Etienne O., Sieniawska E., Maciejewska-Turska M., Świątek Ł., Rajtar B., Polz-Dacewicz M. (2021). Chemical composition, biological properties and bioinformatics analysis of two *Caesalpinia* species: A new light in the road from nature to pharmacy shelf. *Journal of Pharmaceutical and Biomedical Analysis*, 198, 114018.
- Picot-Allain C., Ramasawmy B., Emmambux, M. (2020). Extraction, characterisation, and application of pectin from tropical and sub-tropical fruits: A review. *Food Reviews International*, 1–31.
- Fawzi Mahomoodally M., Picot-Allain C., Zengin G., Llorentmartinez E., Abdullah H., Ak G., Senkardes I., Chiavaroli A., Menghini L., Recinella L., Brunetti L., Leone S., Orlando G., Ferrante C. (2020). Phytochemical analysis, network pharmacology and in silico investigations on *Anacamptis pyramidalis* tuber extracts. *Molecules*, 25(10), 2422.
- Mahomoodally M., Lobine D., Picot-Allain C., Sadeer N., Jugreet S., Zengin G. (2020). Conventional and non-conventional targets of natural products in the management of diabetes mellitus and associated complications. *Current Medicinal Chemistry*, 27(1).
- Zengin G., Mahomoodally M., Sinan K., Picot-Allain C., Yildiztugay E., Cziaky Z., Jekó J., Saleem H., Ahemad N. (2020). Chemical characterisation, antioxidant, enzyme inhibitory and cytotoxic properties of two geophytes: *Crocus pallasii* and *Cyclamen cilicium*. *Food Research International*, 133, 109129.
- Mahomoodally M., Picot-Allain C., Hosenally M., Ugurlu A., Mollica A., Stefanucci A., Llorent-Martinez E., Baloglu M., Zengin G. (2019). Multitargeted potential of *Pittosporum senecioideum* Putt.: HPLC-ESI-MSn analysis, in silico docking, DNA protection, antimicrobial, enzyme inhibition, anti-cancer and apoptotic activity. *Computational Biology and Chemistry*, 83, 107114.
- Mahomoodally M., Sieniawska E., Sinan K., Picot-Allain C., Yerlikaya S., Cengiz Baloglu M., Altunoglu Y., Senkardes I., Rengasamy K., Zengin G. (2020). Utilisation of *Rhododendron luteum* Sweet bioactive compounds as valuable source of enzymes inhibitors, antioxidant, and anticancer agents. *Food and Chemical Toxicology*, 135, 111052.
- Mahomoodally M., Picot-Allain C., Hosenally M., Ugurlu A., Mollica A., Stefanucci A., Llorent-Martinez E., Baloglu M., Zengin G. (2019). Multitargeted potential of *Pittosporum senecioideum* Putt.: HPLC-ESI-MSn analysis, in silico docking, DNA protection, antimicrobial, enzyme inhibition, anti-cancer and apoptotic activity. *Computational Biology and Chemistry*, 83, 107114.
- Zengin G., Sieniawska E., Senkardes I., Picot-Allain C., Ibrahim Sinan K., Fawzi Mahomoodally M. (2019). Antioxidant abilities, key enzyme inhibitory potential and phytochemical profile of *Tanacetum poteriifolium* Grierson. *Industrial Crops and Products*, 140, 111629.
- Zengin G., Mahomoodally F., Picot-Allain C., Diuzheva A., Jekó J., Cziaky Z., Cvetanović A., Aktumsek A., Zeković Z., Rengasamy K. (2019). Metabolomic profile of *Salvia viridis* L. root extracts using HPLC-MS/MS technique and their pharmacological properties: A comparative study. *Industrial Crops and Products*, 131, 266–280.
- Zengin G., Mahomoodally M., Paksoy M., Picot-Allain C., Glamocilja J., Sokovic M., Diuzheva A., Jekó J., Cziaky Z., Rodrigues M., Sinan K., Custodio L. (2019). Phytochemical characterization and bioactivities of five *Apiaceae* species: Natural sources for novel ingredients. *Industrial Crops and Products*, 135, 107–121.
- Zengin G., Mahomoodally M., Picot-Allain C., Cakmak Y., Uysal S., Aktumsek A. (2019). In vitro tyrosinase inhibitory and antioxidant potential of *Consolida orientalis*, *Onosma isauricum* and *Spartium junceum* from Turkey. *South African Journal of Botany*, 120, 119–123.
- Akata I., Zengin G., Picot C., Mahomoodally M. (2019). Enzyme inhibitory and antioxidant properties of six mushroom species from the *Agaricaceae* family. *South African Journal of Botany*, 120, 95–99.
- Picot C., Zengin G., Mollica A., Stefanucci A., Carradori S., Mahomoodally F. (2017). In vitro and in silico studies of mangiferin from *Aphloia theiformis* on key enzymes linked to diabetes Type 2 and associated complications. *Medicinal Chemistry*, 13 (7), 1–8.
- Picot C., Mahomoodally F. (2017). Effects of *Aphloia theiformis* on key enzymes related to diabetes mellitus. *Pharmaceutical Biology*, 55(1), 864–872.
- Picot C., Bender O., Atalay A., Zengin G., Loffredo L., Hadji-Minaglou F., Mahomoodally F. (2017). Multiple pharmacological targets, cytotoxicity, and phytochemical profile of *Aphloia theiformis* (Vahl.) Benn. *Biomedicine and Pharmacotherapy*, 89, 342–350.
- Picot C., Mahomoodally F. (2017). *Faujasia flexuosa* (Lam.) C. Jeffrey (Asteraceae) – an endemic medicinal plant from Mauritius. *Current Traditional Medicine*, 3(2), 93–99.
- Picot C., Subratty H., Mahomoodally F. (2014). Phytochemical profile and antioxidant properties of six medicinal plants traditionally used in the management of diabetes in Mauritius. *Pharmacologia*, 42–49.
- Picot C., Subratty H., Mahomoodally F. (2014). Inhibitory potential of five traditionally used native antidiabetic medicinal plants on α -amylase, α -glucosidase, glucose entrapment and amylolysis kinetics in vitro. *Advances in Pharmacological Sciences*, 1–7.

Book chapters

- Picot C., Mahomoodally F. (2019). Neuroprotective potential of phytochemicals via in silico molecular docking techniques. In Atta-ur-Rahman (ed), *Studies in natural products chemistry*, Elsevier, Vol 63, 1st ed.

Conference presentations

- Picot-Allain C., Melucci D., Locatelli M., Locatelli C., Zappi A., De Laurentiis F., Carradori S., Campestre C., Leporini L., Zengin G., Menghini L., Aktumsek A., Mocan A., Rengasamy K., Mahomoodally M. (2019). *Asphodeline lutea* Reichenb and *Asphodeline cilicica* Tuzlaci: Wild edible medicinal plants with bioactive properties. SAAFoST Congress 2019 – Food Science and Technology for the 21st Century, Johannesburg, South Africa.

- Picot-Allain C., Emmambux, M. (2019). Extraction and characterisation of pectin and cellulose from grape pomace and grapefruit peels. SAAFoST Congress 2019 – Food Science and Technology for the 21st Century. Johannesburg, South Africa.



Mentor profile

PROF NAUSHAD EMMAMBUX

Naushad Emmambux is a professor in the Department of Consumer and Food Sciences in the University of Pretoria's Faculty of Natural and Agricultural Sciences. Originally from Mauritius, he obtained his PhD in Food Science at the University of Pretoria in 2004. He joined UP in 2005 as a postdoctoral researcher and part-time lecturer, supervising honours students in the Department. He has since progressed to lecturer, senior lecturer, associate professor and full professor in Food Sciences.

He is the research leader for Food Processing in the Department of Science and Innovation (DSI)/National Research Foundation (NRF) Centre of Excellence in Food Security, as well as the South African leg of the European Union (EU)-funded InnoFoodAfrica initiative. One of the goals of this initiative is to develop new ways to add value to the cultivation, processing and production of climate-smart African crops, such as sorghum, finger millet, teff, amaranth, faba bean, orange-fleshed sweet potato, Bambara groundnut and cowpea, which have excellent nutritional properties.

Prof Emmambux has a C2 rating from the NRF, which classifies him as an established researcher with a sustained recent record of productivity in the field, who is recognised by his peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

His research focuses broadly on African food biopolymers for nutrition and functional use. His main focus is on the chemistry of starch modification with lipids for clean-label starches used in the production of nanomaterials, non-gelling high-viscosity starches for stabiliser and fat replacers, low glycaemic index foods, the encapsulation of nutraceuticals, and biocomposites with other biopolymers. His research interests include food chemistry, food rheology, spectroscopy, microscopy and nanotechnology.

Under his leadership, researchers in the Department of Consumer and Food Sciences are working on ways to reduce the energy density of food sustainably by using green technologies. They have also patented a novel procedure to produce starch microspheres. The starch is coated with edible nanomaterials that provide lubricity and shear stability.

Consequently, the starch microsphere can be used to mimic fat. This factor has allowed his research team to manufacture oil-free mayonnaise, as the starch microsphere behaves as a fat globule. The starch microspheres have potential as fat replacers in cake, yoghurt and cheese. The technology is relatively simple and does not produce any effluent. ○



“
The fellowship programme proved to be a win-win situation for both the fellow and the mentor.
”



THE EXTRACTION AND CHARACTERISATION OF PECTIN FROM AGRO-INDUSTRIAL WASTE

Postdoctoral fellow: Dr Carene Picot-Allain
Mentor: Prof Naushad Emmambux

In a rapidly developing world, the amount of waste generated from agro-industrial activities has increased substantially. While some waste can be transformed into animal feed or fertilizer, much of it ends up in landfills. Untreated waste affects ecosystems and human communities, and contributes to global warming through the emission of greenhouse gases. Innovative solutions are therefore needed that are geared towards the utilisation and recycling of agro-industrial waste.

In this regard, Dr Carene Picot-Allain realised the importance of green and sustainable chemistry. This is a new and innovative approach to which her mentor, Prof Naushad Emmambux, subscribes. It avoids the use of harsh chemicals in the extraction of natural biopolymers and includes technologies such as microwave, ultrasound and enzyme-assisted extraction.

Dr Picot-Allain was fortunate to have worked with Prof Emmambux previously on a collaborative project between the University of Pretoria and the University of Mauritius. This project entailed the extraction and characterisation of pectin from citrus fruit to develop an edible coating. The topic for her postdoctoral research therefore provided the opportunity to continue working on the extraction of natural polymers such as pectin, micro and nanocellulose from agro-industrial waste, but with further applications.

Her decision to use citrus peel waste for her experiments was based on the fact that citrus fruits are the most widely grown fruit globally. As forms of agro-industrial waste, they are rich in valuable natural compounds, which might be used for further applications in the food, pharmaceutical, nutraceutical and cosmetic industry. They also remain underexploited as a renewable source of novel compounds, such as natural biopolymers. "It is worth noting," says Dr Picot-Allain, "that the last decades have witnessed an ascending trend in research and development on natural biopolymers as a substitute for conventional synthetic polymers".

Her research was therefore aimed at obtaining clean-label biopolymers, such as pectin and cellulose, from selected agro-industrial waste by applying the principles of green chemistry. The main objective of her study was to develop an integrated extraction method for the sequential extraction of phytochemicals, pectin and cellulose from the peel waste of selected citrus fruits to recover valuable components for further applications.

Most of the first year of her fellowship was spent in South Africa, where she was able to work in the University of Pretoria's Food Sciences laboratories under the guidance of Prof Emmambux.

However, with the advent of the COVID-19 pandemic in March 2020, she was forced to re-evaluate her workplan. She therefore focused on extracting pectin from the peel waste of three citrus fruits: grapefruit, lime and lemon, using two different treatments.

The first approach entailed boiling dry powder peel waste at 80 °C for three hours in acidified conditions. The second included a pre-treatment step using ethanol and acetone to remove the phytochemicals present in the peel waste. The aim was to assess the bioactivity, as well as the functional properties of the pectin samples.

She joined her mentor in presenting her research at the South African Association for Food Science and Technology (SAAFoST) Congress from 1 to 4 September 2019.

Upon her return to Mauritius, she made use of the opportunity to establish collaborations with other researchers who were interested in studying pectin. This resulted in the successful publication of several articles in international peer-reviewed journals:

- "Extraction, characterisation and application of pectin from tropical and sub-tropical fruits: A review" (in collaboration with B Ramasawmy and MN Emmambux) in *Food Reviews International* (published in 2020).
- "Isolation, characterisation and application of nanocellulose from agro-industrial by-products: A review" (in collaboration with MN Emmambux) in *Food Reviews International* (published in 2021).
- "Conventional versus green extraction techniques: A comparative perspective" (in collaboration with MF Mahomoodally, G Ak and G Zengin) in *Current Opinion in Food Science* (published in 2021)
- "Assessing the bioactivity, cytotoxicity and rheological properties of pectin recovered from citrus peels" (in collaboration with A Amiri-Rigi, K Abdoun-Ouallouche, L Aberkane, A Djefal-Kerrar, MF Mahomoodally and MN Emmambux) in *Food Bioscience* (published in 2022).

This collaboration with other researchers exposed Dr Picot-Allain to perspectives from other disciplines as well, including food chemistry, chemical engineering and polymer chemistry.

"I learnt a lot about transdisciplinarity, and how one can succeed in solving complex challenges by working together in teams."

“

Reflecting on her mentorship experience, Dr Picot-Allain has great respect for her mentor. “Prof Emmambux is a visionary, who sees things from another perspective. His mentorship has been inspiring. I really learnt a lot from his way of working.”

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Prof Emmambux, in turn, considers programmes such as this an excellent way of building international bonds with universities in other countries, and to join hands to solve challenges that extend beyond borders and that affect all citizens of the world. He commends Dr Picot-Allain for her initiative and for being able to devise innovative solutions when faced with a challenge.

“The fellowship programme proved to be a win-win situation for both the fellow and the mentor,” Prof Emmambux remarked. “Dr Picot-Allain was able to contribute her biochemistry background and knowledge of biopolymers, while I could suggest ways of applying this to food science.” He believes that the programme contributed to Dr Picot-Allain’s development as an early career research leader, and the host university naturally also benefitted from the research outputs that came about during the course of the programme.

Upon conclusion of the ECRLF programme, Dr Picot-Allain had the opportunity to work with a team of multidisciplinary researchers at the University of Mauritius. This project focused on the development of a coating to extend the shelf life of fruit and vegetables in order to reduce food wastage.

She was also granted an extension of her ECRLF grant to participate in an internship at the Biopharmaceutical Unit at the University of Mauritius’s Centre for Biomedical and Biomaterials Research (CBBR). This intensive training opportunity was initially granted for a period of two months, but has since been extended for another month. It will enable her to expand her research into assessing the anticancer activity of pectin samples recovered from citrus peel waste through the application of cell proliferation assays.

The Biopharmaceutical Unit of the CBBR is equipped with a cutting-edge cell culture platform, where she is fortunate to work under the guidance of Dr Vidushi Neergheen, associate professor and inaugural fellow of the Africa Science Leadership Programme of 2015.

Although the academic opportunities in Mauritius are not as vast as they are in other African countries, Dr Picot-Allain believes that the fellowship has given her the confidence to establish herself as a researcher and to uncover the unexplored potential of pectin for the development of novel oncological therapies. ○



GREEN CHEMISTRY SHOWS PROMISE IN ADDING VALUE TO AGRICULTURAL PRODUCTS

The processing of fruit and vegetables often results in considerable waste, comprising peels, pomace and bagasse. Finding a way of utilising these by-products will not only create additional value to the processor, but such a recycling strategy can contribute greatly to mitigating problems associated with solid waste at the processing plants.

The recovery of valuable compounds in the by-products obtained from the processing of fruit and vegetables has received considerable scientific attention from chemists, chemical engineers and polymer chemists. The development of valuable biomaterials from agro-industrial waste is expected to address environmental concerns related to waste disposal and pollution due to agro-processing.

The current environmental challenges, as well as economic realities, are forcing farmers and agro-processors worldwide to look for new opportunities to mitigate these challenges to survive and expand their businesses. By adding value to farm produce through further

processing, the industry has the opportunity to not only grow markets, turnover and profits, but also invest in sustainable practices with many benefits to society and the environment.

The recovery of pectin from citrus peel waste for application in the food, nutraceutical, pharmaceutical and medical industries has attracted much interest. As part of her postdoctoral research, Dr Carene Picot-Allain investigated the physicochemical and biological properties, including the antioxidant, enzyme inhibitory and cytotoxic properties, of pectin extracted from the alcohol-insoluble residue of the peel waste of grapefruit, lime and lemon, as well as the pectin recovered from untreated citrus peel waste.

Dr Picot-Allain postulated that the presence of polyphenols – sometimes regarded as an impurity – in extracted pectin might confer enhanced biological properties. She also evaluated the rheological behaviour of the pectin samples in her study. High methoxyl pectin with galacturonic acid content greater than 60% was recovered from the different pectin samples.

She found that pectin obtained from untreated material possessed a high phenolic content (19.83–5.94 mg gallic acid equivalent/g sample) and showed higher antioxidant activity. Inhibition against pancreatic cholesterol esterase, pancreatic lipase and α -glucosidase was observed and pectin enriched with polyphenol showed higher activity. The addition of pectin samples to healthy Vero cells enhanced proliferation, showing no cytotoxic effect.

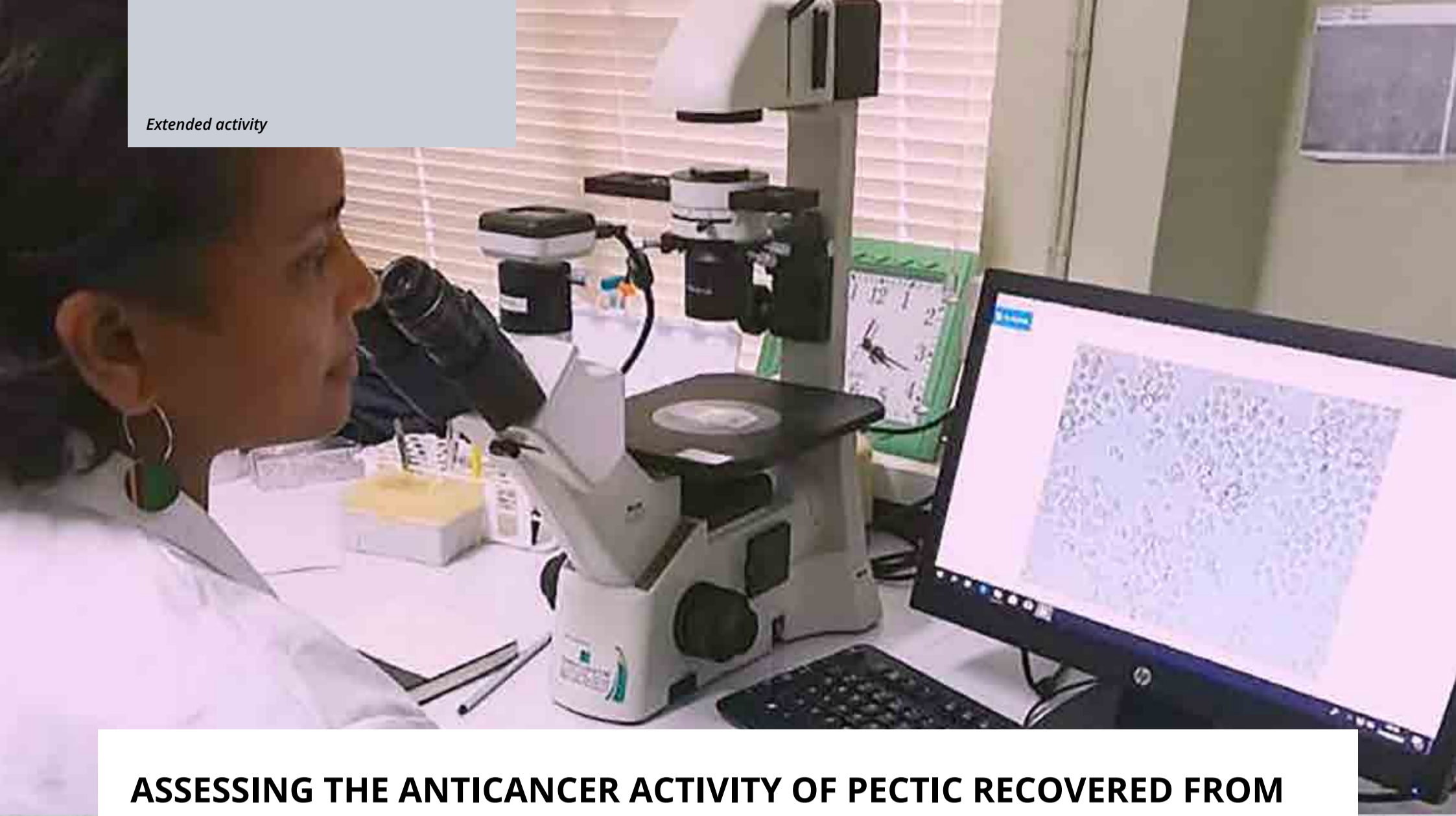
Pectin solutions extracted from untreated lime and grapefruit presented the highest viscosity and elastic modulus, which were comparable to those obtained from commercial high-methoxyl pectin. Pectin extracted from untreated citrus peel material, which has higher biological properties, can be used for their enhanced health benefits.

According to Dr Picot-Allain, pectin extracted from lime, lemon and grapefruit peels possessed interesting biological and viscoelastic properties, which can be exploited for the development of novel bioproducts. ○

Key facts

- Citrus fruit is among the main horticultural crops cultivated and traded worldwide.
- In 2020, South Africa was the second-largest exporter of citrus globally and delivered 146 million cartons of citrus to the rest of the world.
- Citrus fruit is a valuable source of vitamin C, and one of the few fruit of which all parts can be processed. In addition to selling the fruit, the flesh of the fruit can be juiced, canned or frozen. The skin can be dried or sugared and used in the production of citrus oils. The white membranes are used for pectin production. In the case of oranges, the juice can also be fermented to produce orange wine.
- Pectin is a soluble gelatinous polysaccharide that is present in ripe fruits and is used as a setting agent in jams and jellies.
- Due to its highly complex structure, pectin exhibits multiple biological activities. New applications of pectin in non-food sectors, including medicine, pharmaceuticals and cosmetics, make pectic extraction and commercialisation an attractive investment.





ASSESSING THE ANTICANCER ACTIVITY OF PECTIC RECOVERED FROM CITRUS PEEL WASTE

Following up on her research on the extraction and characterisation of natural biopolymers from agro-industrial waste, conducted under the mentorship of Prof Naushad Emmambux at the University of Pretoria, Dr Carene Picot-Allain is investigating new applications of pectin in the pharmaceutical industry - specifically its activity as an oncological treatment.

"Due to the highly complex structure of pectin, it exhibits multiple biological activities," she explains. Despite considerable progress in the field of oncotherapeutics, cancer remains a major public health concern. The complexity of cancer pathophysiology and the multifactorial nature of tumour drug resistance, along with

its toxic effects, have contributed to the lack of effective cancer treatments. "Pectin recovered from citrus peel waste represents an untapped resource that can open new avenues for the development of novel oncological drugs."

During the course of her postdoctoral research on the ECRLF programme, Dr Picot-Allain gathered novel scientific data regarding the assessment of the biological, physicochemical and functional properties of pectin recovered from the peel waste of lime, lemon and grapefruit, and their respective alcohol-insoluble residues. This data supported the application of the recovered pectin as a component possessing biofunctional properties.

She is therefore preparing to expand this research by undergoing intensive training at the Biopharmaceutical Unit at the University of Mauritius's Centre for Biomedical and Biomaterials Research (CBBR).

The CBBR has a cutting-edge cell culture platform, where Dr Picot-Allain is receiving full-fledged cell culture training under the supervision of Dr Vidushi Neergheen, associate professor and inaugural fellow of the Africa Science Leadership Programme of 2015. The new techniques she is learning will enable her to expand her research into assessing the anticancer activity of pectin samples recovered from citrus peel waste through the application of cell proliferation assays. ○

“ This opportunity is providing me with new skills and knowledge regarding cell culture. I am hoping to obtain scientific data regarding the potential anticancer effects of the pectic samples I obtained during the first stage of my fellowship at the University of Pretoria. This is also exposing me to the possibilities and advantages of transdisciplinary research collaboration. ”



NIGERIA



OBAFEMI AWOLOWO UNIVERSITY



Obafemi Awolowo University is located in the ancient city of Ile-Ife, Osun State, Nigeria. The university was founded in 1962. It is organised into 13 faculties, the postgraduate college and the College of Health Sciences. The University also has a number of institutes, including the Institute of Cultural Studies, the Institute of Agricultural Research and Training and the Institute of Public Health. The University offers undergraduate and postgraduate programmes in fields of specialisation spanning the humanities, arts, natural sciences, social sciences, medical sciences, engineering and technology.

Committed to the highest level of scientific research, the University has established several research centres, which are fully equipped with the latest technology. These include the Atmospheric Research and Information Analysis Laboratory and the Drug Research and Production Unit. The University also has its own teaching hospitals, which are used to carry out medical research by students and staff.

The Student Affairs Division is responsible for enriching the student experience and campus life. The division fosters student growth, while offering support and information about programmes that will prepare students for a successful future in a diverse and constantly evolving society. ○



DR OLUWOLE COKER

Dr Oluwole Coker is an associate professor in the Department of English at the Obafemi Awolowo University, Ile-Ife, Nigeria. His interests in post-colonial African fiction, orature and interdisciplinary studies have seen him extend his work into looking at under-explored African cultural forms that lie in the rich indigenous African societies. The focus of his postdoctoral studies is leveraging indigenous knowledge for environmental sustainability.

As a literary scholar, he strongly believes that there are important learnings in African oral traditions, which connect to contemporary realities. He conceives African cultural productions as sites for the interrogation of African sensibilities and challenges. Thus, his research is aimed at affirming that African literary and cultural productions occupy strategic positions in the exploration and nurturing of indigenous-grounded cultural epistemologies.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Leveraging indigenous knowledge for climate change awareness and environmental sustainability



FELLOW'S RESEARCH HIGHLIGHTS

Awards

Postdoctoral Fellow of the American Council of Learned Societies/African Humanities Program (ACLS/AHP) (2014)

Laureate of Council for Development of Social Science Research in Africa (CODESRIA) Child and Youth Institute (2015)

Fellow of the Summer Programme in Social Sciences, Institute of Advanced Studies, Princeton, New Jersey, USA (2015–2017)

Fellow of the Brown International Advanced Research Institute, Brown University, Rhode Island, USA (BIARI) (2017)

George Foster Experienced Researcher Fellowship of the Alexander von Humboldt Foundation, Germany (2022)

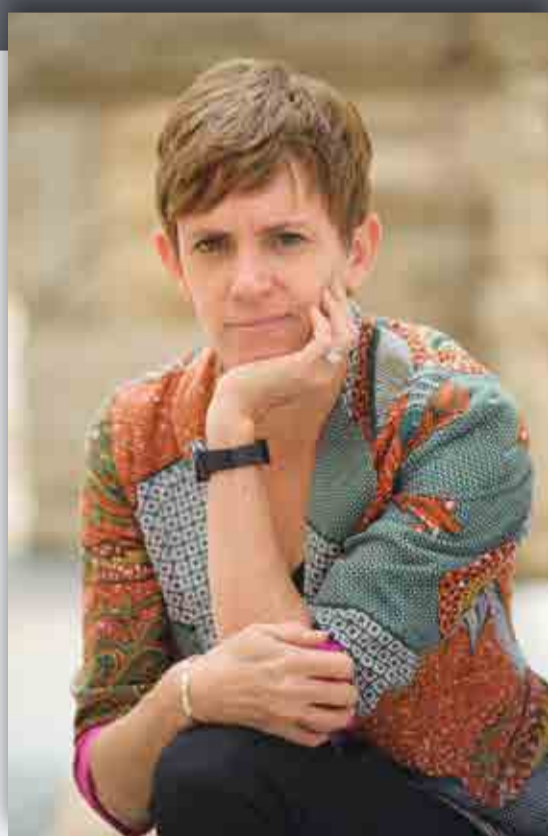
Publications

Coker O. (2019). Okey Ndibe. In Cousins, H., Wanjala, A (eds), *The literary encyclopedia: Anglophone African writing and culture: Sub-Saharan*.

Coker O. (2019). Modernity and the recycling of indigenous knowledge in Ifá literary corpus. *Oye: Journal of Language, Literature and Popular Culture*, 1(1), 65–76.

Coker O. (2019). Cajetan Iheka's naturalising Africa. Ecological violence, agency and post-colonial resistance in African literature. *African Studies Quarterly*, 18(4), 76–77.

Coker O. (2020). 'Weird life' as wildlife consciousness in DO Fagunwa's African literary imagination. *African Identities*.



Mentor profile

PROF CORINNE SANDWITH

Corinne Sandwith is a professor in the Department of English in the University of Pretoria's Faculty of Humanities. She obtained her PhD from the University of KwaZulu-Natal in 2006, where she taught in the English Studies Department for many years. She joined the University of Pretoria as a lecturer in 2014.

She has a C2 rating from the National Research Foundation, which classifies her as an established researcher with a sustained recent record of productivity in the field, who is recognised by her peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

Her research interests include the history of reading, criticism and public debate in early apartheid South Africa, with a particular focus on marginalised and oppositional reading and debating communities. She has also done work on the contemporary public sphere, particularly the South African post-colony. In this area, she has published on the debates that arose in the context of anti-foreigner violence in 2008; on the representation of crime and violence in the tabloid newspaper, *The Daily Sun*; and on inscriptions of the body in the novels of Nigerian writer, Chimamanda Ngozi Adichie.

A recent book-length project offered a reading of early 20th-century African literature through the lens of the popular African press. She examined newspapers in relation to the particular reading communities they constellate and read as important sites for African literary production, which often takes an unexpected form and appears in surprising spaces.

Her published book, *World of letters: Reading communities and cultural debates in early apartheid South Africa* (2014), received the University of Pretoria Vice-Chancellor's Book Award in 2015, and was a runner-up in the National Institute for the Humanities and Social Sciences book awards for an academic monograph. This book recovers the rich historical tradition of public debate about literature and culture in South Africa, within the context of democratic humanism. ○



LEVERAGING INDIGENOUS KNOWLEDGE FOR CLIMATE CHANGE AWARENESS AND ENVIRONMENTAL SUSTAINABILITY

Postdoctoral fellow: Dr Oluwole Coker
Mentor: Prof Corinne Sandwith

In Africa, there is a need to locate environmental consciousness and climate change awareness within existing indigenous models. These should form the basis for hybridising existing local knowledge with formal scientific postulations on climate change among selected communities.

With a background in African literature, particularly post-colonial African fiction, Dr Oluwole Coker is making an effort to deflect from the approaches of previous studies, which have focused mainly on identifying the gaps between local and indigenous knowledge on climate change issues. His research sought to advance the cause of climate change in selected communities through a comparative study and analyses of the orature forms that exhibit tendencies for environmental consciousness, especially as it affects key areas of agriculture, which are the mainstay of economic life for these communities.

In his research, he acknowledges the fact that knowledge of climate change is inherent to the world view of indigenous communities. Thus, in developing appropriate models of engagement, there is a need to harmonise indigenous world views in evolving appropriate models.

According to Dr Coker, the scientific community has been consistent in developing acceptable models for local communities towards enhancing the capacity to engage climate change realities. However, despite several attempts to integrate both arms of knowledge, there is a pervading atmosphere of general distrust that thwarts any lofty efforts. His study was therefore aimed at filling this critical lacuna by developing a model that can be adapted across the selected communities, and which can be effectively disseminated through appropriate communication channels among the mass of the indigenous population.

Growing up, Dr Coker had a deep passion for African literary and cultural studies. "I was fascinated by the depth of African orature and its seeming inexhaustiveness." He is part of a new breed of African literary scholars who are charting a fresh path where African cultural productions play an important role in the creation of indigenous epistemologies.

This was one of the reasons he decided to join Future Africa as a postdoctoral fellow. He believes that Future Africa assumes a unique position as a platform for the cross-pollination of ideas. He intended to use this platform to engage and connect with other African literary scholars, while exploring the interconnected relevance of African literature to contemporary realities.

"The fellowship provided me with the opportunity to engage in transdisciplinary research, particularly with regard to indigenous knowledge systems as they are revealed in philosophy and literature," he explained. "I was able to consult with other researchers who are interested in the literary merit of plant productions in post-colonial literature."

He spent the first year of his fellowship doing field research. He gathered relevant data related to the climate and environmental knowledge of informal rural communities in three locations in Nigeria. He also consulted archives and libraries in Pretoria to obtain information that he could use as a basis for comparative research. His study was therefore a combination of ethnographic research and literature reviews.

The second year was spent largely on analysing the data he had collected, and preparing research articles for publication. "These articles speak to the overall thematic of my research agenda," he said. "They are in conversation with my interrogation of indigenous paradigms for environmental sustainability."

Publications during the fellowship included the following:

- A write-up of Nigerian novelist, Okey Ndibe, in *The Literary Encyclopedia* (2019)
- An article, "Modernity and the recycling of indigenous knowledge in Ifá literary corpus", published in *Oye: Journal of Language, Literature and Popular Culture* (2019)
- A review of Cajetan Iheka's book "Naturalizing Africa. Ecological violence, agency and post-colonial resistance in African literature", published in *African Studies Quarterly* (2019)
- An article, "'Weird life' as wildlife consciousness in DO Fagunwa's African literary imagination", published in *African Identities* (2020)

Dr Coker also edited a book of essays, together with Dr Adebunmi Adeniran, a colleague in the Sociology Department of the Obafemi Awolowo University, Ile-Ife, Nigeria, *Texts and contexts of migration in Africa and beyond*. Published by Pan-African University Press in 2021, the specific chapter he contributed relates to envisioning home and the homeland in the 21st-century African novel. Two other ECRLF fellows, Dr John Mushomi and Dr Ifeanyi Onwuzuruigbo, also contributed chapters to this book.

Reflecting on his fellowship, Dr Coker acknowledges Future Africa for providing a conducive working environment. He appreciates the support of his mentor, Prof Corinne Sandwith, who gave him enough space to express himself as a scholar. "It was a rewarding experience, which enabled me to create networks with other researchers and to share research ideas." ○





FEDERAL UNIVERSITY OYE-EKITI



The Federal University Oye Ekiti is a government-owned and -operated Nigerian university. The University is in the ancient city of Oye-Ekiti and Ikole-Ekiti. It therefore comprises two campuses. It was founded in 2011, and aspires to become an institution of choice, recognised for providing critical opportunities for student success. It seeks to be acknowledged as a primary and engaged regional and global resource for entrepreneurial educational and best practices in mining and farming technology, and to be valued as a university where faculty members, students and professional staff are actively integrating cutting-edge technology in multidisciplinary research.

The institution's mission includes the following:

- Advance the community of learning by engaging in scientific research, humanistic scholarship, multidisciplinary research, entrepreneurship and technological integration.
- Provide a robust and high-quality educational experience for students in a diverse learning environment, while promoting the values and indigenous learning that is responsive to the needs of our society.
- Create an institution that values and prepares students to lead lives of personal integrity and civic responsibility in a global society.
- Prepare the next generation of skilled and ethical professionals by providing robust curricula across and within disciplines that prepare graduates to be research minded and able to compete effectively in a diverse world market.
- Create learning opportunities for faculty members to meet their personal and institutional growth needs.
- Advance best practices in farming and mining, and foster economic development activities that are innovative and research-driven, and will result in a better quality of life for Nigerians. ○

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DR FESTUS ADEJORO

Dr Festus Adejoro was a lecturer in the Department of Animal Production and Health at the Federal University, Oye-Ekiti, Nigeria. He obtained his PhD at the University of Pretoria in 2019. The focus of his postdoctoral studies is the evaluation of the rumen microbial ecology as affected by dietary tannin additives in growing South African mutton merino lambs.

With a background in animal production management, particularly livestock nutrition and management, he has research interests in mitigating enteric methane, improving the utilisation of conventional and underutilised feed resources, as well as optimising nitrogen metabolism in ruminant animals.

He is registered with the South African Council of Natural Scientific Professions and is a member of the South African Society of Animal Science. He is also registered with the Nigerian Institute of Animal Science and is a member of the Animal Science Association of Nigeria.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Effect of encapsulated tannin extract on rumen microbiome, microbial protein synthesis and nitrogen balance in growing South African mutton merino lambs



FELLOW'S RESEARCH HIGHLIGHTS

Grants and awards

Orange Knowledge Programme Fellowship for one month of training in The Netherlands: Short Course on Animal Products Quality and Food Safety (2019).

Tertiary Education Trust Fund Nigeria Research Grant for group research on African yam bean utilisation (2018).

Tertiary Education Trust Fund Nigeria Research Grant for group research on digestive enzymes and restriction in laying chicken (2018).

Netherlands Fellowship Programme Award to undertake three months' training in The Netherlands: International Diploma in Animal Feed (2017).

Publications

Moyo R., Van Niekerk W., Hassen A., Akanmu A., Cortze R., Du Toit L., Adejoro F. (2021). Nutritional quality of wet distillers' grains co-ensiled with maize and evaluation of the feeding value in growing lambs. *Scientia Agricola*, 79(2), e20200122.

Nel T., Hassen A., Akanmu A., Adejoro F. (2020). The use of essential oil in combination with fibrolytic enzymes to reduce in vitro ruminal methane production. *South African Journal of Animal Science*, 50(5), 679–686.

Sanni T., Jesuyon O., Baiyeri S., Adejoro F., Boluwaji O., Akanmu A., Hassen A. (2020). Effect of processing on the chemical composition of African yam bean as supplement, on the in vitro gas production and digestibility of Panicum grass. *Revista Brasileira de Zootecnia*, 49, e20200029.

Akanmu A., Hassen A., Adejoro F. (2020). Haematology and serum biochemical indices of lambs supplemented with Moringa oleifera, Jatropha curcas and Aloe vera leaf extract as anti-methanogenic additives. *Antibiotics*, 9(9), 601.

Akanmu A., Hassen A., Adejoro F. (2020). Gas production, digestibility and efficacy of stored or fresh plant extracts to reduce methane production on different substrates. *Animals*, 10(1):146.

Adejoro F., Hassen A., Akanmu A., Morgavi D. (2019). Replacing urea with nitrate as a non-protein nitrogen source increases lamb growth and reduces methane production, whereas mimosa tannin has no effect. *Animal Feed Science and Technology*, 259, 114360.



Mentor profile

PROF ABUBEKER HASSEN

Abubeker Hassen is an associate professor in Ruminant Animal Nutrition and Pasture Sciences in the University of Pretoria's Faculty of Natural and Agricultural Sciences. He obtained his PhD in Pasture Science from the University of Pretoria in 2006. His fields of expertise include ruminant nutrition, pasture science and climate-smart livestock production.

His research focus is on the optimisation of forage use, the development of plant-based dietary additives to modulate rumen fermentation and reduce enteric methane emission, and the development of feeding systems suitable for climate-smart livestock production in the mixed crop-livestock system in Africa.

Prof Hassen is engaged in multidisciplinary and transdisciplinary research where he is working with different groups to integrate remotely sensed data into crop and grassland computer models to simulate the impact of climate change and various adaptation and mitigation options on ruminant production and the net greenhouse gas emission of livestock systems.

He is a member of the South African Society for Animal Science and the Grassland Society of Southern Africa. He has a C2 rating from the National Research Foundation, which classifies him as an established researcher with a sustained recent record of productivity in the field, who is recognised by his peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

Prof Hassen is currently involved in the following ongoing funded projects:

- "The use of encapsulated Moringa plant extract and Mimosa tannin to manipulate rumen fermentation, enteric methane emission and meat quality" – National Research Foundation (principal investigator)
- "Ecological intensification pathways for the future of crop-livestock integration in African agriculture (EcoAfrica)" – African Union
- "Sustainable natural resource utilisation and livestock production in the era of climate change through targeted interventions" – Agricultural Research Council-Climate Change Collaboration Centre
- "Regional cooperation network for the emergence of crop-livestock (ruminant) systems adapted to the environment" – National Research Foundation (principal investigator) ○



“ Prof Hassen had already seen Dr Adejoro's potential as a doctoral candidate under his supervision, and calls him one of his best students. ”

THE EFFECT OF ENCAPSULATED TANNIN EXTRACT ON THE RUMEN MICROBIOME, MICROBIAL PROTEIN SYNTHESIS AND NITROGEN BALANCE IN GROWING SOUTH AFRICAN MUTTON MERINO LAMBS

Postdoctoral fellow: Dr Festus Adejoro
Mentor: Prof Abubeker Hassen

Several of the problems encountered in Africa that hinder the achievement of the sustainable development goals of zero hunger, the sustainable management of the ecosystem and ensuring a quality life for all are related to climate change. This finds resonance, in particular, in the need for sustainable animal production – especially the sustainable management of ruminant livestock and mitigating this group of animals' environmental footprint.

Methane is one of the by-products of ruminants' fermentation of the herbaceous matter on which they feed. The fermentation takes place mainly in their rumen (or first stomach). The release of ruminal methane gas contributes to the emission of greenhouse gases, which drive global warming and climate change. According to Dr Festus Adejoro, "sustainability relates to livestock production being able to utilise just enough nutrients from the ecosystem as the animal needs, without compromising the long-term ability of the ecosystem to sustain continuous production".

His doctoral research, conducted at the University of Pretoria under the supervision of Prof Abubeker Hassen, related to the use of condensed tannins and nitrate to reduce enteric methane emission and enhance the utilisation of high forage diets in sheep. His postdoctoral research was thus a continuation of this research, focusing on the effect of plant extracts and encapsulated tannin extract on the rumen microbiome, microbial protein synthesis and nitrogen balance in growing South African mutton merino lambs. As the South African mutton merino is a popular breed in South Africa, he chose it as the target of his research, as his findings could easily be related to other ruminants.

Tannin is able to bind to protein. It is therefore an important additive to reduce high-quality protein degradation in the rumen and modulate nitrogen utilisation efficiency in ruminant animals. Tannin can minimise the loss of urinary nitrogen, thereby indirectly reducing nitrous oxide emission into the atmosphere. His research therefore aimed to investigate the effect of the duration of tannin supplementation on microbial populations and enzymatic activities, as well as rumen fermentation parameters in South African mutton merino sheep.

Through collaboration with researchers from various disciplines, he was able to conceptualise theories on mitigating ruminant animals' environmental footprint, and consolidate information derived from fields as diverse as animal science, microbiology and genetics to suggest solutions to a continent-wide dilemma. Seven peer-reviewed articles were accepted for publication during his postdoctoral fellowship period:

- "Effect of lipid-encapsulated Acacia tannin extract on feed intake, nutrient digestibility and methane emission in sheep" (in collaboration with A Hassen and AM Akanmu) in *Animals* (published in 2019)
- "Replacing urea with nitrate as a non-protein nitrogen source increases lamb growth and reduces methane production, whereas mimosa tannin has no effect" (in collaboration with A Hassen, AM Akanmu and DP Morgavi) in *Animal Feed Science and Technology* (published in 2019)
- "The use of essential oil in combination with fibrolytic enzymes to reduce *in vitro* ruminal methane production" (in collaboration with TC Nel, A Hassen and AM Akanmu) in *South African Journal of Animal Science* (published in 2020)
- "Effect of processing on the chemical composition of African yam bean as supplement, on the *in vitro* gas production and digestibility of Panicum grass" (in collaboration with TA Sanni, OMA Jesuyon, SO Baiyeri, OV Boluwaji, AM Akanmu and A Hassen) in *Revista Brasileira de Zootecnia* (published in 2020)
- "Haematology and serum biochemical indices of lambs supplemented with *Moringa oleifera*, *Jatropha curcas* and *Aloe vera* leaf extract as anti-methanogenic additives (in collaboration with AM Akanmu and A Hassen) in *Antibiotics* (published in 2020)
- "Gas production, digestibility and efficacy of stored or fresh plant extracts to reduce methane production on different substrates" (in collaboration with AM Akanmu and A Hassen) in *Animals* (published in 2020)
- "Nutritional quality of wet distillers' grains co-ensiled with maize and evaluation of the feeding value in growing lambs" (in collaboration with R Moyo, WA van Niekerk, A Hassen, A Akanmu, R Cortze and L du Toit) in *Scientia Agricola* (published in 2021)

Dr Adejoro emphasises the importance of this research for solving Africa's food security challenges. "The ruminant mammal occupies a unique ecological niche. It is a major source of animal-based protein, and does not compete with humans for food. As it can be raised on rangelands and marginal fields, it does not endanger the world's shrinking arable lands, which are an important component of the ecosystem. It also utilises nutrients to produce value-added products like meat and milk," he observes. The question Dr Adejoro prompts us to consider, is whether the earth can sustain current production trends.

During his time at Future Africa, Dr Adejoro was able to collect data from animals on the University of Pretoria's Experimental Farm. He was also able to reanalyse the research data in the University's laboratories that he had collected previously as part of Prof Hassen's research group.

With the support of his mentor, Dr Adejoro was also able to establish a collaboration with scientists from the Université Clermont Auvergne in Paris, France. This collaboration was aimed at accessing the technical expertise, as well as facilities, to analyse and interpret the genomic data to be collected from the rumen microbial population analysis of the study.

While on his fellowship, Dr Adejoro was able to share his expertise with students in the Department of Animal Science by lecturing to undergraduate students in the Nutrition Science module. He also provided technical and academic support to doctoral and master's degree students in the design and implementation of their research protocols.

Prof Hassen was grateful for the opportunity to mentor Dr Adejoro as a postdoctoral fellow, as he had already seen his potential as a doctoral candidate under his supervision. He calls Dr Adejoro one of his best students, who had already published three peer-reviewed articles prior to the fellowship. "I am glad that I was able to develop him in various aspects of his research career and to prepare him as a future research leader." Prof Hassen also established research collaborations between the University of Pretoria and the Federal University Oye-Ekiti in Nigeria. "The University of Pretoria therefore also benefitted from the fellowship," Prof Hassen remarked.

Dr Adejoro confirms that the fellowship provided him with the opportunity to grow as a researcher. "Prof Hassen is a great mentor. He gave me more responsibility to work on my own, and taught me to balance time and resources. He contributed to my development as a scientist and a leader, and turned me into an ambassador for Future Africa and research in Africa."

Dr Adejoro believes that, as a result of the fellowship, he was able to become a better supervisor himself, and is better able to teach undergraduate students to relate to the science behind the research. He plans to continue with his research, depending on access to funding, to explore additional opportunities and to conceptualise new ideas.

To bring stakeholders in the livestock sector in Nigeria together and to promote sustainable livestock research in Africa, Dr Adejoro organised the Climate-smart Livestock Production in Africa Conference, with the theme: "Enhancing research impacts". This three-day conference was presented in a hybrid format in June 2021, and covered a wide range of topics to promote sustainable livestock management. It was jointly hosted by the University of Pretoria's Department of Animal Sciences, the Federal University Oye-Ekiti's Department of Animal Production and Health, and the University of Ibadan's Department of Animal Science.

In addition to disseminating the findings of his own research, he was able to introduce delegates to the work of keynote speakers from South Africa, Nigeria and Kenya, as well as from the National Institute of Agricultural Research (INRA) in Paris, France. The Conference Organising Committee anticipated that the conference would transition into stronger collaboration among the participating scientists, and result in the advancement of research and development that is capable of lifting Africa above its current challenges.

It was important for Dr Adejoro to get the farmers' perspective and to enable them to mitigate the impact of farming on climate change. He therefore concluded his fellowship with the presentation of a two-day technical workshop in March 2022, with the theme: "Scalable animal nutrition methodologies". It was aimed at more focused capacity building among the farmers who work with ruminants daily. It was specially aimed at suggesting solutions for a particular farming community in a particular geographical environment.

The workshop provided the farmers with information on animal nutrition and the results of sustainable livestock production research in Nigeria, which was identified as a gap. It presented practical demonstrations that also provided hands-on experience for graduate students and technologists on key animal nutrition protocols to enhance their ability to engage in research. He hopes that the training will help translate research outputs into tangible results that will benefit the end-user. ○

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Dr Adejoro believes that, as a result of the fellowship, he was able to become a better supervisor himself, and is better able to teach undergraduate students to relate to the science behind the research.

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THE POTENTIAL BENEFITS OF ACACIA TANNIN EXTRACT SUPPLEMENTATION IN RUMINANTS

The diverse microbial environment in a ruminant's rumen, or first stomach, helps this animal break down complex carbohydrates, and utilise non-protein nitrogen. This complex ruminal microbial population, however, varies between animal species, age, geographical location, season and – more importantly – feeding regime.

As a by-product of rumen fermentation, ruminant livestock emits methane gas. Similarly, nitrogen loss through animal manure and urine is a significant source of nitrous oxide emission. Compared to methane, nitrous oxide is a more potent greenhouse gas.

Any efforts to reduce the greenhouse gas emissions of ruminant animal production without compromising animal production can reduce the environmental footprint of ruminant animals, and therefore promote a climate-smart agricultural system.

A study conducted by Dr Festus Adejoro of Nigeria aimed to investigate the effect of the duration of tannin supplementation on microbial population and enzymatic activities, as well as rumen fermentation parameters in South Africa mutton merino sheep.

Through its binding to protein, tannin has been recognised as being an important additive that can be used to reduce high-quality protein degradation in the rumen and thus modulate nitrogen utilisation efficiency by ruminant animals.

Ruminant production is a major source of anthropogenic greenhouse gas, which includes mainly enteric methane, and urinary and manure-nitrous oxide, and can cause nitrogen loss to the environment.

Modulating nitrogen metabolism could minimise urinary nitrogen loss and reduce the environmental footprint of ruminant production. Modulating ammonia-nitrogen flux in the rumen for optimum microbial function and overall improved nitrogen retention will ensure the minimisation of nitrogen loss, among other benefits.

Results from previous studies on the impact of condensed tannins on nitrogen metabolism, rumen microbial population and methane emission have varied considerably due to the variations in the biological activities of tannins.

It has been established that the impact of tannins may be influenced by animal species and age, method of administration and diet properties, as well as the potential adaptation of rumen microbes to tannin supplementation.

Even low concentrations of tannin could significantly alter the composition of microbial populations, and are species-specific, with fibre-degrading bacterial species being very sensitive.

Furthermore, the effect of tannin in the rumen waning after prolonged feeding may affect its impact on methane production and

animal product quality. Rumen enzyme activity directly affects proteolysis and overall nutrient digestibility. The duration of tannin supplementation may also affect the variability in the rumen microbial genome population.

How the various rumen microbial genomes respond to tannin supplementation and the effects on nitrogen metabolism may offer a better understanding for strategic use and help farmers take greater advantage of tannin for sustainable livestock production.

An improved knowledge of tannin resistance mechanisms, if at all, proved to exist among tannin-tolerant species and may make it possible to genetically engineer tannin-resistant strains of desirable, but tannin-sensitive species for improved animal performance.

To obtain the required information, lambs from different treatments were placed in metabolic cages and open-circuit respiration chambers. Faecal and urine samples were taken to determine the nutrient digestibility, nitrogen balance and methane emission.

In addition, rumen liquor samples were collected to determine rumen pH, rumen ammonia concentration and volatile fatty acid production, and to extract DNA for sequencing. Such data improved our understanding of the potential benefits that Acacia tannin extract supplementation can have on sustainable ruminant livestock production and nutrition. ○

What is a ruminant?

A ruminant is an even-toed ungulate mammal that chews the cud regurgitated from its rumen. Ruminants comprise cattle, sheep, goats, antelope and giraffe. The word "ruminant" comes from the Latin "ruminare", which means "to chew over again". These mammals' unique digestive system allows them to use energy from fibrous plant material that is not utilised by monogastric animals. The rumen is this animal's first stomach, which receives food or cud from the oesophagus, partly digests it with the aid of bacteria, and passes it to the reticulum.

Ruminant production is a major source of anthropogenic greenhouse gas, which includes mainly enteric methane, and urinary and manure-nitrous oxide, and can cause nitrogen loss to the environment. It has been established that the impact of tannins may be influenced by animal species and age, method of administration and diet properties, as well as the potential adaptation of rumen microbes to tannin supplementation.



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Dr Adejoro confirms that the fellowship provided him with opportunity to grow as a researcher. “Prof Hassen is a great mentor. He gave me more responsibility to work on my own, and taught me to balance time and resources. He contributed to my development as a scientist and a leader, and turned me into an ambassador for Future Africa and research in Africa.”

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CAN LIPID-ENCAPSULATED ACACIA TANNIN EXTRACT REDUCE METHANE EMISSIONS IN SHEEP?

Dr Festus Adejoro was a member of Prof Abubeker Hassen's research team in the University of Pretoria's Department of Animal Sciences. He conducted a study to determine if encapsulating an *Acacia mearnsii* tannin extract in a lipid matrix would favourably mask its bitter taste and possibly slow down its release in the rumen without reducing its anti-methanogenic potency.

Previous studies had indicated that encapsulated tannins may be used to mask or reduce the negative effects associated with tannins and other bioactive compounds in the food or feed industry. They may also to control the release of the active ingredient at the required site for optimum effectiveness.

The use of plant secondary metabolites as natural alternatives to antibiotic growth promoters has elicited great interest globally. If supplementation with plant secondary metabolites proves to be capable of improving livestock productivity, in addition to reducing the impact of livestock production on the environment, it may be applied widely in the livestock industry.

One type of plant secondary metabolite that is known for its wide application in animal production is condensed tannin. This is a water-soluble polyphenolic compound of high molecular weight that is known to modulate rumen fermentation. Past research revealed that condensed tannin can bind with protein in feed, saliva, tissue, enzymes and microbes. This results in reduced rumen protein degradability and reduced urinary nitrogen loss. Other applications of condensed tannin include the control of bloat and intestinal parasites in ruminants, as well as a reduction in enteric methane emissions.

Condensed tannin exhibits anti-methanogenic activity by inhibiting the growth of methanogens through the tanning action of its functional proteins, resulting in bacteriostatic and

bactericidal effects. Enteric methane not only contributes to anthropogenic greenhouse gas emission, but also represents a loss of potential feed energy. The use of Acacia tannin extracts as a dietary additive can effectively reduce methane production, while modulating nitrogen loss.

Tannins have become important phytochemicals in ruminant production due to their wide range of biological activities. The use of a crude extract often comes with limitations, such as reduced feed intake and fibre digestibility, which could be overcome by the use of encapsulated tannin extract. In this study, four rumen-cannulated merino wethers were used in a 4 x 4 Latin square design to determine the effect of encapsulating *Acacia mearnsii* tannin extract (ATE) on intake, nutrient digestibility and methane emission.

The animals were placed on one of four diets: a control diet, a diet that included Silvafeed® (a commercial tannin additive) (10 g/kg feed), a diet that included an Acacia tannin extract (40 g/kg feed) and a diet that included a lipid-encapsulated Acacia tannin extract (50 g/kg feed). Nutrient intake was no different across the treatments, but nutrient digestibility was affected by dietary additives.

Compared to the control, and unlike the crude extract, encapsulated Acacia tannin extract and Silvafeed® did not reduce dry matter, organic matter or neutral detergent fibre digestibility. While the overall nitrogen retention and total nitrogen excretion were not affected by dietary additives, Acacia tannin extract and encapsulated Acacia tannin extract reduced urine nitrogen excretion. Only a slight reduction was observed in the Silvafeed® diet. The faecal nitrogen proportion was highest in the Acacia tannin extract diet, followed by the encapsulated Acacia tannin extract and Silvafeed® diets, with the control diet having the lowest proportion of faecal nitrogen. The acetate:propionate ratio reduced through the inclusion of dietary additives, with

crude ATE and Silvafeed® having a lower acetate:propionate ratio compared to the control diet.

Methane production, expressed in gram per kg of dry matter intake, was reduced by 12, 30 and 19% in the Silvafeed®, crude Acacia tannin extract and encapsulated Acacia tannin extract diets, respectively. The reduced methane production with higher neutral detergent fibre digestibility in the encapsulated Acacia tannin extract, compared to the crude Acacia tannin extract, confirms that encapsulated tannin can be used as an additive in ruminant diets.

The reduction in methane output in sheep receiving the encapsulated Acacia tannin extract, compared to those that received a crude Acacia tannin extract diet, suggests the potential use of encapsulation to improve tannin inclusion in ruminant diets by enabling the sustained release of the tannin to the rumen environment.

The result of this study indicates that the encapsulation of Acacia tannin extract did not specifically reduce its efficacy in methane suppression. The commercial use of extracts such as lipid-encapsulated Acacia tannin extract could, however, be important in mitigating greenhouse gas from agriculture.

Farmer acceptance of such a product would largely depend on the benefits for sustainable animal production being able to exceed the cost of inclusion of such a dietary additive.

The encapsulated Acacia tannin extract, however, showed potential to enhance the utilisation of a high-forage diet, as evidenced by higher neutral detergent fibre digestibility, with a significant reduction in methane production. While condensed tannin protects high-quality proteins from excessive ruminal degradation and reduces enteric methane, it can also affect the nitrogen in the intestine or reduce fibre digestion. ○

“ Dr Adejoro plans to continue with his research, depending on access to funding, to explore additional opportunities and to conceptualise new ideas. ”

CLIMATE-SMART LIVESTOCK PRODUCTION IN AFRICA CONFERENCE 2021

The Climate-smart Livestock Production in Africa Conference was organised by postdoctoral fellow, Dr Festus Adejoro, from the Federal University Oye-Ekiti in Nigeria. It focused on promoting sustainable livestock research in Africa, and took place from 22 to 24 June 2021 in Ibadan, Nigeria. It attracted delegates from throughout sub-Saharan Africa.

The workshop sought to enhance the interconnectedness of research among African scholars and enhance the skills and capacities of early career researchers and graduate students. Co-creation research discussions helped participants share knowledge and develop new research ideas that could sustain collaboration among the participating institutions.

The keynote speakers included distinguished scholars from prestigious institutions, including the University of Pretoria, South Africa (Prof E Van Marle-Köster and Prof A Hassen), the National Institute of Agricultural Research, Paris, France (Dr D Morgavi), the Federal University of Agriculture, Abeokuta, Nigeria (Prof SO Onifade), the International Livestock Research Institute at the Mazingira Centre, Kenya (Dr C Arndt) and the University of Ibadan (Prof MK Adewumi and Prof OG Longe).

The invited lead paper addressed climate-smart livestock production in the era of climate change through targeted interventions. It focused on the impact of global warming associated with the uncontrolled release of greenhouse gases on the livestock industry and food security. It was presented by scientists from the South African Agricultural Research Council and the Northern Cape Department of Agriculture, Environmental Affairs, Land Reform and Rural Development.

The topics of the short oral presentations were as follows:

- Seasonal herbaceous structure and biomass production response to rainfall reduction and resting period in the semi-arid grassland area of South Africa
- Dietary plant extracts influenced growth performance, methane emission and methanogenic archaea population in South African mutton merino sheep
- The negative effect of heat stress on the fertility of extensive beef cattle in South Africa
- The use of the LiGAPS modelling tool to evaluate beef production in South Africa
- Effect of non-protein nitrogen source and tannin inclusion on nutrient digestibility, growth performance and methane production in growing merino lambs
- Effects of Mimosa (*Acacia mearnsii*) tannin encapsulated in sunflower oil on *in vitro* rumen fermentation, methane and organic matter digestibility
- The use of lysine supplementation with reduced crude protein in the diet of weaner pigs: Effect on growth, haematology and serum characteristics
- Effect of plant extracts used as a methane mitigation additive on carcass fat content and fatty acid composition of South African merino sheep
- Effects of dietary *Acacia mearnsii* tannin additives as methane mitigation agents on the carcass characteristics of lambs
- Effect of fertilizer type and age-at-harvest of F1 *Pennisetum purpureum* on *in vitro* gas and fermentation kinetics
- Effect of breed and feed restriction on growth performance and pre-lay characteristics of Isa Brown and Lohmann Brown pullets during rearing
- Spacing effect on agronomic and chemical characteristics of *Moringa oleifera*
- Effect of African yam bean meal in the diet on body condition score and blood parameters of pregnant West African dwarf does
- Seasonality and effect of *Acacia mearnsii* tannin extract supplementation on oxidative status and reproductive performance of South African mutton merino rams
- Effects of feeding weaner pigs with high-quality cassava peel as replacement for maize on growth performance, economic indices and blood profile
- Response of Yankasa rams to varying levels of ensiled cabbage wastes
- Growth performance of West African dwarf sheep stall-fed *Megathyrus maximus* and supplemental diet at different feed delivery times
- Evaluation of the residual effects of three fertilizers, seasons and ensiling duration on the proximate composition of megathyrus maximum (ntchisi) ○



Participants at the dissemination conference

SCALABLE ANIMAL NUTRITION METHODOLOGIES WORKSHOP

Following the Climate-smart Livestock Production in Africa Conference 2021, Dr Festus Adejoro identified the need for a technical workshop for the end-users of the research on sustainable agricultural practices presented at the conference. A two-day Scalable Animal Nutrition Methodologies Workshop was hosted by the Department of Animal Production and Health of the Federal University Oye-Ekiti in Nigeria and took place on 14 and 15 March 2022.

The overall objective of the workshop was to provide a platform to foster transdisciplinary animal nutrition research. It aimed to educate participants by expanding their knowledge of methodologies relating to animal nutrition research to address complex food security problems.

The workshop was organised into plenary and scientific sessions on the first day, followed by a technical demonstration session on the second day. The plenary and scientific sessions were attended by 57 physical participants and seven online delegates. The technical session had 27 participants

(established and early career researchers, technologists and graduate students).

Presenters included the following specialists:

- Prof JT Ogunlade, Department of Animal Science, Ekiti State University of Ado Ekiti
- Dr TA Amole, International Livestock Research Institute, Ibadan, Nigeria
- Prof SB Fakayode, Department of Agricultural Economics and Extension, Federal University Oye-Ekiti
- Dr AM Akanmu, postdoctoral fellow in the Department of Animal Science, University of Pretoria
- Dr FA Adejoro, ECRLF postdoctoral fellow at Future Africa, University of Pretoria
- Mr Taofik Odufoye, Animal Nutrition Consultant
- Mr OT Yakubu, Ekiti State Agricultural Development Programme
- Dr TA Aloba, University of Hohenheim

Dr Adejoro anticipates that, beyond the lifecycle of the workshop, the Department of Animal

Production and Health at the Federal University Oye-Ekiti and the Department of Animal Sciences at the University of Pretoria will benefit from active research engagement as a result of the technical workshop, which will lead to further journal articles and conference presentations as evidence of research productivity.

The workshop responded to the need to contextualise research ideas to meet local needs in order to enhance the potential of translating African research into solutions for Africa's challenges. There was a renewed emphasis on producing more forage to meet increased animal production, while at the same time upscaling proven technologies. The gap between research institutions in Nigeria and the end-users in terms of technology transfer was highlighted. The adulteration of feed ingredients, the high cost of feed and lack of proper feed evaluation were identified as challenges faced by farmers. Upon conclusion of the technical workshop, the delegates received a laboratory technical manual as a guide to implementing some of the identified nutrition methodologies. ○



Participants at the technical workshop





UNIVERSITY OF IBADAN



Established in 1948, the University of Ibadan was the first University in Nigeria. Until 1962, when it became a fully fledged independent university, it was a college of the University of London in a special relationship scheme.

The University, which opened with academic programmes in the arts, science and medicine, is now a comprehensive citadel of learning with academic programmes in 16 faculties: Arts, Science, Basic Medical Sciences, Clinical Sciences, Agriculture, Social Sciences, Education, Veterinary Medicine, Pharmacy, Technology, Law, Public Health, Dentistry, Economics, Renewable Natural Resources and Environmental Design, and Management. The faculties of Basic Medical Sciences, Clinical Sciences, Public Health and Dentistry are organised as the College of Medicine.

The University has other academic units, among which are the Institute of Child Health, the Institute of Education, the Institute of African Studies, the Centre for Child Adolescent and Mental Health, the Centre for Educational Media Resource Studies, the African Regional Centre for Information Science, the Centre for Peace and Conflict Studies, the Centre for Petroleum, Energy, Economics and Law, the Centre for Sustainable Development, the Centre for Entrepreneurship and Innovation, the Institute for Advanced Medical Research and Training, the Centre for Drug Discovery, Development and Production, and the Centre for Control and Prevention of Zoonosis. A National Institute for Maternal Child and Neonatal Health, an Institute for Infectious Diseases, as well as a School of Business are under construction.

The University of Ibadan, in its efforts to promote Nigeria's development, established a Research Foundation. In response to emerging threats to peace and peaceful co-existence in Africa, the University also established the Institute for Peace and Strategic Studies to provide actionable studies and solutions. ○



DR IFEANYI ONWUZURUIGBO

Dr Ifeanyi Onwuzuruigbo is a senior lecturer in the Department of Sociology at the University of Ibadan, Nigeria. His area of specialty is political and development sociology. However, his research interest straddles the nexus of security and development, as well as peace and conflict studies. The focus of his postdoctoral studies is researching the phenomenal growth of herders' and farmers' conflicts in West Africa from a Nigerian perspective. In doing so, he is interrogating extant laws, incipient regulations and policies deployed in managing and mitigating the conflicts.



As a sociologist, his study also examines challenges that arise due to these conflicts, such as organised crime, cattle banditry and the unresolved land question. This includes the much contested discourse on autochthony and belonging, and attempts to deal with these issues. His ultimate aim is to capture the ways in which these seemingly irresolvable questions and re-emerging, but complicated phenomena impinge on the bioeconomy and food security in Nigeria.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

The politics of the bioeconomy: anti-open grazing laws and farmers' and herders' conflicts in the Middle Belt of Nigeria



FELLOW'S RESEARCH HIGHLIGHTS

Publications

Onwuzuruigbo I. (2021). Enclaves of banditry: Ungoverned forest spaces and cattle rustling in northern Nigeria. *African Studies Review*, 64(1), 168–191.

Onwuzuruigbo I. (2020). Of migrant women association and peacebuilding: Rethinking “August meeting” as conflict management mechanism in southeastern Nigeria. In: Coker O., Adeniran A. (eds) *Texts and contexts of migration in Africa and beyond*, Pan-African University Press.

Onwuzuruigbo I. (2019). Land grabs and conflicts in colonial southeastern Nigeria. *Ubuntu: Journal of Conflict and Social Transformation*, 8(1), 137–160.

Onwuzuruigbo I. (2019). Why Nigeria's insecure forests are fertile ground for cattle rustlers. *The Conversation*, 9 April 2019.

Nnabuihe O., Onwuzuruigbo I. (2019). Designing disorder: Spatial ordering and ethno-religious conflicts in Jos metropolis, north-central Nigeria. *Planning Perspectives*, 36(1), 75–93.

Conferences

Eighth European Conference on African Studies 2019, University of Edinburgh, United Kingdom.



Mentor profile*

PROF CORI WIELENGA

Cori Wielenga is an associate professor in the Department of Political Sciences in the University of Pretoria's Faculty of Humanities. She is also Acting Director of the University's Centre for Mediation in Africa. She was previously associated with the Department's Centre for the Study of Governance Innovation. She obtained her PhD in Conflict Resolution and Peace Studies at the University of KwaZulu-Natal in 2010 and joined the University of Pretoria as a senior lecturer in 2017.

She has a Y2 rating from the National Research Foundation, which classifies her as a young researcher, who is recognised as having the potential to establish herself as a researcher based on her performance and productivity as a researcher during her early postdoctoral career, based on recent research products.

Her research focuses on reconciliation, transitional justice, formal and informal governance, and justice systems. This has led to in-depth research on Rwanda's “gacaca” courts, South Africa's Truth and Reconciliation Commission (TRC) and comparative projects on the informal justice systems in Burundi, Mozambique, Namibia and Zimbabwe. Findings from these projects are intended to inform emerging transitional justice policies and guidelines in Africa and further abroad.

Working collaboratively with teams of postdoctoral fellows and postgraduate students both locally and internationally, she intends to challenge current policy and practice in the area of transitional justice after mass violence as they fail to reflect the reality on the ground. Through the collection of large-scale, comparative empirical data at community level, she intends to propose more effective ways of meeting justice needs during transitions. ○



*Prof Cori Wielenga also served as mentor to Dr John Mushomi (see page 75)

“ We learnt a lot from the fellow through our interaction with him, as he made us more aware of the local situation with regard to his area of study. ”



THE POLITICS OF THE BIOECONOMY: ANTI-OPEN GRAZING LAWS AND FARMERS' AND HERDERS' CONFLICTS IN THE MIDDLE BELT OF NIGERIA

Postdoctoral fellow: Dr Ifeanyi Onwuzuruigbo
Mentor: Prof Cori Wielenga

Nigeria's anti-open grazing law was enacted to prevent cattle herders from allowing their livestock to graze anywhere in public. This was intended to put an end to conflicts between farmers and cattle herders, particularly in southern Nigeria. The farmers were of the opinion that the cattle herders were trespassing on their land, while the herders needed to subject their cattle to rotational grazing, but did not have sufficient land of their own.

As a Nigerian national, Dr Ifeanyi Onwuzuruigbo considered the growth of herders' and farmers' conflicts in West Africa, and the subsequent appropriation of land, to be a major problem that affected the country's bioeconomy. In doing so, he interrogated current laws, incipient regulations and policies that were deployed to manage and mitigate these conflicts.

His postdoctoral research not only focused on the conflicts arising from the country's anti-open grazing laws, but also examined other challenges that arose due to these conflicts, such as organised crime, cattle banditry and the unresolved land question. His ultimate aim was to capture the ways in which these questions and complicated phenomena impinge on Nigeria's bioeconomy and food security. This was the focus of previous research Dr Onwuzuruigbo had engaged in during his doctoral studies, so the fellowship provided the opportunity to expand on this work.

His fieldwork was conducted in the rural communities of northern Nigeria. Supported by a review of existing literature and archival resources, the findings of his research have given rise to several publications. He also delivered a presentation on his research at the 8th European Conference on African Studies in 2019.

Dr Onwuzuruigbo observed that, in the past, Africa has witnessed many cases of land appropriation by foreign colonial agents and their local collaborators. His study of archival documents on colonial land legislation and land relations resulted in an article on land grab and conflicts in colonial southeastern Nigeria published in the journal *Ubuntu: Journal of Conflict and Social Transformation* in 2019.

This article demonstrated how attempts to restructure indigenous and precolonial African land practices have prepared African land for capitalist exploitation and have contributed to land grabs.

Remedial measures condensed in a range of land regulations and administrative policy initiatives further complicated rather than resolved the crises and conflicts. Furthermore, local chiefs and agents of colonial rule took advantage of the loopholes in colonial land regulations and lapses in administrative policies to appropriate communal lands for themselves, thereby setting in motion a chain of actions and reactions that ultimately culminated in protracted litigations and domestic feuds.

In another article emanating from his research, he considered ungoverned forest spaces and cattle rustling in northern Nigeria. This article was published in *African Studies Review* in 2020. "Parts of northern Nigeria are becoming enclaves of banditry for gangs of cattle rustlers who maraud largely ungoverned forests," he explains. "Existing studies of banditry shy away from a serious interrogation of cattle rustling and ungoverned forest spaces in northern Nigeria." He highlighted the role of criminal groups creating their own governance structures.

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While at Future Africa, Dr Onwuzuruigbo attended several training workshops on grant and fellowship applications, scholarly writing and computer packages for writing research reports and analysing data. He was consequently able to apply for other funding opportunities to expand his research. As a result, he succeeded in being admitted to the Fellowship Programme of the Merian Institute for Advanced Studies in Africa at the University of Ghana in 2020.

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As a postdoctoral fellow in the University of Pretoria's Department of Political Sciences, he collaborated with several members of staff in relation to his research on ungoverned spaces in northern Nigeria, and assisted two of the Department's PhD students with their fieldwork in Nigeria. He found his mentor, Prof Cori Wielenga, to be very supportive.

According to Prof Wielenga, Dr Onwuzuruigbo contributed to the Department's research efforts with his publications, while expanding the Department's scholarly network. He also published an opinion piece on why Nigeria's insecure forests are fertile ground for cattle rustlers in *The Conversation* as a visiting scholar affiliated to the University's Centre of Governance Innovation, and participated actively in the Centre's monthly engagements.

"We learnt a lot from the fellow through our interaction with him, as he made us more aware of the local situation with regard to his area of study." ○

HISTORIC PERSPECTIVE ON LAND GRAB CONFLICTS IN SOUTHEASTERN NIGERIA

Studies of land appropriation in Africa are increasing. However, there are noticeable gaps in the treatment of this topic. The historical influence on current land appropriation issues has received scant attention in the literature. According to an article published by Dr Ifeanyi Onwuzuruigbo in *Ubuntu: Journal of Conflict and Social Transformation* in 2019, this can be attributed to the fact that emerging studies present land appropriation as the result of Africa's recent food and climate crises. Although few studies liken incipient land grabs to colonial land appropriation, discussions on the theme remain obscure.

In this article, Dr Onwuzuruigbo situates land appropriation in the colonial context. He captures the efforts of colonial authorities to resolve the land question it created on the eve of colonialism through administrative measures and a range of incoherent land policies. Rather than resolve the land question, the policies further complicated and promoted land grabs and conflicts in colonial southeastern Nigeria.

Although large-scale land acquisitions by influential personalities, local business concerns and transnational corporations, as well as national and foreign governments, have received much attention in the literature, scholarly engagement with the phenomenon has remained largely ahistorical.

Contemporary manifestations of land appropriation, as is well known, can be traced back to colonialism and the obsession with African land. The imposition of colonial rule as a prelude to grabbing African land and resources was the driving force of the colonial project in

Africa. Once this had been achieved, European colonial powers proceeded to disassemble and reconstitute precolonial African notions of land and land practices they perceived to be archaic and to constitute an obstacle to capitalist production and accumulation.

While land appropriation has been defined as the acquisition and control of large portions of land and associated resources to derive benefits from such control, the land question refers to the contradictions, contraptions, antagonisms and conflicts generated by colonial state policies, which sought to initiate the profound redefinition of pre-capitalist, customary laws and regulations on land to prepare and present land for capitalist accumulation and production.

In the process, southern Nigeria came under a regime of incoherent and undeveloped land policies, which, in principle, emphasised freehold, but, in practice, tolerated vestiges of communal ownership. When colonial authorities reverted to communal ownership, the hallmark of precolonial land tenure, the policies were essentially "neo-customary", a term used to stress the fact that they often bore very limited resemblance to precolonial land rules and practices.

Communal ownership continued simultaneously with commercialisation, and provided the impetus for local chiefs to illegally grab communal land, sell or lease the land to European trading companies and appropriate the rent accruing to the land. Such actions did not always go unchallenged. In Aguleri, opposition and protests against chiefly exploitation and oppression culminated in protracted litigation and intra-elite conflicts.

Dr Onwuzuruigbo feels that discussions of contemporary foreign large-scale land grab in Africa cannot ignore the rich history of colonial land usurpation and appropriation. "Land grab must be placed in the historical context of the continuous development of capitalism because, although the colonial forms of land grab discussed in this paper may appear different from nascent land grab, both – historically speaking – share many similarities."

One of the major differences between the two forms of land appropriation is the active involvement of Third World states – China, India, Libya, Kuwait, Saudi Arabia and South Korea – and their corporate commercial concerns. These include South Korea's Daewoo and Libya's Malibya in the recent rush for African land and land-based resources. However, their similarities lie in the primitive accumulation of capital, whereby African lands are acquired, enclosed and inserted within the ambit of global capitalism.

History has shown that communities do not stand by and watch idly as their lands are grabbed. They resist and oppose what – to them – constitutes unwarranted interference in their land and internal affairs. Just as the affected communities in the Kwara state of Nigeria resisted the transfer of their land to Zimbabwean commercial farmers in post-colonial Nigeria, resistance against land acquisition by the colonial government and its local and global agents dominated Agulerian politics until the twilight years of colonialism in Nigeria. ○

Key facts

Land occupied, and still occupies, a distinctive position in African societies. Not only is land critical to agricultural production, it also symbolises a sacred force binding the living to the dead. As such, land is a jointly owned and shared asset among families, clans, kinsmen and communities, which cannot be sold. Although individual rights in land existed, they are derived from membership of a community.

“ History has shown that communities do not stand by and watch idly as their lands are grabbed. They resist and oppose what – to them – constitutes unwarranted interference in their land and internal affairs. ”



WHY NIGERIA'S INSECURE FORESTS ARE FERTILE GROUND FOR CATTLE RUSTLERS

In an opinion piece published in *The Conversation* in 2019 as a visiting scholar affiliated to the University's Centre of Governance Innovation, Dr Ifeanyi Onwuzuruigbo states that Northern Nigeria has become a thieving and killing field for cattle rustlers, who maraud the region's ungoverned forests, stealing cattle and killing herders.

Attacks have taken place in the Benue, Nassarawa and Plateau states in north-central Nigeria and the situation appears to be worsening. In January 2018 alone, 371 people were killed by cattle rustlers in the northwestern state of Zamfara. Commercial farms, including those owned by influential politicians, revered clerics and prominent traditional rulers, have not been spared.

The foremost explanation for the rise of cattle rustling in Nigeria relates to pastoral culture and tradition. It encourages cattle theft as a way of replenishing stock after losing herds to drought. Some traditions exclusively confer cattle husbandry to nomads and recommend rustling against non-pastoral groups who dare to rear cattle.

A second reason given to the emergence of cattle rustling relates to climate change. Researchers confirm that climate change has triggered the shrinking of Lake Chad, which has furthered the desertification of northern Nigeria. As herders migrate from the north in search of greener pastures in the Middle Belt and southern regions of Nigeria, their herds are plundered by bandits and marauding Boko Haram militants.

Cattle rustling is also attributed to state failure, intra-state wars and the proliferation of light weapons in Africa. This leads to countries becoming what is described as fragile states. Nigeria is no exception. In addition to its internal political, economic and domestic terrorism challenges, the country is geographically located

in the conflict-ridden Sahel region. Weapons and arms flowing from these war zones are ferried through Nigeria's unmanned borders into the hands of criminal groups, including cattle rustlers.

Although these reasons are rightly cited as facilitating cattle rustling, they ignore one critical aspect: the lack of the effective governance of Nigeria's forests, which provides an enabling environment for cattle banditry, enabling it to flourish in northern Nigeria.

Nigeria's ungoverned forests

Northern Nigeria covers about 60% of Nigeria's land area and hosts a large expanse of forest land. The government has designated one third of the region's land mass as official forest reserves. With a rich repertoire of plants, animals, streams, river tributaries and waterfalls, the forests crisscross rural communities and towns in the region.

Boko Haram terrorists operate the most clandestine and sophisticated network of cattle rustlers and sellers within these forests. They have taken control of the Sambisa forests, a land mass that is estimated to be the size of Lagos. They have been able to do this because the forests have been neglected for years. They are unmanned, unpoliced, acutely underfunded and poorly managed. Like other government agencies, forestry departments are hugely understaffed and operate on lean budgets that are often mismanaged.

Forestry policy also adopts a top-down approach that disregards host communities. When these communities are alienated, they are less inclined to take "ownership" of the forests. So, the forests become a hotbed of criminals and provide a safe haven for cattle bandits. Boko Haram's seizure and subsequent occupation of the Sambisa forests, for instance, has been blamed on years of government neglect and community apathy.

Managing the menace

The Nigerian government only started to respond to cattle rustling in 2014. Yet, the plague has been increasing steadily for more than 10 years. Government's response has been slow and lethargic, and policy discussions have not yet translated into concrete policy actions. Its strategies for combatting cattle banditry have either involved uncoordinated police action or unsustainable military exercises. For instance, Operation Ayem Apatuma, organised in 2018 to tackle cattle rustling in Nigeria's north-central region, was too short to make any lasting impact, ending after three months.

In Dr Onwuzuruigbo's view, the Nigerian government must review its approach to cattle banditry. It needs a clear and specific policy. One aspect of this should be an effort to move herders away from open grazing and encourage them to embrace modern ranching practices. Confining the movement of cattle to ranches ensures a higher level of security and reduces their nuisance value.

The government must also reassess its forest governance so that the management of forests can become an inclusive practice that takes people's needs into account. In addition, forest guards need to be empowered and equipped to discharge their duties effectively.

The government will also need to liberate the Sambisa forests from Boko Haram's control. This would allow for the establishment of cattle colonies within the forest lands. Restricting the movement of herders to colonies within their cultural communities could go a long way in reducing their perennial conflict with farmer communities.

More importantly, the establishment of cattle ranches and colonies will promote the development of associated industries such as dairy, leather and shoe industries, and the long-awaited revolution of meat production in northern Nigeria. ○



UGANDA



MAKERERE UNIVERSITY



Makerere University is one of the oldest and most prestigious universities in Africa. The institution was first established as a technical school in 1922 for a handful of students who began studying carpentry, building and mechanics. The school, later renamed Uganda Technical College, soon began offering various other courses in medical care, agriculture, veterinary sciences and teacher training. It expanded over the years to become a Centre for Higher Education in East Africa in 1935. In 1937, the College started developing into an institution of higher education, offering post-school certificate courses. It later became an independent national university in 1970.

The University is *alma mater* to many post-independence African leaders. In the years immediately after Uganda's independence, Makerere University was also a focal point for the literary activity that was central to African nationalist culture. Many prominent writers attended Makerere University at one point in their writing and academic careers.

Today, the University offers training and research opportunities in agricultural and environmental sciences, business and management sciences, computing and information sciences, education and external studies, engineering, design, art and technology, health sciences, humanities and social sciences, natural sciences, veterinary medicine, animal resources and biosecurity, as well as law.

Makerere University's 2030 Strategic Plan seeks to transform it into a more research-intensive university, enhance relevance to the community and consolidate Makerere's position as Uganda's engine of development. ○



DR JOHN MUSHOMI

Dr John Mushomi is a lecturer in the Department of Population Studies at Makerere University, Kampala, Uganda. He is also a research and policy fellow with the African Institute for Development Policy. He obtained his PhD in Population Studies at Makerere University in 2017. The focus of his postdoctoral studies is emerging rural capitalism and insecurities in Uganda's oil district.

With a background in social sciences, his doctoral studies focused on migration and the use of international remittances. He has several qualifications in the field of demographics, and population and development, including an MPhil in Demography, and a Postgraduate Diploma in Population and Development and in Demography from the Cairo Demographic Centre in Egypt.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Emerging rural capitalism and insecurities in Uganda's oil district



CONTACT: jmushomi@gmail.com

FELLOW'S RESEARCH HIGHLIGHTS

Research grants

Government of Uganda: Mapping the mobility patterns, perceptions, preparedness and response mechanisms towards COVID-19 for Uganda's border communities – co-principal investigator (2020)

Government of Uganda: Developing an integrated framework for addressing population, health and environment for refugees and host communities in Uganda – co-principal investigator (2019)

Publications

Sempewo J., Kisaakye P., **Mushomi J.**, Tumutungire M., Ekayalimpa R. (2021) Assessing willingness to pay water during COVID-19 crisis in Uganda households. *Social Sciences and Humanities*, 4(1), 100230.

Kisaakye P., Ndagurwa P., **Mushomi, J.** (2021). An assessment of availability of handwashing facilities in households from four East African countries. *Journal of Water, Sanitation and Hygiene for Development*, 11(1), 75–90.

Kisaakye P., Nzabona A., Kakuba C., Asiimwe J., **Mushomi J.**, Tuyiragize R., Wandera, S. (2021). Youth migration and perception on business start-up in Uganda. *Journal of Global Entrepreneurship Research*, 1–14.

Madikizela-Madiya N., **Mushomi, J.** (2020). Colleague postgraduate supervision and production of space in higher education: A duoethnographic analysis. *Qualitative Research Journal*, 21(2), 166–176.

Mushomi J., Mirembe S., Nzabona A., Ariho, P. (2020). Youth migration, employment and policy interventions: A case study of Uganda, Metropolis International, London.

Maniragaba F., Nzabona A., Kwagala B., Asiimwe J., Bizimungu E., Ntozi J., **Mushomi J.** (2019). Factors associated with older persons physical health in rural Uganda. *PLOS One*, 14(1), e0209262.

Mushomi J., Ntozi J., Rutaremwa G. (2017). Migrant remittance behavior in Uganda: A household analysis. *African Population Studies*, 31(2).

Nzabona A., Asiimwe J., Kakuba C., Tuyiragize R., **Mushomi J.** (2019). Correlates of youth internal migration and employment in Uganda. *African Population Studies*, 33(1).

Kakuba C., Nankinga O., **Mushomi J.**, Golaz V. (2019). Analyse des métadonnées et des indicateurs relatifs aux enfants hors l'école et à l'(an) alphabétisme. *Le cas de l'Ouganda*.

Mirembe S., Nzabona A., **Mushomi J.** (2019) Internal youth migration in Uganda: Analysing associates and employment outcomes: *International Journal of Population Studies*, 5(1).

Nzabona A, Asiimwe J., Kakuba C., **Mushomi J.**, Maniragaba F. (2019). Factors associated with tobacco: Smoking in Uganda's leading tobacco growing regions. *Etude de la Population Africaine*, 33(2).

Asiimwe J., Ndugga P., **Mushomi J.**, Manyenye Ntozi, J. (2014). Factors associated with modern use of contraceptives among young people and older women in Uganda: A comparative analysis. *BMC Public Health*, 14(1), 926.

Book chapters

Mushomi J. (2017). Gender, migration, remittances and development in Uganda: The demography of Uganda and selected African countries; towards more sustainable development pathways. In Adeniran A., Coker O. (eds), *Migration in Africa and beyond: Text and contexts*, Fountain Publishers.

Mushomi J., Mirembe S., Nzabona A. (2019). Youth migration in Uganda: Analyzing determinants and employment outcomes. In Wieland J., Fischer D. (eds), *Transculturality and community. Learnings from the Hope Development Initiative in Uganda*.

Mushomi J., Mirembe S., Nzabona A., Ariho, P. (2019). Youth migration, employment and policy Interventions: The case of Uganda. In Wieland J., Fischer D. (eds), *Transculturality and community. Learnings from the Hope Development Initiative in Uganda*.

Mushomi J. (forthcoming). Geosocial-spatial comparative context of postgraduate supervision processes and experiences. In Ruguma Tumwine F., Bakkabulindi F., Ntozi J. (eds), *Academics, research and leadership in institutions of higher learning: Experiences from Makerere University*, Fountain publishers.

Commemorative book for the 8th African Population Conference

Mushomi J., Mirembe S. Determinants of receipt of migrant remittances in households: Evidence from Uganda's population and housing census.

Kakuba C., Golaz V., Nankinga O., **Mushomi J.** Measuring illiteracy in Uganda over the past decades: A reflection on available national demographic data indicators.

Nankinga O., Kakuba C., Golaz V., **Mushomi J.** Out of school children in Uganda over the past decade: A reflection on available national demographic data and indicators.

Professional activities

Member of the International Union of Scientific Study of Population

Member of the Population Association of America

Member of the Union for African Population Studies

Member of the Uganda Statistical Society

Founder member of the Population and Social Development Institute



EMERGING RURAL CAPITALISM AND INSECURITIES IN UGANDA'S OIL DISTRICT

Postdoctoral fellow: Dr John Mushomi
Mentor: Prof Cori Wielenga

The discovery of commercially viable oil deposits in Uganda's Albertine region in 2016 has had several socio-economic impacts that need to be addressed if the country is to meet its growth and development objectives. One of these is its impact on land and the region's population dynamics, particularly how it affects land ownership, conflicts related to land occupation, the displacement of individuals and the influx of migrants competing for employment opportunities.

The research that formed part of Dr John Mushomi's postdoctoral fellowship was informed by previous work conducted as part of his PhD journey. It was further motivated by his interest in Uganda's history: a history characterised by resource contestations, mobility, citizenship and conflict. In his doctoral research, Dr Mushomi discovered that, all over the world, the development of nations is directly linked to migration, since one in seven people in the world is a migrant, and one in four people is an international migrant.

The focus of his postdoctoral research was the emerging rural capitalism and insecurities that are present in Uganda's region where oil has been discovered. In his research, he sought to explore the community, socio-economic and political perceptions about oil discovery in the oil-rich Albertine region. His study aimed to explain the different insecurities that had emerged as a result of oil discovery, and the significance of growing demographic pressure in the oil district. In the process, he sought to gain an understanding of the extent to which Uganda's political elites have leveraged the positive expectations that come with oil exploration.

This study would therefore make it possible to compare the outcomes of comparable ethnicities and economic systems in the country's different economic and political contexts. As such, it is intended to contribute to an understanding of how trajectories of exclusion and socio-economic change have been influenced by contrasting national policies, and have – in turn – influenced either social cohesion or conflict. This was done by exploring the experiences and expectations of communities around oil exploration using both qualitative and quantitative methods.

When asked whether he was satisfied that he had achieved the outcomes he had anticipated for his fellowship, Dr Mushomi exclaimed that it had, indeed, exceeded his expectations. "I can attribute the success and extra benefit I obtained from the fellowship to my cooperative mentor and to working with a group of fellows, who all came from different disciplines, and who individually and collaboratively benefitted from the training offered at Future Africa."

As a demographer, Dr Mushomi found his mentorship by a political scientist to have expanded his viewpoint. "The mentorship was the best part of the fellowship. We learnt from each other, and in the process, discovered joint interests in terms of research and scholarship." His mentor, Prof Cori Wielenga, reinforces this: "As our interaction progressed, it was exciting to discover that there was a lot of resonance in our research interests." Dr Mushomi particularly appreciates the fact that his mentor included him in the activities of the Department of Political Sciences and the Centre for the Study of Governance Innovation. He worked with the students and was given the opportunity to contribute to teaching and research supervision.

What Dr Mushomi experienced as challenging on the fellowship relates to the nature of the social sciences, as opposed to the natural and physical sciences, in that social science research cannot be conducted in the laboratory: it is done by observing people and their behaviour in various situations. However, he was able to put his time to good use by reviewing related literature and refining his research proposal. He also succeeded in developing his survey instruments.

According to his mentor, "Dr Mushomi took hold of this fellowship opportunity with both hands, using it to advance his research networks, projects and publications." He contributed to three journal articles written by Ugandan researchers, which were published in *Etude de la Population Africaine* ("Factors associated with tobacco-smoking in Uganda's leading tobacco-growing regions"), *African Population Studies* ("Correlates of youth internal migration and employment in Uganda") and *PLOS One* ("Factors associated with older persons' physical health in rural Uganda").

By the end of 2020, Dr Mushomi had completed the secondary review of relevant documents, as well as his secondary data analysis. He was also preparing two papers for submission to peer-reviewed journals and had prepared five book chapters for publication. He was, unfortunately, unable to conduct primary data collection as the study area was a political hotspot during Uganda's elections, and his study was sensitive. Although data collection had been planned for 2020, this was curtailed by the nationwide lockdown due to the COVID-19 pandemic.

He was, however, able to undertake several additional activities. These included presenting a paper at the 62nd International Statistics Institute's World Statistics Congress in Malaysia, and joining the Southern Africa Social Protection Expert Network and attending a conference on social protection and climate change in the Southern African Development Community (SADC) region in Johannesburg in August 2019. He also participated in the 2019 Summer Academy on World Risk and Adaptation Futures: Demographic Change at the United Nations University in Accra, Ghana, in October 2019. He has been recruited to be part of the Africa research team of the Stellenbosch Institute for Advanced Study.

An important outcome of Dr Mushomi's fellowship was his organisation of a virtual workshop under the title "History meets demography: resource contestations, mobility, citizenship and conflict in Uganda's Albertine region and beyond". It was held at Makerere University on 14 September 2021. The workshop was designed to recognise the full life cycle of academics: from postgraduate students to established senior researchers, and attracted more than 200 delegates both online and in person.

A specific aim of the workshop was to enhance the link among disciplines, including history and demography, to engage with scholars, practitioners in industry and non-governmental organisations working in areas such as demographics, resource contestations, citizenship and conflict, and to promote interaction between researchers at the University of Pretoria and Future Africa, and academic leaders at Makerere University. The papers delivered at the workshop covered four broad themes: Governance, security, peace and conflict; mining, resource extraction and policy frameworks; global trends in interdisciplinary research; and education and development. The transdisciplinary papers each took the form of a draft book chapter, which would be compiled into an edited book with the same title as the workshop. The book has been accepted for publication by Palgrave Macmillan, with Dr Mushomi and Prof Wielenga as joint editors.

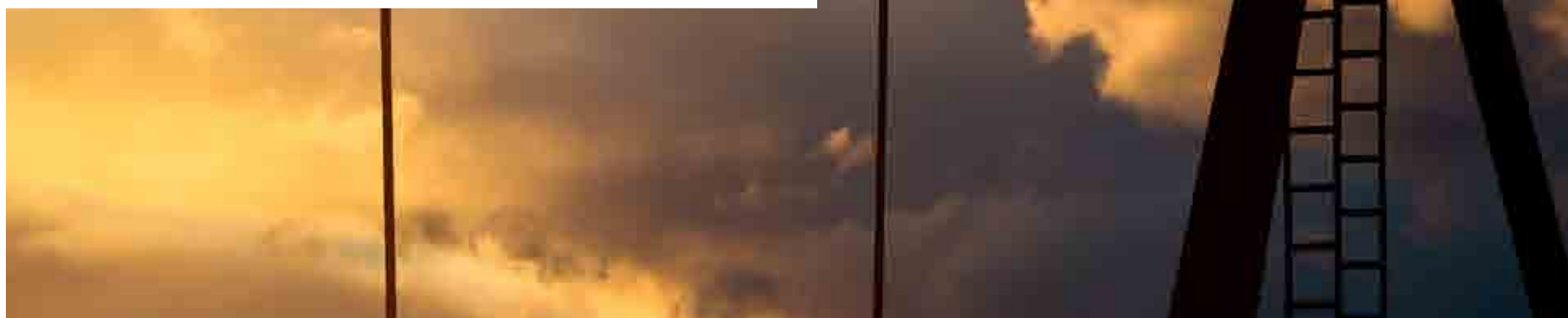
The draft book chapters were further refined during a pre-publication workshop that Dr Mushomi facilitated at Makerere University on 27 January 2022. This workshop was attended by 15 corresponding authors. Its aim was to help the authors incorporate feedback on their drafts from peers and senior academics, and to encourage them to appreciate the role of transdisciplinarity in research through the integration of different methodologies beyond their individual disciplines. It also aimed to develop research cluster teams that would address societal problems resulting from rampant insecurity and conflict in Africa.

The diversity of disciplines included in the book includes population studies, history, economics, philosophy, women and gender studies, literature, civil society and media studies. This demonstrates that the interconnected problems of Africa need interconnected solutions. "I learnt a lot about the concept of transdisciplinarity at Future Africa, and I am now a crusader for collaboration and transdisciplinary leadership. I practice this every day: in my research and even in my daily life."

Dr Mushomi does not consider the conclusion of his fellowship as the end of his association with Future Africa. "I envisage a continued engagement with the University of Pretoria. In fact, I would like to see the ECRLF expanded into a lifelong learning programme." ○



I learnt a lot about the concept of transdisciplinarity at Future Africa, and I am now a crusader for collaboration and transdisciplinary leadership. I practice this every day: in my research and even in my daily life.



HISTORY MEETS DEMOGRAPHY: RESOURCE CONTESTATIONS, MOBILITY, CITIZENSHIP AND CONFLICT IN UGANDA'S ALBERTINE REGION AND BEYOND

Dr John Mushomi presented a blended workshop as part of his postdoctoral fellowship with the title: "History meets demography: Resource contestations, mobility, citizenship and conflict in Uganda's Albertine region and beyond". The workshop, which was held at Makerere University on 14 September 2021, sought to enhance the link among disciplines, including history and demography, and debate regional and continental issues that affect the African continent.

The workshop attracted 36 abstracts from scholars, postgraduate students and practitioners working in areas such as demographics, resource contestations, citizenship and conflict. It was important that the workshop presentations should contribute to policy formulation, as they would each be developed into book chapters and published as an edited book.

The workshop's academic dialogue was facilitated through panel presentations under four overall themes, with the following topics:

Governance, security, peace and conflict

- Alternative justice systems in Africa: traditional authorities
- Land, special courts and small claims courts
- Camps, integrated development plans, refugees, irregular and forced migration
- Migration and mobility
- Identity and hybridity

Global trends in interdisciplinary and multidisciplinary research

- Interdisciplinary research and development
- Funding interdisciplinary research and development
- University-industry partnerships

Mining, resource extraction and policy frameworks

- Conflicts over oil production
- Policy framework for resource extraction
- Planning and management of strategic natural resources
- Social protection and corporate social responsibility

Education and development

- Global networks, higher education, linkages, research, partnerships and publishing
- Science, industry, technology and UNESCO projects in education
- Private education and venture capital
- The informal and non-formal sector

Workshops such as this are crucial in promoting partnerships and collaborations across disciplines, and its outcomes would allow all stakeholders to have a peaceful and secure Africa that is stable and functional, while ensuring that the values and ideals of Africa are prioritised.

Upon conclusion of the workshop, Dr Mushomi called on the delegates and contributors to embrace the concept of transdisciplinarity, and for researchers to question the issues of resource contestations, citizenship and migration in Uganda and elsewhere on the continent.

The publication of the workshop proceedings into an edited book would ensure that African research on the issues of resource contestation, mobility, citizenship and identity in Uganda's oil-rich region and beyond could be accessible to the public.

PRE-PUBLICATION WORKSHOP

Following Dr Mushomi's dissemination event, 16 of the papers that were presented at the workshop were identified to be developed into book chapters for publication. The proposal for the edited book has been accepted by Palgrave Macmillan.

This important outcome of the workshop was consolidated through the presentation of a pre-publication workshop, held at Makerere University on 27 January 2022. The main aim of the workshop was to develop the academic chapters of the book. Authors and contributors had the opportunity to present their specific chapters and engage in discussions around the topics. Dr Mushomi specifically wanted to achieve the following objectives with the workshop:

- Launch the process of developing the book chapters
- Help the chapter contributors to focus based on additional feedback from peers and senior academics
- Enhance field research-based chapters that are informed by communities affected by conflict
- Encourage contributors to appreciate the role of transdisciplinarity in research through the integration of different methodologies beyond their disciplines
- Develop research cluster teams that would address societal problems resulting from rampant insecurity and conflicts in Africa

The workshop would furthermore connect disciplines within the natural and social sciences, and create a transdisciplinary space for discussions around specific goals shared by scholars, practitioners in industry and non-governmental organisations, and policy makers. Dr Mushomi hoped that it would also encourage mutual learnings and joint problem-solving to create sustainable solutions in a real-world context. In the process, interaction would be promoted between the University of Pretoria and other academic institutions in Africa.

Publishing proposal

The proposed title of the book is "History meets demography: Resource contestations, mobility, citizenship and conflict in Uganda's Albertine region and beyond". It resonates with the topic of Dr Mushomi's postdoctoral research, as well as the

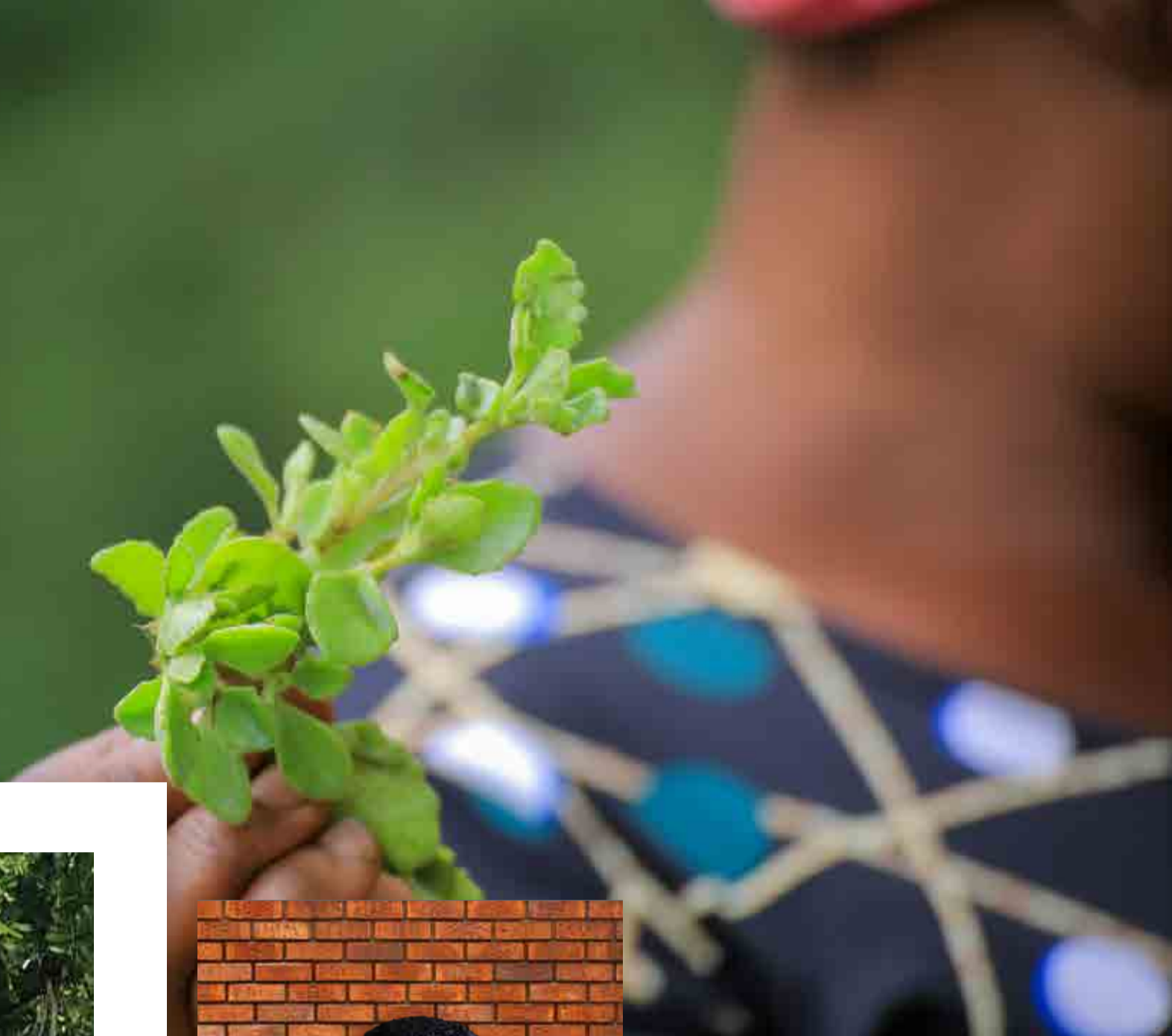
title of his dissemination workshop. It is being co-edited by Dr Mushomi and Prof Cori Wielenga, who had acted as his mentor at the University of Pretoria during his fellowship.

The selected chapters cut across the East African region to the rest of the African continent, thereby offering new insights into the fields of political theory, history, development, peace, security and gender.

The proposed content is as follows:

- Introduction: Histo-demographic overview of resource motivated conflicts in the Albertine region and beyond (Cori Wielenga and John Mushomi)
- Identity assertions and resource claims in the context of oil production: A comparative study of Bunyoro in Uganda and Turkana in Kenya (Peter Wafula Wekesa)
- Migrancy, resource contestation and citizenship claims in Uganda's oil region (John Mushomi and Nicholas Tunanukye)
- A historical situation of neo-extractivism (Roselyne Ajiko Abelle)
- History repeats itself: A reflection of civil-military relations in post-colonial Uganda (Elizabeth Katusiime)
- Migration, mobility and socio-economic relations among communities in the wake of oil discovery along the Albertine region of Uganda (Gordon Onyango)
- Contributing to the citizenship debate: Lessons from western Uganda: 1894–2000 (Nicholas Tunanukye)
- Matriarchy at the crossroads in Africa: The clash between its theory and practice on land tenure systems in Tanzania (Jumanne Kassim)
- Resource distribution a centre of conflict: Gender differences in resource allocation (Deborah Birungi)
- Corporate accountability and the protection of human rights defenders in Uganda: Examining the nexus between sustainable development and human rights (Gerald Tushabe)
- Land and identity conflicts through a positive peace lens: The case of Burundi (Cori Wielenga)
- African solutions to African problems: Political sloganeering or African renaissance? (Charlotte Mafumbo, Zaid Sekito and Jacqueline Nakaiza)
- Indigenous authority and justice in state-society armed conflict: A case of the Uganda National Rescue Front II in Uganda: 1996–2002 (Agatha Alidri)
- Dynamics in land (re)distribution and alternative justice systems in Africa: Lessons from Ghana, Kenya and Zimbabwe (Grace Maina, Samuel Chikowero and Laurene Abdallah)
- Ideal approaches of mobilising local communities to participate in climate change adaptation in Mpanga catchment, Western Uganda (Racheal Ddungu Mugabi)
- Governing by use of parallel security regimens: The case of pastoral communities along the Eleme Triangle (Albert Ochieng)
- Conclusion: Meaningfully supporting justice on the ground in southern Africa (Cori Wielenga and John Mushomi) ○





DR ALICE NABATANZI

Dr Alice Nabatanzi is a lecturer in the Department of Plant Sciences, Microbiology and Biotechnology at Makerere University's College of Natural Sciences in Kampala, Uganda. She obtained her PhD in Natural Products Technology and Value Chains from Makerere University in 2017. Her doctoral work concentrated on the phytopharmaceutical and nutraceutical significance of neglected food species and their potential to improve the nutrition and dietary quality of pregnant women in the rural areas of Uganda (East Africa).

With a background in natural products, her research focus is on phytomedicine, nutrition, nutraceuticals and phytochemistry. For her postdoctoral research, she focused on biomolecules from the sausage tree, *Kigelia africana*, and their potential to stop inflammation and the proliferation of cancer cells. She is enthusiastic about undertaking research that can change society, especially the burden of non-communicable diseases in African societies.

Her research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Anticancer activity and anticancer mechanisms of action of *Kigelia africana*



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FELLOW'S RESEARCH HIGHLIGHTS

Scholarships

Regional Initiative in Science and Education for African Natural Products Research Network (RISE-AFNNET) – Doctoral Research Scholarship (2013–2016)

Regional Initiative in Science and Education for African Natural Products Research Network (RISE-AFNNET) – MSc Research Scholarship (2011–2013)

Research grants

Phase II: Developing multipurpose phytonutraceuticals from indigenous wild edible fruits and vegetables for mitigating malnutrition among pregnant women and school-going children in Najjembe sub-county, Buikwe district, Uganda (co-investigator) – Government of Uganda (2022)

Valorisation of waste chicken feathers for water purification: Designing and constructing low-cost keratin-based nanofilters as adsorbents of heavy metals and nanosized contaminants (principal investigator) – Government of Uganda (2021)

Development of value-added phytogenic feed additives to replace conventional antibiotics in chicken feeds (principal Investigator) – Government of Uganda (2020)

Developing multipurpose phytonutraceuticals from indigenous wild edible fruits and vegetables for mitigating malnutrition among pregnant women and school-going children in Najjembe sub-county, Buikwe district, Uganda (co-investigator) – Government of Uganda (2019)

Development of a safe and efficacious anti-malarial drug from traditional medicine (co-investigator) – Government of Uganda (2019)

Publications

Walusansa A., Asiimw, S., Nakavum, J., Ssenku J., Katuura E., Kafeero H., Aruhomukama D., Nabatanzi A., Anywar G., Tugume A., Kakudidi E. (2022). Antibiotic-resistance in medically important bacteria isolated from two commercial herbal medicines in Africa from 2000 to 2021: A systematic review and meta-analysis. *Antimicrobial Resistance and Infection Control*, 11(1), 11.

Nkadimeng S., Nabatanzi A., Steinmann C., Eloff J. (2020). Phytochemical, cytotoxicity, antioxidant and anti-inflammatory effects of *Psilocybe natalensis* magic mushroom. *Plants*, 9(9), 1127.

Nabatanzi A., Nkadimeng S., Lall N., Kabasa J., McGaw L. (2020). Antioxidant and anti-inflammatory activities of *Kigelia africana* (Lam.) Benth. *Evidence-based Complementary and Alternative Medicine*, (1), 1–11.

Nabatanzi A., Nkadimeng S., Lall N., Kabasa J., McGaw L. (2020). Ethnobotany, phytochemistry and pharmacological activity of *Kigelia africana* (Lam.) Benth. (Bignoniaceae). *Plants* 9, 753.

Nabatanzi A. (2018). In-vitro antibacterial activity of *Allium sativum* L. clove extract against *Agrobacterium tumefaciens*. *Advances in Research*.

Nabatanzi A., Kabasa J., Nakalembe I., Owiny D., Mugisha C., Nyanzi S. (2016). Phytoconstituent analyses of selected wild edible plants constituting diets of pregnant women in Buikwe District, Uganda. *International Journal of Biochemistry Research and Review*, 14(2), 1–12.

Nabatanzi A., Nakalembe I. (2016). Wild food plants used by people living with HIV/Aids in Nakisunga Sub-County, Uganda. *African Journal of Food, Nutrition, Agriculture and Development*, 16(4), 11311–11331.

Nabatanzi A., Kabasa J., Nakalembe I. (2015). Phytochemicals and antioxidant properties of five wild edible plants consumed by pregnant women in Buikwe district, Uganda. *International Journal of Pharmacognosy and Phytochemical Research*, 7(6), 1267–1271.

Nabatanzi A., Kabasa J., Nakalembe I. (2015). Wild edible plants consumed by pregnant women in Buikwe district, Uganda. *International Journal of Technology Enhancements and Emerging Engineering Research*, 3 (11), 18–27.

Nyamukuru A., Nabatanzi A., Mpiira S., Tabuti J. (2015). Locally preferred woody species and their management in Kiruhura and Arua districts, Uganda. *Ethnobotanical Research and Applications*, 4,49–61.

Conferences

Najjembe Community Engagement Workshop on Stewardship for Indigenous Knowledge Health Systems through the sharing of real-life stories and demonstrations of traditional treatment practices. Mabira, Uganda, 18 January 2022.

1st NAPIANA Symposium on Reconciling Indigenous Knowledge Health Systems to bridge the gap between science, societal needs and global challenges. Makerere University, Uganda, 17 January 2022.

69th International Congress and Annual Meeting of the Society for Medicinal Plant and Natural Plant and Natural Product Research (GA), Bonn, Germany, 5–8 September 2021.

Women in Leadership. Achieving an equal future in a COVID-19 world. University of Pretoria, South Africa, 25 August 2021.

1st International Conference on Reimagining the Natural Products Industry in Uganda. Uganda, 5–7 July 2021.

Climate, Land, Agriculture and Biodiversity (CLAB) Symposium. Future Africa, University of Pretoria, South Africa, 21–23 June 2021.

The Sustainability Research and Innovation Congress 2021. Future Africa, University of Pretoria, South Africa, 14–15 June 2021.

3rd International Conference on Traditional Medicine, Phytochemistry and Medicinal Plants. Thailand, 2–4 November 2020.

Global Forum on Women in Scientific Research. Senegal, 18–19 July 2019.

8th International Scientific Conference on Global Health Security, Makerere University, Uganda, 28–29 June 2019.

Robert Bosch Stiftung Transdisciplinary Research Workshop. Future Africa, University of Pretoria, South Africa, 27–28 March 2019.

EuroScience Open Forum. France 9–14 July 2018.

Professional activities

Consultant:

Climate, Land, Agriculture and Biodiversity (CLAB) AFRICA Initiative, Future Africa, University of Pretoria, South Africa

Founder:

Natural Products Industry Advancement Network Africa (NAPIANA)

Professional membership

Founding member:
NAPIANA

Member:
RISE-AFNNET



*Mentor profile**

PROF LYNDY MCGAW

Lyndy McGaw is a professor in the Department of Paraclinical Sciences in the University of Pretoria's Faculty of Veterinary Science at Onderstepoort. She also heads the University's Phytomedicine Programme.

This is a multidisciplinary and collaborative research programme that investigates therapeutically useful compounds present in plants growing in South Africa. It started in 1995 in the Department of Pharmacology in the University's Faculty of Medicine, but was transferred to the Department of Paraclinical Sciences in 2002. In 2007, it was designated as a Research Niche Area of the National Research Foundation (NRF). It has delivered many master's and doctoral graduates from many countries in Africa and Europe, as well as several patents and two products in the market. The programme targets the development of effective and safe anthelmintic, acaricidal and antimicrobial remedies for use in animal and human medicine, as well as alternatives to antimicrobial feed additives.

Prof McGaw obtained her PhD at the University of KwaZulu-Natal (the former University of Natal) and has worked in diverse fields at the University of Pretoria, King's College London and the University of Adelaide. She joined UP in her current capacity in 2015. She has a C2 rating from the National Research Foundation, which classifies her as an established researcher with a sustained recent record of productivity in the field, who is recognised by her peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

Much of her research career has involved the development of biological activity and cytotoxicity assays to investigate the potential usefulness of South African plants to treat health issues in humans and animals. Her current interests include the evaluation of the antibacterial, antifungal, anthelmintic, antimycobacterial, anti-inflammatory, cytotoxic, mutagenic and antimutagenic effects of plant extracts and plant-derived purified compounds. She is also interested in the immune modulatory activity of plant preparations, cell culture applications and mechanism of action studies.

She is leading the Faculty's Research Theme "Translational Medicine", which aims to translate laboratory research into generating or repurposing useful products that can assist in overcoming common problems, such as antimicrobial and antiparasitic resistance. It draws together expertise from various departments in the Faculty of Veterinary Science. Excellent results have been obtained with projects investigating the development of plant-based formulations to reduce the incidence of mastitis-causing bacteria in dairy cattle, and alternatives to antibiotic feed additives in chickens. ○

**Dr Alice Nabatanzi was jointly supervised by Prof Lyndy McGaw and Prof Namrita Lall (see page 42)*



“ Dr Alice Nabatanzi has seized the idea of using African indigenous knowledge to develop pharmaceutical solutions. ”



ANTICANCER ACTIVITY AND ANTICANCER MECHANISMS OF ACTION OF *KIGELIA AFRICANA*

Postdoctoral fellow: Dr Alice Nabatanzi

Mentors: Prof Lyndy McGaw and Prof Namrita Lall

Despite the development of tools for disease diagnosis, treatment and prevention, cancer is still the second leading cause of mortality in the world after cardiovascular diseases. Globally, about one in six deaths is due to cancer.

The postdoctoral research conducted by Dr Alice Nabatanzi was aimed at investigating the antioxidant, anti-inflammatory and anticancer activity of *Kigelia africana*. This tree, known colloquially as the sausage tree, is native to Africa and is traditionally used to treat various conditions. It builds on research she conducted for her PhD, which concentrated on the application of the phytopharmaceutical effect of natural products.

She realised that some of the findings from her doctoral research could be reconceptualised to fill a knowledge gap in Uganda and the rest of Africa on the pharmaceutical value of indigenous tree species.

“Future Africa taught me the importance of conducting research that can transform African society by finding solutions to Africa’s problems,” she remarked. “Africa is characterised by issues such as poverty and a lack of infrastructure,” she continued. “This helped me decide on the topic for my postdoctoral research.” According to her mentor, Prof Lyndy McGaw, the work she is doing on the fruit of this tree is new, and Dr Nabatanzi has a good background for this research.

The fruits, leaves and twigs of *K. africana* have been used for their medicinal properties for many years. Dr Nabatanzi therefore seized the idea of using African indigenous knowledge to develop pharmaceutical solutions. By determining whether extracts from the tree had antioxidant, anti-inflammatory and anticancer activity, she was confident that she could succeed in finding a solution to an African societal problem. “After examining the existing body of knowledge of phytopharmaceuticals in cancer treatment, I realised that the natural products industry needed something that was available, affordable and effective, but with minimal side-effects.”

Focusing specifically on the use of extracts from *K. africana* as a cancer treatment, her preliminary research included examining its antioxidant properties, as well as the acute toxicity and profile of the phytochemical compounds in the extracts. She investigated the cytotoxicity of *K. africana* extracts on normal cells (a Vero cell line) and human cancer cell lines, including colon colorectal, lung carcinoma, liver cancer and breast cancer.

She found that arachidonic acid plays an important role in cancer development and progression. The cyclooxygenase and lipoxygenase enzymes are responsible for the metabolism of arachidonic acid into the potent biologically active lipid mediators that are intimately involved in inflammation.

She also investigated the potential of *K. africana* to inhibit the activity of cyclooxygenase and lipoxygenase enzymes, as well as the nitric oxide inhibition capacity of *K. africana*, using raw macrophages. The results of these analyses showed that *K. africana* is a significant source of natural antioxidants and is a potent antioxidant that could inhibit the production of nitric oxide, as well as the activity of cyclooxygenase and lipoxygenase enzymes, while also inhibiting the proliferation of colon colorectal, lung carcinoma, liver cancer and breast cancer cell lines. Furthermore, there is potential for these extracts to be used as additives in the food industry to provide protection against oxidative damage.

During her period in South Africa, she spent a lot of time in the University of Pretoria’s Phytomedicine Laboratory, under the guidance of Prof McGaw, conducting bioactivity studies on the mechanical action of natural products. Her specimens were collected at the University of Pretoria’s Experimental Farm. She collected the *K. africana* fruit, leaves and twigs from a site in Lynnwood, in Pretoria East. She also collected the leaves, flowers and twigs of the African tulip tree, *Spathodea campanulata*, which she processed in the laboratory. This was followed by antioxidant activity investigations, in which she tested 22 extracts.

In the Department of Paraclinical Sciences’ Cell Culture Laboratory at the University of Pretoria, she tested the nine extracts with the highest antioxidant activity to determine the cytotoxicity of K. africana against Vero cells. The nitric oxide inhibition by three extracts of K. africana was determined. Their antiproliferative effect on four human cancer lines was also determined. She could then do the preliminary qualitative phytochemical screening of the three extracts.

Back in Uganda, she was able to continue analysing her data. She could also profile the compounds in the three *K. africana* extracts using gas chromatography-mass spectrometry in the University of Pretoria’s Chemistry Department.

Her analyses confirmed that the extracts from *K. africana* exhibited anti-inflammatory properties by suppressing the expression of the pro-inflammatory cytokines IL-1 β , IL-6 and TNF- α in lipopolysaccharide-stimulated macrophages, and inhibited cyclooxygenase enzymes.

The hypothesis of her study could thus be accepted. “Fortunately, our extracts did not suppress the anti-inflammatory cytokine (IL-10), which further justifies their selective inhibitory activity on important cytokines,” she commented.

“

After examining the existing body of knowledge of phytopharmaceuticals in cancer treatment, I realised that the natural products industry needed something that was available, affordable and effective, but with minimal side-effects.”

”



The results of her study suggested that the bioactive constituents of *K. africana* and *S. campanulata* extracts had both antioxidant and anti-inflammatory activities. However, further research is needed to isolate, identify and characterise the bioactive compounds that are responsible for the various medicinal activities. “Once the active compounds have been isolated, the mechanism of activity can be examined,” she explained. “Prior to clinical use, the *in vivo* antioxidant and anti-inflammatory activity of these extracts needs to be assessed.”

Reflecting on her postdoctoral fellowship, Dr Nabatanzi realises that the opportunity to engage in independent research that was not associated with a particular qualification enabled her to grow in maturity academically. “The fellowship trained me to be a research leader so that I can transform Africa by increasing the impact of research.” She believes that, through the fellowship, she became a better person and could do better research. She also developed her capacity as a leader, who was able to write grant proposals and develop networks with stakeholders in the natural products industry. “My mentors and the other fellows inspired me and encouraged me to do better work. As a result, I achieved so much more than I had set out to do.” She found Prof McGaw, who heads the University’s Phytomedicine Programme, to be especially supportive. “I learnt a lot from her.”



Dr Nabatanzi succeeded in publishing articles on her research in three publications:

- “Antioxidant and anti-inflammatory activities of *Kigelia africana* (Lam.) Benth” (together with SM Nkadameng, N Lall, JD Kabasa and LJ McGaw) in *Complementary and Alternative Medicine* (2020)
- “Ethnobotany, phytochemistry and pharmacological activity of *Kigelia africana* (Lam.) Benth” (together with SM Nkadameng, N Lall, JD Kabasa and LJ McGaw) in *Plants* (2020)
- “Phytochemical, cytotoxicity, antioxidant and anti-inflammatory effects of *Psilocybe natalensis* magic mushrooms” (together with SM Nkadameng, C Steinmann and J Eloff) in *Plants* (2020)

Dr Nabatanzi organised the First International Conference on Reimagining the Natural Products Industry in Africa (RNPIA) to discuss the possibilities of changing the image of Africa’s natural products industry and to disseminate the key findings of her study. The conference took place at the Imperial Royale Hotel, Uganda, from 5 to 7 July 2021. The theme was: “Advancing Africa’s natural products industry through transdisciplinary and sustainable innovations”.

According to Dr Nabatanzi, the conference offered scientists and professionals from around Africa the opportunity to discuss the latest state-of-the-art technologies, products and solutions used in the natural products industry.

The three-day event gave scholars, practitioners in industry, non-governmental organisations and policy makers the chance to meet and network with high-ranking officials and the top leaders from academia and industry. “Organising the conference was a breakthrough experience for me,” she admits. “It was challenging and exciting – I cannot thank Future Africa and the Carnegie Corporation of New York enough for this opportunity.”

However, what Dr Nabatanzi considers to be the most significant output of her fellowship is the establishment of the Natural Products Industry Advancement Network Africa (NAPIANA). “The need for such a network was identified when it was realised that traditional natural product networks in Africa have concentrated mainly on academia,” she explained, “and have neglected other actors along the value chain”. There is therefore a need to reimagine Africa’s natural products industry using a transdisciplinary approach. “This is necessary for sustainable, transformational societal change.”

“Through the establishment of this network, it will be possible to bridge the gaps along the natural products value chain,” she says, “and change the image of Africa’s natural products industry.” What makes NAPIANA unique is that it includes all the actors along the natural products value chain: farmers, herbalists, traditional healers and birth attendants, academics, entrepreneurs, industry, policy makers, government, regulatory authorities, non-governmental organisations and funders. “The policy makers need to know what is happening on the ground,” she says, “and one needs to involve the entrepreneurs who are going to help get the products to the market following their commercialisation.”

NAPIANA was officially launched on 7 July 2021 the final day of the RNPIA Conference. One of the first events hosted was the NAPIANA symposium held at Makerere University on 17 January 2022. This was followed by a one-day Najjembe community engagement workshop on 18 January 2022.

“Only by embracing a transdisciplinary approach can the natural products industry in Africa transform,” she concludes. ○



“
The vitality of African natural products is a forgotten asset that must be hauled back to ensure the socioeconomic and environmental resilience of the continent. This is not just a vision, but a necessity that the research of Dr Alice Nabatanzi will help harness.”

– Prof Cheikh Mbow, Former Director: Future Africa

EXPLORING THE MEDICINAL BENEFITS OF INDIGENOUS PLANTS

The sausage tree, *Kigelia africana*, has been known through the ages for its medicinal benefits. Anecdotal uses include the application of the powdered mature fruit as a dressing to treat wounds, abscesses and ulcers, as well as skin conditions. The green fruit is also traditionally used as a poultice for syphilis and rheumatism, and the leaves are used as a poultice to treat backache.

Traditional medicine plays a prominent role in indigenous health care systems, especially in developing countries, where access to allopathic medicines and practitioners is limited. Communities have relied on traditional medicine for centuries because it

is easy to access, culturally appropriate and considered safe. Traditional medicine includes explicit practices that exploit materials from plants and animals, as well as from inorganic materials such as soils. It also includes implicit methods that entail cultural spiritual traditions.

Plant materials from medicinal plants find their widest application in traditional medicine preparations, but these practices have threatened the plant species from which such materials are sourced due to unsustainable harvesting, habitat modification and conversion. The sausage tree is one such species that has been heavily exploited for its medicinal, religious and cultural values.

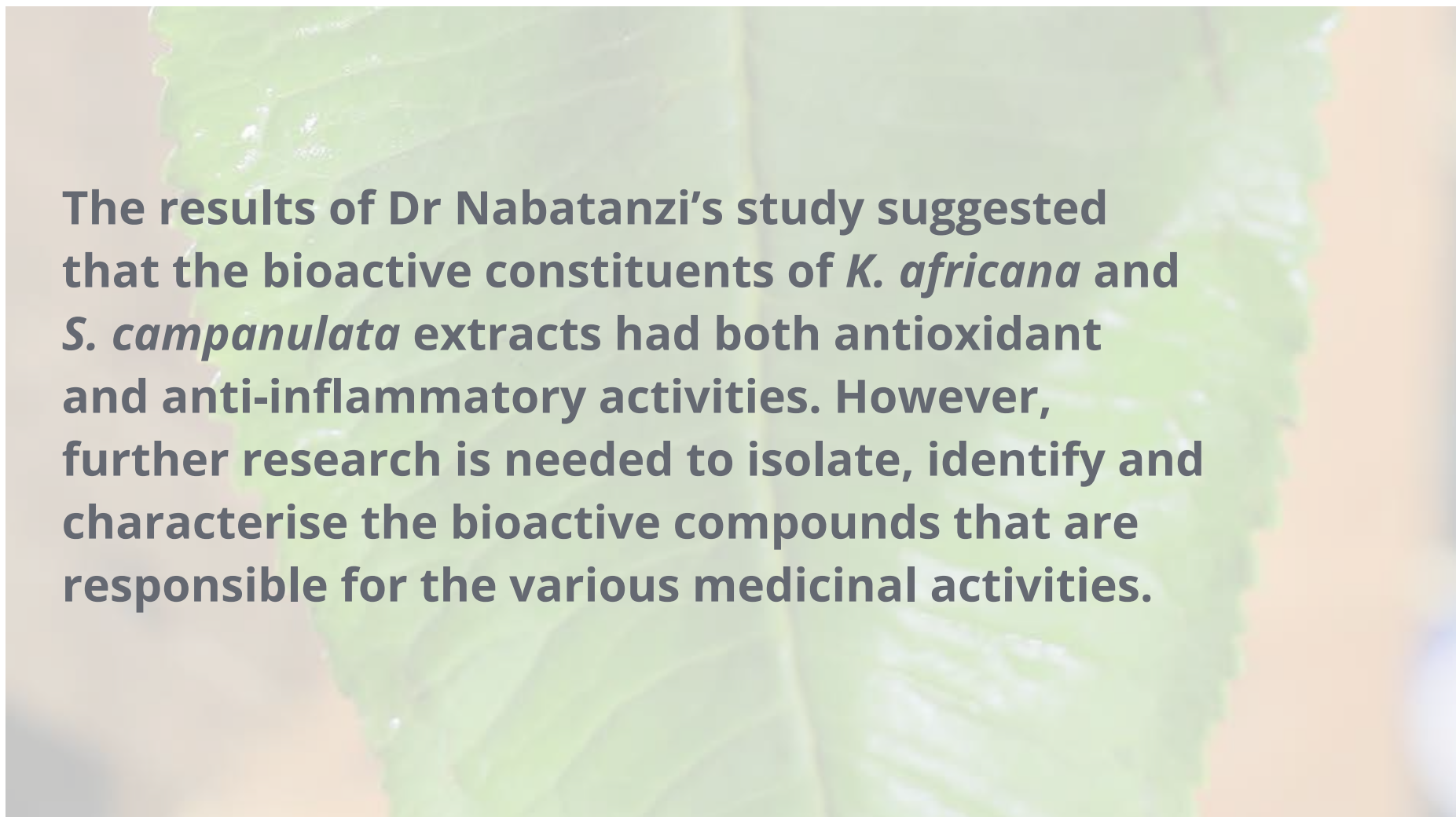
It belongs to the family Bignoniaceae and is the only species in the genus *Kigelia*. Its common name is derived from the shape of its fruit, which looks like a sausage. The tree grows mostly in the wild, in wet areas along watercourses, in riverine fringes, in alluvial and open woodlands, in high-rainfall savannas, in shrublands and in rain forests. It occurs on loamy red clay soils, which are sometimes rocky, damp or peaty, in altitudes up to 3 000 m above sea level.

Some local communities protect the saplings in the wild, which enables the trees grow to maturity. It has also been domesticated and planted in gardens from propagated seeds. ○

One tree with many names

The local names of *K. africana* vary throughout Africa due to its ethnic and cultural diversity on the continent. The many dialects reflect its ethnobotanical significance among several African communities.

Acholi: Yago; **Adanme:** Lele; **Afrikaans:** Worsboom; **Arabic:** Abu Shutor, Abu Sidra, Um Shutur, Umm Hashatur; **Ashanti and Akwapem:** Nufuten, Nanaberetee; **Ateso:** Edodoi; **Baule:** Blimmo; **Bemba:** Mufungufungu; **Bini:** Ugbongbon; **Boni:** Sheole; **English:** Sausage tree; **Ewe:** Nyakpe; **Fante:** Etua; **Fulani:** Jilahi; Ga: Akpele; **Gitama:** Muratini; **Hausa:** Rawuya, Hantsar giiwaa; **Ibo:** Uturubein; **Kaonde:** Kufungule; **Kakamega:** Morabe; **KalanBa:** muZunguru; **Kamba:** Muatini, Kiatine; **Kanuri:** Bulungu; **Kikuyu and Meru:** Muratina; **Kipsigi:** Ratiunet; **Lozi:** mPolota; **Luganda:** Omusa; **Lugisu:** Sifungu; **Luo:** Yago; **Lusoga:** Naizungwe; **Lunda:** Ifungufungu, Mufunofuno; **Masai:** Ol-Suguroi, Ol-Darpoi; **Nandi:** Ratiunet; **Ndau:** muVumati; **Nupe:** Bechi; **Nyanja:** Chizutu, Mvula, Mvunguti; **Pokot:** Roti; **Sepedi:** Modukguhlu; **Shona, Zezuru and Manyika:** umBvewe, iPfungwani, muBvee; **Somalia:** Bukuraal; **Swahili:** Mvungunya, Mvungavunga, Hwegea, Mwicha, Mranaa; **Taveta:** Mukisha; **Teita:** Hwasini, Mvongonia; **Tonga:** muVeve, Muzungule; **Venda:** Muvevha; **Yoruba:** Pandoro; **Zande:** Rangbarabgo.



The results of Dr Nabatanzi's study suggested that the bioactive constituents of *K. africana* and *S. campanulata* extracts had both antioxidant and anti-inflammatory activities. However, further research is needed to isolate, identify and characterise the bioactive compounds that are responsible for the various medicinal activities.

CONFERENCE ON REIMAGINING THE NATURAL PRODUCTS INDUSTRY IN AFRICA

The theme of the First International Conference on Reimagining the Natural Products Industry in Africa (RNPIA), hosted by Makerere University, Uganda, from 5 to 7 July 2021, was “Advancing Africa’s natural products industry through transdisciplinarity and sustainable innovations”. The conference was organised by postdoctoral fellow Dr Alice Nabatanzi from Makerere University, and attracted more than 400 online participants.

The conference featured graduate students (master’s and PhD candidates), postdoctoral and early career researchers, and entrepreneurs, and included an exhibition of natural products. The presentations focused on drug discovery and drug design, natural products chemistry, cosmeceuticals, nutraceuticals and pharmaceuticals, ethnoveterinary medicine, intellectual property and permits, the pharmaceutical market in Africa, gender and conservation, climate change, and policy and governance.

The first day focused on the work of graduate students from South Africa and Uganda. The keynote address was delivered by Prof Namrita Lall, Chair in Plant Health Products from Indigenous Knowledge Systems at the University of Pretoria. She discussed challenges and coping strategies facing female researchers in science, technology, engineering and mathematics research.



Participants at the dissemination conference

After Dr Nabatanzi had provided an overview of the natural products industry in Africa, the following presentations were delivered:

- “Comparing the use of 2D and 3D melanoma models to investigate antiproliferative activity in preclinical drug screening”, Talita Turvey, University of Pretoria
- “The effects of a promising South African medicinal plant in wound healing”, Samantha Rae Loggerenberg, University of Pretoria
- “Phytogeographical metabolomic analysis of wild rooibos populations”, Catherine Wilkinson, Stellenbosch University
- “Pharmacological importance and *in vitro* safety of selected plants with potential for application in mastitis prevention and treatment”, Chika Ogbuadike, University of Pretoria
- “Cytotoxicity of medicinal plant species used by traditional healers in treating people living with HIV/AIDS in Uganda”, Anywar Godwin, Makerere University
- “Ethnoveterinary remedies used in avian complementary medicine in selected communal areas in Zimbabwe”, Prosper Jambwa, University of Pretoria
- “Ethnobotany, ethnopharmacology and phytochemistry of traditional medicinal plants used in the management of symptoms of tuberculosis in East Africa: A systematic review”, Samuel Baker Obakiro, Busitema University
- “Antibacterial interactions, anti-inflammatory, cytotoxic, anti-biofilm, and synergistic interaction effects of five medicinal plants species used for cutaneous wound infections on animals”, Jacobus Kori Madisha, University of Pretoria

The second day focused on the work of early career researchers. The keynote address was delivered by Prof John RS Tabuti of Makerere University, who discussed the conservation of traditional medicines. This was followed by the following presentations:

- “*Psilocybe cubensis* leucistic A+ strain magic mushroom extracts exhibit cardioprotection on angiotensin II-induced hypertrophy *in vitro* on cardiomyocytes”, Sanah M. Nkadimeng, University of Pretoria
- “Antioxidant, antibacterial activity and phytochemistry of Ugandan plants used to treat skin infections”, Dr Jane Namukobe, Makerere University
- “Navigating the sea of intellectual property: Technology transfer and patenting innovative ideas”, Dr Marco Nuno De Canha, University of Pretoria
- “Isolation of new flavonoids from selected *Tephrosia* species and their effects on cytokine production”, Dr Richard Oriko Owor, Busitema University
- “Antibacterial activity and combined effect of essential oil and isolated compound from *Echinops kebericho* mesfin tuber”, Dr Serawit Deyno, Hawassa University
- “Traditional therapeutic uses of *Aloe* spp. in Eastern Africa and their potential for drug discovery”, Dr Patience Tugume, Makerere University

- “Oral toxicity of the leaf extracts and antiplasmodial activity of the compounds isolated from the extracts of *Clerodendrum rotundifolium* plant species in Uganda”, Dr Madina Mohamed Adia, Makerere University
- “An appraisal of the use of medicinal plants for managing headache and migraine in African traditional medicine”, Dr Ebenezer K. Frimpong, University of North-West

The day’s events were concluded with two presentations from industry:

- “The role of the National Drug Authority in the development and regulation of traditional medicine”, Dr Brian Sekayombya, National Drug Authority
- “The role of the National Chemotherapeutic Research Institute in the development and regulation of traditional medicine”, Nambejja Cissy, National Chemotherapeutic Research Institute

The highlight of the final day was the launch of the Natural Products Industry Advancement Network Africa (NAPIANA) by Dr Nabatanzi and Prof Paul Waako, Vice-Chancellor of Busitema University, Uganda.

The keynote address was delivered by Prof Lyndy McGaw, Head of the Phytomedicine Programme at the University of Pretoria, who spoke about ethnoveterinary medicine. This was followed by the following presentations:

- “Pharmacological approaches in drug discovery”, Prof Paul Waako, Busitema University
- “Natural products value chains in Africa”, Prof John David Kabasa, Makerere University
- “African medicinal plants as a solution to the continent’s health challenges: Importance of a collaborative endeavour and a high-throughput approach to explore this resource in search of COVID-19 treatment regimens”, Prof Vinesh Maharaj, University of Pretoria.
- “Fisheries and aquaculture in the face of climate change”, Prof Fredrick Muyodi, Makerere University
- “Natural products drug discovery”, Dr Grace Nambatya, Director of the Natural Chemotherapeutic Research Institute in Uganda’s Ministry of Health
- “The theoretical framework, processes and challenges of registering a pharmaceutical company”, Mongezi Mabena, South Africa

The event was concluded with a certificate presentation ceremony, after which a panel discussion was held on the way forward. The panellists included Prof Cheikh Mbow, former Director of Future Africa, Prof Waako of Busitema University, Prof Namrita Lall of the University of Pretoria and Prof David J Kabasa of Makerere University. ○

NATURAL PRODUCTS NETWORK BRIDGES THE GAP BETWEEN SCIENCE AND SOCIETY

The emergence of the COVID-19 pandemic brought about the realisation of the large gap between science, societal needs and global challenges. The coronavirus took the world by surprise, and scientists across the globe had to revisit their existing knowledge, systems and technologies in search of a cure. Despite ongoing investigations and vaccine development, there is still no cure.

With the omicron and subsequent variants making their rounds and threatening global health security once again, there is an increasing need to reconceive indigenous knowledge health systems, since the most potent cures around the world have been discovered using the ethnopharmacological approach to drug discovery: the interdisciplinary scientific exploration of biologically active agents that are traditionally employed.

During the First International Conference on Reimagining the Natural Products Industry in Africa (RNPIA) that was presented by Dr Alice Nabatanzi in Uganda from 5 to 7 July 2021, a need was identified to refocus Africa's natural products industry. Various African researchers presented their work in the field of natural products (plants, animals and microorganisms) at this conference. This was followed by discussions on how to promote Africa's natural products industry so that African researchers can find health solutions suitable for Africa's challenges.

This led to the conceptualisation of the Natural Products Industry Advancement Network Africa (NAPIANA), which was launched on the final day of the conference. This network will provide linkages for the drug development process, support product standardisation and augmentation, and help with intellectual property issues. It will also enable inventors and entrepreneurs to market their products through supportive networks, and provide support

with the scientific validation of products. It will serve as a support centre to provide information on natural products research, and as an advocate for infrastructure. All registered and organised actors along the natural products value chain will qualify to be part of this network, which will be hosted at the College of Natural Sciences at Makerere University.

In January 2022, Dr Nabatanzi presented the network's first two events, supported by the Carnegie Corporation of New York: a one-day symposium, followed by a one-day community engagement workshop. Both events were aimed at reconceiving indigenous knowledge health systems to bridge existing gaps and pave the way for the discovery of novel natural cures. These events would also facilitate an understanding of where the real gap is and how trained scientists can work together with the stewards of indigenous knowledge health systems to bring new solutions on board without clashing.

NAPIANA SYMPOSIUM

The theme of the First NAPIANA Symposium on Reconceiving Indigenous Knowledge Health Systems to Bridge the Gap between Science, Societal Needs and Global Challenges, held at Makerere University on 17 January 2022, was: "Reinforcing the roots of natural product value chains through transdisciplinarity for sustainable societal transformation".

The main activity of the symposium was the establishment of NAPIANA. Through its transdisciplinary approach, the network aims to bridge the gaps between stakeholders along the different natural product value chains to advance the natural products industry in Africa. The symposium had the following sub-themes:

- Local communities as stewards of indigenous knowledge health systems
- COVID-19 and natural products research
- The protection of intellectual property
- Natural products in the face of climate change

The event was officiated by Prof Christopher Mbazira, Deputy Vice-Chancellor: Academic Affairs of Makerere University. It was attended by major stakeholders in the natural products industry: from the Ugandan National Bureau of Standards to the National Drug Authority and the Natural Chemotherapeutic Research Institute.

Dr Nabatanzi noted that what had pushed her to form NAPIANA was the fact that the natural products industry in Africa was far behind its counterparts in Asia and Europe, yet Africa is richer in biodiversity, and Africa's indigenous knowledge health systems have existed for eons.

She realised that the large gaps that existed between stakeholders in the natural products value chain were among the reasons for the stalling Africa's natural products industry, accompanied by poor infrastructure, intellectual property issues and inadequate funding.

The presentations included the following:

- "Natural medicines: Innovations and breakthroughs during COVID-19 in Uganda", Dr Grace Nambatya, Director: Research of the Natural Chemotherapeutic Research Institute in Uganda's Ministry of Health
- "Regulations and support to natural medicines innovations in Uganda", Dr Brian Sekayombya, Uganda's National Drug Authority
- "Patenting of indigenous knowledge", Dr Marco de Canha, University of Pretoria
- "Indigenous knowledge health systems: The roots of natural products value chains", Prof John David Kabasa, Principal: College of Veterinary Medicine, Makerere University
- "Natural products in the face of climate change", Prof John RS Tabuti, College of Agriculture and Environmental Sciences, Makerere University
- "Najjembe community's involvement in natural products research and stewardship", Mr Magomu, Chairman, and Ms Nansamba, Resident.



Participants at the symposium



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Dr Nabatanzi believes that the conferences offered scientists and professionals from around Africa the opportunity to discuss the latest state-of-the-art technologies, products and solutions used in the natural products industry.

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NAJEMBE COMMUNITY ENGAGEMENT WORKSHOP

The NAPIANA Symposium was followed on 18 January 2022 by a community engagement workshop among Uganda's Mabira forest communities in the Najjembe Subcounty, Buikwe district.

In Uganda, the local communities have always depended on natural resources for their livelihoods. In the case of health, these communities have always found natural cures from the environment – some of which have been investigated by scientists and new drugs discovered. With the emergence of new global pandemics, especially COVID-19, people all over the world have dug into their indigenous knowledge health systems, with the assistance

of the local communities as stewards or living libraries, to search for cures, as many novel bioactive constituents, which have not received resistance, have been extracted from nature.

With this activity, community members who have access to valued social settings and activities were made to feel that they can contribute meaningfully to solving complex health challenges, which will, in turn, strengthen their commitment to preserving nature.

The Mabira Forest is the second largest natural forest in Uganda with a high biodiversity. Inside the forest are communities whose livelihoods depend entirely on the forest.

These are the local communities who participated in the one-day workshop. During the community workshop, they discussed and showcased the different natural medicines they use for pre- and post-pregnancy care, childcare, COVID-19 management, family care, nutrition and cosmetology, and ethnoveterinary medicine, and how they have managed to conserve their natural resources. They also discussed issues related to climate change and natural products stewardship.

According to Dr Nabatanzi, the events were a great success, and a lot of important information was gathered. "I recommend more such engagements, as interactions with stakeholders and the community are the best way to gather accurate data." ○

Participants at the community engagement workshop







DR NICHOLAS KAGIMU

Dr Nicholas Kagimu is associated with the Department of Agricultural Production in the College of Agricultural and Environmental Sciences, Makerere University, Kampala, Uganda. He obtained his PhD in Nematology at Stellenbosch University, South Africa, in 2018. His doctoral thesis was on the development of a formulation for the commercialisation of entomopathogenic or insect-killing nematodes (EPNs) in South Africa. The findings have enabled NemaBio, a South African company conducting research on the commercialisation of local strains of EPNs to realise one of its goals. The focus of his postdoctoral studies is the biocontrol potential of the metabolites of *Xenorhabdus* and *Photorhabdus* bacteria associated with insect-killing nematodes for agricultural production.

With a background in nematology, his research aims to extract, identify and characterise novel bioactive compounds, isolated from the *Xenorhabdus* and *Photorhabdus* bacteria of local strains of insect-killing worms, and to investigate their potential to control key agricultural and forestry pests.

He completed his MSc at Ghent University in Belgium in 2015 and participated in the MSc in Nematology Exchange Programme of the Christian Albrechts University in Kiel, Germany. It is here that he was posted at the E-nema Society of Biotechnology and Biological Plant Protection in Schwentinental, Germany, where he conducted research on the liquid storage of insect-killing worms. While completing his MSc studies in Belgium, he completed a professional internship at the Institute for Agricultural and Fisheries Research in Merelbeke, Belgium.

His research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

Biocontrol potential of *Xenorhabdus* and *Photorhabdus* bacteria for agricultural application

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FELLOW'S RESEARCH HIGHLIGHTS

Publications

Kagimu N., Nxitywa A., Malan A. (2021). Storability at room temperature of *Steinernema yirgalemense* (Rhabditida: Steinernematidae) in diatomaceous earth and the effect of antifungal agents.
Journal of Plant Diseases and Protection, 129, 137–144.

Kagimu N., Malan A. (2019). Formulation of South African entomopathogenic nematodes using alginate beads and diatomaceous earth.
BioControl, 64, 413–422.

Kagimu N., Ferreira T., Malan A. (2017). The attributes of survival in the formulation of entomopathogenic nematodes utilised as insect biocontrol agents.
African Entomology, 25, 275–291.

Conferences and seminars

Meeting of the International Union of Forest Research Organisations (IUFRO) Working Group 7. Biological Control of Forest Insect Pests and Pathogens. Future Africa, University of Pretoria, South Africa.

58th Society of Nematologists Annual Meeting.
North Carolina State University, Raleigh, USA.

European Society of Nematologists Conference.
Ghent University, Belgium.

International Congress on Invertebrate Pathology and Microbial Control and the 50th Annual Meeting of the Society for Invertebrate Pathology (Golden Jubilee). University of California, San Diego La Jolla.

21st Symposium of the Nematological Society of Southern Africa.
Durban, South Africa.

International Symposium on Crop Protection and Nematology Seminar. Ghent University, Belgium.



Mentor profile

PROF BRETT HURLEY

Brett Hurley is an associate professor in the Department of Zoology and Entomology at the University of Pretoria. He is a research leader at the University of Pretoria's Forestry and Agricultural Biotechnology Institute (FABI) and a research associate at the Institute for Commercial Forestry Research (ICFR) in Pietermaritzburg. His research is mainly within FABI's Tree Protection Cooperative Programme (TPCP) and the Department of Science and Innovation's Centre of Excellence in Plant Health Biotechnology (CPHB). Within the TPCP, he also oversees the research-linked services provided to industry and government partners, in the form of the diagnostic clinic, field extension and biological control.

His research focuses on insect pests of forest trees, examining the effect of these interactions and how these effects can be managed in the context of an integrated pest management programme. Much of his research examines the use of biological control as a management strategy. Here, various approaches are used to understand factors affecting biocontrol, as well as the suitability of potential new biocontrol agents. These include bioassays, field trials, and molecular and microbial analysis. He has worked extensively on the *Sirex-Amylostereum-Deladenus* interaction and, more recently, has become involved with biological control projects on the eucalyptus gall wasp, *Leptocybe invasa*, the bronze bug, *Thaumastocoris peregrinus*, the red gum lerp psyllid, *Glycaspis brimblecombeii*, as well as the use of entomopathogenic nematodes for the management of white grubs. His research incorporates various other fields that are relevant to the understanding and management of forest insect pests, such as host resistance, insect-microbial interactions, genetic diversity and introduction history, risk assessment and pathway management.

He has a C1 rating from the NRF, which classifies him as an established researcher with a sustained recent record of productivity in the field, who is recognised by his peers as having produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field, and as having demonstrated the ability to conceptualise problems and apply research methods to investigating them.

He enjoys extensive international recognition and exposure for his research, having presented as invited and keynote speaker at international meetings and presentations. He has also organised several international congress sessions, and has been involved in organising various scientific meetings and workshops. He participates in international research panels and collaborative projects, and consults nationally and internationally on issues of tree health. He is the coordinator of the International Union of Forest Research Organisations (IUFRO) Working Group on the Biological Control of Forest Insects and Pathogens, and is a member of the IUFRO Task Force for Biological Invasions in Forests. He is also a member of an international collaborative effort on the biological control of eucalyptus pests, and is coordinator of the Forest Invasive Species Network for Africa. ○



“ Through his participation in the ECRLF programme, Dr Nicholas Kagimu was able to benefit from the strong mentorship network at the University's world-renowned Forestry and Agricultural Biotechnology Institute. ”

BIOCONTROL POTENTIAL OF *XENORHABDUS* AND *PHOTORHABDUS* BACTERIA FOR AGRICULTURAL APPLICATION

Postdoctoral fellow: Dr Nicholas Kagimu
Mentor: Prof Brett Hurley

The United Nations' Food and Agriculture Organisation (FAO) is concerned about the effect of transboundary plant pests and diseases on food crops, as they are causing significant losses to farmers and impacting on food security. The number of insect pests that are threatening agricultural crops internationally is increasing at an alarming rate. Biological control is considered the best method of eradication.

The research of Dr Nicholas Kagimu focuses on the use of nematodes as a biological control agent. Insect-killing worms or entomopathogenic nematodes (EPNs) represent an important part of the spectrum of potentially available biological control agents that could be used to control insect pests. Current research on the use of EPNs against key pests of fruit crops in South Africa has focused on the use of nematodes on a commercial scale against key insect pests of deciduous fruit and citrus, and in forestry. Alternative control measures against insect pests are needed to overcome environmental contamination and chemical resistance.

For this objective to be realised, nematodes should be mass produced *in vitro* in liquid culture. A detailed understanding of the biology and behaviour of the nematode species and the associated bacterial symbionts in relation to their mass production is, therefore, required. Bacteria of the genera *Xenorhabdus* and *Photorhabdus* are symbionts in the intestine of their respective EPNs in the genera *Steinernema* and *Heterorhabditis*.

The objective of Dr Kagimu's study was to examine the biocontrol potential of metabolites from Xenorhabdus and Photorhabdus bacteria for agricultural application. He aimed to extract, identify and characterise novel bioactive compounds isolated from these bacteria, and to investigate their potential to control key agricultural and forestry pests. This will supplement existing biocontrol strategies in integrated pest management.

Research on the use of EPNs in South Africa over the past 15 years has shown their potential use to control key insect pests in crops. Nematodes and bacteria synergistically kill the insect host within 12 to 48 hours. As biological control agents of key agricultural insect pests, these nematodes produce an array of metabolites that facilitate interactions that can inhibit insects' immune response and kill or prevent other microorganisms from invading or decomposing the insect cadaver. The metabolites are broad-spectrum compounds, which are active against bacteria, fungi, insects and nematodes, and have pharmaceutical, cosmetic and agri-forestry applications.

Recent work has revealed the potential of metabolites from EPN-associated bacteria. The produced metabolites have various chemical structures with antibiotic, antimycotic, insecticidal, nematocidal, antiulcer, antineoplastic, antiviral and antioxidant properties. In South Africa, preliminary research on the antibiotic properties of secondary metabolites from bacteria associated with native EPN species has been

performed at Stellenbosch University. This research, however, focused on medical applications. The agricultural application against insect pests, plant-parasitic nematodes, fungi and bacteria has not yet been investigated.

Although EPNs are widely used in insect pest management, the direct use of the bacteria-produced metabolites has only recently attracted attention. Many naturally produced antimicrobial metabolites produced by other bacteria, such as *Bacillus thuringiensis*, are being used in integrated pest management approaches. "It is important to investigate the agricultural applications of secondary metabolites from local strains of EPNs in South Africa," says Dr Kagimu. "Isolating the novel secondary metabolites from *Xenorhabdus* and *Photorhabdus* from native EPNs could lead to numerous applications for insect pest management."

Discussing the overall objectives of his study, Dr Kagimu explained that the isolation processes of crude secondary metabolites can be attained by both in-vivo and in-vitro progressions. "The quality of metabolites from in-vivo extraction is probably superior to that of metabolites extracted in vitro. This is because the triangular interaction of insects, nematodes and bacteria could require stronger metabolites."

To achieve this, he evaluated the bioactivity of crude extracts (cell free) obtained from cultures of these bacteria against a selection of pests of agricultural relevance for insect toxicity. This was followed by the chemical characterisation of secondary metabolite extracts for structure clarification following isolation. These analyses would enable the identification of all secreted metabolites based on their chemical structure and molecular weight. At this stage, novel metabolites would be revealed. Dr Kagimu explained that the purified novel metabolite was tested against wax moth and several species of white grub larvae to determine its ability to suppress the insects' immune systems.

Dr Kagimu's postdoctoral research was a continuation of work he had conducted on nematodes in his master's studies at Ghent University in Belgium and his doctoral studies in the Department of Conservation Ecology and Entomology at the University of Stellenbosch in South Africa. "The interaction between insect pests and bacteria was something that I felt needed further research," he explained. The use of manufactured pesticides is very expensive, and needs additional resources to be applied across the whole country. "I recognised the need to develop natural pest control measures, and would like to develop this further by engaging in work on bioprospecting natural products from bacteria."

Through his participation in the ECRLF programme, Dr Kagimu was able to benefit from the strong mentorship network at the University of Pretoria's world-renowned Forestry and Agricultural Biotechnology Institute (FABI). He appreciates the fact that he was paired with a mentor with international recognition in the field of biological pest control, Prof Brett Hurley, as their interests were well aligned. "The fellowship also gave me the opportunity to diversify into the field of biochemistry," he adds. "It opened up my awareness of the additional application of nematodes to eradicate insect pests that are threatening the world's forests and plantations."

Through collaboration with researchers at the University of Stellenbosch's Department of Conservation Ecology and Entomology, and the Department of Microbiology, as well as scientists in the University of Pretoria's Department of Chemistry and the Department of Zoology and Entomology, he learnt a lot about the bioprospecting of natural products, which he plans on expanding upon in the future.

Prof Hurley commented that Dr Kagimu came to the fellowship with valuable skills, and his research can be further developed by applying nematodes as a biocontrol agent in the forestry sector, in addition to agriculture. "The existing insecticides have restricted use, and it would be beneficial to develop environmentally friendly alternatives," Prof Hurley commented.

The fellow learnt quite a lot working with Prof Hurley in FABI's Tree Protection Cooperative Programme. "I found Dr Kagimu to be open-minded and engaging, and he brought a certain charisma to the group," Prof Hurley remarked. "He introduced us to a new element in insect pest management, which we found quite interesting."

Dr Kagimu admits that he did not succeed in achieving all he had set out to do. With the challenges presented by the COVID-19 pandemic, he could not complete all his laboratory work. He plans on continuing with his research if he succeeds in obtaining additional funding, after which he will publish the findings of his research.

He was able to conduct several additional activities during his fellowship. This included his attendance of the annual meeting of the Society of Nematologists at North Carolina State University in July 2019 and the meeting of Working Group 7 (Biological Control of Forest Insect Pests and Pathogens) of the International Union of Forest Research Organisations (IUFRO) at Future Africa in November 2019.

Upon conclusion of his fellowship, Dr Kagimu organised a dissemination workshop on the impact of pathogens on agricultural production. The workshop was organised together with scientists in the Department of Agricultural Production of the College of Agricultural and Environmental Sciences, Makerere University. It was held at the Golf Course Hotel in Kampala, Uganda, on 8 and 9 November 2021. The keynote speaker was Paul Mwambu, Commissioner of Crop Inspection and Certification of the Ugandan Ministry of Agriculture, Animal Industry and Fisheries. It attracted 50 online participants.

The workshop served as a learning platform for post-graduate students, as well as an avenue for interaction among research scientists, policy makers and industry players in Uganda's agricultural sector. Prof Hurley remarked that it was a really great initiative, and he believes that it gave Dr Kagimu excellent exposure as an early career researcher in Uganda. He hopes that the leadership and capacity development the fellow received on the programme will be utilised by an institution in his home country, as Dr Kagimu is not presently employed in such a capacity.

Dr Kagimu will also be presenting his research at the International Congress of Nematology, which will be held in Antibes Juan-les-Pins, France, in May 2022.

"The fellowship taught me that global problems like the infestation of crops and forests by insect pests are difficult to eradicate once they have taken root in a country," he said. "However, by collaborating across disciplines with entomologists, mycologists and conservation ecologists, a solution can be found that does not only lie within the discipline of nematology." ○

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By collaborating across disciplines with entomologists, mycologists and conservation ecologists, solutions can be found that do not only lie within the discipline of nematology.

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WHAT IS A NEMATODE?

A nematode is any worm of the phylum Nematoda. They are among the most abundant animals on earth, and occur as parasites in animals and plants, or as free-living forms in soil, fresh water and marine environments. Nematodes help distribute bacteria and fungi through the soil and along the roots by carrying live and dormant microbes on their surfaces and in their digestive systems. They are an effective biocontrol agent for insect pests that threaten the survival of agricultural crops, forests and plantations. Some are used as bioindicators and others as model organisms in developmental biology.

DIVERSITY OF ENTOMOPATHOGENIC NEMATODES AND THEIR SYMBIOTIC BACTERIA IN SOUTH AFRICAN PLANTATIONS AND INDIGENOUS FORESTS

Earlier research conducted by researchers from the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria and the Department of Conservation Ecology and Entomology at the University of Stellenbosch found that the discovery of native entomopathogenic nematodes (EPNs) in sub-Saharan Africa could promote the development and use of these species as biocontrol agents against local insect pests.

Many insect pests pose a risk to the forestry industry in South Africa, especially during the establishment of saplings. Insecticides are widely used to control these pests, but their use in plantation forestry is under increasing pressure due to high costs, environmental contamination and restriction by certification bodies such as the Forestry Stewardship Council.

EPNs have been successfully used to control some insect pests in agricultural crops and offer a possible alternative for the management of these pests in the forestry industry.

The study found *Steinernema* species to occur in diverse habitats, including indigenous South African forests and non-native wattle and pine. The *Heterorhabditis* species, on the other hand, was only found in indigenous forests. More nematode species were recovered from indigenous forest sites and wattle plantations than from eucalypts and pine plantations. It also revealed a substantial diversity of EPN species and their associated bacteria in the plantation and indigenous forests of South Africa.

The results of this research provided the opportunity to consider the potential of nematodes as biological control agents of establishment pests in forestry. In this regard, effectively utilising native EPNs against these pests would reduce the reliance on insecticides. It is also the preferred option compared to introducing exotic EPNs that may have possible unintended side effects on non-target organisms and the environment.

The ability to mass-rear these nematodes using solid media and liquid culture bioreactor technology, as well as their broad host range and ease of application, has rendered them useful biological control agents of insect pests in various crop systems. The ideal solution would be if they could be used successfully on a commercial scale to control insect pests. ○

Why are forests important?

We depend on forests for our survival: from the air we breathe to the wood we use. Besides providing habitats for animals and livelihoods for humans, forests also offer watershed protection, prevent soil erosion and mitigate climate change. Over a billion people around the world live in and around forests. They depend on them for fuel, food, medicine and building materials. However, human impacts have already led to the loss of around 40% of the world's forests. According to the World Wide Fund for Nature (WWF), an area the size of a football pitch is being destroyed every second of every day. Protecting and restoring forests has never been more urgent.

THE IMPACT OF PATHOGENS ON AGRICULTURAL PRODUCTION

Dr Nicholas Kagimu organised a dissemination conference on the impact of pathogens on agricultural production together with the Department of Agricultural Production of the College of Agricultural and Environmental Sciences, Makerere University. It was presented at the Golf Course Hotel in Kampala, Uganda, on 8 and 9 November 2021. Mr Paul Mwambu, Commissioner of Crop Inspection and Certification of the Ugandan Ministry of Agriculture, Animal Industry and Fisheries was the keynote speaker.

The presentations included the following:

- “Forest pest surveillance to protect Africa’s forest resource” – Prof Brett Hurley, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria
- “Chemical defences of forest trees to fungal infection and the consequences of these defences on insect herbivory” – Prof Almuth Hammerbacher, FABI, University of Pretoria
- “Bioprospecting of the natural products from *Xenorhabdus* and *Photorhabdus* bacteria and their application in agriculture” – Dr Nicholas Kagimu
- “Status of nematology research in Uganda” – Prof Herbert Talwana, Department of Agricultural Production, College of Agricultural and Environmental Sciences, Makerere University, Uganda
- “What FABI can offer in collaboration with research and industry in Uganda” – Prof Bernard Slippers, FABI, University of Pretoria
- “Past, present and future of entomological research in Uganda” – Prof Samuel Kyamanywa, Department of Agricultural Production, College of Agricultural and Environmental Sciences, Makerere University, Uganda
- “Biocontrol agents in pest management in Uganda’s forest systems” – Dr Peter Kiwuso, National Forestry Resources Research Institute, Mukono, Uganda
- “Bio-prospected products from insects (pharmaceutical, nutritional, cosmetics)” – Dr Alice Nabatanzi, Makerere University, Uganda
- “An overview of EPN in Africa” – Dr Solveig Haukeland, International Centre of Insect Physiology and Ecology, Nairobi, Kenya
- “Status of liquid culture development for commercialisation of entomopathogens in South Africa” – Prof Antoinette Malan, Stellenbosch University, South Africa
- “Entomopathogenic fungi for insect crop management” – Prof Jeninah Karungi, Department of Agricultural Production, College of Agricultural and Environmental Sciences, Makerere University, Uganda
- “Endophytes research and bio-pesticides use” – Dr Michael Otim, National Agricultural Research Organisation, Kampala, Uganda
- “Tsetse fly vector: Effects, distribution and control in Uganda” – Entomology Department, Ministry of Agriculture, Animal Industry and Fisheries, Uganda
- “Tick epidemic and vaccine development” – National Livestock Resources Research Institute, Kampala, Uganda
- “Helminths and helminths control in small ruminants” – Dr Idibu Joachine, Department of Agricultural Production, College of Agricultural and Environmental Sciences, Makerere University, Uganda
- “Veterinary drug use and resistance” – Veterinary Department, Makerere University, Uganda
- “Chemical control of internal and external parasites in livestock” – MTK Uganda
- “Potential of bio-pesticides in smallholder agricultural systems” – Dr Vitalis Wekesa, Dudutech, Kenya ○



ZIMBABWE



DR ENESS MUTSVANGWA-SAMMIE

Dr Eness Mutsvangwa-Sammie served her postdoctoral fellowship in the University of Pretoria's Department of Agricultural Economics, Extension and Rural Development. She obtained her PhD in Agriculture at the University of Zimbabwe in 2018, titled, "Examining pathways of agricultural innovations and their impact on rural livelihoods and natural resource management in the Limpopo River basin of Zimbabwe". The focus of her postdoctoral studies was to build resilience capacity for food security in the context of climate change.



With a background in agricultural economics, she is passionate about rural development, agricultural innovations, and building resilience to climate change, food systems and natural resource management. Her current interest is on conducting strategic research to assess resilience to food security across sub-Saharan countries. This entails identifying where progress in resilience to food security has been achieved in the region, using a systematic country study approach. The approach analyses which policy decisions were taken to substantially improve resilience to climatic, environmental and conflict-related shocks and stresses, while drawing lessons from such successes.

Her research topic as an ECRLF postdoctoral fellow from 2019 to 2021 was:

**Assessing resilient capacity:
A cross-sectional analysis of
African countries**



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FELLOW'S RESEARCH HIGHLIGHTS

Peer-reviewed journal articles

- Odhiamo V., Hendriks S., Mutsvangwa-Sammie E. (2021). The effect of an objective weighting of the global food security index's natural resources and resilience component on country scores and ranking. *Food Security*, 13(6), 1343–1357.
- Mutsvangwa-Sammie E., Manzungu E. (2021). Unpacking the narrative of agricultural innovations as the sine qua non of sustainable rural livelihoods in Southern Africa. *Journal of Rural Studies*, 86, 181–188.
- Mutsvangwa-Sammie E. (2020). Impact narratives of agricultural innovations and their implication on rural livelihoods in southwest Zimbabwe. *Outlook on Agriculture*, 1(10).
- Mutsvangwa-Sammie E., Manzungu E., Siziba S. (2018). Key attributes of agricultural innovations in semi-arid smallholder farming systems in southwest Zimbabwe. *Journal of Physics and Chemistry of the Earth*, 105, 125–135.
- Mutsvangwa-Sammie E., Manzungu E., Siziba S. (2017). An assessment of the contribution of agriculture to rural livelihoods in a semi-arid smallholder agricultural environment in southwest Zimbabwe. *Zambezia*, 44(1), 77–94.
- Mutsvangwa-Sammie E., Manzungu E., Siziba S. (2017). Profiles of innovators in semi-arid smallholder agricultural environment in southwest Zimbabwe. *Journal of Physics and Chemistry of the Earth*, 100, 325–225.
- Nyamwanza O., Manzungu E., Mutsvangwa-Sammie E., Dzingirai V. (2013). Institutional proliferation in natural resource management and agricultural innovation in southwest Zimbabwe. *Zambezia*, 38(1), 1–21.
- Mubaya C., Njuki J., Mutsvangwa E., Mugabe F., Njanja D. (2012). Climate variability and change or multiple stressors? Farmer perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management*, 102, 9–17.
- Mubaya C., Njuki J., Liwenga E., Mutsvangwa E., Mugabe F. (2010). Perceived impacts of climate related parameters on smallholder farmers in Zambia and Zimbabwe. *Journal of Sustainable Development in Africa*, 12(5).

Conference papers

- Mutsvangwa-Sammie E.P., Mazvimavi K., Murendo C and Kundhlande G. A micro-level analysis of vulnerability to climate change by smallholder farmers in semi-arid areas of Zimbabwe. Conference paper for the 4th International Conference of African Association of Agricultural Economists, 22–25 September 2013, Hammamet, Tunisia.
- Manzungu E, Dzingirai V and Mutsvangwa-Sammie E.P. Trajectories of agricultural innovations and their impact on rural livelihoods in the Limpopo river basin and implications for policy, The 3rd International Forum on Water and Food (IFWF), 14–17 November 2011, Pretoria, South Africa.

Opinion pieces

- Mutsvangwa-Sammie E. (2021). Zimbabwe had a bumper harvest; What worked and what needs work *The Conversation*.
- Mutsvangwa-Sammie E. (2020). Why a Zimbabwean farming project failed: Lessons for rural innovation. *The Conversation*.

ASSESSING RESILIENT CAPACITY: A CROSS-SECTIONAL ANALYSIS OF AFRICAN COUNTRIES

Postdoctoral fellow: Dr Eness Mutsvangwa-Sammie
Mentor: Prof Sheryl Hendriks

Building resilience capacity to food security and climate change is one of the issues at the top of Africa's research and development agenda. According to Dr Eness Mutsvangwa-Sammie, there is a genuine window of opportunity to demonstrate how a focus on building resilience capacity in African countries can strengthen and promote broad-based security and poverty alleviation. However, there is a constant danger of slipping into uncritical and context-insensitive responses. This must be avoided now more than ever.

Africa is considered one of the most vulnerable continents to calamities and disasters. This vulnerability is manifested, among other things, by chronic food insecurity, malnutrition and, in some instances, even migration. As a response, resilience has risen to the top of Africa's development agenda. The term is being accepted as a valuable conceptual tool for understanding how people respond and adapt to multiple changing shocks and stresses. Resilience is defined as the capacity to accommodate these shocks, stresses and disturbances. It is that ability to "bounce back" after calamities and disasters, by countries organising and learning, in order to maintain or improve the functionality of their essential basic structures.

However, resilience capacity challenges in developing countries are pervasive and intertwined with multiple factors, such as population growth, food and nutrition security, conflict, migration, institutional frameworks and increasing manifestations of climate change. This plethora of factors affecting resilience leads to complex questions around the conceptualisation, operationalisation and measurement (evaluation) of resilience.

Therefore, the assessment of resilience capacities and the practical application of answers and tools given in response to these questions become a central concern for donors, policy makers and practitioners, not only on the African continent, but within the international development and humanitarian context.

The aim of Dr Mutsvangwa-Sammie's research, done in the University of Pretoria's Department for Agricultural Economics, Extension and Rural Development, was to determine what makes certain countries more resilient to climate change in terms of food security.

The overall objective of her study was to identify where progress in resilience to food security had been achieved in Africa, using a systematic country study approach. Such an approach analyses which policy decisions are taken to substantially improve resilience to climatic, environmental and conflict-related shocks and stresses, while drawing lessons from such successes for other countries to replicate.

She identified a set of policies and practises that, if scaled up, could have a significant impact on improving both risk reduction and adaptation elements in Africa.

She addressed three specific objectives:

- Characterising resilience in terms of conceptualisations and perceptions as deduced from studies across African countries
- Reviewing resilience measures and establishing a criterion for clustering countries based on their performance
- Identifying the most resilient and least resilient countries and linking this to policy decisions and practices that were instrumental in contributing to their success or failure, thereby drawing lessons from them.

Her hypothesis centred on the fact that what counts as “resilience” and who defines it has implications on how it is operationalised and evaluated. She furthermore theorised that attempts at building resilience capacities are based on an insufficient understanding of the complexities of African communities.

A review of literature showed that it is imperative to improve our understanding of the relationship between climate, food security and nutrition, and livelihoods, as it helps guide practical initiatives such as policies and innovations that are intended to aid sustainable livelihoods in Africa as the climate changes. This called for a food systems approach to better understand the powerful forces of change that impact resilience.

The Global Food Security Index (GFSI) was used as a tool for clustering countries based on their performance. The GFSI is an international composite indicator that examines food security and nutrition, considering issues of food affordability, availability, quality, and natural resources and resilience across 113 countries in the world.

The 2019 GFSI was used to analyse 28 sub-Saharan African countries, to understand underlying factors that affect food security in the context of climate change. The principal component analysis (PCA) was used to isolate the influence of indicators in the GFSI and their relevance for sub-Saharan African countries.

Change in the average cost of food, agricultural import tariffs, public expenditure on agriculture research and development, dietary diversity, disaster risk management and early warning measures or climate-smart agriculture were identified as key drivers of food security and nutrition in the context of climate change for sub-Saharan Africa.

The study showed the need to translate this evidence into implementable policy solutions and practical interventions that can transform the food system in the context of climate change, by drawing lessons from successful policies that are implemented in the top high-ranking countries identified.

In March 2021, the Future Africa Institute received funding from the French Embassy and the French Development Agency to host a symposium on Climate, Land, Agriculture and Biodiversity (CLAB-AFRICA). This symposium was complemented by an extensive research report, which featured at the United Nations Climate Change Conference, that was held from 31 October to 12 November 2021. During this period Future Africa received further funding from the United Nations Environment Programme (UNEP) until June 2022, as well as funding from the Bill & Melinda Gates Foundation until December 2023. Two of the ECRLF participants, Dr Alice Nabatanzi and Dr Eness Mutsvangwa-Sammie, were introduced to the CLAB initiative based on their ECRLF experience. Dr Nabatanzi was the research lead on the land-water-energy resource uses thematic area, while Dr Mutsvangwa-Sammie led the research on the climate change impacts on food systems. They were – and still are – an integral part of CLAB-AFRICA. Although the funding was from other grant agencies, it must be acknowledged that this was a direct result of the CCNY-funded ECRLF programme, and a remarkable outcome to be celebrated.

As a member of the Department of Agricultural Economics, Extension and Rural Development, Dr Mutsvangwa-Sammie was given the opportunity to provide editorial input into the work of two master’s students.

She also benefitted from her attendance of a meeting of the South African Vulnerability Assessment Committee (SAVAC) and a meeting of the United Nations’ Food and Agriculture Organisation (FAO) at which the pilot testing of the first South African Integrated Food Security Phase Classification (IPC) Artificial Swarm Intelligence tool was discussed. She furthermore attended the regional multistakeholder dialogue of the pan-African Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), “Building better and resilient agriculture and food systems”, in October 2020.

Challenged by the lockdown restrictions imposed by the COVID-19 pandemic, Dr Mutsvangwa-Sammie was prevented from proceeding with her research. However, she made use of this time to publish the research that formed part of her PhD. This resulted in the publication of two peer-reviewed articles:

- “Impact narratives of agricultural innovations and their implication on rural livelihoods in southwest Zimbabwe” – published in *Outlook on Agriculture* in 2020.
- “Unpacking the narrative of agricultural innovations as the sine qua non of sustainable rural livelihoods in Southern Africa” – published in *Journal of Rural Studies* in 2020

She also published an opinion piece in *The Conversation* research dissemination platform on the reasons for the failure of a Zimbabwean farming project.

Reflecting on her fellowship journey, Dr Mutsvangwa-Sammie found it to be well rounded, even giving her the chance to supervise students and identify platforms for engagement.

She found the fellowship to be very flexible. “The way it was structured allowed me to define the direction of my career.” She particularly appreciated the chance she got to work with other researchers and fellows to solve the challenges faced on the continent, and the exposure she got on global platforms. “The opportunities and scope of work I experienced at the University of Pretoria were on another notch,” she exclaimed. “It was really a worthwhile experience.”

An outcome of Dr Mutsvangwa-Sammie involvement in the ECRLF programme was her participation in Future Africa’s Climate, Land, Agriculture and Biodiversity (CLAB-AFRICA) research initiative. This project was instituted to provide a platform for Africa’s scientific community to contribute to the developmental work of African governments and development institutions. She provided an input in the work of the research cluster that focused on the impact of climate on food systems.

Upon conclusion of her fellowship, she was accepted as a postdoctoral fellow on the Food Systems Research Network for Africa (FSNet-Africa) of the Global Challenges Research Fund (GCRF) at the University of Pretoria. This is an initiative that seeks to strengthen food systems research capabilities and the translation of evidence into implementable policy solutions and practical interventions in support of the Sustainable Development Goal (SDG) targets for Africa.

The focus of her work in this programme is the design and implementation of food systems research to identify solutions that bring about sustainable change in African food systems. ○

WHY A ZIMBABWEAN FARMING PROJECT FAILED: LESSONS FOR RURAL INNOVATION

In an opinion piece published in *The Conversation* in 2020, Dr Eness Mutsvangwa-Sammie states that many countries in sub-Saharan Africa commit resources to promote agricultural innovations. This is based on the assumption that rural livelihoods are mainly agricultural and that the innovations will increase agricultural production and household income.

As resources come under pressure from growing populations and natural resource degradation, governments and donors want to see that agricultural research and innovation has an impact. They want to see “success” and “value for money”. However, success is understood in different ways, and depends on how it is framed and by whom.

Studying conflict in agricultural innovations can lead to a better understanding of the appropriateness of certain technologies in terms of how they are designed and promoted, and how they are linked to rural livelihoods. Conservation agriculture in Zimbabwe provides a good example of such an innovation.

This approach to farming has been widely promoted by non-governmental organisations, research institutes and the state. It is also promoted in other countries in East and Southern Africa. The method is based on minimal soil disturbance, mulching soil with crop residues and crop rotation. These are meant to conserve moisture, reduce soil erosion and build up soil organic matter to improve crop yields and rural livelihoods.

A study to determine how this innovation was promoted and implemented in Zimbabwe and how its “success” was framed and assessed found that there were differences in how farmers and promoters of conservation agriculture defined its success. These differences matter when investments are made in promoting agricultural innovations. It is particularly important to understand the diversity of rural livelihoods.

The research

This study was conducted in the Gwanda and Insiza districts in southwestern Zimbabwe.

Droughts are a common feature in the area, occurring every two or three years on average. Data was collected via a household questionnaire survey, interviews and focus group discussions. Participants included farmers, non-governmental organisations and government extension officers. The researchers found that innovation was understood by the majority of respondents as having three main attributes: novelty, adaptability and utility. Despite novelty being mentioned more often than other understandings of innovation, some respondents felt that it existed in theory and not practically. For example, a farmer said interventions promoted in their communities were not new, but rather repackaged existing technologies with different names. Some were not suitable for the area.

Conservation agriculture was identified as the innovation most often promoted by non-governmental organisations and government extension officers in the area. Huge investments were committed to promoting it. The Department for International Development set aside about US\$23 million to promote it in Zimbabwe. Yet, after the project’s three-year lifespan, farmers mostly abandoned the practice.

The locals gave it the name “diga ufe”, which means “dig and die”, because it required so much physical labour. The manual digging of conservation basins during land preparation and the multiple weeding was labour intensive. However, farmers found that using conservation agriculture techniques in their vegetable gardens yielded better results compared to bigger plots. Under crop production, farmers prioritised irrigated agriculture compared to rain-fed agriculture. Gardening was therefore identified as the second-most important livelihood source after livestock production.

Respondents agreed that innovation was vital for sustaining food security and nutrition in the context of climate change. One farmer said that innovation was about experimenting with resources at one’s disposal to come up with something new and suitable for the area. He also emphasised that innovation was a collective action that included farmers,

researchers, extension agents and the private sector. He said it was not only confined to new technology (hardware), but to processes such as governance, which would yield positive results.

Locals identified climate-smart crops such as sorghum, millet and cowpea, and climate-smart livestock (goats and indigenous poultry) as being potentially suitable to addressing dry spells in the area. However, poor informal markets, limited bargaining power, shortage of grazing land, pests and diseases constrained productivity. Diversifying out of agriculture was identified as an alternative response to climate change. It could boost the income of the household and help sustain food and nutrition security.

Government extension officers felt that innovations in the area should be targeted towards livestock production. The area’s semi-arid climate means it is not conducive for rain-fed agriculture. So, despite the efforts to promote conservation agriculture, dryland cropping was ranked as the lowest source of livelihood for rural people. People in the area prioritised livestock production. Promoting more livestock production-related innovations would have been ideal for the area.

What does this mean for policy and innovation?

Innovation can thrive in rural areas, but this depends on understanding the communities’ perceptions and livelihood context to appreciate their priorities.

Rural communities are dynamic and complex. Imposing innovations that do not speak to the needs of these communities will not achieve rural development. The study showed the importance of developing innovations *with* communities as opposed to innovations *for* communities.

People in rural areas do not lack capacity. They need support to utilise the available resources and to innovate in a flexible manner that is context specific. They should be key players in coming up with solutions, since they have a better understanding of the challenges and opportunities within their communities. ○

LOOKING AHEAD

During the course of the Early Career Research Leader Fellowship (ECRLF), several challenges were experienced that provided valuable lessons for future endeavours of this nature. These challenges can be summarised as logistical, financial, COVID-19 related, expectation management, and research difficulties:

- Logistics included issues with procuring visas, finalising travel plans, processing funds for travelling, and conference attendance due to the foregoing.
- Financial obstacles pertained to the absence of budget implementation flexibility, and the processing of claims, invoices and fieldwork expenses due to incomplete or inadequate paperwork, organisational constraints at both the University of Pretoria and the home institution's financial departments, as well as instances where the fellow appointed field workers without bank accounts or formal identification, which are required to claim for services rendered.
- COVID-19-related concerns had by far the greatest impact, since the pandemic constrained the fellows' ability to sufficiently reside at Future Africa for the full period. It influenced international travel (between home countries and South Africa), limited to no conference participation, and the inability to host the mentor at the fellows' home institutions.
- Expectation management included procuring a leave of absence from the home institutions. Despite being initially supported, teaching and research loads were not suitably adapted. There was also miscommunication between the fellows and mentors due a number of factors, such as misaligned research objectives.
- Research difficulties translated to the lack of the requisite skills and adequate research capacity to conduct the proposed project with minimum supervision. It was found that some of the fellows came from universities where they do not have exposure to some of the resources to do research. However, as compounded by COVID-19, the fellows suffered from the suspension of many activities, including seminars, workshops and dialogues, regular interaction with other researchers, industry, civil society organisations, and policy makers, which all contribute to research development.

However, both Future Africa and the Carnegie Corporation of New York can look back with pride at what has been achieved in the development of early career researchers, and the dissemination of their research findings across Africa. The programme also succeeded in building collaborative networks across the continent that will contribute to developing solutions to the challenges of society.

The implementation of programmes such as this are essential to enhance transdisciplinarity and the societal orientation and impact of research, while at the same time advancing science development through the empowerment and support of African early career researchers.

The programme leaders are confident that the programme succeeded in developing research leaders to fill a critical gap in the African research capacity ecosystem. The capacity of the fellows who participated in the programme has been developed to the extent that they can start addressing the continent's most urgent challenges in order to develop a sustainable and inclusive bioresource-based economy in Africa.

QUO VADIS?

Following the successful implementation of this programme, Future Africa and the Carnegie Corporation of New York (CCNY) have launched a follow-up fellowship programme, the Future Africa Research Leader Fellowship (FAR-LeaF).

This postdoctoral research fellowship programme is open to doctoral graduates and early career postdoctoral fellows based at universities in Africa.

It is a two-year research-oriented fellowship programme that is focused on developing transdisciplinary research and leadership skills to address the complex, interlinked challenges of health, wellbeing and environmental risk in Africa. It recognises the value of creating a long-term network of future-focused science leaders with transdisciplinary research skills who can address the challenges of a post-COVID-19 society.

The fellowship includes training on transdisciplinary research approaches, through Future Africa and its partners, and through the inclusive co-design of fellows' research projects with relevant role players.

The training and support provided by FAR-LeaF will create opportunities to establish research relationships at diverse African universities in collaboration with and through mentorship opportunities offered by the University of Pretoria. ○

FUTURE AFRICA'S EARLY-CAREER RESEARCH LEADER FELLOWSHIP (FAR-LEAF)

The CCNY board approved a grant for the Future Africa Research Leader Fellowship (FAR-LeaF) programme with a focus on transdisciplinary research on 3 September 2021. To ensure the successful launch of the FAR-LeaF programme, use of the ECRLF's no-cost extension was approved to establish a Pan-African Science Committee, and to develop diverse online platforms, tools and resources for the incoming cohort.

The areas of research that will be supported in the programme will address complex wellbeing issues in the health and environmental nexus through a transdisciplinary approach, including the social sciences, humanities and the liberal arts. It will strengthen the network of African leadership programmes and initiatives on the African continent, including those supported by CCNY.

Principles of transdisciplinary research and engagement will be expected of fellows, who will participate in various co-creation streams: supervisor-fellow; mentor-fellow; advisory team-fellow; fellow-fellow; and fellow-communities.

The FAR-LeaF programme design incorporates the following goals:

- Consolidating the ability of fellows to extend their research using learning systems that favour systems thinking and transdisciplinary approaches, and innovative research practices in the post-COVID-19 scholarly society.
- Promoting sustainability research for the co-creation of innovation that fosters a continuing exchange of experiences, lessons and best practices by integrating fellows and experts from across the pan-African network.
- Focusing on building resilient societies in the face of the increased global challenges and vulnerabilities to extreme events that negatively impact on Africa, such as communicable diseases, and socio-ecological challenges.
- Supporting early career researchers to enhance the professional skills and research independence needed to pursue their chosen career path as research leaders. This should enable young researchers to establish and contribute to research programmes at their home institution, in support of sustainable development.
- Creating a collaborative research platform to promote research excellence, institutional engagement, transdisciplinarity, skills transfer, networking and exposure to society. ○





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