Annual Progress Report

2022

DSI-NRF CENTRE OF EXCELLENCE IN FOOD SECURITY (COE-FS)

> Professor Julian May, Director Professor Lise Korsten, Co-director Dr Elaine Sinden, Research Centre Manager Carla Bernardo, Communications Manager Elaine Petersen, Finance Manager

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ACRONYMS / ABBREVIATIONS

AAMP	Agriculture and Agro-Processing Master Plan
ARC	Agricultural Research Council
ARUA	African Research Universities Alliance
ASSAf	Academy of Science of South Africa
ASSURE	Agent-based modelling of Social Segregation and Urban Expansion
BDU	Bahir Dar University
BVM	Breede Valley Municipality
CAs	Collaborating Agreements
CaBFoodS- Africa	Capacity Building in Food Security for Africa
CDM	Child-directed marketing
CHEC	Cape Higher Education Consortium
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement / French Agricultural Research Centre for International Development
CoE-FS	DSI-NRF Centre of Excellence in Food Security
CoP	Community of Practice
CSG	Child Support Grant
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DHS	Demographic and Health Surveys
DoH	National Department of Health
DRDAR	Eastern Cape's Department of Rural Development and Agrarian Reform
DSI	Department of Science and Innovation
DUT	Durban University of Technology

DVC	Deputy Vice-Chancellor / Deputy Principal
ECD	Early Childhood Development
EDP	Western Cape Economic Development Partnership
EGI	Estimated Glycaemic Index
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	United States Food and Drug Administration
FOPL	Front of Package Labels
FSNet-Africa	Food Systems Research Network for Africa
GCRF	Global Challenges Research Fund
GFS	Global Food Security Conference
GHS	General Household Survey
GovInn	Governance Innovation
GSA	Grain South Africa
HICD	Human and Institutional Capacity Development
НМТ	Heat Moisture Treatment
HPH	High-Pressure Homogenisation
HPL	Health Promotion Levy
HSRC	Human Sciences Research Council
ICP-OES	Inductively Coupled Plasma Optical Emission
IR HMT	Infrared Heat Moisture Treatment
ISD	Institute for Social Development
KPA	Key performance area
KSQ	Key Sustainability Questions

KU Leuven	Katholieke Universiteit Leuven		
LEAP-Agri	Long-term Europe-Africa Research and Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture		
МАК	Makerere University		
MANCO	Management Committee		
MoU	Memoranda of Understanding		
MU	University of Missouri		
NIDS-CRAM	National Income Dynamics Study – Coronavirus Rapid Mobile Survey		
NRF	National Research Foundation		
NWU	North-West University		
OFSP	Orange Fleshed Sweet Potato		
PI	Principal Investigators		
PL	Project Leaders		
PSA	Potatoes South Africa		
ROFE	Researching the Obesogenic Food Environment		
ROT1	The Crop Rotation 1		
SACSoWACH	South African Civil Society for Women's Adolescent's and Children's Health		
SADC	Southern African Development Community		
SAFL	Southern Africa Food Laboratory		
SALGA	South African Local Government Association		
SAMRC	South African Medical Research Council		
SARChI	South African Research Chairs Initiative		
SCFA	Short-chain Fatty Acid		
SCICOM	Scientific Sub-Committee		

SLA	Service Level Agreement
SLF	Sustainable Livelihoods Foundation
SONA	State of the Nations Address
SSB	Sugar-sweetened beverages
Stats SA	Statistics South Africa
STEERCOM	Steering Committee
SU	Stellenbosch University
TAFS	The Transition to Agroecological Food Systems
TARDI	Tsolo Agricultural and Rural Development Institute
Tgel	The gel point temperature
TPP	Transformative Partnership Platform
TUT	Tshwane University of Technology
UCT	University of Cape Town
UD	University of Delaware
UFH	University of Fort Hare
UG	University of Ghana
UJ	University of Johannesburg
UKRI	UK Research and Innovations
UKZN	University of KwaZulu-Natal
UL	University of Limpopo
UMD	University of Maryland
UNAS	Uganda National Academy of Sciences
UNDESA	United Nations Department of Economic and Social Affairs
UNISA	University of South Africa

- UP University of Pretoria
- USDA United States Department of Agriculture
- UWC University of the Western Cape
- VU Stichting Vrije University
- WCG Western Cape Government
- WFP Women on Farms Project
- WHO World Health Organization
- Wits University of the Witwatersrand
- WP Work Package
- WRC Water Research Commission
- WWF World Wide Fund for Nature

1 DIRECTORS' REPORT

It has been almost a decade since the DSI-NRF Centre of Excellence in Food Security (CoE-FS) was launched, with the vision "to become a global leader in research, capacity building, and knowledge brokerage and service provision in food security and nutrition in Africa". In 2019, 2020 and 2021, the <u>University of Pennsylvania's 'Global Go To Think Tank Index'</u> ranked the CoE-FS in the top 100 global think-tanks in food security. This has been achieved through our output, science communication and collaborations with outstanding institutions and scholars.

Since our inception, we have concluded 43 memoranda of agreement and Collaborating Agreements (CAs) with universities, research institutions, civil society organisations and public institutions. These include the Institute for Development Studies, University of Sussex (IDS), ranked first in the field of development studies by the Times Higher Education Index; the Food and Agricultural Organization of the United Nations (FAO); the World Bank; and the French Agricultural Research Centre for International Development (CIRAD), ranked second in the world in terms of co-publications with African researchers in the field of agricultural science. We have collaborated with 10 out of South Africa's 26 universities, seven of which are other historically disadvantages institutions (HDIs). We have also collaborated with the Agricultural Research Council (ARC), South African Medical Research Council (SAMRC), Human Sciences Research Council (HSRC) and the Academy of Science of South Africa (ASSAf). At the same time, we work with local government and grassroots organisations including the Breede Valley and Witzenberg municipalities, the cities of Cape Town and Johannesburg, the Neighbourhood Farm, Local WILD and the Western Cape Economic Development Partnership (WCEDP).

Our Steering Committee (STEERCOM) has guided our work throughout our 10 years of research, capacity building and community engagement, and has involved internationally renowned scholars. These have included World Food Prize Laureate Professor Lawrence Haddad; the former chair of the High-Level Panel of Experts (HLPE) Professor Patrick Caron (now CIRAD); and Dr Mickey Chopra, the World Bank's Global Solutions Lead for Service Delivery in the Health Nutrition and Population global practice. We are delighted to welcome Professor Mary Scholes as the new Chair of our STEERCOM. Professor Scholes holds the Research Chair in Global Change and Systems Analysis at the University of the Witwatersrand (Wits) and serves on the Council of ASSAf.

The CoE-FS has operated as a virtual centre since its founding and thus quickly adapted to the COVID-19 and post-pandemic environment. In 2022, we continued to bring together the expertise of South African and international institutions, across various disciplines. In this current three-year cycle, research and training activities take place in three long-term research programmes: (1) Governance, Policy and Power; (2) Innovation and Technology; and (3) Health, Nutrition and Safety.

Science communication in all forms has been our priority. In 2022, we have published 58 peer-reviewed journal articles, one book, six book chapters, 12

working papers/reports, graduated 33 students (this figure includes postdoctoral fellows who completed their research), and received 200 media mentions (and counting). We have also supported 127 students in 2022.

Food and nutritional security are imperative for human survival with dignity and must take account of economic vitality, social justice, and human and environmental health. To operationalise this value, we have worked with human rights research and advocacy institutions, such as the Dullah Omar Institute for Constitutional Law, Governance and Human Rights (DOI) at the University of the Western Cape (UWC), the Centre for Human Rights (CHR) at the University of Pretoria (UP), and the Children's Institute (CI) at the University of Cape Town (UCT). This work has contributed towards submissions to the South African Human Rights Commission (SAHRC) among others, including on the right to food for students studying at higher education institutions (HEIs). In recognition of this, in 2021, the CoE-FS was invited to become one of the founding members of the international Food Equity Centre hosted by IDS. During 2022, we participated in an international webinar on food equity, and co-presented a paper on our place-based research, together with examples of similar studies in Brazil and Ghana.

The bulk of our bursaries are awarded to South African students. However, leverage funding has enabled us to undertake research in 10 other countries on the continent, including in north Africa. The extension of our reach was consolidated with the award of the UNESCO Chair in African Food Systems in 2017, and in 2022 we participated in 30th Anniversary of the Chairs programme in Paris and applied for the renewal of the Chair to be jointly hosted by UWC and UP.

Our capacity to assist with policy formulation was enhanced in 2022 with the appointment of the Director to the National Planning Commission (NPC) where he serves on a task team focusing on agriculture, land and rural development. In addition, following the successful completion of the South African Rapid Food System Assessment for the FAO in 2021, the CoE-FS was appointed as the lead on the Southern and East African Synthesis of food systems at the end of 2022.

Over the past decade, the CoE-FS has served to advance UP's track record in food and nutrition security, while consolidating UWC's expertise in public health, food system governance and agrarian studies. It has drawn together a research group in food plant molecular biology at UWC, and a similar group in food safety at UP. More importantly, the CoE-FS has provided a safe space for engagement between researchers at different universities, the different government departments with which these researchers have been working, and the civil society organisations that engage with the food system as consumers and producers of food. Our science communication activities have contributed towards widening engagement with food systems, and debates over how outcomes from this system can be more sustainable, inclusive and efficient.

Although much has been achieved, food systems are constantly changing. Climate change, a global pandemic, food safety crises, and war have added to the complexity and pace of this change. In the immediate term (three to five years), we can expect escalating food prices; outright shortages; new products, technologies and processes; new ways of transacting; and changing systems of governance and innovation.

Discipline-specific research and training will remain essential as will the need to increase both the diversity and output of those producing this knowledge. However, the achievement of food and nutrition security requires more than scientific enquiry. Critically, transdisciplinary approaches need to be mainstreamed so that environmental, social, cultural, economic and political drivers of change can be better understood and leveraged in a manner that achieves positive outcomes.

A centre of excellence is well placed to contribute towards this. By accepting that research output is a prerequisite rather than a goal, that science communication is embedded rather than desirable, and that impact is a value and not an aspiration, the CoE-FS is a fit-for-purpose institution to further contribute towards the knowledge and innovation infrastructure of South Africa and the continent.

The ambitious model in which an HDI has led a co-hosted centre of excellence has been challenging, but has, nonetheless, endured. Our 2022 Lekgotla concluded that the union of the host and co-host offers strength, opportunity and diversity, and committed the CoE-FS to continue — whatever funding opportunities may be in place. In August 2022, the vice-chancellors and deputy vice-chancellors (research and innovation) met and agreed that our collaboration will continue, irrespective of the source of funding that the CoE-FS may receive.

> Professor Julian May, CoE-FS Director Professor Lise Korsten, CoE-FS Co-director

2 INTRODUCTION

The DSI–NRF Centre of Excellence in Food Security (CoE-FS) was established in 2014. It is hosted by UWC and co-hosted by UP. The CoE-FS's vision is to be "a global leader in research, capacity building, knowledge brokerage and service provision in food security and nutrition in Africa". This is to be achieved through collaborations with outstanding institutions and scholars.

The CoE-FS operates as a virtual centre that brings together the expertise of South African and international institutions across various disciplines. We receive an annual core grant from the National Research Foundation (NRF) and have successfully bid for additional research grants to increase our output and reach. Our mission is to undertake research, capacity building and dissemination on how a sustainable food system can be achieved to realise food security for poor, vulnerable, and marginal populations. Our driving value proposition is that food and nutritional security is imperative for human survival with dignity, and must take account of economic vitality, social justice, and human and environmental health.

Our long-term goals are to:

- Continuously build a comprehensive understanding of the changing national and global food system and how this affects the sustainability, availability, access and attributes of food in South Africa
- Identify the 'food insecure' in South Africa; identify where they are located; identify their choices, strategies and opportunities when seeking food security, health, and well-being; and understanding how these change in response to the changing food system
- Develop and promote policies, technologies, interventions and products that enable access to affordable and nutritious food in ecological, economic, social and politically sustainable ways; and
- Grow the capacity in South Africa to undertake this research through training, grants and bursaries.

We pursue these research goals through:

- **Transdisciplinary modes of inquiry:** This mode of knowledge production and cooperation offers innovative methodologies for high-impact science through understanding and acting on complex societal problems. The design of our three research programmes is further informed by direct engagement and knowledge co-production with actors in the food system in addition to more conventional approaches to scholarly endeavour
- A partnership approach in the organisation of our research activities: This has required building purposive strategic relationships for the co-design and co-ownership of research problems, methodologies and solutions by the host institutions and our collaborators
- A transformative agenda in terms of the South African and African food security situation: We provide leadership, evidence for decision-making and informed debate, and critique of policies and

programmes aimed at addressing food insecurity through a comprehensive and systems approach to development that recognises the underlying causes of food insecurity, including poverty, patriarchy, unemployment and inequality

- **Research excellence:** We see this as both increasing our output of rigorous fundamental and applied research, and increasing our impact as determined by citations, peer review, research ratings, alternative metrics (Altmetrics) and evidence of use of research papers and products
- Active engagement in knowledge brokerage and science communication to contribute to policy development; and
- Our approach takes a "farm-to-fork" approach to the food system. Our contention is that in the African context, food security is shaped not simply by agroecological factors but also by political, economic and the terms upon which producers, processors, distributors, and consumers participate in the food system.

To focus our work on our comparative advantages, we prioritise research that includes:

- Multi-level governance and policy dialogues to create a sound and resilient food system at the global, national and local levels
- Innovation for the sustainability, productivity and utilisation of indigenous African and other locally available foods that affect food security
- Quantity, quality, diversity and safety of diets concerning to all forms of malnutrition.
- As a transdisciplinary approach is vital to deepening each of these areas, our research includes cross-cutting themes:
- A humanities perspective to explore the complex, dynamic and diverse relationships between food and human beings. Although this has become a discrete project led by UWC, UP and the University of KwaZulu-Natal (UKZN), the research undertaken in all of the CoE-FS programmes continue to be informed by a humanities perspective;
- A food systems perspective addressing the complexities of the production, processing, marketing, distribution and consumption of food with consideration of the environmental impacts of the food system. Increasingly, our concern is shifting to local, spatially bound food systems, particularly those in which there are distinct urban/rural flows and dynamics; and
- A social protection and poverty reduction perspective concerned with the causes and consequences of, and solutions to, multiple deprivations.

We work as a multidisciplinary team of research leaders, project managers, and students drawn from more than 43 collaborating institutions in South Africa and abroad. The CoE-FS uses both deductive and inductive reasoning to better understand the changing nature of food environments of vulnerable consumers and food producers: their responses, food security strategies, and choices within the context of a growing health and environmental crisis. Since inception, we have collaborated with 10 out of South Africa's 26 universities, seven of which are HDIs.

Furthermore, the CoE-FS continues to seek innovative ways to apply its research at the local level, as well as to engage with policymakers, practitioners, other academics and the general public. While pursuing its mission and vision, the CoE-FS uses every effort to contribute to government initiatives, as well as to deliver on international development food security priorities. In 2022, our research activities included a South Africa/United Kingdom Bilateral Research Chair in Social Protection for Food Security (SARChI), a UNESCO Chair in African Food Systems, projects funded by the Long-term Europe-Africa Research and Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture (LEAP-Agri), and the Family Larsson-Rosenquist Foundation (FLRF).

The CoE-FS is actively collaborating with all spheres of the South African government through entities and organisations such as the NPC; Department of Statistics South Africa (Stats SA); the Department of Agriculture, Land Reform and Rural Development (DALRRD); the Department of Social Development (DSD); the Department of Health (NDoH); the Western Cape Government (WCG); the cities of Johannesburg and Cape Town; the South African Local Government Association (SALGA); Witzenberg Municipality; Breede Valley Municipality (BVM); CIRAD; Southern Africa Food Lab (SAFL); WCEDP; Southern African Faith Communities' Environment Institute (SAFCEI); Public Affairs Research Institute (PARI); and the South African Urban Food and Farming Trust (SAUFFT).

Internationally, collaborating agreements are in place at University of Missouri – Columbia (MU), US; IDS, UK; Bahir Dar University (BDU), Ethiopia; the University of Ghana; Makerere University (MAK), Uganda; the Center for Development Research (ZEF) at the University of Bonn, Germany; Vrije Universiteit Amsterdam, the Netherlands (VU-A); University of Constantine 3, Algeria; FAO; and Katholieke Universiteit Leuven, Belgium (KU Leuven). Additional MoUs exist between UP and the following institutions linked to the CoE-FS: Wageningen University & Research, the Netherlands; Cornell University, US; the University of Leeds, UK; and the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN).

3 STEERING COMMITTEE

In 2022, STEERCOM consisted of members representing academia, civil society, and the public and private sector. The members are listed in Table 1. Professor Mary Scholes was appointed in November 2022 as chairperson of STEERCOM, following a decision by the NRF that an independent chairperson be appointed.

The CoE-FS also established a Scientific Sub-Committee (SCICOM) in 2021 who are responsible for reviewing its planned activities, in terms of identifying what the CoE-FS should be doing, and evaluating outputs against what has been proposed in the Business Plan. SCICOM meets bi-annually and consists of active researchers and research users. The details of these members are provided in Table 2 below.

Table 1: List of STEERCOM members

Position	Name		
Chairperson	Professor Mary Scholes (University of the Witwatersrand (Wits)) – from November 2022		
Co-chairpersons	Professors Anton Stroh/Barend Erasmus (UP) – until October 2022		
Co-chairpersons	Professors Jose Frantz/Joliana Phillips (UWC) – until October 2022		
Director	Professor Julian May (UWC)		
Co-director	Professor Lise Korsten (UP)		
DSI	Rose Msiza (DSI representative)		
NRF	Dr Makobetsa Khati/Nathan Sassman (NRF representatives)		
Member	Professor Patrick Caron (CIRAD)		
Member	Bongiwe Njobe (Independent consultant)		
Member	Dr Joan Matji (United Nations Children's Fund (UNICEF)) – SCICOM chairperson		
Member	Professor Sagadevan Mundree (University of Queensland)		
Member	Professor Bocklines Bebe (Egerton University)		
Member	Dr Mickey Chopra (World Bank)		
Member	Professor Christine Foyer (University of Birmingham)		

Table 2: List of SCICOM members

Position	Name
Chairperson	Dr Joan Matji (UNICEF)
Member	Professor Karen Hofman – Wits
Member	Professor Nick Vink – Stellenbosch University (SU)
Member	Professor Joyce Tsoka-Gwegweni – University of the Free State (UFS)
Member	Dr Arlene Alpha (CIRAD)

4 COE-FS DETAILS

4.1 Director and co-director

The leadership of the CoE-FS comprises a director and co-director who are responsible for the overarching management of the CoE-FS. They are supported by the Management Committee (MANCO) comprising Principal Investigators (PIs), who lead multi-year, multi-institutional programmes of research. The PIs are expected to be scientists who craft the research agenda, mediators who bridge gaps, project leaders (PL) who manage diverse teams, knowledge brokers and 'boundary spanners', and networkers assembling a Community of Practice (CoP) on specific topics of national importance. The details of the director and co-director are listed in Tables 3 and 4.

Table 3: Details of	of the	director	and	co-director
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Details	Director	Co-director	
Title	Professor	Professor	
Name	Julian	Lise	
Initials	JD	L	
Last name	Мау	Korsten	
Organisation	UWC	UP	
Citizenship	SA	SA	

Details	Director	Co-director		
Gender	Male	Female		
Race	White	White		
Highest qualification	PhD	PhD		
NRF rating	C1	B2		
Rating period	2016–2021	2013–2018		

Table 4: Contact details of the director and co-director

	Director	Co-director	
Organisation where based	UWC	UP	
Department	DVC: Research & Innovation	Vice-Principal: Research, Innovation and Postgraduate Education	
Primary funder: salary	NRF	UP	
Faculty / School	Institute for Social Development (ISD)	Department of Plant and Soil Sciences	
Work telephone	021 959 3846	012 420 3295	
Mobile number	082 771 7368	079 522 8476	
Website address	www.foodse	ecurity.ac.za	
Email address	jmay@uwc.ac.za	Lise.Korsten@up.ac.za	
Contact person	Elaine Petersen	Professor Lise Korsten	
Work telephone	021 959 3817	012 420 6149	
Alternate email	eapetersen@uwc.ac.za	Lise.Korsten@up.ac.za	

4.2 Collaborators

The CoE-FS has concluded formal CAs or MoUs with the following 43 institutions/entities:

- 1. ARC
- 2. SAMRC
- 3. Nelson Mandela University (NMU)
- 4. North-West University (NWU)
- 5. SU
- 6. Tshwane University of Technology (TUT)
- 7. UCT
- 8. University of Fort Hare (UFH)
- 9. University of Johannesburg (UJ)
- 10. University of Limpopo (UL)
- 11. University of South Africa (UNISA)
- 12. MU
- 13. IDS
- 14. Human Sciences Research Council (HSRC)
- 15. ASSAf
- 16. DSI-NRF CoE in Human Development (CoE-HUMAN) at Wits
- 17. CIRAD
- 18. Women on Farms Project (WFP)
- 19. Neighbourhood Farm
- 20. World Wide Fund for Nature (WWF)
- 21. Sustainable Livelihoods Foundation (SLF)
- 22. McGregor MAC Project
- 23. ZEF
- 24. VU Foundation (Stichting VU)
- 25. MAK
- 26. KU Leuven
- 27. UP
- 28. United States Food and Drug Administration (FDA)
- 29. University of Delaware (UD)
- 30. University of Maryland (UMD)

- 31. United States Department of Agriculture (USDA)
- 32. BDU
- 33. University of Ghana (UG)
- 34. Evoke Kyne
- 35. FAO
- 36. groundWork
- 37. SAFCEI
- 38. Wits
- 39. BVM
- 40. WCEDP
- 41. SAUFFT
- 42. University of Constantine 3
- 43. FLRF

4.3 CoE-FS details for verification

Host institution	University of the Western Cape	
Co-host institution	University of Pretoria	
Year of current funding cycle	Nine	
Gate stage	Five	

5 OVERVIEW OF ACHIEVEMENTS DURING THE REPORTING PERIOD

5.1 Achievements related to the current stage

Tables 5 to 7 set out 2022's achievements against the targets for 2022. The information pertaining to presentations; conference, workshop and seminar attendance; as well as the publications is listed in appendices 1 to 3 in the report.

Following the launch of the CoE-FS in 2014, a register of researchers was developed. The list of researchers for 2022 is provided in Appendix 4. This list is updated and maintained as the base for communication and identifying potential collaborators and referrals for networking opportunities. In 2022, the CoE-FS had 68 active researchers; of these 37 (54%) men and 31 (46%) women. Also, 30 (45%) of the researchers are Black (this includes, Indian and Coloured), 33 (48) are White, two are Chinese, one Japanese, one Tunisian and one Columbian.

Student records are updated each year with the acceptance of new students to the CoE-FS's programmes. Appendices 6 and 7 reflect details of new and continuing NRF students for the reporting period. Appendix 8 provides a detailed summary of NRF-funded students. Appendix 9 provides the information of students who were supported through leverage funding in 2022. Appendix 14 provides information of students who did not receive bursaries from the CoE-FS (non-bursary holders), but who are included in projects (supervision and work studies). The information of NRF and leverage-funded students who graduated in 2022 are provided in appendices 10 and 11 in the report, and the information of non-bursary holders who graduated are in Appendix 15.

Output	Achieved
Participate in official events of the CoE-FS programme	√
Continuously update the register of participants (including students) in the CoE-FS	√
Continuously update the project register that lists all research being conducted within the CoE-FS	V
Make available to the NRF on a quarterly basis "nuggets" of information for publication on the CoE-FS and NRF websites	√
Maintain digital repository of completed research outputs funded by its resources, including theses, research reports, policy briefs and published papers	√
Submit a written claim with supporting documentation to trigger transfer payments each January	√
Submit monthly cash flow statements, within 15 days of the end of each calendar month	V
Collect income and expenditure reports from all collaborating partners on completion of projects	V
Collect income and expenditure reports from all collaborating partners on completion of the 2021 and 2022 projects that have received extensions	√
Submit Annual Progress Report by no later than 30 May each year	✓
Submit an External Audit Report by no later than March each year	√

Table 5: Activities related to the current stage of deliverables

Submit Gate Review Documentation by no later than 27 February 2023	To be done in 2023
Submit a Statement of Compliance by no later than March each year	✓

An online management information system was established to record, track and monitor all projects funded and managed by the CoE-FS in 2014. This system has been integrated into a cloud-based bursary and project management information system. The current system, which includes Excel spreadsheets of the progress of projects and research outputs, and an electronic filing and administrative system, is accessible at UWC and UP. Nuggets of information are extracted and published on the CoE-FS's website and social media pages and reported to the NRF on a quarterly or more frequent basis.

5.2 Achievements related to the SLA: 2018–2023

Table 6 provides the 2022 outputs and targets, as well as the 2018–2023 outputs and targets for the current stage. The overview of the achievements from 2018–2022 is to illustrate the CoE-FS's progress against 2018 to 2023 targets. The evidence for each target is provided as appendices and tables in the report, as explained above.

In 2022, the CoE-FS supported 127 students; that is 59 NRF-funded, 37 leverage funded and 31 non-bursary holders¹. In terms of gender, a total of 87 female students (of all students), and 40 (68%) were supported from NRF funding. A total of 109 Black students (of all students), and a total of 43 (90%) were supported by NRF funding. The CoE-FS also supported 12 postdoctoral fellows.

It should be noted that the 2022 output targets for NRF students, as approved in the *2022 Business Plan*, were amended according to the DSI-NRF 2022 Post Graduate Funding Policy. The amended information is reflected in the SLA.

¹ The NRF requested that the CoE-FS report on students not funded but supported.



Figure 1: Highlights of CoE-FS progress in 2022

A total of 33 students graduated in 2022: 16 of these received NRF funding, 15 received leverage funding, and two were non-bursary holders. The CoE-FS produced 77 publications, 40 with an impact factor of three and more. A total of 22 students authored/co-authored these publications.

Table 6: SLA 2022

Description	Outputs: 2022	Output targets: 2022	Appendices
Students included in projects funded by the CoE-FS (all students)	127	90	6,7,9,10,11,14,15
Women students supported (all students)	87	50	As above
Black students supported (all students)	109	63	As above
Postdoctoral fellows (all students)	12	5	As above
South African citizens and permanent resident students (funded by the NRF)	48 ² (81%)	95%	6,7,10
SADC countries students, and students from the rest of the world (NRF funded)	11 (19%)	5%	6,7,10
Women students (NRF funded)	40 (68%)	55%	6,7,10
South African citizens and permanent resident students (NRF-funded)			

² The total NRF-funded students is 59.

Description	Outputs: 2022	Output targets: 2022	Appendices
Black (African, Coloured and Indian)	43 (90%)	90%	
White	5 (10%)	10%	
Disability	1 (2%)	1%	6,7,10
Proportion of students graduating by the next Gate Review	To be determined in 2023	≧ 75% of all students since inception	NA
Average duration of submission of master's degrees (post honours)	24 months	\leq 24 months	NA
Average duration of submission of PhD degrees	36 months	\leq 40 months	NA
Average duration of submission of PhD degrees (upgraded from master's)	60 months	\leq 60 months	NA
Number of unrated researchers who become rated, or rated researchers who retain or improve their rating	9 ³	5	4
Number of patents, products and artefacts	2	3	Section 18

³ These researchers retained their NRF rating.

Description	Outputs: 2022	Output targets: 2022	Appendices
Number of articles in accredited journals, chapters in peer-reviewed books or books	65 ⁴	55	3
Number of articles with an Impact Factor greater than 3	40	8	3
Number of joint-venture student training initiatives	17	3	
Number of local conferences organised	17	1	NA or 5
Number of international conferences organised	0	0	
Presentations at local conferences	30	40	
Presentations at international conferences	7	10	
Food security panels organised at conferences	18	1	

⁴ This number includes one book, six book chapters, and 58 accredited journals. It does not include the 12 working papers/reports.

Description	Outputs: 2022	Output targets: 2022	Appendices
Annual social media (Facebook, etc.) views	3 015⁵	222	
Number of face-to-face policymaker engagements	35	10	
Annual website views	NA ⁶	4500	
Annual media activities (radio, TV, press)	240	200	5
Number of citations of pooled articles/book chapters that acknowledge CoE-FS funding (Google scholar)	25	6-7	NA
Additional funds raised	R59.5 mllion	R25 million	13

⁵ As there is no metric for "views" on social media (other than video/Reels/livestream views/plays), this is engagement on Facebook.

⁶ Work on the CoE-FS website is ongoing, including reinstating Google Analytics. In the interim, there were 1 684 clicks on CoE-FS bitly links (shortened links, created for some of the CoE-FS website content; this does not include traffic via other social media referral or organic searches.

Despite notable improvements in various targets set out in the Service Level Agreement (SLA), the CoE-FS fell short in the participation of students with disabilities. The CoE-FS will continue its efforts to bring on board more students and researchers from other HDIs in 2023, especially students with disabilities. Support from the NRF centralised application process will be necessary.

In order to increase the number of black researchers, the CoE-FS's sustainable strategy targets black South African senior researchers to replace PIs who have resigned, and identifies successors to the current director and co-director from within this group. Regarding the CoE-FS's management and support structure, we have made excellent progress in appointing staff from previously disadvantaged backgrounds. Additionally, the CoE-FS's full-time staff, and the two UWC contract staff, includes coloured and black women.

5.3 Transformation targets for the current stage

The table below reflects achievements against transformation targets. The collaborative nature of the projects provides unique opportunities for capacity development, within and between collaborating partners. The CoE-FS's MANCO, together with PLs and researchers, comprises colleagues from previously disadvantaged groups. In addition to developing the capacity of senior and emerging researchers, the CoE-FS also encourages its staff and students to strengthen their individual skills.

Elaine Petersen's role over the last few years has developed from an administrative role into a finance coordinating role. The benefits offered in terms of staff rebate assisted her with building her knowledge and skills in the specific field. The skills and knowledge gained enabled her to make better strategic decisions and apply the knowledge learned. The projects increased her knowledge of the various funding instruments. She has completed her honours degree at UWC in 2022. She intends registering for a master's in 2023.

Robyn Engelbrecht, who has been appointed on contract as an administrative assistant, completed various in-house training courses in the university's Finance and Human Resources departments. Nolutando Didiza is currently enrolled for a Master's in Development Studies at the Institute for Social Development (ISD) at UWC, and also completed various in-house training courses in the university's Finance and Human Resources departments.

Dr Elaine Sinden is currently supervising two master's students enrolled at the ISD at UWC. A master's student whom she supervised graduated in September 2022. She has also submitted two journal articles in 2022 which are currently under review.

Finally, Carla Bernardo's Master's in Political Communication from UCT is financed through the staff rebate, and she intends to complete the degree in 2023.

Table 7: Transformation targets

Output	Achieved
At least five senior academics from formerly disadvantaged groups have experienced further capacity development	√
At least 15 emerging academics from formally disadvantaged groups have experienced capacity development	✓

5.4 Specific targets for the current stage

The table below provides evidence related to achievements of specific targets for the reporting period.

Table 8: Specific output targets

Output	Achieved
Six MANCO meetings have been held	√
One MANCO planning meeting/Lekgotla has been held (virtual)	√
Annual Business Plan was submitted	✓
40 nuggets per year have been provided to the NRF	✓

6 KEY PERFORMANCE AREA (KPA) 1: RESEARCH

The CoE-FS undertakes research, capacity building, multistakeholder dialogue, and policy advocacy on how sustainable food systems can achieve food and nutrition security for all. The objective of this work is to improve people's nutritional status by linking innovative science with critical inquiry and implementation strategies. Three areas of work are prioritised as follows: (i) Multi-level governance and policy dialogues to create a sound and resilient food system at the global, national and local levels; (ii) innovation for the sustainability, productivity and utilisation of indigenous African and other locally available foods that affect food security, and; (iii) quantity, quality, diversity and safety of diets in relation to all forms of malnutrition. Crosscutting themes are a humanities perspective to explore the complex, dynamic and diverse relationships between food and human beings; a food systems perspective; addressing the complexities of the production, processing, marketing, distribution and consumption of food with consideration of the environmental impacts of the food system; and a social protection and poverty reduction perspective concerned with the causes and consequences of, and solutions to multiple deprivations.

The six areas of research adopted and endorsed by the STEERCOM in 2015, and approved by the NRF in 2016, remain the focus of our work in 2022 but have been re-aligned, as a consequence of the outcomes of the May 2019 Lekgotla to mainly enhance the integration of the CoE-FS's research but also to take into consideration the CoE-FS's mid-term review.

The three research questions that inform the scope of work for the CoE-FS's research activities for the second planning cycle (2020–2024) remain unchanged. These are:

- How is the global and national food system changing and how does this affect the sustainability, availability, access, and attributes of food?
- Who are the 'food insecure', where are they located, what are their choices, strategies, and opportunities when seeking food security, health, and well-being, and how do these changes in response to the changing food system?
- What policies, technologies, interventions, and products enable access to affordable and nutritious and safe food in ecological, economic, social, and politically sustainable ways?

In 2022, the CoE-FS retained its programme PIs drawn from the two host institutions and consortium partners, based on relative strengths in each area in a supportive context. These PIs form the CoE-FS's MANCO. The research programme of the CoE-FS is undertaken as projects within multidisciplinary programmes and synthesised at the core through transdisciplinary analysis.

The CoE-FS supported nine NRF-funded projects/Work Packages (WPs) in 2022 and these are listed in Appendix 12 in the report. This list also outlines the contributions to HDIs; these are marked in orange. Of the nine NRF projects/WPs funded in 2022, six were administered by an HDI.

6.1 Programme 1: Food Systems, Governance and Policy

This programme is led by Professor Bruno Losch and Professor Julian May (CIRAD/UWC).

Africa's food system is undergoing rapid restructuring with implications for food and nutrition security being both direct (via impacts on the nature and availability of food) and indirect (via the implications for livelihoods, employment, and economic activity).

In this cycle of research, the Programme 1 focuses on the ability of Africa and South Africa's institutions in government and civil society to engage effectively with these dynamics in the food system. Issues of coordination have repeatedly been identified as barriers to the implementation of policies concerned with food and nutrition security, while the public good nature of food security results in collective action problems. The programme seeks to understand the institutional arrangements required to make food security governable, and the ability of policy frameworks to link questions of food and nutrition security to broader development priorities.

The objectives of the programme in 2022 are unchanged and continue to:

- Strengthen a local governance approach for food and nutrition security while taking account of strategies being implemented at higher levels
- Improving the precision with which local government can intervene in the food system, both spatially and in terms of target groups and sectors
- Develop strategies for selecting successful local governance food security approaches for adoption for transference to provincial, national and regional implementation through knowledge brokerage
- Engage with national and regional policymakers through the implementation process of the integrated National Food and Nutrition Security Plan 2017–2022, the National Development Plan, the Comprehensive African Agricultural Development Programme and the draft Agriculture and Agro-Processing Master Plan
- Use a 'food systems' and 'place-based' approach to contribute to the dialogue on what form of food system best meets the triple burden of malnutrition for poor people in Southern African cities and towns in such a way that it benefits all stakeholders in the food system.

Research undertaken, as well as the highlights under this programme for 2022, are provided under the following projects.

6.1.1 Local food governance (Project ID – 22101)

This project involves Dr Camilla Adelle (UP) and Florian Kroll (UWC).

During 2017–19 a series of 'knowledge brokerage platforms' (CoPs) were set up. These platforms bring together government officials, practitioners, academics, and other stakeholders in the food system with academic researchers associated with the CoE-FS in an iterative process through which policy problems are discussed, existing research shared, research gaps identified and new knowledge created integrating multiple perspectives. The knowledge brokerage platforms, originally developed as pilots in 2017–18, focused on local food governance in the Western Cape and then in Gauteng. In parallel, activities were conducted at the municipal level with the support of SALGA, a Schedule 3A public entity in terms of the Public Finance Management Act (1999) that is an autonomous association of all 257 South African local governments.

The objectives of this project in 2022 were to:

- Identify transferable actions that strengthen a local governance approach for food security
- Deepen the existing platforms as these take time to mature and become sustainable, and to explore how to roll-out further platforms to other provinces and regions

- Study and better understand the process of knowledge brokerage and the co-production of knowledge for food governance, identifying reasons for success and failure
- The project adopts an action-research approach, engaging directly with the transformation of governance practice by generating knowledge to inform practice. To do so, and considering multiple perspectives, the study employs a mixed-method approach, combining quantitative and qualitative instruments, as well as frequentist and Bayesian inference approaches to model development.

In 2022, the CoPs in Gauteng and Western Cape merged and were rebranded as the Food Imbizo. The new name reflects the reality of what the gathering of scholars, government representatives and food practitioners has become under COVID-19: an influential network that has supported the rising of other communities from within its fold. The meetings have continued to meet online with six main meetings in 2022 (and a few spin-off workshops) each reaching on around 50 to 70 participants from across the country. In collaboration with SAFCEI, the Food Imbizo developed policy briefs and conducted online workshops specifically highlighting the role of faith communities in food governance, thereby extending its influence and engagement to a novel domain with potentially powerful reach. Efforts are being made to include speakers and participants from other provinces, such as eThekwini. The rebranding has been accompanied by a new Food Imbizo website all the resources and records derived from the meetings. The Food Imbizo also started to further disseminate the knowledge co-produced in its meetings through articles published in The Conversation Africa. The project also completed publication of two journal articles specifically highlighting the importance of food governance in the urban design, planning, and management contexts, thereby making a significant contribution to the global profile of food issues in this professional domain.

Building on recent literature on transdisciplinary CoPs, which bring together stakeholders from very different disciplines, organisations and backgrounds, our research has reflected on the experiences of our emergent CoP. Our results show the following lessons for managers and participants engaged in establishing similar 'third spaces' for knowledge co-production:

- 1) make inevitable power asymmetries explicit
- 2) the identity of the group should not be built on a particular normative position but emerge from discursive processes and,
- 3) create a balance between supporting peripheral learning and maintaining the specialist cutting edge discussions needed for co-production.

Furthermore, the most beneficial legacy of a CoP (or another kind of social learning space) may not be the outputs in terms of the co-produced knowledge but the development of a cohesive group of stakeholders with a new shared way of knowing. This shared way of knowing and reflexivity or 'meta-learning' (i.e. learning to learn) is a key governance capability for dealing with complex and ambiguous social problems. In this way, CoPs can foster social learning not only for the co-production of knowledge for solving wicked policy problems but also

help transform learning and ways of knowing necessary for the emergence of novel governance arrangements.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.2 National food governance – Towards national knowledge brokerage (Project ID – 22102)

This project involves Dr Camilla Adele (UP), Florian Kroll (UWC), Professor Lise Korsten (UP), Dr Marc Wegerif (UP), Professor Julian May (UWC) and Professor Bruno Losch (UWC/CIRAD).

Through developing knowledge brokerage platforms, the project aims to increase the visibility and societal impact of CoE-FS's research as well as produce new socially robust knowledge on how to better govern South Africa's food system.

The main activities of this project in 2022 were to:

- Engage with national policy through dialogue, policy analysis, and systematic review
- Engage with the food and nutrition implications of 'hot topics' that arise, such asland reform, food safety governance, and COVID-19 mitigation strategies
- Engage with international experiences of policies for food and nutrition security that explores national experiences of food policy dialogues.

With initial support from WCG and SALGA, food policy debates have already been developed at the local level with the Witzenberg Municipality and the City of Cape Town (CoCT). These debates have also been initiated in Gauteng and with the City of Johannesburg (CoJ).

Due to the importance of food system governance and the role of power relations in explaining the characteristics of the South African food system, and acknowledging the wealth of existing research on the topic, the programme decided to engage in a systematic literature review. Investigating the South African food insecurity paradox (persisting insecurity in spite of a wealth of food policies, research programmes, and developed social welfare instruments), the review of 1994 to 2020 publications highlights the central role of the national government in food system governance and the limited contribution of other actors characterised by major asymmetries. The diagnosis of the main food system governance issues exists (priority to production and food supply, policy fragmentation, weak coordination, partial and inadequate stakeholder engagement), as well as many solutions to the governance challenges (the need for a legislative framework, adequate coordination mechanisms, better stakeholder engagement through a larger role to be given to local governments).

The current status quo leads to questions about the willingness of the state for change and its possible abdication in governing the food system, rooted in the

characteristics of the post-apartheid political economy (deregulation, oligopolisation and financialisation). The rising power of the private actors leads to a private food system governance (impacting prices and pricing, food standards, food environment, and the framing of problems and design of solutions). It calls for new knowledge and a better-informed public debate for improved food democracy, and an effective institutionalisation of dialogue between stakeholders based on inclusiveness, transparency and mutual accountability.

Specific research on food system governance in the cities of Cape Town and Johannesburg based on engagement with officials at the provincial and metropolitan levels has permitted deeper insights into processes of statecraft and the underlying rationalities of government. This has revealed that the intersecting logics of New Public Management and neo-patrimonialism create a risk-averse organisational culture (giving priority to food relief and urban agriculture support based on tools, seed and fertiliser) which hampers the development of a food system governance agenda which could promote the transition to nourishing, equitable, sustainable and resilient urban food systems. In Cape Town, the convergence of several crises (water, COVID-19), a change in political leadership, and the establishment of a novel resilience unit have led to collaborative responses incorporating officials within the CoCT and WCG alongside a researcher network, the inclusion of food systems within the CoCT's Resilience Strategy, and the subsequent establishment of a food systems programme. By contrast, food system governance in the CoJ has remained conservative and proposals for more systemic governance have fallen on barren ground — likely as a result of neo-patrimonial politics, capacity constraints, and conceptual limitations on framing food systems as objects of governance.

These findings suggest that, despite mentalities averse to the political and institutional risks of challenging incumbent power within the food system, networks of officials and academics can develop novel governance narratives to formulate policy proposals ready to take advantage of policy windows presented by systemic crises. They show the importance of developing an enabling environment, supportive political leadership, and the establishment of transversal mandates such as the resilience unit.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.3 Maximising access to a balanced, safe and healthy diet for the poorest urban residents (Project ID – 22103)

This research is led by Dr Marc Wegerif (UP).

Around the world, there are pressures from urbanisation, a crisis of growing inequality, ecological breakdown, and a denial of people's right to food manifesting increasingly in the phenomena of the triple burden of malnutrition. With more than half the world now in urban centres, and urbanisation continuing rapidly, the challenge of feeding the world becomes increasingly one of feeding the cities, with the different logistical and social challenges that follow. South Africa is now a majority urban country and is experiencing all of these conditions in extreme ways, in part due to the history of racial division and imposed inequality, and the current trends of corporate concentration and capture of value, alongside poverty.

South Africa faces particular challenges in building a more inclusive economy that brings greater opportunity for black ownership as well as incomes. Any sustainable food system needs to contribute to addressing these issues. The research continues to be on the informal food sector due to the lack of knowledge about the sector and its key role in creating livelihoods and serving low-income communities. The focus remains on fresh produce that is essential for balanced diets and the importance of fresh produce to emerging black farmers. The informal trade does not operate in isolation, but is closely linked to the formal sector with mutual trade and exchanges taking place between them. This unique landscape forms an interesting, but complex backdrop to what requires context-specific interventions to address its most pressing concerns.

Work on this project undertaken in 2020/21 found that street traders perform a key function in making food accessible to low-income communities through their pricing and locations. They have also been found to be a key market for emerging black farmers. But there is a lack of sufficient data on the pricing, costs and other factors that determine the viability of trader-farmer links, and the ensuring of food accessibility. It has also been found, from the experiences of actors in the food system, that they are often negatively impacted, especially under COVID-19, by regulations and their enforcement. The regulations also affect the viability of new market opportunities. More work is needed to understand what is reasonable and needed regulation, and what can be eased to enable the food system. This also requires a better understanding of the interface between forms of self-regulation in the informal sector and government regulation.

Recognising these drivers, and their importance, the project has been amended and extended to reflect a shift to a wider focus that incorporates looking at production, pricing and governance. Continuation of the project in 2023 will complete work underway, and introduce new work to fill the gaps identified above. The project incorporates more collaborative work across Gauteng and the Western Cape, and will give more attention to sharing findings and stakeholder engagements aimed at improving food systems. The intention is to expand the project in the future to include food systems in secondary cities, small towns and their rural hinterlands.

In 2022 six #FoodTalks seminars, that later became online webinars, were organised with a range of speakers and participants from academia, government and civil society. These seminars covered the following topics:

- School food, equity and social justice
- COVID-19 impact on food systems
- Endogenous paths to a resilient food system
- Student hunger and achieving the right to food for all: what role for universities?
- Land and food
- Creating a more equitable, just and democratic food system in South Africa.

Work on mapping urban food systems revealed the importance of the informal fresh produce sector, in particular, street traders and bakkie traders for fresh produce markets and, therefore, farmers, as well as for making fresh produce more accessible to low-income eaters. The informal sector accounts for over 50% of municipal fresh produce market sales and also sells fresh produce at prices substantially below those of supermarkets and other formal retailers. This has led to the initiation of more systematic price-checking among street traders and engagement with key institutions involved in market regulation. Discussions have been held with the National Agricultural Marketing Council (NAMC) and the Agricultural Produce Agents Council (APAC). These focused on the future of the fresh produce markets, in particular, the municipal fresh produce markets, given the challenge of them losing market share and the lack of transformation in what remains a divided agriculture and food sector. Presentations of research findings have also been made to a NAMC-organised webinar and to the City Economic Development Managers Forum (convened by the cities support programme run by Treasury for municipal local economic development managers).

The work on urban food systems also positioned the CoE-FS to contribute to debates on the impact of COVID-19 on food systems. An advocacy position on informal food traders was drafted for the C19 People's Coalition and supported research which contributed to persuading the government to allow informal food traders to be able to operate after they were initially blocked by COVID-19 regulations. Several publications on the impact of COVID-19 were published in collaboration with other initiatives and using CoE-FS supported research.

Research and a publication on the National School Nutrition Programme revealed a strong programme, feeding over nine million children a day, but also that more could be done to ensure food safety and to use this large-scale state procurement to leverage greater agricultural sector development and transformation. Lessons from homegrown school feeding programmes elsewhere show how, with explicit and more coordinated strategy, school feeding can contribute to agricultural sector and food system improvements.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.4 A place-based approach in selected municipalities (Project ID – 22104)

This research was led by Professor Julian May (UWC) and includes Professor Bruno Losch (UWC/CIRAD), Professor Peter Verburg (VU-A), Dr Jacqueline Davis (VU-A), Dr Michelle Eichinger (VU-A), Ashely Haywood (UWC), Professor Jane Battersby (UCT), Professor Scott Drimie (SU/SAFL).

The place-based project was proposed in the 2019 Lekgotla, but its inception was postponed to 2021 due to funding constraints. The project applies methods that

draw on the territorial approach to development. This recognises that people don't live in sectors; they live in places where the potential, constraints, and plausible future of that place matter.

It builds on collaborations engaged in 2018/19 with SALGA and local municipalities in the Cape Winelands District of the Western Cape, the LEAP-Agri-funded projects currently being implemented by the CoE-FS, and ongoing work in the Johannesburg and Cape Town metropoles. Food4Cities collected spatially referenced data from households and enterprises in Worcester, a secondary town in the BVM, during November 2019. These data have been used to develop a predictive model using Bayesian inference methodologies. Nouricity has collected data on foodsheds in Mount Frere, a secondary town located in the Alfred Nzo District of the Eastern Cape, and Langa, in the Cape Town metro. The CoE-FS project 'Balanced and Healthy Diets for the Urban Poor' collected data in Johannesburg metro; this is reported elsewhere.

The project also builds on previous research undertaken by the CoE-FS in the Umzimvubu Local Municipality as part of the PURE Project, funded from 2014 to 2018. In 2021, new collaborations were initiated in the Matatiele Local Municipality that are reported on under Project 2.2 (Climate-Smart Regenerative Agriculture) in Programme 2.

There are two actions to be reported on: Food system map of Worcester (UWC), and the co-design process of interventions. The objective of this task is to deliver a food system map for Worcester by conducting secondary research, expert interviews and a participatory mapping workshop with stakeholders. The objective is to elicit potential innovations and solutions for urban food system futures, embedded in (climate) scenarios with stakeholders in local government and trans-government organisations, civil society and the private sector using network models. These research activities are being implemented using a learning journey methodology that draws together the Participatory Research Approach (PRA) with methods used to develop innovation labs. Once the first round of data collection has been completed, a stakeholder co-design workshop will be held with local stakeholders to test findings, challenge assumptions and identify missing information.

The research undertaken and the highlights in 2022 are as follows:

Spatial mapping of food system actors located in the BVM using Google Earth: This includes identifiable producers (farms, broiler estates, piggeries, diaries, vineyards, orchards); agri-processors (abattoirs, bakeries, canners, butcheries, wineries, juicers); upstream suppliers (farm equipment; fertiliser manufacturers and distributors, pesticide and fungicide manufacturers and distributors; irrigation equipment, extension); downstream services (logistics, cold-storage, packaging, marketing, agri-processing inputs); financiers and fintech; intermediaries (export agents, market agents, wholesalers); retailers (supermarkets and other chains, formal shops, informal shops, street traders); and food services (catering, fast food). In addition, schools, medical services, water and sanitation infrastructure, transport networks and government offices

have been mappers. A preliminary mapping was completed in January 2022 and it is updated on an ongoing basis. Most recently, data on environmental biome and on the Breede-Gourtitz catchment area have been added using existing .KML files from the South African National Biodiversity Institute and the Water Research Council. This activity will continue until July 2023.

Stakeholder engagements and gualitative data collection: As UrbanFosc overlaps with the previous Food4Cities project, the stakeholder engagements planned for the latter have informed our preparations for UrbanForsc. Three learning journeys were funded from Food4Cities: the first was in December 2021 and took place in the Zwelethemba settlement in the BVM, and which focused on interactions with community members concerning food consumption, with a specific focus on infant feeding. The second took place in April 2022, and was located in the Durban Rd/Parkersdam area of the Worcester CBD, a low-income area in which street trading, formal shops and supermarket chains are located. The third also took place in April, and was located in Zwelethemba and in the north of Mandela Square, an informal settlement. It focused on early childhood development (ECD) centres where pre-school children receive meals. A stakeholder report on these journeys has been produced. Two learning journeys have been funded by UrbanFosc, both of which took place in October 2022. The first was held in the BVM municipal offices and in other national, provincial and trans-agent government offices located in the BVM. The second took place in the Mtwazi Street/Kolo Street area in Zwelethemba and focused on formal and informal food vendors, including a supermarket and the local taxi association. A stakeholder report on these journeys has been produced, and sessions that were recorded have been transcribed and are in the process of being coded. A fifth learning journey is planned for March 2023 and will take place in Touwsrivier, a formal and informal settlement located in the arid biome of the BVM, and which has been reported to be the poorest area in the municipality. In addition to these iourneys, meetings have been held with the BVM municipal manager, the director of strategic services and the director of the Integrated Development Planning division. A townhall meeting was held in July 2021 and was attended by elected councillors and ward committee chairs, as well as by the Director of Policy, Strategy and Research, located in the WCG's Policy and Strategy Unit.

It is likely that one more learning journey will be held in the second half of 2023 where preliminary results from UrbanFosc will be discussed. This is currently planned for September 2023 and would be located either in the agro-industrial park in Worcester or in Avian Park, a low-income neighbourhood. It would be conducted as an input into Task 5.2 as a co-design activity to identify interventions.

Although learning journeys are well suited to engage with government officials at all levels and with vulnerable stakeholders such as informal sector traders and communities, they are time-consuming and costly. For this reason, more conventional qualitative methods will be used to engage with private sector stakeholders in food value chains. These include agri-business owners and managers, farm owners, upstream and downstream actors, and organisations that represent the cognitive, regulative and normative institutions within the food system. The latter includes universities, think-tanks, consultants, other government agents, industry associations, NGOs and consumer groups. A mix of in-depth interviews and focus group discussions will be held from February until July 2023. These activities will be recorded, transcribed and coded. This activity will continue until July 2023.

Stakeholder mapping of actors influencing the BVM food system: Using an adapted food systems framework derived from that which was developed by the HLPE, a detailed review of food system actors is in progress using secondary data and internet sources, including social media. The results from the learning journeys and other stakeholder engagements are being incorporated into this review which has been used to prepare a compendium of actors, food system drivers, and issues already identified as concerns. Summaries of the existing national, provincial and local regulations that influence the BVM food system have also been collated. This activity is ongoing and currently, about 600 food system actors and over 30 Acts, programmes and by-laws have been identified as being of relevance to the objectives of UrbanFosc. This activity will continue until July 2023, but will be updated following the final set of co-design workshops.

Analysis of secondary quantitative data to identify value chains and food system flows: Three sources of quantitative data have been identified that provide information on food consumption and production in the BVM. The first is the household survey undertaken by the Food4Cities project in late 2019 and early 2020. This is a probability survey of about 800 households in Worcester that includes a 24-hour recall of food consumption, the source of the food consumed, and standard socioeconomic variables. A shortcoming of these data is that although total food expenditure was collected, expenditure by food item was not. These data are geo-coded and have been linked to the Google Earth file discussed above. To resolve the missing information concerning the levels of expenditure, the second source of data is the Living Conditions Survey (LCS) 2014/15 undertaken by Stats SA. This is a 23 000-probability household survey and is the most recent survey of household expenditure on food available in South Africa as the "2023 Income and Expenditure Survey" will only be available in 2024. The LCS collected information on about one million purchases during a two-week recall period using a diary method for the food purchases. The food expenditure patterns and levels for the Western Cape have been extracted, rebased, and used to estimate the value of food purchased by item in the BVM. Using the price data compiled by Stats SA for the National Poverty Line update in 2014, and the monthly report on food prices prepared by the NAMC, the quantity of food purchased in BVM has been estimated by population group. Also using Stats SA data, supplemented by the FAOSTAT Food Balance estimate, these quantities have been converted to calories. The third source of data are from the Census of commercial agriculture 2017 undertaken by Stats SA. The quantity of agricultural items produced in the BVM, the Cape Winelands District Municipality (CWDM) and the Western Cape have been extracted. These data can be used to estimate the flows of food consumed in BVM, but need to be supplemented by the trade data available in FAOSTAT to take account of exports from, and imports to, South Africa. A first draft of the food flows that impact on the BVM food system

has been prepared and can be fed into WP3: Climate change impact of food production systems and WP4: Network models of food systems. The estimates will be updated as additional data are extracted. The activity will be completed in July 2023.

One PhD candidate was supported by Food4Cities and continues to be funded by the NRF for 2023. Ashley Haywood has been involved in all of the learning journeys and continues to collect data for his study of food systems analysis on the BVM Integrated Development Plan (IDP). Two new PhD candidates have joined the research team, although neither hold bursaries from the NRF. Zona Ndondo is preparing her proposal which will investigate the impact of BVM by-laws on informal sector food vendors. Jani Truter is a sandwich PhD candidate at UWC and KU-Leuven and is preparing her proposal on urban design for informal sector food vending. A master's student will be recruited in early 2023 to work on food waste and the circular economy in the BVM. Funds have been budgeted for PhD bursaries for UrbanFOSC in the CoE-FS's *2023 Business Plan*, but no students have applied for these yet.

Although there have been both academic and science communication outputs concerning our work in the BVM, at this stage, these flow from the Food4Cities project and have already been reported. One conference paper on transport networks and food security is in progress which will be developed into a journal paper. A second paper on the application of our food systems framework as an instrument for place-based analysis is planned for the first quarter of 2023. Three science communication actions are also planned to follow from the next learning journey in Touwsrivier. These will include a Conversation article, an op-ed and a radio interview.

Although it is possible to identify impacts of the previous Food4Cities project on food system planning in the Western Cape and the BVM, it is too soon to identify the value added of UrbanFOSC. Noteworthy changes to policy documents that can been attributed to Food4Cities are the inclusion of interventions and budget for ECD in the approved *5th Generation IDP* of the BVM which were not previously identified in the previous IDP; the inclusion of a more detailed discussion of managing climate change in this IDP; and the identification of the BVM as a pilot site for the WCG's Nourish to Flourish food security strategy. There are also indications that the Do More Foundation, the largest NGO in the BVM working on food security, have adapted some of their strategies, including their support of ECD centres and their engagement with the local and provincial government. There are also indications that the WCG's Department of Agriculture is making use of the Food4Cities and preliminary UrbanFOSC findings in the implementation of the SmartAgri Strategy, the provincial flagship policy to adapt to climate change.

6.2 Programme 2: Innovation and Technology

The PIs for this programme are Professor Naushad Emmambux (UP) and Professor Ndiko Ludidi (UWC).

The focus of this programme is to investigate the organisational and technological innovation of food systems in terms of the food production and processing required to maintain and improve livelihoods through enterprise development for food security. Enterprises include all sizes of farm and non-farm enterprises, although the focus is on small- and medium-size activities rather than on subsistence or micro-enterprises. The nature of the problem is complex and requires a transdisciplinary approach, although with a strong science focus. The technological transformation for enterprise development should impact positively on environmental, economic, social and nutritional health.

Research undertaken, as well as the highlights, under this programme for 2022 are provided under the following projects:

6.1.5 SMART Food Processing (Project ID – 22201)

This project is led by Professor Emmambux (UP).

The team includes Professor Gyebi Duodu (UP), Dr Nwabisa Mehlomakulu (UP), Dr Danie Jordaan (UP), Professor Elna Buys (UP), Dr Maboko Mphosi (University of Limpopo (UL)), and Professor Riëtte de Kock (UP), Professor Shakila Dada (UP), Dr Phesheya Dlamini (UL), Professor Eric Amonsou (Durban University of Technology (DUT)).

The primary question of the project is "What technological innovation is required for food and nutrition security in the processing of indigenous and local foods?". This research project works hand-in-hand with the Climate-Smart Regenerative Agriculture project. This is a continuity of the previous SMART foods project that started in 2020.

The objectives of this project in 2022 were:

- The creation and processing of SMART foods and food ingredients from indigenous and local plants that have been enriched to combat malnutrition and diet-related non-communicable diseases (NCDs)
- Necessary tools in terms of appropriate food processing technologies for entrepreneurs to produce affordable, safe, convenient, consumer-driven, nutritious foods, and food ingredients
- Value addition to waste from the food processing industry for sustainable food production.

Adult malnutrition is multifaceted and one of the causes is energy-dense rather than nutrient-dense foods. This is also characterised as 'nutrition transition' that has resulted in substantial increases in the intake of sugar, salt, and saturated fats, at the expense of reduced consumption of whole grains, pulses, vegetables, and fruits. An energy-dense diet has been associated with obesity and Type 2 diabetes, elevated fasting insulin levels, and metabolic syndrome. There has been a rise in the consumption of street and fast foods in South Africa and it is estimated that about 18% of South Africans buy street or fast food twice a week, especially in urban areas. Street and fast foods are often characterised as affordable, tasty, and convenient, and but are often energy-dense. Only three percent of children's meals from fast food outlets met all National School Lunch Program criteria from the United States. Meals that did not meet the criteria were more than 1.5 times more energy-dense. It has been established that there is no improvement in the nutritional quality of fast food items and these are still characterised as energy-dense with a high glycaemic index (GI), sugar and saturated fat. Although there is an inconsistent correlation between fast food and obesity in the US and other countries, lower socioeconomic status was associated with unfavourable fast food restaurants, and these environments had higher concentrations of fast food restaurants, and the population with lower socioeconomic status had higher obesity rates.

Food loss across the food chain is a global issue. Post-harvest losses as well as by products of the food processing industry account for about one-third or more. By-products from the food industry are generally discarded, used for composting or used as low-quality ingredient for animal feed. Examples of by-products are wheat bran from milling industry or peels from fruits processing industry. The peels from fruits have useful ingredients such as fibre or biopolymers, for example pectin and cellulose, considered as functional and healthy food and non-food ingredients. The potential of those ingredients has not been explored, especially for local and indigenous crops during processing. For example, South Africa is one of the main grape-producing countries in the world (world production is about 68 million tonnes) and about 10% is by-product as grape pomace, suggesting a substantial quantity of the by-product. Fruits are rich in micronutrients that can be used to fortify nutrient-dense porridge. Grape pomace is abundant in phytochemicals that can be used as nutraceutical foods. Similarly, Africa is blessed with fruits for example marula, wild melon and other tropical and subtropical fruits. These fruits also contain phytochemical and biopolymers such as pectin and cellulose that can extracted and used as food ingredients. Pectin as a food biopolymer, is mostly extracted from beetroot and apple pomace and pectin from citrus fruits can have different properties. Cellulose is mostly supplied locally by wood pulp and is not regarded as sustainable. This project mainly addresses the Sustainable Development Goals (SDGs) 2, 3, 8 and 13.

The research undertaken and the highlights for 2022 are as follows:

Technological innovation to reduce energy density of foods

Maize and teff starch microspheres were prepared and analysed as fat replacer in food systems like mayonnaise. This novelty as fat replacer was patented and Patent Cooperation Treaty (PCT) is applied in a few countries. Both microspheres (i) were not disintegrated during high shear homogenisation and thus, can be applied in mayonnaise; (ii) were not hydrolysed by alpha-amylase enzymes which suggested that they functioned as resistant starch (or dietary fibre); (iii) they have good lubricity properties as they have low-friction coefficient suggesting that it will provide a creamy feel to food products. The fat replacer was also used in normal yogurt. However, it looks like the maize starch microspheres interferes with the casein micelle structure and produces a low gel strength or lower viscosity yogurt.

The maize starch microspheres were also used in a few culinary food products. Appropriate and suitable recipes that met the requirements of high-fat ingredients (butter and cream and other high fat-containing ingredients) were selected. The products were savoury: a cream-based soup, vichyssoise, and short-crust pastry; and sweet: refrigerated cheesecake (no-bake), pannacotta and ice cream.

In brief, the results can be summarised as follows:

The fat replacer up to 50% in the soup had a very good overall acceptability. However, more needs to be done in terms of smoothness and flavour. The milky colour of the soup also changes as the fat replacer is increased.

The fat replacer was generally acceptable for both the 25% and 50% culinary adaptations of the baseline recipe for short-crust pastry. However, the texture became more brittle and tough. The taste was also flourier for the 50% reduced fat content. The fat replacer performed very well in the cheesecake adaptations. Both the 25% and the 50% reduced fat cheesecake were acceptable and had a good taste and flavour. However, there was a slight starchy aftertaste with the 50% replacement, but the products were creamy and smooth.

The fat replacer in the pannacotta only worked at 25% replacement but was not acceptable for the 50% replacement as the product had a low gel strength and starchy taste. The ice cream with the fat replacer was acceptable for both at 25% and the 50% product adaptations. However, the 50% product was icier and had a starch aftertaste.

Low-GI foods and food ingredients

Several indigenous and locally available grains and flours are used for reducing the estimated GI (EGI) by starch modification using green chemistry. Maize meal modified with fatty acid (stearic acid) and heat moisture treatment (HMT) showed a reduction in digestibility and formation of about 38% resistant starch. The resistant starch showed prebiotic effects as it produced short-chain fatty acids and promoted commensal gut microbes.

The team has also started working on microwave and infrared treatment of sorghum flours with the aim to reduce EGI. Untreated sorghum meal (red and white tannin-free and red tannin sorghum) showed lower digestibility compared to our previous studies on maize meal. The tannin sorghum showed lower EGI compared to the non-tannin sorghum. The heat moisture treated sorghum meal showed lower starch digestibility than untreated samples. We are now preforming experiments in model systems to explain the science.

The interaction between normal maize and high amylose maize starch with fatty acid and cowpea protein isolate showed different functional properties in terms of its pasting viscosity. This suggests interaction between starch, fatty acid and protein to form ternary structures. This will be the first report using cowpea protein isolate to produce ternary structures. The GI of these ternary structures still needs to be determined.

Our research in the manufacturing of low-GI food only used in vitro analyses for starch digestibility and EGI; this is a limitation for any nutritional claim. Recently, we have started working on in vivo method for determining GI.

Functionality and nutrition of indigenous/local pulses:

A response surface methodology design was used to successfully optimise the extraction conditions of Bambara protein to enable its complexation with gum Arabic at pH below the isoelectric point of globular proteins. Bambara protein-gum complexes have been formed and produced at pH 3.5, thus shifting the optimum pH from the usually reported pH range of 4.0-4.5. These complexes can potentially be applied as encapsulating material in acidified drink due to greater electrostatic stability. In addition to the observed increase in protein yield, the coacervates yield significantly improved from 16% reported in previous studies, to 63%. The complexes formed were successfully characterised using various analytical techniques including particle size analyses, zeta potential, and microstructures. The molecular structures and composition of protein fractions derived from different extraction conditions were determined to understand the complexation behaviours of these fractions with gum Arabic. Mostly, we have been able to establish that changes in amino acid composition, protein hydrophobicity and secondary structure alteration were responsible for the shift in the optimum complexation pH. Composition and selected functional properties of Bambara groundnut and sugar bean flours were compared. Sugar bean flour appeared to have better emulsifying properties and water holding capacity than Bambara flour, possibly due to the presence of high water soluble non-starchy polysaccharide in sugar bean.

Two new students have started working on modification of marama protein for (i) bread making and (ii) nanofibre by electrospinning. Marama will be modified with phenolic to improve its viscoelastic properties. Marama proteins will be composited with sorghum kafirin protein and the rheological properties are determined followed by properties of the nanofibres. So far, the two students have successfully presented their research work, have extracted and characterised the proteins.

Technology, sensory and quality of quick cooking and ready-to-eat foods

Sorghum pasta was manufactured by extrusion technology. The pasta showed some promising properties in terms of cooking loss and cooking quality. The main limitation is that the pasta was quite sticky. Follow-up experiments will be using bronze die to reduce shear. The other limitation is the availability of a pasta drier.

Decorticated sorghum was also extruded with and without the addition of fibre to produce expanded snacks. It is noted that the fibre reduced the expansion ratio. The suggestion is to modify the fibre so that it does not have sensory defects like fibre residues in the mouth and a low expansion ratio.

In terms of sensory and consumer studies, two documents were produced based on experiments. They are 1) the development and validation of an updated and more suitable alternative scale instrument to measure food neophobia in people, and 2) a validated questionnaire to measure the knowledge, attitudes, and practices (KAP) of employees in the food industry. These were developed by researchers from UP and the University of Helsinki. The questionnaire is valuable to understand the neophobia associated with indigenous foods. The research projects of three BSc Hons Food Science students contributed to the development of an alternative food neophobia scale (FNS-A). FNS-A is a promising tool for the quantification of individual responses to unfamiliar or novel foods. The details of the development and validation of the scale is captured in a research publication in an international peer-reviewed journal.

A validated questionnaire for assessing sensory quality control (SQC) related KAP in the food industry was also developed. The SQC-KAP questionnaire can be used to quickly assess SQC knowledge and attitudes of food employees toward sensory services, and to identify SQC training needs. Interested parties can also use it to measure the sensory quality practices of companies to estimate their compliance with good practices and spot potential areas of improvement in their SQC programmes. The study revealed that companies with better sensory evaluation practices received fewer customer complaints. The details are described as follows:

"A trained sensory panel of 10 evaluated Bambara flour and porridge that was manufactured by microwave and infrared heat treatment. The results indicated that a nutty flavour was perceived by most of the panellists in the microwave and the combined treated flour with infrared and porridge. About 95% of the panellists detected nutty flavour in the combined heat-treated porridge. The treatments did not show a difference in texture but differences in appearance, aroma and flavour were observed. The "raw green beans" descriptor from the panellists was closely associated with the untreated samples. The nutty flavour and the beany flavour seem to cluster together, and these were associated with the microwave heat-treated and combined heat-treated samples. This suggests that microwave and infrared can be used to remove the beany flavour of legume grains. Beany flavour can be the cause for rejection in many foods."

Health benefits of indigenous and local foods

Studies have been conducted on the iron bio-accessibility of extruded instant sorghum porridges fortified with baobab fruit pulp and moringa leaf powder determined using the ferritin ELISA assay in Caco-2 cells. In comparison with conventionally cooked porridge, instant sorghum porridges fortified with baobab fruit pulp had increased ferritin formation which is an indication of enhanced iron uptake and bio-accessibility. This may be due to destruction of antinutrients such as phytate by the extrusion cooking process used in producing the instant porridges which, in turn, enhances iron uptake by the Caco-2 cells. However, instant sorghum porridges fortified with moringa leaf powder did not show increased ferritin formation, possibly due to the rather high levels of antinutritional factors (phytate and polyphenols) in moringa. The bioactive compounds in Carica papaya (C. papaya) peel crude extracts were identified using high-resolution ultra-performance liquid chromatography system with diode array detection, guadrupole time-of-flight and mass spectrometer (UPLC-DAD-QTOF-MS). Furthermore, the ability of the crude extracts to inhibit Listeria monocytogenes and Escherichia coli (E. coli), and prevent browning in minimally processed fresh cut fruits and vegetables was investigated. Overall, the bioactive compounds identified within the crude extracts were organic acids, phenolic acids, flavonols and a glucosinolate. The bioactive component profiles of C. papaya peel crude extracts included metabolites such as citric acid, ascorbic acid, gluconic acid, malic acid, p-coumaric acid, ferulic acid, caffeic acid glucoside, vanillic acid, sinapic acid, rutin, guercetin-3-O-rhamnosyl-rutinoside, Isorhamnetin-3-O-dirhamnosyl glucoside and benzyl glucosinolate. Phenolic compounds were found to be the most predominant in the crude extracts. The Total Phenolic Content, Total Flavonoid Content and FRAP in the crude extracts were 6865 ± 153 mg GAE/g dw, 3638 ± 252 mg QE/g dw and 7968 ± 38 mM TE/g dw, respectively. The crude extracts therefore showed antioxidant activity.

Enriched foods by fermentation

Fermented sorghum showed changes at the microstructure and molecular level to the functional properties of sorghum slurry and sorghum paste. The microbes during fermentation can disrupt the protein matrix, possibly by exogenous enzymes. This was shown by an increase in free amino nitrogen and microscopy showing the release of the starch granules. Thus, the starch granules are free to paste and have high viscosity. This high viscosity can be related to the better baking properties of fermented sorghum as a gluten-free flat bread.

Bacteriocins with potential food preservative properties were isolated from the *Bacillus* species from fermentation. The *Bacillus* spp. bacteriocins achieved about 3.2–4.6 log CFU/ml reduction in the viable number of investigated microorganisms. With LC-MS/MS proteomic analysis, five proteins with antibacterial activity were identified in the bacteriocin extracts.

This research studied the effect of souring using spontaneous fermentation and citric acid acidification on the bio-accessibility of phenolic compounds and related antioxidant and health promoting properties of sorghum (Type I, red and white phenotypes) porridges. For determination of the bio-accessibility of phenolic compounds, supernatants were obtained from sorghum porridges digested using a static simulated in vitro gastrointestinal digestion procedure. Phenolic compounds identified in the two sorghums were phenolic acids and flavonoids. Souring through spontaneous fermentation led to an increase in TPC and radical scavenging activity against ABTS, DPPH and ORAC values for the sorghum flours and resultant porridges. Fermented red sorghum slurry exhibited higher esterase enzyme activity compared to that white sorghum. Simulated in vitro gastrointestinal digestion also enhanced the TPC and the radical scavenging properties of the porridges. The flours, porridges and supernatants from both sorghum types exerted Caco-2 cellular antioxidant activity and protected the DNA from AAPH-induced oxidative damage. This is an indicator of the potential

health-promoting properties of the soured sorghum porridges by offering protection against diet-related NCDs.

Microbes from fermentation have been used to successfully increase vitamins and pro-vitamins in energy-dense foods. We have completed selecting the isolates with optimal folate production. The microbial culture was applied for fermentation in a cereal/milk combination product. Variable folate production was noted depending on the amount of milk included in the product. Another recent project is currently confirming the carotenoid production of the isolates *Lactobacillus plantarum*.

Another fermented-related project looks at the effect of *Pichia kudriavzevii* yeast on the functional properties of Ting. It looks like the yeast increased the nitrogen solubility index and showed higher content of free amino nitrogen. The yeast also showed more pitting of starch granules suggesting that these properties will affect the properties of the beverage.

Food biopolymer/food by-product characterisation and application

High-purity cellulose was successfully extracted from cowpea side stream using chemical methods. A new method using fewer chemicals was also developed. The materials were first extruded to pre-treat the fibre before extraction. This reduces the environmentally degrading chemicals. The cowpea side stream was also used to produce biodegradable plastics with appropriate tensile and barrier properties.

A selenium/potato starch nano-film with the potential for food packaging was developed by casting method. The presence of selenium nanoparticles (SeNPs) in the potato starch film enhanced the antioxidant and antimicrobial activity of the film.

Research has been conducted on exploring indigenous South African plant species as sources of natural pigments for application as food colorants. Pigmented extracts from flowers of plant species from the Geraniaceae and Lamiaceae families were prepared using acidified aqueous solutions. These pigments primarily consisted of various anthocyanidin and anthocyanin derivatives. The pigments were applied successfully as colourants in yogurt (acidic pH food system), fondant (high sugar food system) and gelatine (high protein food system) sweets. The yoghurt, fondant and gelatine coloured with the pigments were comparable in colouring ability and storage stability to the commercial anthocyanin-rich colourant E163. While the E163 colourant produced a deep purple colour in the three food systems, the pigments gave the products a variety of colours including purple, pink and orange and also in different shades of intensity and brightness.

Research has been conducted on exploring alternative protein sources, specifically insects for use either as protein-rich ingredients or for incorporation into SMART foods for enhanced protein quality. The effect of sun drying, solar cabinet drying, blanching prior to sun drying or solar cabinet drying on the drying time and moisture diffusivity of edible crickets (*Gryllus bimaculatus*) was investigated by comparing six empirical drying models. An empirical quartic polynomial model was the best to determine drying time for a given moisture content. Blanched cricket dried the fastest in the solar cabinet, followed by the fresh cricket in the solar cabinet, and the fresh cricket placed directly in sunlight recorded the longest drying time. A similar order was observed for moisture diffusivity with the highest value recorded when crickets were blanched and solar-cabinet-dried and the least when crickets were only sun-dried. These results suggest that blanching before solar-cabinet drying which produces the shortest drying time could be a preferential drying method for edible crickets in rural settings where energy and expensive drying equipment are lacking.

Training and community-based work

During July and October 2021, 20 SMMEs in the Capricorn, Vhembe and Sekhukhune districts in Limpopo were trained on the principles of Good Manufacturing Practices (GMP). The SMMEs process different types of products such as fermented sorghum beverages, mixed vegetable pickles, and squash yogurt. The clients face different challenges where processing safe products and maintaining quality is common in all of them. GMP is an important food safety system that most SMMEs are not using. The training assisted the clients in implementing the system. They understood the requirements for GMP, and it was recommended that they adhere to food safety practices in order to reduce the risks of contamination and improve food safety.

During November 2021 and February 2022, 14 SMMEs in the Capricorn, Vhembe and Sekhukhune districts in Limpopo were trained on microbial food contamination regarding Hazard Analysis and Critical Control Point (HACCP) AND ISO 22000. Microbial contamination happens when food products have been contaminated by microorganisms, including bacteria, viruses, mould, fungi and toxins. This can happen through various means for example, undercooking or storing and preparing high-risk raw foods close to ready-to-eat foods, and poor hygienic practices. The training sessions assisted the SMMEs to better understand microbial hazards and how to critically control them during processing to ensure safe food products are processed.

During March 2021 and June 2022, 10 SMMEs (one of the SMMEs was a cooperative consisting of seven members who were all trained) in the Capricorn, Vhembe and Sekhukhune districts in Limpopo were trained on chemical contamination food regarding HACCP AND ISO 22000. There are different types of chemical contaminants such as dioxins which are environmental contaminants (industrial contaminant), and process contaminants that form while heating or cooking food, such as acrylamide and detergent. These chemical contaminants were trained on clients to ensure they understand their roles in food safety. It was recommended that the clients adhere to food safety practices to reduce the risks of contamination and improve food safety. The correct food processing steps must be followed to avoid compromising the quality of the food products.

Techno-economic feasibility of manufactured food

Various products are being evaluated together with a European Union sponsored project, InnoFoodAfrica.

Communication for low-literacy consumers

Some questionnaires for sensory and consumer studies were translated and adapted for use by food scientists.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.6 Innovation for Environmental Change-resilient Agriculture Drought Responses in Cereals and Legumes (Project ID – 22202)

Professor Ludidi (UWC) is leading this project.

Other team members include Professor Robert Sharp (MU), Professor Scott Peck (MU), Professor Hon-Ming Lam (Chinese University of Hong Kong), Professor Mounawer Badri (Centre of Biotechnology of Borj Cédria, Tunisia), Professor Nandipha Ndudane (Tsolo Agricultural and Rural Development Institute (TARDI)), Professor Joyce Govinden-Soulange (University of Mauritius), Professor Kohtaro Iseki (Japan International Research Center for Agricultural Sciences), Professor Ueli Grossniklaus (University of Zurich, Switzerland), Professor Marshall Keyster (UWC), and Professor Emmambux (UP).

This project aims to prevent the negative impact of drought and heat stress on food and nutrition security while improving soil health and reducing excessive use of limited water resources. This will be done by using technological innovations that improve soil health, support regenerative agriculture, while increasing the biodiversity of insects and the soil microbiome that bear benefits to crop production.

The specific objectives of the project in 2022 were to:

- A. Evaluate the performance of maize, sorghum, soybean, wild sweetpea, pigeon pea, finger millet, and pearl millet under both drought and heat stress conditions to ensure that lines of these crops which possess drought tolerance together with heat tolerance can be used in identifying genes that mediate the tolerance of these lines to combined drought and heat stress
- B. Conduct a breeding programme for soybean, maize and sorghum to develop new soybean, maize and sorghum cultivars with enhanced tolerance to drought and heat stress
- C. Implement regenerative agricultural practices using crop rotation, intercropping and soil cover techniques in a cropping system that uses maize, soybean, cowpea, wheat, pearl millet, finger millet, alfalfa (lucerne), marama, *Vigna vexillata* (wild sweetpea), common bean, garden pea, *Vicia faba* (faba bean/broad bean), pigeon pea and white mustard (*Sinapis alba*). This will result in the determination of the effect of this cropping system on soil health and biodiversity concerning plant beneficial insects and

micro-organisms. This will be tied to agroecology policy work in Programme 1, which seeks to establish policy to promote regenerative agriculture

- D. Isolate and assess the efficacy of endophytic micro-organisms isolated from the cropping systems in (C) and from harsh environments in improving crop performance under limited water supply and in improving crop nutrient content
- E. Identify wheat accessions with contrasting responses (sensitive versus tolerant) to combined drought and salinity stress to understand the genetic factors that determine wheat tolerance to these stresses. This will lay a foundation for future breeding efforts to produce new wheat varieties with improved tolerance to these stresses
- F. Identify animal feed combinations, from those in (C) and in combination with local kelp species as a feed additive, that results in the lowest methane emissions from ruminants, and evaluate the impact of these low-methane emission livestock feeds on average daily gain in cattle, sheep and goats.

The research undertaken and the highlights for 2022 are as follows:

Regenerative agriculture ensures continuous minimum mechanical soil disturbance, permanent organic soil cover, and diversification of cultivated crop species. Furthermore, regenerative agriculture enhances biodiversity and natural biological processes above and below the ground. It also ensures that external inputs such as agro-chemicals and plant nutrients of mineral or organic origin are applied optimally so that they do not interfere with the biological processes above or below the ground. It thus follows that regenerative agriculture is a requirement for sustainable agricultural production intensification, which increases options for integration of crop production with livestock production since crops and pastures can be integrated into regenerative agriculture to serve as a feed source for livestock production.

A shift towards regenerative agriculture will lead to large savings in machinery and energy use, reduction in carbon emissions, a rise in soil organic matter content and biotic activity, increased biodiversity above and below ground, increased diversity of crops produced and thus, the diversity of food consumed, less erosion, increased crop water availability and thus, resilience to drought and reduced impact of climate change on food security. The inclusion of African indigenous crops in African food systems not only allows for diversified diets using environmentally resilient crops but also aids in ensuring that these crops regain their utilisation (and thus, value) as mainstream crops. However, because some of these crops have been neglected, their acceptability and knowledge of food preparations from them are limited. This offers opportunities for processing of these crops to make new edible food products with superior nutrient value.

The diversity of crops grown under regenerative agriculture also contributes to the sustainable production of livestock feed/forage. When indigenous crops — which are more adapted to poor soils and harsh conditions such as drought and heat — are produced together with more popular crops such as maize and soybean as

part of this cropping system, adequate livestock feeding can be achieved and the feed diversity allows for selection of livestock feed sources that may result in reduced production of greenhouse gases, such as methane, from ruminants. Such intervention may not only benefit livestock producers by ensuring the availability of feed which sustains livestock but may also reduce the impact of ruminant production on global warming because of reduced methane production from the livestock. When coupled with the selection of livestock breeds with enhanced tolerance to drought, heat, and tick resistance, these interventions can ensure that livestock farmers can farm profitably despite challenges presented by climate change.

Because of the need to produce crops that can withstand the impacts of climate change and the need to reduce the contribution of agriculture to global warming, the project will:

- 1) identify maize, soybean, and sorghum varieties with less sensitivity to the simultaneous occurrence of drought and heat stress
- develop new soybean cultivars with enhanced tolerance to drought because of the extreme importance of soybean to the livestock production industry and the frequent incidents of drought in Sub-Saharan Africa
- use regenerative agriculture to preserve the health status of soil in which these crops can be grown and promote biodiversity that impacts crop yield positively
- reduce the impact of ruminant farming on greenhouse emissions by designing appropriate ruminant diets which enhance average daily gain, in terms of weight, in livestock (cattle, sheep, and goats).

Work was conducted on *Medicago truncatula* and *Medicago sativa* in relation to their interaction with soil-borne endophytic bacteria, drought and pathogenic fungi. The work has led to identification of genetic determinants of drought and black stem rot disease resistance genes in alfalfa. The work on soybean and maize has identified genes that confer drought and heat stress tolerance in soybean and in maize. We have developed a drought and heat stress tolerant cultivar of sorghum, which we must subject to field trials to ascertain its drought and heat stress tolerance in 2023. Through this work in sorghum, we have also identified genes that confer drought and heat stress tolerance.

The work on marama bean has shown that marama growing in north-western Limpopo (near Lephalale) is more drought-tolerant than marama growing in eastern Limpopo (near Tzaneen), which we ascribe to differences in rainfall levels in the two climatic regions. We have also identified insect pest that are potential threats for marama, which we found that when they have caused damage to marama pods, they increase susceptibility of marama to fungal diseases. We are in the process of identifying the fungi and developing biocontrol strategies for managing these fungal infections. The major challenge for the project, as it evolved to more practical applied aspects, was access to land on which regenerative agriculture practices could be explored. However, this challenge turned out to be a benefit because it directed us to smallholder farmers in the Eastern Cape (parts of the Alfred Nzo District (Matatiele and Bizana) and the OR Tambo District (Mthatha and Port St. Johns)) where we could access land for this purpose. This also meant that our community engagement became much easier to achieve, which is also why we were able to provide the smallholder farmers in some of the villages in these municipalities with our drought-tolerant crop varieties for their use while we benefit by obtaining performance data on these varieties. This will also allow us to initiate a breeding and performance evaluation programme in selected secure fields in these sites because none of the stress-tolerant varieties have yield close to cultivated commercial varieties and thus, there is a need to use them mainly as genetic material to transfer the stress-tolerance trait to the better-yielding varieties. This breeding and evaluation programme is the next phase of our work.

Work on the reduction of greenhouse emissions from ruminants has been delayed by challenges in obtaining animal ethical clearance. This has now been resolved by enlisting the collaboration of veterinarians and animal scientists from TARDI and enrolling a PhD candidate (in 2021).

A further challenge is the cost of the biotechnological work that goes into identifying genes that confer stress-tolerance to crops in a manner that will make a difference in the real field. For this to be realised, it becomes necessary to go beyond standard commercialised mainstream/staple crops such as maize and soybean because these crops have lost the ability to have a high degree of stress-tolerance. However, the same commercialised crops have become staple crops for human consumption and animal feed. Therefore, it is obligatory to improve their stress-tolerance. It is for this reason that we have started to investigate genetic determinants of stress-tolerance in indigenous crops such as sorghum, pearl millet and finger millet in order to use these genetic determinants for improvement of mainstream crops such as maize or cowpea, Bambara nuts, tuber cowpea and marama bean for improvement of mainstream crops such as soybean and common bean.

This requires extensive investment into functional genomics, comparative genomics and translational genomics together with other omics technologies (such as proteomics and metabolomics) coupled with new breeding technologies such as CRISPR. Looking at such approaches as fundamental research that does not immediately address food security directly and thus, not investing in them urgently, is a grave mistake because none of the mainstream crops can significantly be improved for stress-tolerance without these approaches (as an example, although the maize and soybean accessions we have identified as having better tolerance to drought and heat than the commercially available varieties of these crops are at our disposal, they – and any other current varieties – can never match the tolerance of their indigenous/wild relatives, which is why, to date, nowhere in the world has such level of stress-tolerance been achieved, simply because maize and soybean lost the genetic capacity to tolerate such stresses several centuries ago).

Therefore, it is essential to explore the genetic makeup of the wild crop relatives/indigenous crops in a comparative genomics/omics approach to truly achieve stress-tolerance that would make a difference to climate change

resilience of the food production system. Therefore, such omics and modern breeding approaches must not be seen as basic fundamental research but, rather, as tools necessary to achieve food security, for which investment must be committed within efforts of food security attainment. This is because society is unlikely to switch to wild/indigenous crops over the 'traditional' mainstream staple crops, meaning that a viable option is to improve climate change resilience of the mainstream staple crops by tapping into the genetics of the rather neglected indigenous crops. This can only be achieved if tools enabling this goal are seen as integral components of achieving food security, which is a challenge we face from a financial investment point of view since it is a costly exercise. Nonetheless, we have been relatively successful in obtaining leverage funding and tapping into our collaborative networks to make progress in addressing this challenge (for example, we are in the process of wrapping up our comparative proteomics work within the next few months involving sorghum and pearl millet to benefit maize improvement for drought- and heat-stress-tolerance).

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.7 Reclamation of Heavy Metal Contamination of Soils: (Project ID - 22202 - WP 2.2.4

Professor Keyster (UWC) is leading this research with the support of Professor Ludidi (UWC).

The purpose of the project was to analyse soil for nutrient status, physical properties, chemical properties, biological properties, and microbial diversity before and during cultivation of the crops to assess its soil health status. Furthermore, the soil was analysed for microbial diversity to identify plant growth-promoting bacteria in the soil. The previous work identified endophytic bacteria that promotes nutrient uptake from the soil to plants while preventing heavy metal accumulation in the plant. These endophytic bacteria will be introduced to test plots in order to monitor their effect on crop yield and crop nutrient profile (only for maize, soybean and common bean).

The research undertaken and the highlights for 2022 are as follows:

Soil analysis

Inductively Coupled Plasma Optical Emission (ICP-OES) Spectrometry will be used to analyse soil samples collected from a variety of study sites which are earmarked for field trials. Preliminary analysis showed that there are variations in nutrient amounts throughout the study sites. Some sites are mostly Phosphorous- and Potassium-deficient as well as overabundant in Iron. Some sites are deficient in Iron and have an overabundance of macronutrients. Analysis will give more insight into the soil health status of the study site in question. The same analysis will also be performed on soil-sand mix obtained from pot-trail experiments.

Microbial diversity of soil and plants

Various extreme weeds were identified, and GPS tagged on sites around UWC, the broader Cape Town area and coastal areas. Endophytic bacteria will be extracted from the weeds and pure cultures will be obtained. Candidates and preliminary screening for growth promotion will be conducted. We will conduct 16S rDNA sequencing and identify novel bacterial endophytes. We will then screen the endophytes for impacts on seed germination as well as overall seedling growth using a small phenotyping robot in real-time (every five hours, over seven days).

Plant growth under endophyte inoculation

All bacterial candidates will be used in plant growth experiments conducted in both field and greenhouse experiments, respectively.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.3 Nutrition, Health and Safety for Food Security

The PIs for this programme are Professor Rina Swart (UWC) and Professor Lise Korsten (UP).

Significant sectors of the South African society continue to experience high levels of chronic undernutrition as well as nutritional deficiencies. At the same time, obesity among adults and children is a growing public health problem in the country and is accelerating the burden of food-related NCDs in both poor and middle-class populations.

Since the inception of the CoE-FS, a key question has been "what is on the plate of South African consumers?". Within the reconfigured CoE-FS 2020–2024, this question will remain central to work of the Nutrition, Health and Safety for Food Security programme within the CoE-FS. The spectrum of work to be explored within the 2020–2024 cycle includes a continuation of the exploration of food consumption patterns, paying special attention to particularly vulnerable groups where possible, the safety of the food on the plate, possible effects (on nutrition and health) of appropriate, affordable and accessible interventions to improve the amount and quality of food on the plate, as well as the interaction between and impact of changing food systems in the country on the content of the "plate", and subsequent consequences for the nutrition and health of the population.

Safe food is the outcome of an integrated ecosystem and requires that the food available (produced or purchased), prepared and consumed does not pose a health risk to the consumer. Through exposure assessment, intervention, education and awareness, safe food systems can be assured at a community-based level. By understanding the link between community health and an inclusive One Health approach (environmental, plant, animal and human health), adaptive solutions can be secured. Unfolding novel technologies to

provide adaptive solutions can contribute towards the development of more effective intervention strategies.

Programme 3 benefits from Programme 1 in which global, national and local challenges concerning nutrition, health and food safety are illustrated, and it identifies trends, drivers and patterns to be fed into Programme 1 through the CoP, knowledge co-production and engagement activities. Programme 3 also learns from the innovations identified in Programme 3 which offer potential solutions to the nutrition and safety hazards that are identified, as well from methodological advances.

Projects within the programme can loosely be categorised into three themes: (1) nutrition and health, (2) safe food and (3) an integrated food-environment-systems theme.

Research undertaken as well as the achievements under this programme are highlighted under the following projects:

6.1.8 Safe Food (Project ID – 22301)

This project is led by Professor Korsten (UP).

Other team members include Dr Stacey Duvenhage (University of Greenwich, UK), Dr Chris Marufu (UP), Dr Ishmael Jaja (UFH), Professor Kalmia Kniel (UD), Professor Shirley Micallef (UMD), Dr Manan Sharma (USDA's Agricultural Research Services).

To understand the preventable disease burden of potentially unsafe food and poor-quality diets, a multipronged approach is required. Firstly, a risk-based approach to understand food products, practices and the level of community exposure that can contribute to poor food quality and safety, and determine the consequential health impact. Secondly, assessing and understanding how diets affect the gut microflora and influences the overall health burden and well-being of the studied community and to understand how nutrients are being absorbed within the gut in the context of the microbiota intake, as well as the prevention of communicable diseases.

In addition to assessing the level of risk to the community, an essential part of the food safety and security paradigm is the prevention of communicable and NCDs as well as assuring nutrition security. In line with global food safety authorities, three areas of priority will be addressed ensuring excellence over the next five years, drawing on data and information collected in the previous five-year cycle. An integrated approach is, therefore, taken which includes risk analysis, risk reduction and mitigation through innovation, education and communication, as well as assessing the effect of the naturally occurring micro-organisms in the prevention of disease in the hope to reduce risk within vulnerable communities to lessen the double burden of food insecurity and communicable disease.

The research undertaken and the highlights for 2022 are organised under the following sequence of WPs:

All-inclusive One Health risk analysis for community health

The World Health Organization defines "One Health" as "an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes". The food safety One Health approach incorporates the three main interlinking facets of animal, plant and human health with the crosscutting facets of water and environment. This approach is critical to address the control of zoonosis as well as antibiotic resistance. A One Health approach is critical because the same microorganisms infect animals and humans often disseminated on plants, as well as through water, therefore, resulting in a need for transdisciplinary research. Pathogens which have been identified in previous studies in the research team, and globally, include *Salmonella spp.* and *E. coli* as major pathogens prevalent in the environment and informal food system.

Risk assessment studies

The research "Qualitative and Quantitative Microbiological Risk Assessment of dark leafy green vegetables commonly consumed in South Africa to build expertise regarding hazard assessment and exposure assessment which are critical elements in developing and implementing risk mitigation strategies" is progressing well and builds on information generated from research results in the informal supply chains, as well as results on the microbiological quality and safety of fresh vegetables consumed as part of the school feeding programmes.

Potential human pathogenic bacteria (including E. coli and Salmonella spp)

This research "Impact of water pollution on the microbiological safety and biome of fresh produce from farming to retail/ (predominantly informal) for fresh vegetables and to development of a fit-for-purpose water microbiological quality guideline for smallholder farmers and retailers and evaluate microbiological risk reduction strategies/technology to ensure food safety in the supply chains" is progressing well. Additionally, antibiotic-resistant bacteria pose a hazard to our food supply and overall food security. Contamination can happen at any point throughout the production process, including on the farm, in processing facilities, during transport or storage, and at the retail level. The possible link between the water-plant-food interface, human pathogenic Enterobacteriaceae as well as antibiotic resistance (ABR) within fresh produce chains must, therefore, be considered. This study will, therefore, aim to determine the microbiological quality, sources of microbial contamination, and characteristics of target organisms within smallholder fresh produce farms. Additionally, multidrug-resistant bacteria, including ESBL/AmpC-producing Enterobacteriaceae, will be explored from selected smallholder fresh produce farms in South Africa.

Cryptosporidium detection

The research "Molecular detection of *Cryptosporidium* in the water-soil-plant nexus within selected South African small-scale vegetable farms" is also progressing well. There is limited knowledge on the occurrence of *Cryptosporidium* in water, soil and fresh produce in South Africa, and previous studies have only reported on contaminated water sources. Water, soil and fresh produce samples have been collected from four smallholder farms selected in collaboration with Ali Mkgato from the Gauteng DALLRD. Inoculation studies and optimising extraction methods for isolating *Cryptosporidium* DNA are in progress.

An ethical clearance application entitled *Prevalence of* Cryptosporidium *infection and associated risk factors in ruminants* 14169101 (HUM011/0522) in the Department of Veterinary and Tropical Sciences, Onderstepoort, UP has been submitted by Dr Chris Marufu and approved. Tebogo Atlivia from UP Veterinary Sciences has been a part-time MSc student. Her progress was severely hindered by the fact that the ethical clearance took almost 18 months to be approved.

Risk reduction through innovation:

The research "The efficacy of Moringa oleifera-zero valent iron sand filtration on the reduction of *Escherichia coli* in borehole water for the irrigation of spinach" has been impacted significantly due to the COVID-19 pandemic, especially during 2020, but is now progressing well. Contact was made with a chemical engineer to optimise the application and flow rate of the irrigation water to be tested to the filtration columns. Initial results showed improvement of the microbiological quality of the irrigation water by using a ZeroValent Iron-sand mixture in one of the columns and ground Moringa seeds mixed with sand, mixed in a second column.

Risk mitigation, communication and education:

Mitigation of various One Health risk factors include the education and awareness of consumers and food handlers as well as various mitigation strategies to ensure that environmental factors are addressed, like cleaning of hands and contact surfaces which can only be effectively done with good quality water. Additionally, risk communication was undertaken with various stakeholders, which included two PhD candidates, who compiled a summary of activities to date to address the goals of the WP. In addition, food safety training in the current South African school curriculum was also included in the summary.

From 2015 to 2020 there have been six research projects that aimed to assess the food safety knowledge, attitudes and practices of different roleplayers involved in fresh produce and meat value chains as indicated in Table 1. These included street vendors (183), consumers who brought fresh produce from the formal sector (n=503), consumers in the metropoles (n=159), consumers residing in informal settlements (n=262), food handlers at schools (n=49), as well as meat farmers (n=184), butchery(n=218), and abattoir workers (208) in both the formal and informal meat sectors. These projects were carried out across four provinces, namely, Gauteng (Tshwane, Tembisa) Mpumalanga (Delmas, Bethal), Eastern Cape (Alfred Nzo, Amathole, Chris Hani, Joe Gqabi, OR Tambo, and Sarah Baartman districts) and the Western Cape.

From the results, good (or average) food safety knowledge and a good food safety attitude were a common trend across these projects. However, these did not always translate into good food safety practices being followed. Personal hygiene and handwashing were identified as lacking or not being done in the correct way. Furthermore, the lack of knowledge on safe handling, preparation and storage methods of fresh produce was also identified as potential threats to food safety. Consumers and street vendors were found to use one chopping board for both fresh produce and raw meat. This was a concern that came up in two of the research projects. Another huge challenge picked up by the researchers involved was the lack of adequate infrastructure (water and sanitation, electricity, fridges, or storage equipment) which often leads to good food safety practices not always being followed. The lack of soap and sanitisers was also identified to be a problem. It is important to note that these projects were carried out before the use and importance of sanitisers and handwashing was highlighted during the COVID-19 pandemic; it would be interesting to see if there has been a change in these two aspects currently.

To bring about change in future, training for street vendors, food handlers and workers in the meat industry was recommended. Consumer education is also required. Researchers play an important role in effecting change and have a responsibility to share their findings with people in a way that will be understandable. Media (radio, TV, news articles) and art (plays) provide a way that science communication can be done for the benefit of the public. These activities indicate that communicating the food safety work done, offers the opportunity to inform people of what they can do better to ensure that their food is safe, thereby allowing us to do research recommendations.

Assessing the microbiota of fruit and vegetables and how that affects the gut microflora of selected communities

Ethical clearance for the research on this work has been obtained, and the research is progressing well. This research aims to investigate the microbiome-based transmission of pathogens from fresh and dry indigenous produce such as morogo, *nyii* and marula collected from the Gauteng and Mpumalanga regions. It also aims to unravel the complex microbiomes that are present on fresh and dried indigenous produce that is traded in the formal and informal sector by following the food system from the point of collection to the plate, and assessing the microbial shifts. The food safety One Health approach incorporates the three main interlinking facets of animal, plant and human health with the cross-cutting facets of water and environment. This approach is critical to address the control of contagious infectious agents that spread from vertebrate animals to humans and vice-versa, posing a health risk, i.e., zoonosis.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.1.9 Nutrition and Health (Project ID – 22302)

This project is led by Professor Swart (UWC).

The 2022 projects are a continuation of the 2021 projects. The Nutrition and Health component of the CoE-FS continues to focus on the key questions, "What is on the plate of South African consumers?" and "How does the food on that plate impact on the health of South Africans?".

To this effect, three areas were explored in 2022, and these are as follows:

- "Food consumption, gut-microbiome and chronic disease" will explore the relation between the composition of the gut-microbiome and lifetime cardiovascular disease (CVD) risk profile among a sub-sample of participants in the PURE study with a particular focus on obesity, Type 2 diabetes mellitus and colon cancer
- "Food consumption patterns" will contribute students to a leverage-funded national food consumption study which will assess the nutritional status and dietary intake of different age and gender groups in South Africa. This WP will also explore the drivers of food choice through qualitative methods, complementary to the National Dietary Intake Study (NDIS)
- "Maternal health and nutritional status of mothers" will fund a new postdoc towards the exploration of maternal nutritional status and birth outcomes in a study on "Cardiovascular, haemostatic and micronutrient status of pregnant women in urban food environments".

The postdoc will also remain involved in the young child nutrition aspects of NDIS.

Social, cultural and economic factors like price, accessibility, marketing and influencer messages, health concerns, taste and convenience, have all been indicated in studies in other countries to influence personal food choice and eating behaviour. With the new food consumption information that will become available from the NDIS in South Africa, a gap remains to better understand the main drivers of food choice in South Africans. This is needed to inform nudge strategies to increase heathier food choices by South Africans. Lastly, food production and food consumption make a huge contribution to our ecological footprint. Exploration of the role of food and food systems and their responses to changes in dietary intake is necessary towards achieving the SDGs.

The research undertaken and the highlights for 2022 are organised under the following WPs:

6.1.9.1 Food consumption, gut-microbiome and chronic disease in disadvantaged urban and rural communities (Project ID - 20302 - WP 3.2.1)

This research is led by Professor Swart (UWC).

This project explores the relation between the composition of the gut-microbiome and lifetime CVD risk profile among a sub-sample of participants in the PURE study, with a particular focus on obesity, Type 2 diabetes mellitus and colon cancer. The CoE-FS funding is only for the assessment of dietary intake, while the microbiome analyses and endoscopies are covered (as leverage funding) by the African Microbiome Institute at SU. Recruitment of colon cancer patients is done by the Department of Gastroenterology/Medicine/Surgery at SU.

In 2020, data for the pilot was collected before COVID-19 restrictions were implemented. Fieldwork could not continue. The team did use the data from the pilot study to submit a proof-of-concept proposal to the NRF in June 2021. Findings from the pilot study was reported at the American Nutrition Association. The abstract for this online presentation was published in the journal *Current Developments in Nutrition*. A poster was also presented at the Digestive Disease Week 2021.

In 2021, the project started recruiting candidates from the PURE cohort in October when restrictions were reduced to lockdown level 1. Data collection for the baseline assessment will only be completed in first term of 2022. The criterion for inclusion is participants with a BMI>35 with diagnosis of diabetes Type 2. The intervention component will include a complete feeding intervention to provide at least 40-50g fibre per day, from a diet consisting of whole foods most commonly consumed by traditional rural Africans in South Africa. Concurrently, an expanded team has started preparing a multi-country intervention proposal (countries from southern, eastern and western Africa) for the European Union Horizon call.

In 2022, Professor O'Keefe received an NRF grant for the intervention study; this is ongoing. Recruitment of participants according to the entry criteria is a slow process.

The proposal of the master's student received ethics approval and she is currently compiling an amended food composition database which contains polyphenol content of food in order to explore possible associations between the polyphenol content of the diets and the gut microbiota (specifically *Bifidobacterium* and *Lactobacillus*) of participants in the pilot study. She will also complete a systematic review on the topic "The association between polyphenols flavonoids and specific components of the GM's microbiota, *Bifidobacterium* and *Lactobacillus*".

The master's student completed her analyses of polyphenol content of the diet of the participants. She is still busy with her systematic review, with the postdoc (who took up the position in September 2022) as the second reviewer. Contrary to findings in previous studies showing rural South Africans (amaZulus) consuming >50g fibre/d, there is lower fibre consumption in the rural and urban amaXhosa populations – not sufficient to suppress colon cancer risk.

It was expected that short-chain fatty acids and dietary fibre levels would decrease in individuals migrating from rural to urban regions, but the macronutrient levels actually increased. This is the first study reporting differences in diet and faecal short-chain fatty acid (SCFA) between rural and urban South African populations. Despite the differences in fibre intake between South African groups, there were no significant differences in major faecal SCFA. Despite no differences in faecal SCFA and butyryl CoA gene expression, the faecal microbiota profiles of each of the rural and urban populations were distinct. Dietary data and the BMI suggest high risk of obesity in urban South Africa.

Other factors that can help explain these results may be in total carbohydrate and fat intake associated with ultra-processed food consumption.

6.1.9.2 Food consumption patterns (Project ID – 20302 - WP 3.2.2)

This research is led by Professor Swart (UWC).

This WP primarily fund students on a leverage-funded NDIS which will assess the nutritional status and dietary intake of different age and gender groups in South Africa.

Due to COVID-19 and the low vaccination rate, fieldwork for the NDIS could not commence. The revised start date for data collection is February 2022 with training of fieldworkers taking place in January 2022.

During 2020, a desktop review (including two systematic reviews and analyses of data from household survey reports covering the period 1997–2020 was completed by three groups of researchers. This review is now in the process of being published by UWC Press as an e-book and papers are being prepared for a special journal edition. The systematic reviews that will be reported in the special edition will include all new publications from 2020 and 2021 that may not have been included in the desktop review. Some of the key findings of this project are as follows:

The majority of the population procure most of their food from commercial enterprises (SMMEs). The gains in reduction of hunger since 2002 have, in all likelihood, been erased by the socioeconomic effects of the COVID-19 pandemic control measures. Dietary diversity is low and heavily reliant on energy-dense foods that are not necessarily nutrient dense. Intakes of fruit and vegetables are particularly low. Intakes of food sources of calcium are very low.

The intake of commercially manufactured, ultra-processed foods that are high in added sugar, salt and saturated fat are growing exponentially across all income groups. The high intake of ultra-processed foods, such as sugar-sweetened beverages and salty snacks, among young adults who were born into an obesogenic food environment suggests the need for far-reaching and impactful strategies to improve the healthiness of their diets.

The desktop review has been converted to an e-book which will be available online. It is currently awaiting the final sign off from the director-general (DG) of the NDoH (ISBN number of e-book is 978-0-621-50088-2. Citation: National Department of Health & DSI-NRF Centre of Excellence in Food Security (2022) Foods procured, Nutritional status and Dietary Intake of People Living in South Africa: Desktop review. Pretoria, National Department of Health, South Africa). Collaborators to the desktop review have updated their systematic reviews to include 2020, 2021 and 2022 and prepared six papers to be published in a special edition of the *PHN journal* (once approval has been granted by the DG of the NDoH). The group also had their abstracts accepted for presentation in a symposium at the 2023 Nutrition Congress which will take place from 18 to 20 April 2023 in Somerset West, Cape Town.

Training of fieldworkers took place in January and February 2022. Fieldwork for the NDIS was completed between February and September 2022 by 12 teams of seven fieldworkers each. Each team also have an appointed coordinator and a dedicated academic from the supporting university for that team. Data collected during this period include the following:

	Total	Target	% of target achieved
Number of EAs surveyed	449	446	100,67
Number of households surveyed	3563	4460	79,89
Number of schools surveyed	381	446	85,43
Number of ECDs surveyed	381	446	85,43

Figure 2: NDIS data collected, Feb-Sep 2022.

Postdoc Dr Nazeeia Sayed acted as assistant to the PI during the planning and management of the NDIS. Another postdoc Dr Sicelo Siro acted as coordinator for the North-West and is currently assisting with quality assurance of dietary intake data. Dr Jaah Mkupete, a newly appointed postdoc, has been instrumental in the data cleaning process. Statistical analyses are underway and teams from the research collaborators are writing various sections of the research reports.

Dietary intake data is, however, still in the process of being quantified and coded as it was collected manually, whereas all other data was collected digitally. The first draft of the report is due by the end of January 2023, with a final draft due by the end of March 2023. It is envisaged that the final report may be released in September 2023, provided that the DG has signed off on it by that time.

6.1.9.3 Leverage project: Impact evaluation of the Health Promotion Levy (HPL)

This project received leverage funding from Bloomberg Philanthropies. Data collection of dietary intake of young adults (aged 18–39 years) in a low-income community in South Africa immediately prior to the implementation of the HPL on 1 April 2018 and one year later, resulted in two project specific publications as

well as two congress presentations: one in South Africa and the other in the US. A third paper is under review. Information from this project also contributed to several other publications. Some of the key findings of this projects are:

- One year after the tax was implemented, taxed beverage energy intake declined by 24% due to behavioural change and an additional 8% due to reformulation compared to baseline. Most behavioural drivers were not strongly linked to taxed beverage intake, had small changes after-tax implementation, and did not appear to modify the association between policy implementation and dietary intake
- The media analysis found industry expressed no support for the HPL, whereas academics, government, and other sources mainly expressed support. Health reasons were the most common justifications for support, and economic harms were the most common justifications for opposition. Statements that sugar intake is not related to obesity, the HPL will not reduce SSB intake, and the HPL will cause industry or economic harm were all disproportionately high in industry sources
- The tax effect on SSB intake was modified by SSB knowledge and intention to reduce SSB intake, with higher levels of each associated with lower SSB intake
- After implementation of the HPL, the sugar content of beverage purchases fell by 4.9 g/capita/day overall, a 32% decrease. Taken in isolation, consumer switching, and volume changes together led to a reduction equivalent to 71% of the total change, while reformulation accounted for a decrease equal to 34% of that change. Middle-LSM households experienced larger reductions than high-LSM households due to larger changes on the consumer side. For both LSM groups, reformulation-led reductions mostly occurred after implementation, and most changes came from taxable beverage purchases. As sugary drink tax designs evolve with broader implementation globally, understanding both supply- and demand-side factors will help to better assess the population and equity potential of these policies.

6.1.9.4 Leverage project: Front of package labels (FOPL) on food products to inform on high levels of nutrients of concern for NCDs

This research is led by Professor Swart (UWC).

This project started in 2018, and several CoE-FS funded students are using data from the project for their research. Leverage funding is from Bloomberg Philanthropies. The project collects data on the nutrient composition of all packaged foods in South Africa, and also developed and tested a warning label as a possible FOPL for packaged foods high in nutrients of concern (such as sugar, sodium, and saturated fat) in SA. Some of the key findings of this project are:

Almost all participants from all socioeconomic backgrounds were positive about warning labels, reporting that warning labels concisely and understandably educated them about the nutritional composition of foods.

Some participants anticipated that warning labels would reduce their purchases of unhealthy foods. Participants found the warning labels attention grabbing and stated that their preferred most effective label included a black triangle placed on a white background (referred to as a holding strap henceforth), the words "high in" and "warning" in bold and uppercase text, an exclamation mark, and an icon depicting the excessive nutrient. In South Africa, policies that mandate warning labels may improve consumer understanding of nutrition information and assist consumers in determining the nutritional quality of packaged foods and drinks.

The newly developed warning label consistently and statistically significantly outperformed the other FOPLs (Guideline Daily Amount (GDA) and multiple-traffic light) in terms of assisting participants to identify products high in nutrients of concern (sugar, sodium and saturated fat) as well as the unhealthiest of the food products. The warning label as FOPL will complement existing health promotion and obesity prevention strategies such as HPL and restriction of marketing to children. Eighty percent of packaged foods and 60% of packaged drinks in the sample were ultra-processed.

The assessment of sugar in foods was found to "far exceed" recommendations by WHO, and beverages were a big contributor. Before the HPL was implemented, 30% of beverages already contained non-sugar sweeteners (NSS). A total of 222 breakfast cereals were studied, of which 96.9% had a nutritional or health claim, 95.0% had illustrations, 75.2% had product and consumption appeals, 10.8% had characters, 10.8% consisted of different appeals, 8.6% alluded to fantasy and 7.7% had role models. In breakfast cereals with direct child-directed marketing (CDM), the protein and fibre content were significantly lower than in breakfast cereals without direct CDM.

The mean total sugar content was significantly higher in breakfast cereals with CDM compared to those without CDM. The NDoH's director of nutrition as well as the deputy DG: Health Promotion announced on eNCA (19 November 2022) that the revision to Labelling regulation (R146) will be published for public comment before the end of 2022. The revised regulation makes provision for FOPL (as proposed by the research from this group) as well as regulation of marketing to children on packaged foods (as proposed by the research from this group). This group assisted the NDoH (Food Control) with the preparation of the draft regulation as well as the *Socio Economic Impact Assessment System* report to the Department of Monitoring and Evaluation within the Presidency.

6.1.9.5 Leverage project: Researching obesogenic food environments in South Africa and Ghana

This research is led by Professor Swart (UWC).

This project was conducted between 2017 and April 2020 with a no-cost extension to September 2020 and used a three-phase mixed-methods approach to trace the links between foodways, local food retail environments, key value chains and the policy and regulatory environment in South Africa and Ghana.

Some of the key findings of the project are as follows:

Small but significant associations between gender and the frequency of consumption of different foods. Households where men were responsible for food purchases tended to consume higher levels of meat, fast food, salty snacks and ready-to-eat meals, which have been associated with increased risks for NCDs. Households where women oversaw food purchasing and preparation tended to consume more sugar and home baked bread.

Customised data analysis frameworks identified fish as the most commonly consumed protective food in Ghana whilst the most frequently consumed protective food in South Africa was fruit with higher consumption among non-deprived (76.5%) compared to deprived households (50.1%). Lived poverty was higher in South African than in Ghana. Sugar was the most frequently consumed obesogenic food in both South Africa and Ghana. In South Africa, formal retailers were key sources of most of both obesogenic and protective foods. In both Ghana and South Africa there is an increasing 'concentration' of producers, importers and/or distributors into a few large companies. Nutrition related concerns are largely inconsequential within the food system and where it features, it is focused on desire to drive sales, including higher profit yielding products.

Food safety considerations overshadow nutrition, including with regards to the scanty forms of state-based governance. Food vendors on ground level were generally indifferent regarding perceived contribution of their cooking and handling practices to the risk of obesity (malnutrition).

Small-scale actors in the supply chain (a particular feature more relevant in Ghana than in South Africa) have limited capacity in terms of asset base. The lack of access to refrigeration and poor infrastructure (such as roads/transportation modes for fresh produce) drive postharvest losses and make fruits and vegetables less readily available and expensive. Information and power asymmetries lead to weak negotiating/bargaining position of primary producers as against traders (wholesalers and retailers) and drives decline in local markets. This is the case specifically for chicken in Ghana.

Nutrition was a stated policy priority in both Ghana and South Africa; however, policy responsibility was located within the health sector, and integration of nutrition into food system sectors (including agriculture, trade and industry) remained challenging. These sectors had primarily economic mandates, and food policy tended to be aligned with the interests of large commercial industry, with a productivist and 'sufficiency' approach to food security. Furthermore, industry was positioned as a vehicle for economic growth and a 'knowledge holder' with respect to food policy.

Integrating nutrition into multisectoral food policy to achieve multiple food system policy goals will require strategic action across jurisdictions and regional levels. This study identified opportunities for reconceptualising 'nutrition' policy outside of the narrow health or food sector, including through emphasis on externalities associated with malnutrition and, in Ghana, investment in traditional minimally processed foods.

6.1.9.6 Maternal health and nutritional status of mothers (Project ID – 20302 (WP 3.2.4)

This research is led by Professor Swart (UWC).

This project will fund a postdoc towards the exploration of maternal and child nutrition aspects of the Food Consumption survey.

Whilst no data from the NDIS was available for analyses, the postdoc played an instrumental role in the development of the instruments for the Food Consumption survey and the logistics planning for the survey. An alternative data source was identified, and two papers were prepared from this data. Both papers are currently under review and have had comments from reviewers addressed.

The study, called the *Coronavirus Rapid Mobile Survey of Maternal and Child Health* (CRAM-MATCH) formed part of the *National Income Dynamics Study Coronavirus Rapid Mobile Survey* (NIDS-CRAM) data collection and used MomConnect to obtain information on hunger, breastfeeding and mental health of pregnant women and women with young infants during June and July 2020. Some of the key findings of this project are:

- High breastfeeding initiation rates were confirmed (94% in study participants). Although exclusive breastfeeding could not be determined, we assessed the prevalence of children being predominantly breastfed. For infants 0-3 months, 76% of study participants reported predominantly breastfeeding, but by six months, only 28.6% were predominantly breastfeeding although 93.1% of infants were still getting breastmilk
- Eighteen percent of participants (18.3%) reported hunger with 10% reported children in the household also going hungry. The odds of hungry mothers breastfeeding were significantly lower (OR = 0.66; p = 0.045). The prevalence of depression in this survey sample was 26.95%, but there was no association between breastfeeding behaviour and depression scores (OR = 0.89; 95% CI: 0.63, 1.27). A positive correlation was found between not breastfeeding and not going to the health clinic
- Both child and adult hunger were significantly associated with an increased likelihood of depression with postpartum women at greater risk of depression than pregnant women. In September 2022, data collection for the "Cardiovascular, haemostatic and micronutrient status of pregnant women in Johannesburg" (CHAMP study) commenced at the Discoverers Community Health Centre in Roodepoort, Johannesburg. To date, 149 participants (pregnant and non-pregnant) have been recruited for which questionnaires were completed, and anthropometric and cardiovascular assessments (blood pressure and pulse wave analyses) were conducted.

Blood samples were also collected which were processed and stored at Wits Medical School. The postdoctoral fellow, Dr Olive Khaliq, assisted with fieldworker documentation for appointment, procurement procedures for consumables and training of fieldworkers at the end of 2021. However, she resigned at end 2021. A new postdoc (Dr Xolisa Nxele) was appointed, but is currently on maternity leave.

The research under the above-mentioned WPs will continue in 2023, and further results will be reported in the 2023 APR.

6.4 Leverage project: SA–UK Bilateral Research Chair in Social Protection for Food Security in South Africa

This project is led by Professor Stephen Devereux (UWC).

The first five-year cycle of this bilateral SARChI concluded on 31 May 2022; therefore, new research activities were initiated in 2022. In July 2022, the NRF awarded the chair a six-month bridging grant, while they consider a proposal for a second five-year cycle. The intention is to allow him to continue supervising master's and PhD students, and to conclude writing up of ongoing projects.

This SARChI has two overarching research objectives:

- (1) To contribute to knowledge about the drivers of food insecurity in South Africa, which remains at unacceptably high levels for an upper-middle-income country
- (2) To inform improved social protection policies and programmes, in support of efforts to reduce food insecurity for poor and vulnerable South African citizens and residents. Social protection refers to state interventions such as social grants, school feeding, public works, graduation programmes, and Basic Income Support, that provide assistance to poor and vulnerable people.

The strategy for achieving these objectives was to initiate research on several topics that are directly relevant to food security and social protection, mainly in South Africa but also (with co-funding) in other countries, and to generate high-level academic outputs (journal articles, chapters, books) as well as lessons that can be communicated to policymakers through academic and policy engagement (online articles, media appearances, and participation in South African government processes).

The academic outputs include 19 peer-reviewed journal articles, 14 book chapters, six conferences or workshops organised, 32 presentations at international conferences including four keynote addresses, numerous blogs, seminars, webinars, and project workshops, and 33 TV or radio interviews. The majority of these outputs are directly attributable to the SARChI, but all were made possible by the time provided by the award of this Bilateral Research Chair for academic writing and public engagement.

Public engagement and policy advocacy are important components of SARChI chairholder's work, and essential for achieving societal impacts out of academic research. Professor Devereux was appointed to two South African government advisory panels, in 2017 (Food and Nutrition Security) and in 2021 (Basic Income Support). In 2019, the CoE-FS communications manager estimated that my media appearances in South Africa since 2016 (broadcast, print, and online) had reached more than 12 million viewers, listeners, and readers.

The proposal for this Chair had six workstreams. Substantial work was conducted in the first two years (2016 and 2017) on four of these workstreams – social grants, school feeding, public works, and economic and social rights.

Workstream #1: Social grants

A review of literature and quantitative analysis of secondary data of the NIDS dataset in 2016-17, in collaboration with a visiting researcher hosted at UWC by the Chair, explained the paradox that child malnutrition rates in South Africa are unchanged since the 1990s despite a massive expansion in the Child Support Grant. Findings were presented in seminars at ISD in Cape Town and at IDS in Brighton. The Chair made a plenary address on this topic at the World Nutrition Congress in Cape Town, and international conferences in Bonn and Johannesburg. Publications include: one CoE-FS Working Paper, two online articles in The Conversation, one journal article in *Food Security*, and one book chapter co-authored with the CoE-FS director.

In 2017, Professor Devereux was invited by the DSD to join their Technical Working Group on Food and Nutrition Security, and he chaired a commission at government's Food and Nutrition Security Indaba, which reviewed and revised the social protection chapter of the *National Plan for Food and Nutrition Security*.

Workstream #2: School feeding programmes

This Chair established a national School Feeding Working Group in 2016 and chaired four working group seminars at UWC under the CoE-FS. Professor Devereux conceived, organised and was director of South Africa's first National School Feeding Workshop, where he delivered the keynote address. He did a radio interview and a TV interview during the workshop. He lead-authored a CoE-FS Working Paper based on the National School Feeding Workshop. Professor Devereux supervised the research of two MA students at UWC on the impacts of the National School Nutrition Programme (NSNP).

Workstream #3: Public works programmes

The Chair led a research project on public works in Chad (Devereux and Watson 2016) that generated relevant learning for South Africa. Professor Devereux supervised the research of a PhD candidate at UWC into the impacts of the Expanded Public Works Programme on Food Security in South Africa.

Workstream #4: Economic and social rights

SARChI research on this theme focused on the rights to food and to social protection. Professor Devereux was an advisor for a Max Planck Institute project titled "The ILO Recommendation on Social Protection Floors" in 2016. His SARChI co-sponsored a workshop on this topic at the University of Johannesburg, where he presented a paper titled *Social Protection Floors and the Right to Food* that was published as a book chapter in 2017. Professor Devereux delivered the keynote address, 'The Right to Social Protection in Africa', at the conference "Law for Development" in Berlin that was published in the journal *Law in Africa* in 2017.

In the period 2018 to 2022, research and related activities were conducted under the two remaining workstreams – farmworkers, and graduation programmes – and four new workstreams were added – social protection policy process, COVID-19, basic income support, and resilience and food security.

Workstream #5: Farmworkers in South Africa

The Chair collaborated with WFP, a feminist NGO, on a research project that analysed violations of labour rights of farmworkers in the Western Cape and Northern Cape. The research report was presented to a South African parliament portfolio committee meeting and was well received – one MP called it an "excellent" report. Findings were presented at seminars at the Institute for Poverty, Land and Agrarian Studies (UWC) and IDS (Sussex), and at the "National Conference on the Future of Farm Workers in South Africa" that was conceived and directed by the Chair. A single-authored journal article was published in *Development Southern Africa*.

The Chair also designed and managed a research study into food insecurity among farmworkers in the Northern Cape. Outputs included co-authored online articles in GroundUp and the Mail & Guardian, and a paper Professor Devereux presented at the 4th International Conference on Global Food Security in 2020, and an article in the journal *Nutrients* (impact factor = 4.171), co-authored with a UWC researcher I mentored. Two of the Chair's NRF-supported MA students wrote their mini-theses on food security among farmworkers under his supervision, building on work as research assistants for this project.

Workstream #6: Graduation model programmes

Graduation programmes deliver an integrated package of social protection plus livelihood support to poor households, and have proved their ability to lift beneficiaries out of extreme poverty in several countries in Africa and Asia. Professor Devereux led a series of research studies of graduation model programmes in Burundi, Rwanda and Bangladesh, with funding from other sources, to generate evidence that could be synthesised and adapted to the South African context. Publications include two book chapters, three journal articles, four research reports, and one conference paper.

Workstream #7: Social protection policy process

This SARChI provided an opportunity to develop a research agenda around the social protection policy transfer process in Africa, including in South Africa, exploring the roles of governments, international agencies, and individuals in the rapid rise of social protection as a policy agenda in Africa since 2000. In 2019, Professor Devereux was awarded a Mercator Fellowship by the SOCIUM Research Centre on Inequality and Social Policy, at the University of Bremen, Germany, and a contract with Palgrave Macmillan for a book provisionally titled "Policy Pollinators: The role of transnational agents in propagating social protection in Africa". Research is ongoing, and the manuscript will be submitted to the publisher later in 2022. Outputs to date include two Working Papers, four conference papers, and five seminars or webinars.

Workstream #8: COVID-19

The COVID-19 pandemic arrived in early 2020 as an unprecedented shock that affected food security and provoked a substantial social protection response by governments around the world, including in South Africa. Since this is highly relevant to the themes of the SARChI, Professor Devereux added new research, advisory and advocacy activities to his workplan in 2020 and 2021. He conducted new research into the impacts of COVID-19 on food security, in Ethiopia, in Eswatini, and on social protection in Bangladesh, the Middle East, and South Africa. Professor Devereux conducted a two-round panel survey on COVID-19 impacts on farmworkers in the Northern Cape. He was invited by the African Union to contribute a chapter on social protection to *Africa's COVID-19 Recovery Strategy*. Outputs include three journal articles, one briefing paper, seven online articles, two research reports, four conference presentations, five webinars, and seven radio interviews.

Workstream #9: Basic income support

COVID-19 reignited a public policy debate around a Basic Income Grant in South Africa. This issue relates directly to the SARChI's research interest in social grants in South Africa, so Professor Devereux added this theme to his work programme. In 2021, he was appointed to an expert panel by the DSD to investigate "The Appropriateness and Feasibility of a System of Basic Income Support for South Africa" for the Cabinet. He co-authored the expert panel report and participated in several dissemination activities. Outputs include one research report, three online articles, two webinars in the presence of the DSD minister, four television interviews and five radio interviews. This work provided empirical support for the government's decision to extend the COVID-19 Social Relief of Distress Grant until March 2023, after which it could become a permanent Basic Income Support.

Workstream #10: Resilience and food security

A colleague from the International Center for Tropical Agriculture and Professor Devereux secured a contract from Palgrave Macmillan for a co-edited book on "Resilience and Food Security in a Food Systems Context". They conceived the book, identified authors for thematic chapters, organised and chaired an online workshop and an online conference, edited the draft chapters, co-authored two chapters, and submitted the manuscript to the publisher in March 2022. Contributors include world leading experts from Cornell University, Johns Hopkins University, University of London, CIRAD and the International Food Policy Research Institute, as well as South Africans from UWC, UCT and the CoE-FS. The book synthesises cutting-edge research and thinking on resilience, food systems, and food security.

The main challenge faced throughout this SARChI was the fact that it covered only half of Professor Devereux's time, since he was seconded from his employer (IDS) for 50% of each year, with the other 50% being dedicated to work undertaken for IDS. At the same time, since capacity strengthening is the *raison d'être* of this Bilateral Research Chair (being co-funded by UK's Newton Fund and South Africa's NRF), Professor Devereux carried two full loads of postgraduate supervision since 2016, at the ISD at UWC in South Africa and at IDS in the UK. This left only one-third of his time for research and policy engagement in South Africa under this SARChI.

COVID-19 presented major challenges in 2020 and 2021. Several students under Professor Devereux's supervision were unable to undertake fieldwork or were personally affected by COVID-19 in ways that significantly slowed their progress towards completion. In terms of research, Professor Devereux had to postpone and then abandon a planned study of informal social protection mechanisms in South Africa such as burial societies, due to a moratorium on conducting face-to-face interviews during the lockdown.

This Chair has been extended for another five-year cycle from 2022.

6.5 Leverage project: Partnerships for Healthy Diets and Nutrition in Urban African Food Systems – Evidence and Strategies (NOURICITY)

This is a collaborative agreement between the project lead, ZEF, and the CoE-FS. The other PIs are at Wageningen University, UG and MAK, Uganda. The core team consists of: Dr Nicolas Gerber (PL, team coordinator), ZEF; Professor Julian May (PL, UWC); Professor Felix Asante (PL, UG); Professor Vincent Linderhof (Wageningen University); and Dr Coretta Jonah (UWC) (2018–2019).

The research project investigates three factors influencing urban food systems. These are:

- Urban food sources, characteristics (including food safety) and rural-urban linkages as "systemic" drivers of food choices and nutrition
- People's access to nutrition-related knowledge (formal and informal, indigenous and Western), income, food tastes, habits and culture, as "individual" drivers of food choices
- How systemic and individual drivers combine to determine people's food consumption and nutrition status.
Little is known about the differences within Sub-Saharan Africa that shape transitions from diets characterised by undernutrition to overnutrition, especially in the urban context where food systems become more complex. In particular, lack of evidence on food consumed in the informal sector and away from home hampers the analysis of the different burdens of malnutrition in communities, households, sometimes individuals. The urban food system in Sub-Saharan Africa is also often associated with issues of food safety and low food quality (low nutritional value), which need to be addressed at the food system level but also within the households. A wide variety of policies need to be considered in the way they affect the different actors of the urban food system and the ultimate goal of improved nutrition and health.

This project aims at improving urban nutrition in Africa by bridging some of the knowledge gaps on urban malnutrition and its systemic (in our case, mostly retail-level) and individual (household level) drivers as well as on the impacts of policies and their spheres of action and mandates. By bringing together stakeholders of the urban food systems to disentangle their roles, responsibilities and possibilities to act and support improved urban nutrition, research outcomes strived to deliver a partnership concept for improved policy interventions for urban nutrition in the three main study cities: Accra, Cape Town and Kampala. The partnership concepts are key contributions to foreseen impacts, i.e., improved urban nutrition in Africa.

Further progress is realised in the project teams' understanding of the drivers of behaviour toward food quality and safety at the retail space and in the households, as well as individual behaviour of urban consumers with respect to safe and nutritious diets in the context of their urban lifestyle and its constraints (e.g. time management), or their level of information about safe and nutritious diets and their acceptance (internalisation) of such information, for specific groups of the urban society (income groups, age, gender, etc.).

Research uptake activities have been completed, though delayed in all study countries due to the pandemic and to the mentioned funding issues in Ghana.

The highlight and achievements of this project are as follows:

Stakeholder engagement: In Ghana, four stakeholder workshops have highlighted the main issues at the retail sector level, discussed them with public authorities, mapped policy and public interventions around urban nutrition and food safety/quality, especially highlighting the applicability of the institutions' mandates, and a partnership workshop. In Kampala, two workshops were conducted. On the first day of the first stakeholder workshop with people from Kanyanya, there was initiated a "CoP" group in the parish on "Improving nutrition quality and reduce food unsafety". On the second day, high-level stakeholders discussed the food security challenges with the main challenge, the knowledge of people of Kanyanya on what healthy food is or what healthy diets are. In the second workshop (Feburary 2020), potential strategic interventions to improve healthy food and healthy diets were discussed. Participants were higher level stakeholders and a selection of representatives of Kanyanya parish. **Capacity building:** The "working" workshops for stakeholders took place in 2021 and 2022, capitalising on the first workshops, strong media attention to food safety and nutrition in 2019 (e.g. in Ghana) and COVID-19. On the research side: young female colleagues from South Africa (Dr Coretta Jonah and Winnie Sambu) stayed for one month at the coordinators institute in Germany in September 2019, developing their research plans with German colleagues and with the Ghanaian partner, who also visited ZEF once for a month and another time in 2021 for a week. The ZEF doctoral researcher is also Ghanaian. Another doctoral colleague in South Africa benefited from a scholarship delivered by the German coordinator to complete her thesis in the project.

No monitoring and evaluation of uptake have taken place within the project. However, the academic impact has been the sharing of research methodologies and study protocols across the consortium. For example, the research team in Pretoria has shared food safety lab protocols with research institutes in Accra; the teams in Cape Town have shared methodologies for urban food systems mapping with consortium members at the University of Ghana and Bonn. The impact of the last participatory activities in 2022 will only be visible after the project end and, thus, are not part of a set monitoring and follow-up process, unfortunately.

The success of the stakeholder engagement process in Accra relied heavily on the connection of the Ghanaian partner with research facilitators in the local communities around the open markets and with policymakers and the ministerial level. Crucially, seizing on local media buzz and national level discussions on food safety and hygiene, linked to the country's open markets, has worked to guarantee support and participation of the stakeholders, despite the long break in the field activities due to the pandemic. This participation led to a stronger focus on the food safety issue in the retail space throughout the research activities. In Uganda, there are small initiatives (pilots) to improve food and nutrition security but most of them are related to traditional settings (urban agriculture via sack gardening, keeping traditional diets with traditional preparations). In South Africa, the presence of the NOURICITY partner and its associates in the field of food security was well positioned long before the project. This just continued throughout the project, embedded in the consultation activities and exchange with, notably, the Cape Town and Western Cape town and district authorities and the community associations in Langa, in particular.

6.6 Leverage project: Exploring Food System Transformations in Rapidly Changing African Cities (Food4Cities)

This is a collaborative agreement between the project lead, VU-A and UWC. The other collaborators and PIs are at KU Leuven and MAK. The core team consists of Professor Peter Verburg (PL, team coordinator) (VU-A); Professor Anton van Rompaey (PL, Kampala) (KU Leuven); Professor Shuaib Lwasa (MAK); Dr Jacqueline Davis (VU-A), (2018–2020); Dr Nyasha Magadzire (UWC) (2019–2020); Lisa-Marie Hemerijckx (KU Leuven); Professor Julian May (PL, Worcester) (UWC), and Raymond Esau (BVM).

Food4Cities developed representations of food systems and urban growth of rapidly developing African cities through multidisciplinary methods that identified trade-offs and synergies between food systems, urbanisation and other development goals. Focusing on the secondary city of Worcester in South Africa, and Kampala, Uganda, this project aimed to analyse and map the urban food system and its relationship with food security. The project comprises of the following WPs:

Knowledge co-production and participatory planning

The Food4Cities team worked collaboratively with local stakeholders to acquire knowledge and plan interventions in the local food system. Through remote imaging via drones, household surveys and stakeholder interviews, they team was able to produce a robust picture and understanding of local food systems and levels of food security in the urban context. As a result, the knowledge produced had proven insightful and helpful in addressing and planning for food security in the midst of the COVID-19 pandemic.

Characterise the food system

Through the co-production of knowledge, it became evident the important role informal food retailers share with formal retailers. Household food technologies for food preparation and cooking affect diet quality. Food insecurity varies at smaller geographic units than at the neighbourhood-level. While subsistence farming plays an important role in some cities, it has not shown to protect against hunger; informal food-sharing networks and an income were protective against hunger.

Model food systems dynamics and explore alternative futures

The spatial relationship between households and the food environment provides a dimension that allows for monitoring change in food accessibility and availability. Urbanisation leads to patterns of residential segregation contributing to inequalities in urban food access. Through analysis and modelling, local stakeholders can explore scenarios for proactive planning to examine the urban landscape influencing food security and the food environment.

Collaboratively plan for the future

The COVID-19 pandemic provided an opportunity to leverage the acquired knowledge to mobilise a plan to address food security during nationwide lockdowns that saw the closures of informal markets and restricted market hours. The research approach fostered synergies among different stakeholders to proactively address food security beyond interventions focusing on individuals and households.

One of the main innovative outcomes was the Massive Open Online Course that was developed in partnership with KU Leuven. The MOOC will be hosted on an edX platform and accessible for all stakeholders and the public. Further, the Food4Cities work contributed to informed policy decisions to address food access in vulnerable areas during the COVID-19 pandemic. Through the course of the project period, the following results and progress were made toward our research outcomes:

Cross-sector planning and decision making for city food systems:

<u>Worcester, South Africa:</u> Four meetings and three in-person stakeholder workshops were held with officials and councillors from the BVM and the Cape Winelands District in which the BVM is located. Five meetings and two in-person stakeholder workshops were held with officials from the WCG under the auspices of their Nourish2Flourish Strategy. Lastly, one meeting was held with the NPC and there was participation in four online stakeholder engagements with the DALRRD at which results from Food4Cities were presented.

<u>Kampala, Uganda:</u> Meetings were held with Uganda National Farmers Federation, Kampala Capital City Authority (KCCA) and the <u>Meeting at Ministry of</u> <u>Agriculture, Animal, Industry and Fisheries</u>. The planning cannot keep up with the urban growth rates of Kampala. Urban expansion is a major threat to food systems as high-quality farmland is lost to residential use. KCCA is very interested in any urban growth models. With the growing demand for food in urban areas, there is increased efforts to work with the other departments of the government as well as the private sector to address this situation by improving infrastructure such as transport and electricity. As youth become less interested in farming, the age of farmers is going up, with labour productivity going down, as a result. In addition, there was also an issue of labourers leaving farming to work in construction. Introducing new technologies may help address this deficit. Demand for food in rural areas is becoming higher as urbanisation continues. This demand going up also influences food prices. Also, eating habits in Uganda are changing, as youth want to eat fast food.

In both projects the project played a key role, through its activities of mapping the food system and co-designing interventions, in bringing stakeholders of different sectors together and creating awareness of the need for inter- and cross-sectoral planning.

The highlights and achievements of this research in 2022 are as follows:

Science, data and decision support tools for city food systems planning:

In Worcester, through household surveys, the team was able to map hot spots of food insecurity. Overlaying these data with spatial locations of the formal and informal food retailers and traders, it was the important role informal retailers have in these communities was evident. Further, through local co-production of knowledge, the role ECD centres have on feeding children to combat food and nutrition insecurity was also evident. As a result, ECD centres were also mapped to inform local stakeholders of gaps and opportunities in supporting food assistance. Progress continues in mapping the movement of food in and out of the Worcester area, as well as movement within the city. Participatory food system mapping was used with different stakeholder groups and integrated in consistent models.

In Kampala, spatial analysis focused on the relationship of food and nutrition security and the three dimensions of food access: physical, social and economic. The team mapped the formal food system to measure the physical accessibility.

With the social and economic factors, a radar chart was created to visualise the vulnerability of different socioeconomic groups within the city food system. The results show that more established urban dwellers experience different access vulnerabilities than newly migrated residents, depending on their income. Lower income groups compensate their limited economic accessibility by participating in food-sharing networks.

The work demonstrated a socioeconomic segregation and urban sprawl jeopardising food access for vulnerable population groups. The team also examined the difference in food origins among households of different socioeconomic status through the lens of foodsheds. This foodshed assessment showed that over 95% of the food consumed in the city originates from within national borders. With 9% of the food consumed in Kampala grown in Greater Kampala, urban agricultural activities are, at present, twice as important as import for the urban food provision.

Human capacity development for enhancing food and nutrition security in city planning:

Urbanisation threatens residential development and agricultural land uses while increasing demand for food. As result, it was important to examine the food system and patterns of human settlements. In Worcester, as part of the larger BVM, the IDP highlights the need to transform rural and urban development to prioritise equitable, sustainable communities and food security. Due to limited resources within the BVM, IDP emphasised the importance of social capital. The roles of ECD centres and informal food trade provide a capacity to improve food security in vulnerable communities. With access being a significant factor of the local food system, the IDP also addresses the patterns of food movement through the taxi ranks that provide a crucial connection between residents and informal food traders.

In Uganda, the team used Agent-Based Modelling (ABM) for future planning of the food system. The ABM factors patterns the local food system, urban growth and socioeconomic segregation in Kampala. This is currently in progress (due to delayed funding) and will aim to give stakeholders and policymakers information to plan for potential food demand and distribution.

Communication materials for policy makers, planners and civil society:

The results and findings from the Food4Cities have been communicated and shared are various forums. During the COVID-19 pandemic, the BVM reviewed where food insecurity hot spots are and where informal food traders are located. During the strict lockdown, this information allowed agencies to identify where to prioritise food distribution sites. Similar work was done in Kampala: a rapid response brief was prepared for city managers to examine the impact of COVID-19 lockdown measures on food access in the Kampala city region, Uganda.

Further, the IDP is a formal policy and planning document informing policymakers of growth and economic development strategies that include improving food security. In addition, results of the study also informed the FAO Rapid Food System Assessment which fed into the UN Food System Summit in September 2021. Results have also been presented to an online Food Forum organised by partnering collaborator, the WCEDP and the SAFL. In Kampala, the team created a database of household food consumption and vendor food-selling activities for municipality planning.

In the broader public and communities, the results have been mentioned in community radio interviews conducted with Valley FM and Radio 786. There have also been articles published in The Conversation, Daily Maverick, and Business Day, among others.

As mentioned above, one of the key innovative outcomes of the project is the dissemination of findings through an online education platform. The MOOC focuses on "Urban food systems in Africa" and it will be hosted on the edX platform, with open-access options for stakeholders and an option to purchase a course completion certificate.

Also, the Food4Cities project mapped the local food system and household food consumption and food purchasing behaviours in Kampala, Uganda and Worcester, South Africa. Through the co-production of knowledge with local stakeholders, there is now a better understanding of the spatial relationship of households experiencing food insecurity and where households get their food. Food insecurity varies at smaller geographic units than at the neighbourhood-level. In addition, while subsistence farming has not shown to protect against hunger, informal food-sharing networks, and an income were protective against hunger.

Further, there is an understanding of where food sources originate. The majority of food is sourced within the national boundaries. In addition, the informal food sector has an important role in improving food accessibility for vulnerable communities. Urbanisation leads to patterns of residential segregation contributing to inequalities in urban food access. Through modelling, local stakeholders can explore scenarios for proactive planning to examine the urban landscape influencing food security and the food environment. It is evident that urban growth and socioeconomic segregation creates vulnerabilities for food access. Therefore, modelling is a useful tool for local policymakers and other stakeholders in planning for food demand and equitable access to adequate nutrition. Modelling continues to be a work in progress.

The team engaged with their stakeholders in various ways. In addition to in-person and virtual meetings, they conducted stakeholder workshops and on-the-ground engagement through learning journeys. A learning journey is a research process engaging researchers and stakeholders for a "visit to the system". This interactive approach allows for co-production of knowledge from the community. The Food4Cities project team and partners worked closely with local partners in building capacity to inform food systems planning. In Kampala, the team developed a dashboard and database of household food security and the formal food system. Similarly, the food system and household food insecurity maps contribute to the capacity for local governments to make informed decisions for food distribution. Further, the Food4Cities project engaged local partners and stakeholders who will continue to support capacity-related needs.

The modelling of the local food systems continues to be a work in progress as these communities' plan for urban growth; however, it is understood that the community faces challenges with urbanisation. As a result, this will increase the demand for food. The project had a communications and dissemination plan which accounted for internal communications and external communications and dissemination of information including research findings. Internally, all protected data were stored in a secured data repository. Shared drives were used to share working documents and meetings notes. Externally, the project shared information in several ways: though media, project activities and findings were shared via social media (i.e., Twitter, Facebook and Instagram) and through radio interviews and print and online media.

In addition, the team prepared policy briefs to stakeholders, including policymakers. Among the academic community, the teams has six peer-reviewed papers published or in press. Additionally, they presented their findings at several conferences and seminars. The proposal did not specifically address monitoring and evaluation of uptake. Stakeholder meetings have raised awareness and commitment of the stakeholders, as can be seen in their continued participation in learning journeys. Insights discussed will propagate into planning and policy, but in complex ways, integrated with other inputs. The MOOC will soon be released, and uptake will be monitored.

6.7 UNESCO Chair in African Food Systems

The UNESCO Chair in African Food Systems, held by the CoE-FS director, was established at UWC by UNESCO on 12 December 2017. The Chair was launched in December 2017 at the 3rd Global Food Security Conference (GFS) in Cape Town. During 2018, funding was raised for an inception meeting held in April 2019 in Tunisia. This was attended by 15 representatives from founding universities located in eight countries. An agreement on the goals, objectives and action plan for the first cycle of the Chair was reached. The final objectives are thus:

- To support transdisciplinary modes of inquiry to better inform the analysis of food security and nutrition in Africa
- To promote and facilitate Africa-wide partnerships for research, innovation and training activities
- To foster a transformative agenda for African scholarship on the food system through research, training and engagement by providing opportunities, leadership, evidence for decision-making and informed debate, and critique of policies and programmes aimed at addressing food insecurity.

These align with the UNESCO priorities of gender equality and Africa. Gender is central to the production, processing and utilisation of food in Africa which is shaped by relationships of patriarchy that impact on issues as divergent as access to land, uptake of technology and 'maternal buffering' whereby women give up food to ensure that their children receive nutrition. Scholarship in the field is itself gendered. African women remain under-represented in the Science, Technology, Engineering and Mathematics (STEM) fields of enguiry that are central to the analysis of food systems. Activities undertaken by the Chair focus on the eradication of poverty as manifested by hunger, malnutrition and food insecurity. Emphasis is placed on the situation of children, and the Chair was involved in the publication of a significant report on child nutrition in South Africa during 2020. Sustainable development is a priority with activities directed towards climate change, soil and plant health, and the sustainability of the African food system. Finally, intercultural dialogue is central, both in terms of the activities in all regions in Africa, as well as the spread across the natural and social sciences, and the humanities.

The COVID-19 pandemic exposed the vulnerabilities and inequities of both the global and African food systems. It also disrupted the plans prepared in Tunisia. While the first and last of these objectives were achieved, the GFS was postponed and then run as a smaller virtual event, while the restrictions on international travel hindered networking activities. Nonetheless, the Chair has made progress toward its goal to increase and promote the contribution of the African academic community towards building sustainable food systems.

Firstly, the Chair was able to facilitate three successful proposals concerning the African food system. In 2018 and 2020, the Chair worked with universities in Europe responding to joint Europe Africa Research and Innovation funding calls to partner with universities in Africa. Through LEAP-Agri H2020 and the ERA-Net Co-Fund on Food System and Climate (FOSC), consortia were established that included the Universities of Bonn, Ghana, KU Leuven, Makerere, Moi, UP, VU-A, UWC, and CIRAD. Projects in Ghana, Uganda and South Africa have been completed, and a project concerning climate change in Algeria, Kenya and South Africa was launched in 2022. These resulted in mobilities of students from South Africa, Ghana and Kenya to Europe in the period prior to COVID-19, which will continue now that global travel is possible. Each project also generated scholarly publications and included a component focused on knowledge brokerage and engagement with policymakers.

Secondly, in 2021 the Chair prepared an African Food Systems conceptual framework developed with the African Research Universities Alliance (ARUA) Centre of Excellence in Sustainable Food Systems at UP and its collaborators, the universities of Ghana and Nairobi. This framework is being used by their Food Systems Network (FSNET) project discussed below. More than half of these researchers are women drawn from countries throughout the continent. Before the global lockdown, the Chair gave presentations of this conceptual framework and planned activities at the Erasmus University, VU-A, KU Leuven, and the universities of Bonn, Ghana and Pretoria. Virtual presentations have been given in Cairo, Nairobi, and Paris.

Finally, the chairholder was appointed as a visiting fellow in the Centre for the Advancement of Scholarship at UP. In this capacity, two international events were held in 2022 to celebrate World Food Day, one of which was at the 2022 Norman E. Borlaug International Dialogue: World Food Prize meeting, and a special edition of *Sustainability*, which is in progress. An application for the extension of the Chair has been done in 2022, and the CoE-FS is awaiting the outcome of this.

6.8 Leverage project: Infant and Young Child Feeding Advocacy (IYCF) project

The project is led by Dr Chantell Witten (UWC), and is supported by Dr Nazeeia Sayed (UWC).

The WHO has set a target for EBF of 50% at country-level by 2025. Despite the global evidence base for the benefits of breastfeeding, and the national policies and programmes that predominantly target pregnant and breastfeeding mothers, suboptimal and premature cessation of breastfeeding are the norm in South Africa. Without accelerated efforts to build a pro-breastfeeding environment, South Africa will not reap the many benefits of optimal breastfeeding, or meet the 2025 target for EBF. Based on the current evidence, the trajectory for breastfeeding indicates that breastfeeding will no longer be a norm, having significant negative impacts on the health and development of future generations.

This project aims to create an environment where women's breastfeeding choices are not unduly influenced by the marketing of infant formula. The project is aligned with and in support of the strategic initiative of WHO to work with countries including South Africa to strengthen legislation with respect to implementing the "International Code of Marketing of Breast-milk Substitutes", and monitoring and enforcing the "Regulations Relating to Foodstuff for Infant and Young Child Feeding in South Africa" (Regulations R991). This is an 18-month project funded by the FLRF. The project uses a multisectoral engagement process to develop an advocacy strategy to counteract the marketing of infant formula in South Africa. It is designed to follow and test a prescribed process previously used for policy development in Ghana, and falls within the domain of operational research. The project is currently in the initiation phase.

A project kick-off meeting was held on the 3 May 2022. A Technical Working Group with monthly meetings, was established; a IYCF STEERCOM with monthly meetings was established; the ethics application for research study was submitted; and a media analysis to inform the target market research has started.

This project has been invited to share project progress at several forums with engagements with the CoE-HUMAN, SU's Department of Global Health, The Health Living Alliance, Food Justice Coalition and Black Sash. The project hosted two symposia sessions at The Global Health Networks Conference in Cape Town, 22 November 2022, and the Child Health Priorities Conference, 24 November 2022.

The project has been cited in several articles in the Daily Maverick that has specifically addressed industry influence and interference in public health discourse. The project has been recognised by the NDoH as an undertaking that will positively influence the breastfeeding landscape in South Africa, and the IYCF participated in the CoE-FS and NRF co-hosted webinar, "Strengthening resilience in nutrition and food security on the African continent.

Research under this project will continue in 2023, and further research outputs will be provided in the 2023 APR.

6.9 Research outputs

Table 9 provides the cumulative total of peer-reviewed and other recognised research outputs.

Output	Output
Articles in refereed/peer-reviewed journals	58
Books/chapters in books	7
Conference output (presentations)	37
Other significant conference output (seminars, workshops attendance)	60
Working papers/technical/policy reports	12
Other recognised research outputs (communication and visibility)	293

Table 9: Research outputs

7 KPA 2: EDUCATION AND TRAINING

7.1 Education and training numbers

The CoE-FS supported, in total, 127 students in 2022 (NRF-, leverage-funded and non-bursary holders).

Appendix 6 outlines the continuing students and postdoctoral fellows who were supported through NRF funding, and Appendix 7 outlines the new students and postdoctoral fellows who were supported through NRF funding in 2022. Appendix 9 outlines students who were supported through leverage funds, and Appendix 14 outlines students who were not funded by the CoE-FS but who were supported.

7.2 Synthesis of training

Table 10 presents the spread of NRF bursary holders, and Table 11 provides the information of students across the collaborating institutions. Also, Table 12

provides the information of leverage-funded students. Table 13 provides information of students who were supported by the CoE -FS but who did not receive bursaries.

Category	Total
Honours students	0
Master's students	14
Doctoral candidates	21
Postdoctoral fellows	8
Total postgraduate students	43
Total RSA master's and doctoral students	32
Total students from African countries (master's and doctoral)	6
Total foreign (not from Africa) master's and doctoral students	0
Female master's and doctoral students (RSA)	26
Black master's and doctoral students (RSA)	22
Honours/BTech graduations	1
Master's graduations	10
Doctoral graduations	3
Postdoctoral fellows	2

Table 10: NRF bursary holders

2022		Level							
Institution	Doctoral	Honours/B Tech	Master's – Research-based	Postdoc	Total				
SU	-	-	-	-	-				
UCT	-	-	-	-	-				
SAMRC	-	-	-	-	-				
UP	7	0	6	3	16				
UFH	-	-	-	-	-				
UL	-	-	-	-	-				
UWC	14	0	8	5	31				
Wits	-			-	-				
Total	21	0	14	8	43				

Table 11: NRF bursary holders across collaborating institutions

Table 12: Leverage-funded bursary holders

Category	Total
Honours students	1
Master's students	6
Doctoral candidates	13
Postdoctoral fellows	2
Total postgraduate students	22

Table 13: Non-bursary holders supported

Category	Total
Honours students	6
Master's students	11
Doctoral candidates	12
Postdoctoral fellows	0
Total postgraduate students	29

7.3. Graduations/fellowships completed

In 2022, a total of 33 bursary holders graduated, or completed their studies. That is 16 NRF-funded students and 15 leveraged-funded students, and two non-bursary holders. See tables 14, 15 and 16 below. Appendices 10, 11 and 15 provide the details of these graduates.

Table 14: NRF degrees conferred

Degree	Total
Honours	1
Master's	10
Doctoral	3
Postdoctoral	2
Total	16

Table 15: Leverage-funded degrees conferred

Degree	Total
Honours	5
Master's	7

Degree	Total
Doctoral	3
Total	15

Table 16: Non-bursary holder degrees conferred

Degree	Total
Master's	2
Total	2

7.4 Education and training highlights

The education and training of students and postdoctoral fellows is a core activity through which the CoE-FS works towards systematically developing a creative research training environment that is internationally competitive. Most of the research undertaken by the CoE-FS takes place via student research training at postgraduate level. It thus creates a conducive and collaborative environment in which students are exposed to experts from various fields of research under the food security umbrella.

However, opportunities for training and education take place not only through bursaries. Students are also developed through various workshops, conferences and meetings, which are forums for student development. The CoE-FS engages in a broad range of capacity-building activities. For example, our CoP meetings involve civil society and the private sector (especially from the informal economy). These meetings include a co-production of knowledge component explicitly focused on transformation and capacitation. We have also undertaken learning journeys that have a similar function. We have engaged with summer and winter school programmes at UCT and SU, as participants and as trainers. In addition,all Pls serve on mentoring programmes at their universities.

Not only has the CoE-FS provided opportunities and incentives for academics based at various institutions (locally and internationally) to work together, but additionally, students associated with the projects have also been exposed to a range of experts from other institutions, as well as other disciplines, through participation in research meetings, conference presentations and seminars.

Mentoring is a component of our education and training activities. For example, three black South Africans at the UP Department of Consumer and Food Sciences were trained by Professor Emmambux; they are now in a position to train other students in this field. Dr Nwabisa was mentored as a young scientist,

Mukwevho is a lecturer and is still working towards his PhD, and Nekhudzhiga, a lab manager, is also working towards his PhD. These three will hopefully be future academics that thrive for excellence and will promote food security and nutrition research.

Postdoctoral fellows are also given the opportunity to supervise honours students and form part of MSc and PhD projects. Students in the project led by Professor Ludidi were given opportunities to attend training courses locally, and some have been supported to undertake training abroad (in theoretical and practical work that will enhance their competency within their discipline). Through the exposure to practical work using various laboratory protocols, students will hone their skills in different techniques and operation of sophisticated equipment. They will mentor junior students and pass on these skills. Students will also be expected to report and present their work in both a formal and informal setting to gain both writing and presenting skills in both a scientific and lay setting. The constant interaction with fellow scientific researchers will also improve the students' abilities to adapt fast to changing situations and be confident in their work.

Mariam Nakitto, a PhD candidate from Uganda, attended a "Handling media interviews" training session at UP on 14 October 2022. The training provides researchers with the skills to communicate the impact of research to broader audiences. BSc Hons Food Science students presented the outputs of food product development projects at the annual South African Association for Food Science and Technology (SAAFoST) Student day event at UJ. This event provides an opportunity for junior researchers to benchmark their work with that of their peers.

All students, CoE-FS-funded, and leverage-funded or non-bursary holders, in the project led by Professor Swart, are part of the mailing list of international collaborators and invited to webinars and congresses on relevant topics. Students are also often funded (from sources other than CoE-FS) to attend conferences. As an example, all of the CoE-FS-funded students were funded to attend the International Congress of Dietetics held online from 1 to 3 September 2021. Four students attended the 2022 EAC meeting on 11 and 12 October 2022.

Dr Sayed participated in the South Africa Sweden University Forum (SASUF) collaborative visit to Umea University. She is currently preparing a proposal for funding through the SASUF virtual engagement theme. A master's student (leverage-funded), Tyler Coates, is doing the scoping review on "Environmental impact metrics of foods and diets" for this project as part of his MSc thesis.

Alice Khan, a former CoE-FS-funded master's student who is currently funded for her PhD through leverage funding, has participated in several of the Bloomberg-funded Healthy Food Policy activities. The postdoc Juley de Smidt and master's student Mariam Hassan (leveraged-funding) attended the Investigators meeting of PURE in Istanbul, Turkey, from 23 to 25 October 2022 with Professor Swart. Their participation was funded by the Population Health Research Institute Canada. Master's and PhD students presented their preliminary findings during a mini-symposium on 9 September 2022. This meeting was attended by Professor Shu Wen Ng from the University of North Carolina. Abstracts from four of the students have been accepted for presentation at the 2023 Nutrition Congress. Two PhD candidates (Catherine Pereira-Kotze and Tamryn Frank) participated in the M3T competition and Frank won the UWC event and came third in the national competition. Her presentation is currently being adapted to be used by HEALA as an advocacy tool for FOPL regulations (when it has been promulgated).

8 KPA 3: INFORMATION BROKERAGE AND RELATED ACTIVITIES

The CoE-FS met and exceeded its information brokerage targets as per the SLA 2018–2023 and has done so annually. This, despite ever-increasing competition in the attention economy; regular changes to algorithms; the proliferation of content producers and content dedicated to, for instance, food and nutrition; the restrictions and challenges presented by the COVID-19 pandemic; and a lengthy vacancy in the communications manager position, which was filled in October 2021.

The CoE-FS uses its communications platforms to disseminate and translate its research and share its events and activities. In 2022, this has taken place predominantly through proactive media engagement and across its social media and digital platforms.

Below are some of the highlights of the CoE-FS's performance and, and the visibility achieved through our various channels in 2022:

- Partnering with the NRF for a special "Science for Society" Africa month lecture
- Extensive coverage of the <u>IYCF</u>
- Collaborative communication and engagement around the learnings journeys in Worcester and Langa, with the WCEDP, and the World Food Programme's (WFP) regional director joining one of the days.
- Gastronomies, a creative and collaborative science communication exhibition, showcased ahead of World Food Day by Professor Korsten's team
- The reintroduction of the 'glossy' version of the <u>Annual Progress</u> <u>Report</u>
- Attendance, participation and coverage of the 2022 Norman E. Borlaug International Dialogue – World Food Prize Foundation, and a visit to the University of Missouri, Columbia.

8.1 Nuggets and external coverage

As per the SLA, the CoE-FS is to share a total of 40 nuggets with the NRF on an annual basis. In 2022, via a shared Google Drive, the CoE-FS has shared a total of 53 internal nuggets, which are pieces of information produced by the CoE-FS, for its website. Thus, we have more than doubled our required output for the year.

By far, the most successful internal nuggets have been the press releases and articles for the launch of the IYCF Advocacy project and for PhD candidate Catherine Pereira-Kotze's first journal article on maternity protection. Both were picked up extensively by external media, with IYCF rendering a 21.4% open rate via Mailchimp (the chosen platform for email marketing), and 26.1% for the maternity protection piece. The success of these two nuggets illustrates the benefit of planning ahead and anchoring content to specific commemorations (World Breastfeeding Week and month, in this case) — and it is certainly the preference of newsrooms. For these two nuggets alone, the total Ad Value Equivalency (AVE), which is the estimate amount of revenue attributed to an article, is R431 197.07, which, alone, exceeds the budget allocated to communications and engagement.

Another internal nugget that received notable traction is "<u>How Russia's invasion of</u> <u>Ukraine impacts global food security</u>", an article based on Professor Devereux's input at a related panel discussion, which was then picked up by the <u>Inter Press</u> <u>Service</u>, a wire service for news from the Global South, and <u>teleSUR</u>, the "Latin socialist answer to CNN". Unfortunately, there are no AVE amounts available for this nugget, as the CoE-FS was not credited in these articles and so it cannot be tracked or measured by media monitoring services, but it would be significant.

Notable too is the internal nugget created for the <u>Rapid Food System</u> <u>assessment</u>, which was conducted by professors May and Losch. As a press release, it had the second highest open rate of all email marketing in 2022 (27.9%; the top is 44.4% for "Response to SONA 2022 from the CoE-FS") and was in the top five most clicked articles and Facebook posts for 2022. Yet, this did not translate into external media coverage. Lessons from this includes the need for more digestible content (a summarised press release was evidently insufficient; a full press pack should be used for a report of this nature in future), anchoring, and a schedule of researchers' availability for interviews agreed to and shared upfront.

Elsewhere, the CoE-FS has received extensive external coverage, both from media, other organisations, and blogs. At the time of writing, there were 200 media mentions of the CoE-FS and/or its researchers (directors, PIs and project leads). As media, in particular, decide whether to attribute statements/interviews/insights to the CoE-FS, and the name is frequently used incorrectly (e.g., "DST-NRF...", "NRF-DST", "Centre for Food Security", etc.), mining all external coverage has remained a challenge over the years. To attempt to counter this requires tirelessly combing through various search engines, news outlets and blogs, and consistently reminding researchers to share whatever coverage they've received with the communications manager, and to properly reference the CoE-FS.

 Table 17: Comparative overview of nuggets

Output	2014-15	2016	2017	2018	2019	2020	2021	2022
Nuggets (internal)	12	9	52	67	73	55	44	53
Nuggets (external)	55	45	129	239	189	404	74	240

According to AVE, the top five CoE-FS stories for 2022 (for which we have data) are:

- (1) "<u>12% of working women in South Africa are domestic workers yet they</u> <u>don't receive proper maternity leave or pay</u>", written by Catherine Pereira-Kotze with the assistance of the CoE-FS communications manager, and pitched to The Conversation, and then republished multiple times and picked up by external media. AVE: R721 416.10. Researcher: Catherine Pereira-Kotze.
- (2) "<u>Worcester project teaches how to future-proof food</u>" published across Business Day's editions, online and in the Daily Dispatch. AVE: R538 874.48. Researcher: Julian May
- (3) World Breastfeeding Week (combined articles/media mentions/broadcasts). AVE: R527 450.15. Researchers: Chantell Witten, Catherine Pereira-Kotze, Julian May, Nazeeia Sayed
- (4) "<u>Starvation silently kills our kids</u>", published across City Press' editions and distribution points, and on News24, South Africa's largest website. AVE: R438 068.90. Researcher: Julian May
- (5) "SA's fragmented maternity protection landscape: Why benefits should be available to all working women", written by Catherine Pereira-Kotze with the assistance of the CoE-FS communications manager and originally published by the Daily Maverick and then republished and picked up by other media. AVE: R353 793.00. Researcher: Catherine Pereira-Kotze.

It must be noted that while we are able to manually track mentions of our UP-based researchers, access to UP's media monitoring service is required and we hope to achieve this soon. Additionally, to note, AVE is an estimate of the equivalent advertisement spend; it is an estimate, providing us with an industry-accepted idea of return on investment.

Other CoE-FS content that received notable news coverage in 2022 includes:

- Professor Swart's input on the poor regulation of child-directed food advertising for Daily Maverick's Food Justice project (<u>such as this article</u>, for example)
- Co-director Professor Korsten's work on microscopic organisms found on raw fruit (<u>for example</u>)
- Dr Sayed's well-timed tips for healthy eating during Ramadan
- Ongoing and extensive coverage of the learning journeys in Worcester and Langa

- Food Imbizo events on the <u>right to food</u> and World Breastfeeding Week
- Professor Keyster's research on plant tolerance to toxins.



Figure 3: Example of content shared by and about the CoE-FS.

8.2 Digital communication

Website

Following multiple security breaches, the migration of the CoE-FS website was underway, but has since been put on hold, due to concerns around POPIA implications. As a reminder, the purpose of this migration would be to, first and foremost, better secure the website. It is also so that we can improve user experience, such as increasing the speed of loading time on the site.

The migration would have also provided the CoE-FS with a better maintenance offering as the plugins used on the CMS requires constant updating. Not doing so regularly opens the site up to security risks.

In the interim, other work on the website continues. A working snag list is maintained and the latest issues to be resolved are:

 Decreasing the banner and text size on the homepage carousel completed

- Dropping all banners to the lower-third so that images are not covered, the site is more visual, UX improved and the website is better suited to best practice completed
- Making hard-coded/static features editable, such as the front cover of the video and audio pages underway.

We have also commissioned a photographer to capture stock images for the website as the current cover images do not have a uniformed look and feel, are outdated, pixelated and the ownership thereof cannot be verified/was not recorded. This process is a way in which to 'refresh' the site without incurring the type of costs associated with rebuilding a website.

Finally, once the migration is complete, we will reinstate Google Analytics to track performance across the site. This tool was lost during one of the previous security breaches.

Creation and launch of Food Imbizo website

Over the past year, the communications manager has assisted with the launch of the Food Imbizo's standalone website, <u>https://foodimbizo.org/</u>, now in its second iteration. The Food Imbizo secretariat and the previous communication manager agreed on a standalone website so as to share resources beyond the CoE-FS and its formal CAs and MoUs, thereby providing a platform for all Food Imbizo CoP participants.

The website, in its first iteration, was created by PhD candidate and secretariat member Florian Kroll, using a Wordpress CMS. Following discussions between the secretariat, the communications manager and vendor Morgan Morris, the secretariat opted to migrate the site from host GoDaddy, and enlisted a site manager, NT Web Designs. The vendor has also designed a logo for the Food Imbizo, based on the CoE-FS's guidelines, namely brand colours.

8.3 Multimedia production

The CoE-FS continued to produce multimedia content, namely video and audio, and collaborated on a video for the learning journey methodology.

Views and watched time have increased significantly since 2018 to 2022 and will continue to do so as we turn our attention to more visual communication in 2023.

YouTube	2018	2019	2020	2021	2022
Views	1287	1607	1993	1887	2331
Watch time	25.5	47.2	56.4	61.7	63.1

 Table 18: Comparative overview of YouTube metrics

The top YouTube video in 2022, and second most watched since the launch of the CoE-FS YouTube page in 2017/18, is another 'nugget', this time in video form, and used as an added value piece for one of Catherine Pereira-Kotze's journal article coverage. The video didn't cost the CoE-FS anything to produce, besides the premium subscription to Canva, which it uses daily to produce visual content. Click here to watch the video.



Figure 4: Still of the maternity protection video.

The CoE-FS continues to host Food Imbizo livestreams on its Facebook page. In 2022, the most watched livestreams are:

- 1. <u>Food Imbizo: Realising the right to food in South Africa Has the</u> <u>pandemic moved us forward?</u>
- 2. What is the Role of Faith Communities in Food Governance?
- 3. Food Imbizo: Step up for Breastfeeding.

To note, the top watched video is the only one where the communications manager edited the title, thumbnail and description. While these are minor changes, they can have meaningful impact and these changes speak to the advice shared with researchers regarding sentence versus title case (the former provides the reader a more comfortable reading experience), shorter descriptions, and use of rich visuals in all online work.

8.4 Social media marketing

Social media remains a powerful set of tools with which to communicate the work of the CoE-FS, reach new audiences and build brand awareness. Since 2014, our platforms have steadily grown and 2022 was no different (see Table 3). All increases in likes and follows are, since 26 January 2018, entirely organic, i.e., the CoE-FS has not spent any of its budget on boosting posts or social media. This is an achievement but, in order to increase engagement (rather than simply garnering 'vanity metrics') the likelihood is that some budget will need to be spent in 2023.

A new addition to the CoE-FS portfolio is an <u>Instagram page</u>. It is very much still in its infancy, but it opens the door to a younger audience and will provide a great

platform for more visual content which we continue to build up post-COVID-19. Introducing the CoE-FS to a new audience must be a strategic objective going forward as the current audience are, largely, those who are already invested in food security and are, in some way, affiliated with the CoE-FS and its researchers.

As seen in Figure 3, our audience members are, predominantly, between the ages of 25 and 35 (this is the general age group active on Facebook, the world's largest social media platform). Instagram offers access to a younger audience. We are considering establishing a page on LinkedIn, where an older audience exists, but this requires further research. At this stage, TikTok is not a viable option for the CoE-FS.

Platform	Growth by year								
	2014-15	2016	2017	2018	2019	2020	2021	2022	
Facebook group	190	258	317	409	526	736	799	819	
Facebook page (likes)	245	245 469	936	1610	2303	2604	2694	2945	
Facebook page (followers)				100					
Twitter followers	245	640	1134	1714	2099	2541	2604	2753	
Instagram								116	

Table 19: Comparative overview of social media products



Figure 5: Audience age and gender (sex) insights for Facebook and Instagram.

Content shared on social media has been varied and has certainly lifted the feel of our accounts. The next step is to ensure these posts are sufficiently engaged with and that they are always accessible to a lay audience. Figure 4 provides examples of some of our posts across Facebook. Tables 4 and 5 note the most

engaged posts in 2022, across Facebook and Twitter (the results on Instagram are, at this stage, negligible).



Figure 6: Example of Facebook content shared in 2022.

Table 20: The top five posts in 2022 on Facebook, in terms of engagement

	Post	Link to post	Notes
1	A groundbreaking new partnership between the CoE-FS, Local WILD, and the Sustainability Institute is laying the foundation for a radical embrace of forgotten and neglected local indigenous foods from the Greater Cape Floristic Region	https://www.facebook.com/CoEinFS/photos /a.923423967719101/5516413185086800/	Rich visual, multiple tags, about Cape Town (most of our audience are from Cape Town), and about indigenous foods (a hot topic in the city), emotive language used, link included.
2	A group of academics from the CoE-FS and UWC has stepped up to address the "insidious and aggressive" marketing tactics of the formula industry	https://www.facebook.com/CoEinFS/photos /a.923423967719101/5453153798079406/	Rich visual showing three people (human faces perform better online than abstract images), child-related, something new being discussed, emotive language used, link included, anchored around commemorative date.
3	Catherine (Katie) Pereira-Kotze is completing her PhD in Public Health through The University of the Western Cape, with funding from us, the CoE-FS	https://www.facebook.com/CoEinFS/posts/ pfbid0C4S36oLh5gnnRT2181URHRGjttzD MScnEoDrVYaFwgQtZNXSCGHNqPZdod VepKCml	Rich visual, child-related, anchored around a commemorative date, celebrating 'student' research', multiple tags.
4	In October last year, we held four online workshops, where we reviewed the draft findings of the rapid food systems assessment of South Africa	https://www.facebook.com/CoEinFS/posts/ pfbid02GcwNnSQqAHN9EqU1LpcjP4YtcR SnuCb5mTUEcpXgn1yhkdNvSaAVPFWaV 4yjtFk9I	Research, prominence (our connection to FAO, EU and CIRAD) which in turn shows credibility, link included.
5	"Local health lobbying groups have welcomed a decision by multinational consumer goods conglomerate Unilever to stop marketing food and beverages to children under the age of 16".	https://www.facebook.com/CoEinFS/posts/ pfbid0uNcRDXynSLscrqtuC8HoMtRHFV6k rhdYP4LujBEWrBbZoyDY7rE8QchVQXZd 9mkJI	Child-related, familiar topic for a lay audience, link included.
	Read more via BusinessLIVE:		

Table 21: The top five posts in 2022 on Twitter, in terms of engagement

	Post	Link to post	Notes
1	JOURNAL ARTICLE "Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase the products– A randomised controlled trial in South Africa", co-authored by Prof Rina Swart (CoE-FS nutrition lead): https://buff.ly/3r6ddKD.	https://twitter.com/FoodS ecurity_za/status/157436 8247360757761	This was quote-tweeted by Wendy Knowler, South Africa's foremost consumer expert and illustrates the strength of 'seeding'. While this was not deliberate seeding, someone prominent and trusted shared our content, bettering our online credibility.
2	This morning we're joining @WCEDP, @FairFoodSA for a walking tour of Cape Town's City Centre, sharing stories of the food system through history and place, as part of @food_dialogues.	https://twitter.com/FoodS ecurity_za/status/155075 7029651927040	A rich visual with numerous tags showcasing an interesting activity.
3	The regional director of the @WFP Regional Bureau for Southern Africa, Dr Menghestab Haile, and special advisor Hlalanathi Fundzo are in Worcester to see CoE-FS research, namely the #learningjourney co- convened by @SAFoodlab and @WCEDP, in action.	https://twitter.com/FoodS ecurity_za/status/157758 3043451273216	Rich visuals showcasing the CoE-FS's connection to a prominent figure, with multiple tags, and highlighting the innovative and important work of the CoE-FS.
4	Call for applications for postdoctoral fellows 2022: The Food Environment Research Group. Completed applications need to be submitted by no later than 17:00 on 10 January 2022. Kindly refer to the below for more information.	https://twitter.com/FoodS ecurity_za/status/147873 4516705533952	Calls for applications, in general and across HEI communications, does well.

	Post	Link to post	Notes
5	"Research and partnerships for a sustainable African food system", hosted by @FSNetAfrica/ @UPTuks is about to begin at the @WorldFoodPrize Borlaug Dialogue 2022. #FoodPrize	https://twitter.com/FoodS ecurity_za/status/158238 4040350740482	Major build-up preceding this, multiple tags, international conference.

8.5 Events

Events provide a way in which the CoE-FS is able to broaden its reach and share its research with a wider audience, particularly a lay audience. In 2022, researchers participated in numerous events and will continue to for the remainder of the year.

A highlight was co-organising and hosting a special Africa month lecture with the NRF, the "<u>NRF Science for Society Lecture invitation - Topic: Strengthening</u> resilience in nutrition and food security on the African continent" (Figure 6 below).



Figure 7: NRF Science for Society Lecture invitation

The panel discussion featured the CoE-FS's Professor Korsten, Dr Witten, Dr Sayed, FANRPAN's Sithembile Mwamakamba, and was facilitated by Naledia Moleo, an SABC news anchor.

Another highlight has been the multi-day learnings journeys in Worcester and Langa. While not organised by the CoE-FS from a logistics perspective (the WCEDP were commissioned by the CoE-FS to do this), professors Julian May and Bruno Losch had oversight, and the communications manager collaborated with the WCEDP on coverage, namely on social media and video scripting and production.



Figure 8: "Understanding the learning journey | Langa, Cape Town"

Both the Langa and Worcester journeys received extensive media coverage, with a combined AVE of R728 633.88 (from available data). A notable moment in the most recent Worcester learning journey was the inclusion of the WFP regional director Dr Menghestab Haile, which was facilitated by the communications manager. The learning journey has proven to be not only innovative in research methodology, but also in terms of how beneficial collaboration between organisations right down to communication is for the project. As the CoE-FS does not have the resources or capacity to communicate every project to the extent that a fully staffed communications team would be able to, ensuring that there is partnership between researchers and communicators is an effective way forward.



The regional director of the @WFP Regional Bureau for Southern Africa, Dr Menghestab Haile, and special advisor Hlalanathi Fundzo are in Worcester to see CoE-FS research, namely the <u>#learningjourney</u> co-convened by @SAFoodlab and @WCEDP, in action.



Figure 9: Dr Menghestab Haile's participation in the learning journey

Another innovative science communication event was the World Food Day event, led by Professor Korsten and senior postdoctoral fellow Dr Willeke de Bruin. Professor Korsten's research group at the Department of Plant and Soil Sciences collaborated with the UP Drama Department on applied research communication pieces, known as *Gastronomies*, ahead of World Food Day. These short communication pieces were showcased on UP's main campus, at locations known for significant student foot traffic. The creative work consisted of a series of provocations that looked at the relationship between human experiences and food, and conjectures on the meanings of food in this context. It consisted of a series of two short performance 'bites' and two installation-performances. In specific, the work engaged with the themes of food consumption in relation to class and power, and the lure of healthy eating. Gastronomies was yet another display of clever, creative science communication led by Professor Korsten and her UP team, and follows on from the likes of *Aunty Covidia* in 2020.

Circling back to the participation of Dr Haile in the learning journey, the connection between the WFP and the CoE-FS was made when the WFP requested that the two organisations partner on an event in the lead-up to World Food Day. Unfortunately, after speakers were confirmed and the venue booked, the regional director's flights to Cape Town changed and so the event has been postponed until he returns.

There have been plenty of additional stand-out events in 2022 but another that must be elaborated on is the participation of the CoE-FS in the 2022 Norman E. Borlaug International Dialogue – World Food Prize Foundation in October 2022. The CoE-FS's partners FSNet-Africa and UP colleagues were invited to host a breakout session at the premier food security conference in Des Moines, Iowa. Professor May (virtually) and MANCO member Professor Frans Swanepoel (in-person) both participated in the session, which was attended in-person and covered by the communications manager. Numerous pieces of content have been produced, predominantly for the use of FSNet-Africa and UP. Following the conference, the communications manager met with colleagues at the University of Missouri, namely Professor Rodney Uphoff, Professor Robert Sharp, Dr Kate Trout, Dr David Mendoza, and Dr Antje Heese. Communications pieces for the use of MU, the CoE-FS and UWC have been produced.



Figure 10: Some events CoE-FS researchers have participated in

The appendix 5 details the many events in which CoE-FS researchers participated and which cannot, unfortunately, be adequately discussed here. However, it is perhaps sufficing to end this with parts of a transcript from an interview conducted by the communications manager with World Food Prize laureate and former CoE-FS STEERCOM member, Professor Lawrence Haddad, about the value of the CoE-FS's work:

"I am a big fan of the Centre of Excellence ... there are three things I know that you have been working on ... one of which ... is the Child Gauge report. I loved that report, because it took a very wide-angle lens view of what are the issues around child nutrition and child well-being, in general. And it was ... verv technically sound. But it was written with a view, to a particular audience, and the particular audience was policymakers. There's no point in doing fantastic analytical work if no one's going to pay attention to it, or if it's not actionable, and I felt that report was fantastically actionable, and had lots of lots of very memorable phrasing. I remember the 'slow violence of malnutrition', I thought that was a brilliant phrasing. And it really resonated with me ... and I'm sure lots of policymakers. And importantly, the media in South Africa ... I know that centre is also working on indigenous food and neglected food. And I think that's also really important ... the world we're living in now is full of shocks, and surprises, and that's the new normal. And so we have to ... make our food systems much more diverse. And part of that diversity is the kinds of foods we grow. And so looking at indigenous, neglected and underutilised crops ... is absolutely critical. It's not easy, because we have to find the crops that are nutritious, we have to find the crops that are environmentally friendly. And critically, we have to find the crops that have a commercial potential. But it's not impossible. And I think the first step is to do that kind of research, which is the foundation for the business model. And the third thing I know that the centre is doing, which I think is so valuable, is this work on assessing food systems and assessing the South African food system, in particular. And you know, food systems are big, scary places for policymakers, and actually, for all stakeholders, because they're sprawling, they're very complex, they've got lots of different bits that interact and are unpredictable ... And so we absolutely need data and analysis and assessment of which parts of the food system are working pretty well, which parts are not working well, and then some kind of roadmap of how we transformed those food systems in a sort of list of priorities and, more importantly, a sequence of those priorities. And the only way we can get that is through dispassionate analysis that has a focus on action and policy ... My reflection about the centre in general, when I was on the steering committee ... was how it was able to blend these different disciplines, different sectoral approaches, but also how it was able to blend the different perspectives of the private sector, government, academia and civil society. And I think that's really a major strength ... I want to see the COE-FS keep investing in that multi-stakeholder perspective — but with a very strict focus or very laser-like focus on what we need to do to transform food systems. Governments have to be in the lead, they have to set the tone; but they can't do it on their own. Businesses have to be there, civil society, and critically, researchers. So I'm so pleased to have been associated with the CoE-FS and I want it to go from strength to strength, and I'm sure it will".

9 KPA 4: NETWORKING

Since its inception, the CoE-FS has established various national and international collaborations and/or partnerships as a result of research activity and/or affiliations. Collaboration is fundamental to the work of a virtual centre such as the CoE-FS. Connecting with diverse stakeholders in this regard is critical to our success and

relevance. In addition to the formal agreements that the CoE-FS has reached with 43 collaborating institutions, it has nurtured research and networking collaborations with scholars and institutions across South Africa and internationally.

A few networking examples are as follows:

Researchers from several different institutions are involved in Programme 1, including UCT, UWC, CPUT, and SU. Collaboration with the network of global researchers interested in knowledge coproduction and creativity has led to the publication of a paper in a special issue of the *Journal of Evidence and Policy*. The collaboration with SAFCEI has raised the profile of food governance in the faith community's domain, contributing towards greater societal mobilisation around this issue. Researchers have also collaborated with the Centre for Food Policy at City University London to conduct research and present findings; this has increased the visibility of the CoE-FS and shared insights and learnings from these dialogue processes.

Professor Emmambux has joined a consortium that applied for a project entitled "SunGari: A modern solar cooking solution for African staples". The consortium consists of colleagues from Greenwich University (UK), UL, the University of Kassel (Germany), and the University of Lomé (Togo). He also formed part of the proposal "LIMAQUA: African interdisciplinary laboratory in sustainable, nutrition-sensitive marine aquaculture" together with several local and international partners.

Two members of Programme 2, professors Emmambux and Ludidi are also leading the South African part of the project "Food and Livelihood Resilience from Neglected Plant Species in Western and Southern Africa". The development and characterisation of the selenium nano-films were done in chemical sciences (chemistry) and the application in food was carried out at the food microbiology laboratory (Food Science). Further collaboration is expected to improve the characteristics of the film for food packaging. Data from our findings would result in further interdisciplinary collaboration with colleagues in various fields including archaeology, human nutrition, and medicine. The dispersion rheology of complex particles and their flow properties are necessary for food application, especially in the acidified beverage. Furthermore, encapsulation and release studies (in vitro, in vivo) will be important to establish the carrier properties and efficacy of these complexes. Indigenous South African legumes such as sugar beans can be employed in the formulation of nutritious, protein, and fibre-rich foods.

Collaboration with Purdue University (USA), University of Eldoret (Kenya), and ITA Food Technology Institute in a USAID project under the "Feed the Future" programme is continuing under the SMART foods project. The project, "Sustainable Reduction of Post-harvest Losses in Feed the Future Countries through Technologies and Innovations that link Farmers to Markets: Focus on Kenya and Senegal" is within the Food Processing Innovation Lab. This project is based on the concept of food-to-food fortification for enhanced nutritional characteristics of cereal-based foods which is also a core concept of the CoE-FS's SMART food project. The project has opened various avenues for SMART foods and food ingredients with extra funding and analytical resources. InnoFoodAfrica has a multidisciplinary (business, science, sensory science, consumer science, nutritionist, food scientist, food engineer, polymer scientist, communication specialist, social scientist) team to tackle food and nutrition security. The PI of the SMART foods project is also leading the food ingredient and product innovation WP.

The Food Safety project is collaborating with Professor Stefan Schmidt from the School of Life Sciences, UKZN, as well as Professor Gunnar Sigge from the Department of Food Science at UWC. The group of researchers within this project includes researchers from the UP Department of Plant and Soil Sciences, the Department of Veterinary Sciences, the Department of Food Science and Department of Consumer Sciences at, and the Department of Animal Science at UFH. Collaboration with the Department of Rural Development and Agrarian Reform enables researchers in the project to use the modern state-art veterinary laboratories in the Eastern Cape. The department also provides retrospective data on a microbial survey of meat from abattoirs in the province.

All researchers collaborating on this project share the UP-NRF RISP-funded MALDI-TOF for rapid confirmation of pathogens.

UP's Food Safety team has established collaboration with the National Institute of Communicable Disease's Sequencing Core Facility to begin exploring the genome of selected isolates through the supply chains. Collaboration has also been established with Professor Gabriella Berg, Graz University of Graz, Austria who is a human gut and postharvest microbiome specialist. A collaboration between the US FDA Center for Food Safety and Applied Nutrition and this team, through the Genome Trakr, has been created in order to conduct further characterisation isolates in the CoE-FS Virtual Microbial Database. Researchers include Dr Marc Allard, Dr Yi Chen and Dr Dumitru Macarisin. Moreover, a collaboration with Dr Victor Ntuli (University of Lesotho) has been established in order to harness his expertise in risk assessment.

Professor Devereux is a founding member of the Food Equity Centre, a global network of researchers hosted by IDS, Sussex, with partners in the UK, Brazil, Thailand, and the CoE-FS. In September 2022, a symposium was held that will generate academic publications in 2023, followed by collaborative research proposals into the "normalisation" of hunger, food justice, and violations of the right to food, in South Africa and other countries.

The NDIS is a significant national collaborative effort with a total of 43 academics and students from 11 HEIs (of which six are HDIs). The group has been meeting monthly and dedicated working groups have contributed to the development of the instruments of the survey, and the training material for the survey and will similarly contribute to the research output. The primary research output is the report for the NDoH. As per discussions with each individual member of the collaborating team, each person will have a specific contribution to make within a chapter. Each chapter will be authored by a team and the overall report will be edited by Professor Swart and the postdoc. Further scientific publications have also been discussed, and interested parties have submitted concept notes which will be possible after the report and primary papers have been published. The continued work on monitoring of nutritional content of packaged food supply in South Africa – part of the FOPL leverage-funded work and source of research topics for several CoE-FS-funded masters students – has led to engagements with UNICEF to assist with similar support in Zimbabwe; MoUs are currently being developed. A PhD candidate, Persuade Makore Kudenga, from Zimbabwe (nominated for CoE-FS funding, but not awarded) will use some of the Zimbabwe data in her research.

All leverage-funded projects under the leadership of Professor Swart are international collaborative projects. Although the NDIS does not have international collaborators or funders, the instruments were developed in consultation with international collaborators and there are opportunities for papers doing country comparisons where instruments provide sufficient overlap. Collaboration with international collaborator Anne Hereforth of the Global Dietary Quality group continued. Professor Swart assisted as a country consultant and translated the Global Dietary Quality's Diet Quality Questionnaire (DQQ) into Afrikaans. The translations into the African languages which were prepared for the NDIS will also be shared with the global DQQ project, to be available to any researcher who may wish to use it.

The project led by Professor Ludidi consists of collaborators from the ARC, MU, the University of Mauritius, the Chinese University of Hong Kong and Walter Sisulu University. National collaborations under the project led by Professor Keyster include Walter Sisulu University (Dr Ifeanyi Egbichi), UP (Dr Eugene Makgopa), the National Zoological Gardens (Dr du Plessis), and UFH (Maliviwe Mpayipheli). This project also collaborated with MU (Professor David Mendoza-Cozatl and Professor Antje Heese), the University of Mauritius (Navindra Boodia), the Chinese University of Hong Kong (Dr Hon-Ming Lam), and the National Botanical Research Institute (Dr Chandra Sekhar Mohanty).

The developing collaboration with the Food Governance and Policy Reform Programme, the SAFL and the FAO resulted in more visible engagement at national and international levels. As a result of the colloquium held by the Right to Food for School Leaver's project, cordial contacts have been established with some government departments and Chapter 9 institutions. This project has also made important contacts with academia from other universities outside of the country. During a national colloquium, various stakeholders that attended were able to interact with researchers and students affiliated with the CoE-FS.

The project led by Dr Marc Wegerif continued the implementation of the three-country study of the impacts of COVID-19 on food systems. This involves work in South Africa, Ghana and Tanzania. It is a partnership with UWC, Ardhi University in Tanzania, and UG, as well as civil society partners in each country.

In November 2022, Professor May attended the 30th anniversary meeting of the UNESCO Chairs programme in Paris and attended side sessions on the Priority Africa programme of UNESCO, and a working group meeting to establish a network of UNESCO Chairs working on food systems analysis. A video of the activities of the UNESCO Chair in African Food Systems that is embedded in the CoE-FS was part of the public presentations provided at the conference. He also

submitted the application for the renewal of the UNESCO Chair for 2022-2026. If successful, the renewed chair will be co-held by Professor Lindiwe Sibanda from UP and Professor May, and UP and UWC will co-contribute to the running costs of the Chair.

In October 2022, Professor May gave a side-session presentation at the 2022 Norman E. Borlaug International Dialogue - World Food Prize Foundation meeting in Des Moines, Iowa. This was part of the, FSNet-Africa breakout session: <u>https://fsnetafrica.com/news/fsnet-africa-framework-showcased-at-the-2022-</u> <u>norman-e-borlaug-international-dialogue/</u>. He prepared the programme and gave a presentation at the FSNet-Africa World Food Day dinner at UP: <u>https://www.youtube.com/watch?v=mRjbWv0SPes&t=450s</u> and <u>https://www.youtube.com/watch?v=TWcwnzZa6nY</u>.

During this period he also gave a presentation at the Committee of World Food Security 50 Side Event 29 on "Diversified food production and diet: The challenges of transition to more sustainable agrifood systems" which was co-hosted by the EU, FAO, CoE-FS and the SDG 2 Advocacy Hub

(<u>https://www.youtube.com/watch?v=RkzHkDe3SS0</u>). He was one of the speakers for the Business Day Dialogues on "The role of ethical leadership in addressing child hunger", along with Anglican Archbishop Thabo Makgoba, Dr Andew Borrain, Dr Witten and Omri van Zul (Agri-SA)

https://www.youtube.com/watch?v=0IdHfU8Mdcl&t=1s.

During September 2022, the CoE-FS hosted a visit to UWC by the German Federal Ministry of Agriculture, the German Academic Exchange Service and the German Foreign Office. This was the second interaction that has taken place with the group to discuss the possible funding of an African-German Centre for Sustainable & Resilient Food Systems and Applied Agricultural & Food Data Science. The meeting was attended by UWC's Vice-Chancellor Professor Tyrone Pretorius and DVC: Research and Innovation Professor Jose Frantz.

During this period, Professor May participated in the Food Equity Centre's International Symposium, and contributed towards a paper on place-based approaches to food equity analysis. A science communication was published: https://www.dailymaverick.co.za/article/2022-09-23-sa-has-enough-food-yet-its-people-go-hungry-tackling-a-tragic-paradox/.

During August 2022, the German Africa Centre for Development Research hosted the CoE-FS in Bochum for a preparatory meeting with Hohenheim University to discuss collaboration in an African-German Centre for Sustainable & Resilient Food Systems and Applied Agricultural & Food Data Science. This was followed up with meetings in Amsterdam with VU-A. In 2022, Professor May collaborated with Dr Kate Trout, a researcher from MU to implement a study of ECD and was conducted in Worcester. The study is currently being written up. He also co-presented a session at a symposium convened by the Western Cape Department of Agriculture on "Agriculture is pushing forward: Advancing the role of extension and advisory services towards inclusive and resilience food system". This was attended by all extension officers working in the province.

10 KPA 5: SERVICE RENDERING

All the PIs are involved in service rendering, which includes an input to policy debates, keynote presentations, and facilitating workshops.

The Food Imbizo has continued to offer policymakers and other stakeholders' access to current research findings informing policy deliberations. Members of Programme 1 continued to offer informal advice to provincial and local authorities on food system governance matters. They were invited to participate in regular gatherings of the CoCT Food Security Working Group; participated in monthly meetings of the Food Forum coordinated by the WCEDP; actively participated in the advisory committee of the 2022 Food Dialogues; developed two policy briefs in collaboration with SAFCEI; and contributed to a critical review of the draft CoJ Food Resilience Policy.

The SMART food project has various partners locally, including the University of Johannesburg, UL, and DUT. The project leader also engaged with the food industry in terms of communication and frequent virtual meeting. The team has a good relationship with Tiger Brands, Pepsico, and RCL Foods in South Africa; RISE Sweden, and Puratos Belgium at the international level. Sensory evaluation services (descriptive sensory evaluation and consumer testing of food products) are rendered to industry partners.

Professor Ndiko Ludidi's lab has actively engaged with smallholder farmers in August, September, and October 2022 in workshops that offered training to the farmers (in Ward 22 of the Matatiele Local Municipality) in regenerative agriculture in preparation for the 2022 summer planting season.

As part of the WRC deliverables, a policy brief, "Fit-for-purpose irrigation water guidance document to ensure the microbiological quality and safety of fresh vegetables from farm to retail in the formal and the informal sector". This document was prepared as a Ministerial Policy Brief by the WRC in 2022.

UP's Food Safety team is working with the National Institute of Communicable Disease's Sequencing Core Facility to begin exploring the genome of selected isolates through the supply chains.

Professor Keyster and his team are working closely with GrainSA in order to reach more small-scale farmers in the broader crop-growing areas of South Africa. They are writing information brochures to assist farmers with soil quality data as well as the results of scoring pathogen incidence across field sites.

The NDIS is conducted as a tender from the NDoH. The Department of Food Control indicated their intention to include this warning label in revised regulations on food labelling and marketing to children. The revised R146 of 2010 is currently with the legal advisors of the NDoH before being published in the Government Gazette for public comment. It was announced on 19 November on eNCA that the revised regulation on Food Labelling will be published before 15 December 2022. The FOPL team assisted the NDoH's Food Control to prepare the SEIAS report for the DPME – one of the requirements before the promulgation of any regulation. Makoma Bopape (UL and member of FOPL and HPL leverage-funded projects) serves on the task team that is preparing the Obesity Prevention strategy 2022-2030 for the NDoH. The Obesity Prevention strategy was announced during a webinar by the NDoH on 3 November 2022. Members of the FOPL team are also currently serving as advisors on the planning committees for the development of nutrient profiling and FOPL in China and Ghana.

Knowledge generated regarding critical issues such as the increased use and impact of sanitisers on human and environmental health through the CoE-FS Food Safety project will impact society, industries, and policy in the longer term. Establishing the Food Science Platform for South Africa and sharing information about food safety critical matters as an open resource to academia, government, etc., will allow the development and implementation of knowledge-based solutions.

Professor May is the guest editor for a special issue of *Sustainability* on agroecological transitions. The first paper was published at the end of 2022. The remainder of the edition will be published during 2023 (<u>https://foodsecurity.ac.za/news/call-for-submissions-special-issue-of-sustainability/</u>). The co-editors are Dr Melody Mentz-Coetzee (UP) and Professor Claire Quinn at the University of Leeds.

Professor May also serves on the FSNet-Africa Academic Leadership team. FSNet-Africa is a capacity building programme run by the ARUA Centre of Excellence in Sustainable Food Systems (ARAU-SFS) at UP. Targeting early career researchers working on transdisciplinary food system analysis, it is funded by UK Research and Innovation (UKRI). Professor May designed the Conceptual Framework used by FSNet to develop their training programme, and has participated as a guest lecturer and speaker.

Professor May was appointed to the NPC in December 2021 and he will serve until 2027. He serves on both the Economics and Quality of Life Workstreams, chairs a Task Team on Economic Modelling for Redistribution, and participates on Task Teams on ECD and on Agriculture and Rural Development.

Professor May's term as the Chair of the Dullah Omar Institute Board of Trustees and MANCO came to an end in 2022 when he stepped down from this position.

He also serves on the scientific sub-committee of the CoE-HUMAN. His term as the chair of the ASSAf Standing Committee on the Science for the Reduction of Poverty and Inequality came to an end in 2022. He has since been elected onto the ASSAf Council where he serves on the Audit and Rick Sub-committee. In 2022, ASSAf nominated Professor May to serve on the Inter Academy Partnership Programmatic Committee on Policy Advice.

Also, he serves on the ARUA-SFS Steering Committee hosted by UP and chairs the Advisory Board Meeting of the Food and Nutrition Security Survey undertaken by the HSRC for DALRRD. This large sample survey completed its fieldwork in 2022 as planned and data analysis is being finalised. He has also been appointed as a visiting research fellow in the Centre for the Advancement of Scholarship at UP from 2022 until 2023.
He attended the Agricultural Salon in Paris and spoke at a workshop organised by CIRAD to <u>launch the TSARA initiative</u>. TSARA is initiated by two French research institutes – CIRAD and INRAE – and developed jointly with around 20 African partners (universities and research institutes). It aims to strengthen cooperation in order to promote sustainable agriculture, food systems and agricultural, pastoral and forestry landscapes.

11 FINANCIAL INFORMATION

11.1 Funding flows

Table 22: Funding received and spent from NRF in the reporting period

Commitment	Released	Expenditure		
R15 315 378.75	R13 895 138.76	R11 115 573.23		

The unspent balance of R2 779 565.53 is made up of R1 300 000.00 of 20% project committed funds and R600 000.00 in operational funds reserved for equipment, annual report and updated branding. The balance is unallocated bursary funds which were a result of new bursaries being funded by HICD, and postdoctoral fellows not taking up their fellowships which were budgeted for in 2022. The CoE-FS would like to request a carry forward of R400 000 for two postdoctoral fellows who did not join the governance project in 2022 but will do so in 2023.

The CoE-FS disbursed 80% of project expenditure at the signing of the project agreement and the balance of the funds will be released once we have received the final project reports. This process usually happens before June in the ensuing year. The equipment of the CoE-FS is older than five years and needs to be updated. We have reserved R600 000 in running costs to service all equipment, branding and compile and edit the 2022/2023 annual report. We request that R2 779 565.53 be rolled forward into 2023.

Commitment	Budget	Spent	% of budget	
Research	R4 776 650.00	R3 476 650.00	31.19%	
Bursaries	R6 211 366.75	R3 911 561.23	40.56%	
Salaries	R3 555 540.00	R3 555 540.00	23.22%	
Running costs (Operational)	R201 822.00	R100 822.01	1.32%	
Conferences, webinars and media	R270 000.00	R71 000.00	1.76%	

Table 23: Breakdown of NRF funding expenditure

Commitment	Budget	Spent	% of budget	
Equipment	R300 000.00 R0.00 2		2.00%	
Total income	R15 315 378.75	R11 576 283.73	100%	

Direct and leverage funds (funding received by PIs/PLs)

The CoE-FS has managed to raise a total amount of R59 471 448.55 in additional funding as listed in Annexure 13 of this report. This amount is made up of R31 471 448.55 in direct funding and R28 000 000.00 in leverage funding.

11.2 Return on investment

The CoE-FS publication list and students registered for 2022 as outlined in Tables 5, 6 and 7 of this report, represents a significant return on investments, and once the published output has been verified and converted into subsidy income, this will represent a considerable income for the universities at which research is taking place. It is difficult to accurately estimate the value of the expenditure in terms of subsidy income, since this varies year-on-year and is affected by the number and location of co-authors. Since its inception in 2014, the CoE-FS has published over 370 journal articles, 54 books and book chapters, with the highest cumulative citation of 55. It has also supported more than 700 students, and more than 330 students and postdoctoral fellows completed their studies and produced over 470 conference presentations, which is viewed as a long-term economic and societal investment.

The establishment of the CoE-FS has also resulted in considerable additional funding in 2022, amounting to R59 471 448.55. However, the greatest return on investment is the networking and collaborations that have taken place within the projects supported by the CoE-FS and the findings that are emerging. As mentioned above, the CoE-FS currently has 43 CAs in place, with more than 100 international and national collaborators since 2014.

12 GENDER IMPACT

The CoE-FS has made a concerted effort to include women in its research teams and recipients of student bursaries. In 2022, 87 female students (of all students) were supported by the CoE-FS; and 40 (68%) female students received NRF bursaries. With respect to the CoE-FS management and administrative teams, currently, the co-director, research manager, finance manager, communications manager, and two administrative assistant positions are filled by women.

Gender as a perspective implies that biological and social gender is reflected in research content. A growing number of studies show that diversity, including gender balance and gender perspectives, helps to enhance the scientific quality and social relevance of research. Gender inequality both leads to and is a result of

food insecurity. According to estimates, women and girls make up 60% of the world's chronically hungry and little progress has been made in ensuring the equal right to food for women enshrined in the UN's Convention on the Elimination of All Forms of Discrimination against Women. Women face discrimination both in education and employment opportunities and within the household, where their bargaining power is lower. On the other hand, gender equality is described as instrumental to ending malnutrition and hunger. Women tend to be responsible for food preparation and childcare within the family and are more likely to spend their income on food and their children's needs. The gendered aspects of food security are visible along the four pillars of food security: availability, access, utilisation, and stability, as defined by the FAO. The inclusion of women is essential to the work of the CoE-FS and a few examples are as follows:

In the project led by Professor Losch, one of the three project team members is female. In addition, several of the collaborating academics are female including Professor Jane Battersby (UCT-ACC) and Gillian Black (SLF). In addition, a significant proportion of the participants in the Food Imbizo meetings are female.

Zama Zulu has been a contract research assistant in the Food Safety team and contributed significantly to achieving WRC and other externally funded research project goals in the team. Training through this platform enabled her to apply and be appointed in a permanent researcher position at UP in 2021.

Degracious Kgoale will be completing her PhD degree in 2023. Training of research assistants, postgraduate students, and the next generation of academics in the area of microbiological water analysis and related technologies, and the impact on fresh produce production will equip them with knowledge for potential future employment in the water management and maintenance and/or food safety assurance, as well as conceptualise new research associated with this field.

Professor Korsten is a B2 NRF-rated microbiologist, and her area of specialisation is food safety. She has more than 30 years of experience as a researcher and has published more than 100 scientific papers and book chapters. She has been involved in developing the national food control authority model for the Department of Trade and Industry, and the Department of Agriculture, Forestry, and Fisheries. She has been successful in receiving grants from the fresh produce industries, the WRC, NRF, and international partners (7th Framework of the EU-Vegi trade). She will be mainly responsible for providing input into the supply chain and legislative information for verification.

Dr Erika du Plessis is a Senior Researcher in the water and food safety research programme, Department of Plant and Soil Sciences at UP, responsible for securing external grant funding and coordination of water and food-safety-related research activities and report writing in the Department of Plant and Soil Sciences, Plant Pathology Division. She has 37 years of research experience in Microbiology and Biotechnology including the microbiological quality and safety of water and food in both formal and informal sectors, as well as developing expression systems for overproducing enzymes of industrial/biomedical interest in microorganisms with GRASS (generally regarded as safe) status. The main focus of her recent research activities has been on the prevalence, dissemination, and characteristics of

antimicrobial-resistant potential human pathogenic bacteria in the water-plant-food-public health interface. Dr du Plessis is the research coordinator and collaborator of multiple research projects funded by the WRC, Partnerships for Enhanced Engagement in Research (PEER) a USAID/DSI-funded research project, and the Gauteng Department of Agriculture (GDARD).

The majority (73%) of the collaborators on research projects conducted as part of Nutrition and Health are women. The majority (77%) of CoE-FS-funded students and leverage-funded or non-bursary holders in this project are women. From one of the leverage projects, a paper on gender, food consumption and food procurement has been prepared. This publication is part of the special edition, which is under review by the *Public Health Nutrition* journal.

The IYCF project team consists only of women. This project also has a strong gendered lens, as it advocates for women's rights. Women who wish to breastfeed should have the right to do so, whenever and wherever they choose, with the full support of their families, communities, employers and governments.

13 HUMAN RESOURCES

The CoE-FS operates as a virtual centre with a small number of permanent staff. The universities and departments to which funds are directed provide additional administrative support. The lead researchers, researchers and PLs who were part of the CoE-FS in 2022 are listed in Appendix 4.

Full name	Institution	Sex	Race	Citizenship	Role	% time
Prof Julian May	UWC	М	W	South African	Director	100
Prof Lise Korsten	UP	F	W	South African	Co-director	20
Nolutando Didiza	UWC	F	В	South African	Administrative Assistant (contract)	100
Dr Elaine Sinden	UWC	F	С	South African	Research Centre Manager	100
Carla Bernardo	UWC	F	С	South African	Communications Manager	100
Elaine Petersen	UWC	F	С	South African	Finance Manager	100
Daleen Muller (filled until June 2021)	UP	F	W	South African	Administrator	60

Table 24: Management and administrative staff

Robyn Engelbrecht	UWC	F	С	South African	Administrative Assistant (contract)	100

14 TRANSFORMATION GOALS

Transformation is a corrective action necessary to deal with the past injustices of colonialism and apartheid. It is necessary also to create a critical diversity of perspectives that will produce new insights, a healthier education environment, promote inclusiveness within the CoE-FS, and prepare its students for a multicultural world of work. Finally, it is necessary for succession planning both for the directors and senior researchers. We discuss this in more detail in the next section.

With regard to its management and support structure, the CoE-FS has made good progress in placing staff from previously disadvantaged backgrounds and all of the full-time permanent staff are black women. We are also among the minority of CoEs to have a female director. As already mentioned, our transformation accomplishments include disability.

All students in the "Drought responses in Cereals and Legumes" project are from designated groups (Black, Coloured or Indian) and the majority of them are female. The project is multi-institutional in the sense that it includes collaborators from the ARC, MU, the University of Mauritius, the Chinese University of Hong Kong, and Walter Sisulu University (an HDI). The research team led by Professor Ludidi is formed from institutions of diverse groups and countries (Walter Sisulu University is an HDI and TARDI is a provincial institutionin a poor rural setting; MU and the Chinese University of Hong Kong are world-class institutions recognised for their international academic leadership). The project is multidisciplinary, bringing together plant science, soil science, and entomology while using these diverse disciplines for social impact by collaborating directly with smallholder farmers.

Professor Ludidi's project promotes transdisciplinary research by bridging plant science with animal science and is working towards the inclusion of indigenous knowledge systems from a social sciences point of view to address mainstreaming of indigenous grain crops in the South African food system.

The Safe Food project involved various disciplines such as microbiology, veterinary public health, social sciences, food science, epidemiology, consumer science, and bioinformatics. Also, UP's Department of Plant and Soil Sciences, Food Safety team, Animal Sciences, Veterinary Sciences, UFH's Animal Sciences, UD, UMD, USDA's Agricultural Research Services, and the FDA's Center for Food Safety and Applied Nutrition were involved in this research. Various black South African students are funded through this programme. Additionally, further African collaborators have been included and will form part of future projects. As an example of our contribution, the SFPP team includes two black women, and five African males (four Black and one Indian). Also, of the 34 students involved in this project, 26 are from previously disadvantaged groups.

In our pursuit of a more equitable, just, and sustainable society we must examine not only who gets to make decisions, but also on whose evidence these decisions are made: the question of whose knowledge is to be recognised, translated, and incorporated into action is particularly important in South Africa in the context of decolonising knowledge and our universities. The approach of knowledge co-production through CoPs workshops and co-elaborative scenarios adopted is inherently transformative as it creates hybrid forums where groups otherwise marginalised in knowledge production (women, small farmers, informal workers, refugees) were not only considered but helped inform the overarching research agenda and had their knowledge integrated into the co-production process. We continue to focus our research on marginalised groups within the food system that, we argue, should have a more central role in food governance, namely informal food traders and civil society organisations.

The approach of knowledge co-production is also inherently transdisciplinary as it includes researchers from multiple academic disciplines (geography, sociology, political science, public health) but also participants from outside of science (various state and civil society institutions).

The approach of co-production that underpins the Local Governance project lends itself to transdisciplinary research. This can be seen in the participatory approaches used in data collection and in policy engagement.

Similarly, the leverage-funded food environment projects have collaborators in the US, Chile, Mexico, Colombia, Jamaica, Peru, and Brazil, with advisors in the UK, New Zealand, and Thailand. All collaborators meet at least twice a year for the equivalent of a three-day conference and have monthly webinars and discussion groups on thematic topics. Where possible, students are able to attend discussions. Researchers from Nutrition as well as, PhD candidates, have been invited as either collaborators or advisors on international planning committees or research projects.

Multiple institutions have been involved in the "Reclamation of heavy metal contamination of soils" project. In South Africa, Walter Sisulu University (Dr Egbichi), UP (Dr Makgopa), the National Zoological Gardens (Dr du Plessis), and UFH (Maliviwe Mpayipheli) have all contributed to the advancement of the project. All the students (Esihle Gcanga, Lee-Ann Niekerk, Fahiem Carelse, Anushka Gokul, Junaid Mia, and Dr Arun Gokul) listed in this project are from previously disadvantaged communities.

15 SOCIAL IMPACT

The CoE-FS has made a concerted effort to advance social impact. Most of the activities have already been described in the projects and KPAs, but a few additional examples of such interactions are below:

The social impact on students' lives who earned a bursary through the CoE-FS, have graduated, and have been successfully placed within society, is infinite.

The social impact was also achieved through the involvement of civil society in the CoP meetings and also through close collaboration with SALGA. Extensive consultation with Western Cape representatives of SALGA has taken place, not only by involving them in the CoP gatherings but also by convening a series of meetings with SALGA representatives. During these meetings, SALGA officials were sensitised to key issues of local food systems governance, were invited to provide feedback on the draft food governance posters (in collaboration with Programme 1), and consulted on the identification of small-town municipalities with whom to conduct co-elaborative scenario processes.

The research led by Dr Wegerif includes civil society, including the East and Southern African Farmers Forum, the Masifundise Artisanal Fishers Organisation (South Africa), the Association for Rural Advancement (South Africa), the Environmental and Management and Economic Development Organisation (Tanzania), and the Network for Women's Rights in Ghana. They also interacted and shared information with the South African Informal Traders Alliance and the Women in Informal Employment: Globalizing and Organizing network.

The project led by Professor Ludidi is working with social scientists who specialise in 'Augmentative and Alternative Communication' where the team has published a paper on food and nutrition security for people with disabilities. They are also working on two papers with a social scientist (i) relating properties of indigenous porridge for baby foods and policy impact (ii) why marama plant should be domesticated. It is also noted that traditional food crops are mainly grown by smallholder farmers. This research will have a major socioeconomic impact on rural societies through value addition. This will contribute to government efforts to end hunger, and poverty and ensure food security for vulnerable rural households. The project also aims to show proof of the nutritional and health benefits of indigenous African foods. Some prototypes also have to be used by entrepreneurs for better livelihood.

Professor Ndiko's lab has also actively engaged with smallholder farmers in August, September and October 2022 in workshops that offered training to the farmers (in Ward 22 of the Matatiele Local Municipality) in regenerative agriculture in preparation for the 2022 summer planting season. This is at no cost to the smallholder farmers.

The social impact was also achieved through the involvement of civil society in the FG CoP (Food Imbizo) meetings and also through close collaboration with SALGA. Extensive consultation with Western Cape representatives of SALGA has taken place, not only by involving them in the Food Imbizo gatherings but also by convening a series of meetings with SALGA representatives. During these meetings, SALGA officials were sensitised to key issues of local food systems' governance, and were invited to provide feedback on the draft food governance posters (in collaboration with Programme 1),and consulted on the identification of small-town municipalities with whom to conduct co-elaborative scenario processes. These scenarios covered plausible food futures and how they relate to wider local government concerns, including local economic development and the provision of basic services such as roads, water, power, and waste management. These

consultations resulted in the identification of the Witzenberg municipality as a pilot town in the Western Cape.

Community engagement activities under the project led by Professor Keyster include continuing the research activities with TARDI as well as starting a new community engagement project with a community in Matatiele. This project will explore possibilities of converting land into farming land for subsistence farming. This project also started a new community engagement project with a community in Mthatha. He and his team are regularly involved with the community in the Westbank area of Cape Town to assist the community with farming vegetables. They also conducted an analysis on the surrounding soils in order the assess the appropriateness of the soil for vegetable farming.

An important aspect to highlight is the science impact reflected in the international recognition of the food safety group. Professor Korsten has been appointed as an independent expert on the Global Food Safety Initiative forum. Professor Korsten has also been appointed as an expert on the FAO and WHO Joint FAO/WHO Expert Panel on the Prevention and Control of Microbiological Hazards in Fresh Fruits and Vegetables. She also serves as a technical expert on the SABS ISO standards committees and has been invited to serve on the ministerial commission on antimicrobial resistance (AMR) contributing towards the stewardship technical working group representing environmental and plant health within AMR One Health.

Through our work on policy and governance, we have contributed towards building the capacity for policymakers and institutions at the municipal, provincial and national levels to engage with the systemic dynamics of food systems change. We thus speak directly to the need for 'improved, science-based information to direct development-oriented decision-making'. By linking food security to health, livelihoods, productivity and employment, we are supporting the different spheres of government in attaining their key social development outcomes. These include "a long and healthy life for all South Africans"; "a skilled and capable workforce to support an inclusive growth path"; and "sustainable human settlements and improved quality of household life". In this regard, we directly address the "Farmer to Phama value chain" and at least two of the four research foci of the Social Dynamics Grand Challenge: 'The dynamics of human and social behaviour' and 'Societal change and the evolution of modern society'.

Regarding the national science and technology framework, we believe that we have been able to contribute to several of the outcomes in the performance agreement between the Minister of Science and Technology and the President. Our work directly assesses outcomes working towards vibrant, equitable and sustainable rural communities with food security for all (7) and sustainable human settlements and improved quality of household life (8).

The SMART foods project is working with social scientists who specialise in 'Augmentative and Alternative Communication' where we have published a paper on food and nutrition security for people with disabilities. We are also working on two papers with a social scientist on (i) relating properties of indigenous porridge for baby foods and policy impact (ii) why marama plant should be domesticated. The traditional food crops are mainly grown by smallholder farmers. This research will have a major socioeconomic impact on rural societies through value addition. This will contribute to the government's effort to end hunger, and poverty and ensure food security for vulnerable rural households.

Honours students from UP attended the South African Association of the Flavour & Fragrance Industry Flavour Seminar, an important platform for meeting potential employers and for assisting students with Food Product Development projects.

Professor Julian May commented on the <u>SONA 2022</u> and contributed to a discussion on <u>South Africa's Cuba donation</u>. Lastly, he presented on Governance in the Agri-Food Sector in South Africa to the CIRAD-Eduardo Mondlane University "Workshop on governance of the agri-food sector in Southern Africa: new approaches for new challenges".

16 SCIENTIFIC CONTRIBUTIONS

The world faces many challenges to food security including undernutrition and over consumption, rising food prices, population growth, threats to agricultural production, etc. In addition to causing widespread human suffering, food insecurity contributes to degradation and depletion of natural sources and economic instability.

The growing threat of, for instance, global climate change amplifies the need for food systems to better meet human needs and align with planetary sources. The work of the Professor Ludidi and his team play an essential role in meeting the global challenge of moving the world into a safe operating space in which agriculture can meet global food needs. A research group on the microbiology of food plants in the context of climate change has been established in the Faculty of Science following a UWC and MU Plant Science Symposium. This group have re-focused part of their work on indigenous grains and legumes, and undertaken seed collection visits in remote areas of the Northern Cape and Limpopo. The CoE-FS has also funded research on food authenticity using DNA metabarcoding.

Work on public nutrition in the Faculty of Community and Health Sciences at UWC has also expanded with a growing focus on obesogenic food environments and diet-related NCDs. Studies have also been undertaken on the specific nutritional needs of highly vulnerable groups including waste-pickers, people living with HIV/AIDS and students. The Department of Dietetics and Nutrition is one of five departments in South Africa offering a degree in this field.

The project led by Professor Keyster disseminates the ICP results with the farming community in the Eastern Cape which could aid in better soil management and planning for the 2022 growing season. This team is also working closely with GrainSA in order to reach more small-scale farmers in the broader crop growing areas of South Africa. This project will write an information brochure to assist farmers with soil ICP data as well as pathogen incidence across field sites.

Our research publications have highlighted two noteworthy contributions to the science-policy interface concerning food issues:

- a. Firstly, that creative processes of storytelling can complement more conventionally "rigorous" forms of knowledge to lend greater experiential granularity, to highlight the intersection of multiple forms of oppression and deprivation, and to invoke more emotionally compelling rationales to drive policy and governance change
- b. Secondly, that networks of change agents including academics, officials and civil society activists, can leverage disruptive impulses (such as the COVID-19 lockdown) to raise food issues on the policy agenda and embed policy changes that enable subsequent incremental enhancements in the democratisation and responsiveness of food systems governance.

The finding that extrusion cooking produced enhanced ferritin formation in Caco-2 cells compared to conventional cooking is an important scientific contribution. It highlights the role that modern processing technologies for the production of SMART foods, such as extrusion cooking, can play in enhancing iron bioavailability. Explaining the scientific mechanism of why fermented sorghum flour produced better quality flatbread is a good contribution towards science. This mechanism can be used to explain a lot of food and can be exploited to improve the properties of gluten-free flours for flatbread. Microwave and infrared can be used to make quick cooking legume grain with less beany or removal of beany flavour. The manufactured starch microspheres as fat replacer have been used in many food products and may have commercial application.

In June 2022, Professor May published two science communications: https://www.netwerk24.com/netwerk24/za/worcester-standard/nuus/unique-foodand-nutrition-journey-20220615-2 and https://foodsecurity.ac.za/news/breede-rivermunicipality-hosts-unique-food-security-learning-journey/. Also, an additional three science communications were published in June 2022: Multiple interviews and pieces for the Worcester learning journey: https://wcedp.co.za/understandingworcesters-food-system-through-learning-journeys/; https://www.dailymaverick.co.za/article/2022-05-24-localised-food-systems-key-toeconomic-inclusion-and-environmental-sustainability/; and "Starvation silently kills our kids" - https://www.news24.com/citypress/news/starvation-is-silently-kills-ourkids-20220410.

In addition, in 2022, Professor May was the contributing author to *The Oxford Handbook of the South African Economy*, a book <u>President Cyril Ramaphosa</u> <u>praised</u> for its "holistic take on the economy, ranging from chapters examining South Africa's economic history, its performance over time, and detailed analyses on various industries". He also participated in African and French institutions virtual meetings on a partnership through TSARA and gave an <u>SABC interview on</u> <u>inequality in South Africa</u>.

17 DATA STORAGE, UTILISATION, AND ACCESSIBILITY

Administrative data on students, grants, projects, financial information and all other information relevant to the management of the CoE-FS is kept on cloud storage and is backed up manually onto external hard drives. The CoE-FS is also using the

Data First facility at UCT to access large social survey datasets and will deposit its datasets and Stata Do files on this service in future.

18 PATENT, PRODUCTS OR INTELLECTUAL PROPERTY

A manual on analyses of CDM on products and in media, produced by a master's student is now being applied in projects at Wits/PRICELESS.

A manual on assessment of Anthropometry as part of a population assessment, developed for the NDIS, will be published on the CoE-FS website.

19 CHALLENGES AND CONSTRAINTS

Although most restrictions on travel, the working environment and research were eased early in 2022, the legacy of the global COVID-19 pandemic continued to present the CoE-FS and our students with challenges in 2022. In particular, the sequencing of our projects was impacted, whereby student mobilities budgeted for in 2019 could not take place, while stakeholder engagements with decisionmakers had been postponed. In the case of our two LEAP-Agri projects, we were able to complete such engagement via learning journeys undertaken with the assistance of the WCEDP and the SAFL based at SU. In both cases, we were able to present and discuss our research findings with a diverse group of respondents in Langa, Worcester and Zwelethemba. However, resources set aside at our EU partners were unspent and were returned their funders.

UP returned to full campus attendance in 2022, while UWC only opted to open the campus in the second half of 2022. We hope that the disruptions to our postgraduate feeder programmes that were experienced in 2021 will now be resolved and that more students will apply for NRF bursaries within the stipulated timeframe. In this regard, the decision by the NRF to introduce some flexibility in the application cut-off for postgraduate degrees is warmly welcome and this should assist in bringing undecided/hesitant students into the various postgraduate degrees that we support.

The CoE-FS elected to continue to work virtually throughout 2022 although, in the last quarter, we ensured an office presence during the week. The CoE-FS will likely operate as a blended model in 2023 given that our activities stretch across multiple institutions in South Africa. Our CoPs have benefitted from this model and our reach has been extended well beyond our expectations.

Social science research has returned largely to pre-COVID-19 methodologies, and face-to-face interviews were permitted during the most of 2022. However, we have noticed an increase usage of online interviews, virtual focus group discussions, the use of online apps such as MURAL, and internet-based projects involving the use of social media and systematic reviews. Ethics review processes for such studies continues to evolve given the change in the risk profile for such research. Related to this, and to the sharing of information in general, the POPI Act has raised challenges in terms of the use of cloud-based computing, data storage procedures and obtaining consent. Both universities have dedicated staff who have assisted when necessary.

As mentioned in the 2020 and 2021 APRs, the CoE-FS has faced pressure from stakeholders in the food system to assist directly with interventions and to take activist positions. While we have provided regular science communication, we have stepped back from an activist role, and have preferred to provide evidence that we believe to be robust. In some cases, such as with the rise in child malnutrition, this has involved identifying policy failure, and other cases, such as with the NDIS survey, this has involved providing assistance to government.

We were unable and sometimes unwilling to engage with all of the requests that were submitted to us. In some cases, we lacked the expertise, and used our CoP networks to refer the request. In other instances, we felt that the available science did not support the request being made, and we were unwilling to be drawn into a lobbyist position. Nonetheless, we continue to support campaigns to increase the Child Support Grant, promote EBF, increase the taxation of sugary beverages, and have also contributed towards debates on a universal income grant and regulation of the food industry. As always, we were active in the publication of articles in non-academic media sources, as well as participating in radio and television discussions.

In the area of our science communication, a challenge has been that explicit links to the CoE-FS are often missed by journalists or not mentioned by the researcher involved in the interview/news item. This continues also to be the case with work published in academic journals which has benefitted from leverage funding via the CoE-FS. Further measures need to be put in place to ensure the CoE-FS is appropriately credited. This requires an understanding and ongoing engagement between researchers and the communications manager to make one another aware of any media activity, ideally prior to or as it happens.

Another challenge has been the (in)security of the CoE-FS website, and the multiple 'breaches' experienced from 2020 to 2021, and unscheduled downtime in 2022. These breaches have impacted content production and publication, disconnected the site from Analytics, and result in high bounce rates.

Despite these challenges, we achieved some critical milestones in 2022, most notably the meeting of the vice-chancellors of UP and UWC and their decision to continue the CoE-FS irrespective of the source of funding. Prior to this, at the annual Lekgotla, the MANCO of the CoE-FS had already agreed that the collaborations built by the CoE-FS would continue.

20 WAY FORWARD AND DIRECTORS' NOTES

The CoE-FS is a part of the wider South African research and innovation ecosystem and is also embedded in the specific research and innovation systems of the host universities and, to some extent, our collaborating institutions. It is one of many research and training institutions concerned with food and nutrition security in South Africa. These include university faculties of agriculture, public health, economics and science; research councils such as the ARC, HSRC and SAMRC; as well as food policy think tanks such as the Bureau for Food and Agricultural Policy (BFAP) and industry organisations such as GrainSA. The resources available to the CoE-FS are considerably less than most of these institutions, and 40% of our budget is directed towards meeting the critical demand for postgraduate bursaries. However, what distinguishes a centre of excellence from these more specialised organisations is the ability to initiate enquiries that span multiple disciplines, and that focus on identifying the root causes of impediments and propose solutions. Most importantly, a CoE serves as a catalyst to bring about change by transferring models that have been developed to others in the research ecosystem, who further build the knowledge base and grow capacity.

We have achieved this though directed, long-running programmes of work that attracts a wide range of stakeholders and collaborators. As an example, our research on breeding climate-smart plants has been linked to the processing of these plants into food that is nourishing and safe, as well as the identification of beneficiaries who would benefit from access and use of such food, and finally, through our place-based projects, we can identify the policies and sphere of government that can best achieve such improvements. In this way, we strive to produce models that can be transferred to different contexts, and which enable other role-players in the agri-food ecosystem to achieve positive change.

This approach will continue to inform the CoE-FS as we plan for our future beyond 2024.