SCIENCE, TECHNOLOGY AND INNOVATION FOR A CIRCULAR ECONOMY

2021/22
ANNUAL PROGRESS REPORT

Waste Research Development and Innovation Roadmap South Africa

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR
Touching lives through innovation

SCIENCE, TECHNOLOGY AND INNOVATION FOR A CIRCULAR ECONOMY

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MESSAGE FROM THE DEPARTMENT OF SCIENCE AND INNOVATION

Dr Henry Roman

Ms Georgina Ryan

The DSI Team:

Dr Henry Roman
Director:
Environmental
Services and
Technologies

Ms Georgina Ryan
Deputy Director:
Green Economy

It has been seven years of implementation of the Waste Research, Development and Innovation (RDI) Roadmap. An initiative of the Department of Science and Innovation (DSI), implemented by the Waste RDI Roadmap Implementation Unit (WRIU) and hosted by the Council for Scientific and Industrial Research (CSIR). The work could not have been done without partners, most important of which are the researchers who have rallied to the call to increase and strengthen our researcher cohort in waste research in the country. The Department of Forestry, Fisheries and the Environment (DFFE) is a critical partner for the implementation of the Waste RDI Roadmap both in terms of addressing issues within the waste sector as well as the associated climate change impacts. The South African Local Government Association (SALGA) which brings critical issues from the coal face of implementation, namely the municipalities, ensured that we brought relevant interventions where they are needed most, to the people.

This past year 162 researchers and collaborators have been supported through grant projects, with 60 post-graduate students receiving support across 34 research grant projects. 62% of the supported students were black and 60% were female, demonstrating the transformation effort of the programme.

The DSI internship programme implemented by the Human Sciences Research Council (HSRC) in partnership with the WRIU, launched a targeted post-graduate waste-sector internship programme in 2021 (an initiative of the Waste RDI Roadmap), to further support capacity development of specialist waste-sector graduates through placement with industry and business. This capacity building initiative offers these graduates an opportunity to acquire practical workplace experience whilst at the same time enabling them to transfer their specialist waste knowledge to host institutions. We hope to expand this programme and form a public-private partnership to further capacitate the waste sector to have the expertise required to transform from a landfill-based management system to one of diversion and economic development.

Amongst the projects completed during the 2021/22 financial year was one entitled 'Assessing economy-wide prospects for a more sustainable circular economy in South Africa', by the University of Cape Town. This research has laid the foundation for the upcoming work on developing a circular economy research agenda for South Africa.

The DSI will be embarking on a transformation of the Environmental Services and Technologies Directorate to drive the approved policy imperative of Circular Economy as outlined in the White Paper on Science, Technology and Innovation (STI). During the 2022/23 financial year the DSI will be drafting the Science, Technology and Innovation (STI) for a Circular Economy Roadmap (STI4CE) with partners, including the Climate Technology Centre and Network (CTCN) and the CSIR. This is an important signal to the National System of Innovation (NSI), that the DSI has a critical role to play in the economic transformation to attain a low-carbon economy for the Republic of South Africa. It is important to note that the DSI sees the transformation to a circular economy as a transformation of the whole economy and not only select sectors within it.

Core to the transition of the economy from a traditional linear one to a more inclusive circular one will be partnerships. This envisaged partnerships will require all of us to rethink how we fund programmes in government, especially between different departments, with the private sector and ensuring involvement of communities. The journey towards a net zero carbon economy by 2050 will be a team effort to address the economic challenges while meeting our societal, environmental and economic prosperity goals.

Dr Mmboneni Muofhe

Deputy Director-General:
Socio-Economic Partnerships

MESSAGE FROM THE WRIU MANAGER, PROF LINDA GODFREY

The Department of Science and Innovation (DSI), through the Waste Research, Development and Innovation (RDI) Roadmap, began its investment in targeted waste research in South Africa in 2015. While the total investment in the Roadmap over these seven years amounts to just 1.6% of the original Roadmap funding ask, the Roadmap continues to make an impact in the sector.

Despite the limited funding and a difficult economic climate, the Roadmap was able to maintain its total investment in waste research during the 2021/22 financial year. And, while the value of grant projects on the books declined this year, the number of grant projects funded increased to its highest number since the implementation of the Roadmap in 2015.

The Roadmap has also been able to support much-needed capacity development over the years, through support for under- and post-graduate students. Since 2015, a total of 41 students have successfully graduated from various waste programmes. In just the last year, a total of 60 students were supported through grant projects, and eight (8) post-graduate students were supported through direct scholarships. In addition, 49 post-graduate students were mentored under the two Waste RDI Roadmap – National Research Foundation SARChI Chairs, while 18 post-graduate students were mentored under the University of KwaZulu-Natal and North-West University coursework degrees. As universities returned to in-person graduation ceremonies, we celebrate the students who graduated this past year. Tragically, we lost two young, post-graduate students this past year to the pandemic and to violent crime. Our hearts go out to the families and colleagues of these two students who were taken too soon.

Most universities have still felt the impact of the pandemic this year, including difficulties in accessing research equipment, delays in processing samples and restrictions in field work, among others. Despite this, 49 scientific publications were finalised and published this financial year. Most of these publications, except where intellectual property restrictions are pending, have been made publicly available on the Waste RDI Roadmap website.

Some of my highlights this past year include the development and piloting of a National Waste Picker Registration System, co-funded by National Treasury; mapping the level of circularity of the South African economy, undertaken by the University of Cape Town, in partnership with BOKU, Austria; and the clean cities project, aimed at understanding societal behaviour and the reasons behind the littering and dumping of waste within our communities. The Waste Roadmap Implementation Unit (WRIU) was also able to partner with researchers from the CSIR, producing a series of publications on circular economy sector opportunities, including deep-dive studies into the circular economy opportunities in mining, agriculture and manufacturing.

Eleven (11) new grant projects were added this past financial year, to the 23 ongoing projects, resulting in the largest number of grant projects (34) managed by the Roadmap in a single year. These included six (6) new DSI-funded projects and five (5) new grant projects funded by other organisations but managed by the WRIU. Investment in "waste technologies" remains the core investment area of the Roadmap, accounting for 61% of the total Roadmap investment over the past seven years, followed by "waste and society" at 13%, and slightly smaller investments over the other four clusters of the Roadmap.

These successes would not be possible without a strong cohort of waste researchers at South African universities and science councils who remain committed to delivering high-quality research. The 34 research grant projects funded this financial year supported 162 researchers and collaborators (non-unique), the highest number of researchers supported on grant projects in a single year since the implementation of the Waste RDI Roadmap in 2015. Most of these researchers (78%) stemmed from South Africa, but also included researchers from other African countries, the Americas, Asia and Europe.

The SARChI Chairs in 'Waste and Climate Change' and 'Waste and Society' continue to make strides in their respective fields, building their networks, research portfolios and resultant impact.

It is exciting to see how the broader circular economy concept is gaining traction in the South African landscape. As the *Waste RDI Roadmap Implementation Unit* makes its transition to *the Science, Technology and Innovation for a Circular Economy (STI4CE) Implementation Unit*, I am pleased to present here a summary of the activities of the Roadmap for the 2021/22 financial year.

Prof Linda Godfrey

The CSIR Team:

Bongani Memela
Manager: Hosted National Programmes

Prof Linda Godfrey
Manager: Waste RDI Roadmap

Siphe Ngobese
Project Administrator: Waste RDI Roadmap

Amit Ramsumair
Management Accountant

Lulu Makapela
Contracts Manager

Vision

Development and deployment of performance improvements in waste management has delivered a significant contribution to the strengthening of a sustainable regional secondary resources economy in South Africa.

Mission

This has been achieved by means of a National Waste RDI Programme that supports maximisation of diversion of waste from landfill towards value-adding opportunities, including prevention of waste and the optimised extraction of value from reuse, recycling and recovery, in order to create significant economic, social and environmental benefit.

BACKGROUND AND OBJECTIVES

The Waste Research, Development and Innovation (RDI) Roadmap is an initiative of the Department of Science and Innovation (DSI) aimed at guiding South Africa's public and private sector investment in waste research, development and innovation over the period 2015-2025.

BACKGROUND

The DSI recognised the role that RDI could play in achieving the objectives of national waste policy and transforming the South African waste sector in a way that could provide direct environmental, social and economic benefit for the country.

In 2012, the DSI, in partnership with the CSIR, embarked on a process to develop the Waste RDI Roadmap. This process, which was shaped by business, industry, government and academia, culminated in the publication of South Africa's first Waste RDI Roadmap (2015-2025) in early 2015.

The Waste RDI Roadmap is available to review online at **www.wasteroadmap.co.za.**

OBJECTIVES

With an investment ask of approximately R3.9 billion over 10 years, the successful implementation of the Roadmap is expected to assist government and industry in significantly increasing the diversion of waste away from landfill towards value-adding alternatives, through more effective decision-making; faster insertion of context-appropriate technology; export of know-how and technology; and strengthened RDI capability and capacity.

The Roadmap, which is anchored in the mandate of the DSI, is structured around three core pillars –

- Human capital development (HCD)
- Research and development (R&D)
- Innovation (technological and social)

The Roadmap aims to address issues relating to five priority waste streams –

- Municipal solid waste
- Waste electrical and electronic equipment (WEEE)
- Plastic waste
- Organic waste
- Waste tyres

It does this within six broad areas or clusters of activity:

- Strategic planning
- Modelling and analytics
- Technology solutions
- Waste logistics performance
- Waste and the environment
- Waste and society

IMPLEMENTATION

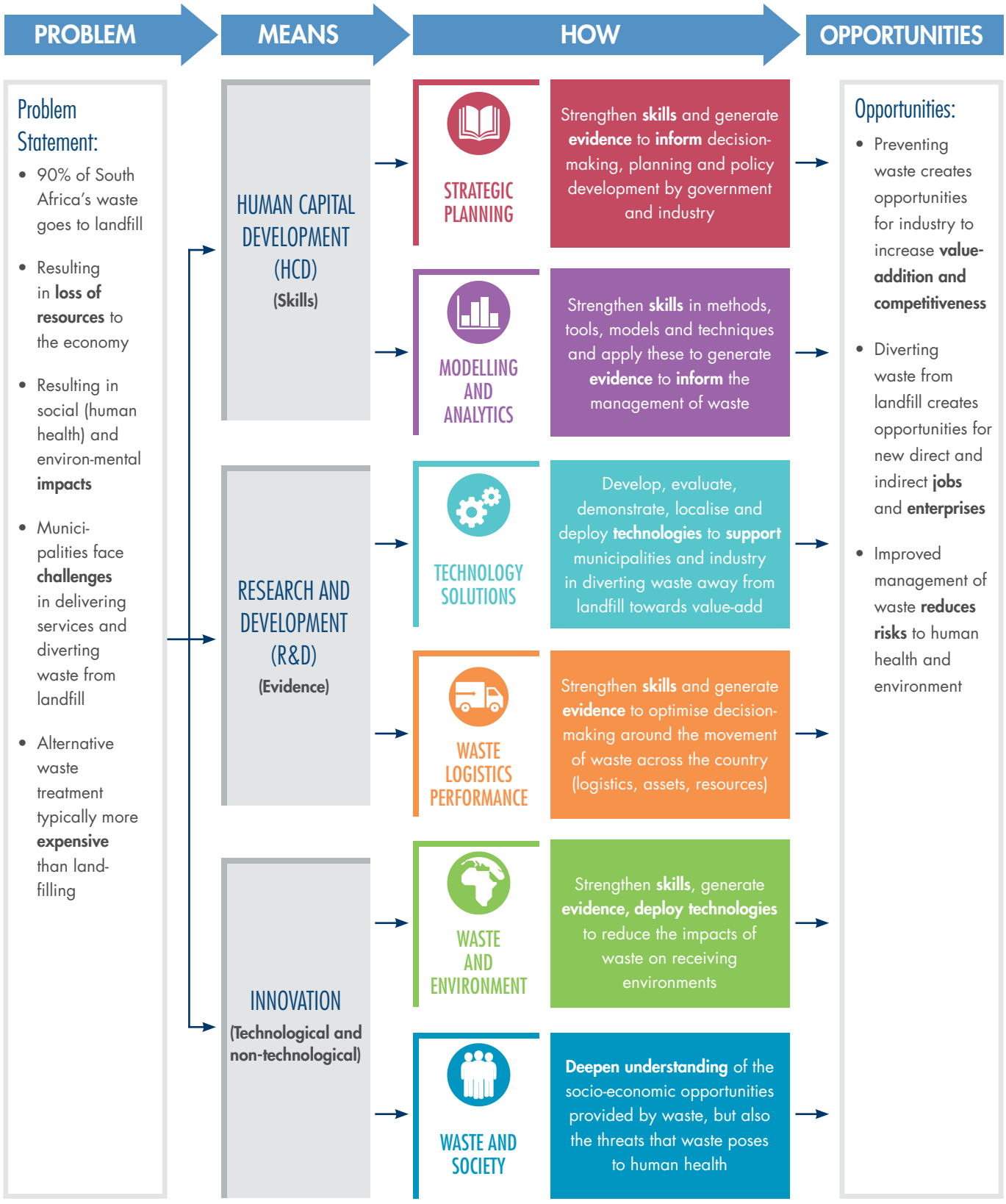
The CSIR was appointed by the DSI to implement the Waste RDI Roadmap from 1 April 2015. The intention is for the CSIR, through the Waste RDI Roadmap Implementation Unit (WRIU), to drive human capital development (HCD), research and development (R&D) and innovation, in partnership with government, industry and academia; and to actively engage opportunities (local and international) for waste RDI collaboration and co-investment.

HUMAN CAPITAL DEVELOPMENT

RESEARCH AND DEVELOPMENT

INNOVATION

PICTORIAL SUMMARY OF THE WASTE RDI ROADMAP



REFLECTING ON SEVEN YEARS OF IMPLEMENTATION (2015-2022)

TRENDS

The Waste RDI Roadmap aims to support the improved management of waste and the increased diversion of waste away from landfill towards value-adding opportunities, thereby maximising the potential environmental, social and economic benefits, while remaining true to the mandate of the DSI.

This section provides an overview of major indicator trends over the duration of the implementation of the Waste RDI Roadmap.

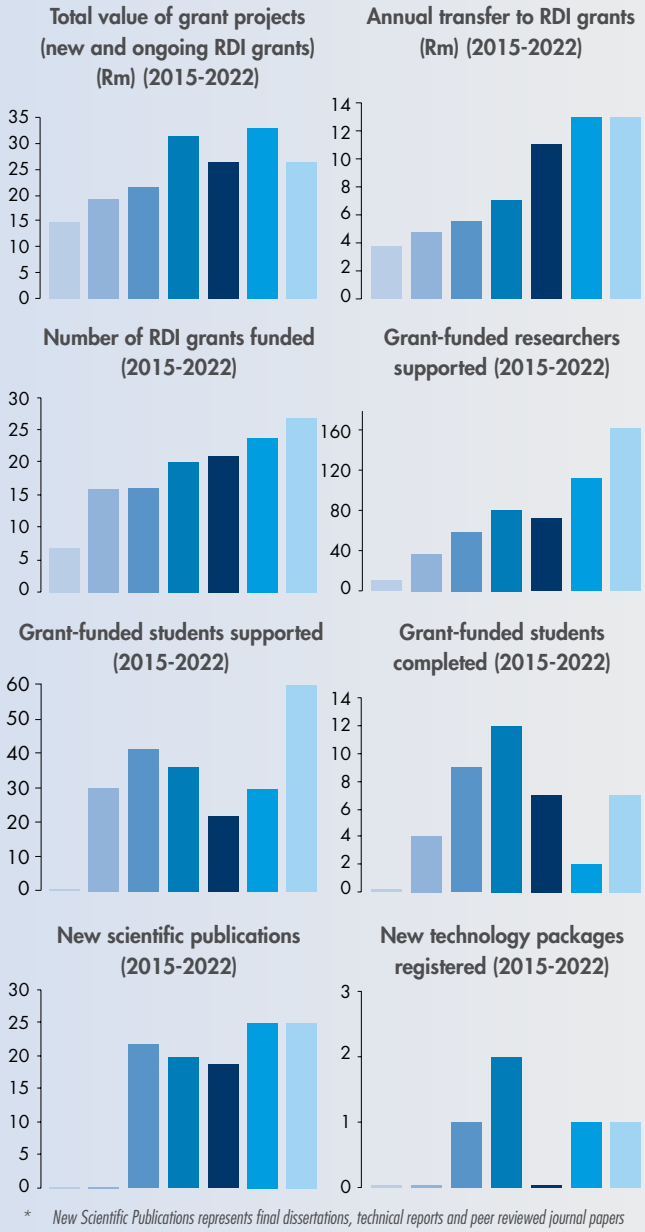
Funding for science, technology and innovation has been under pressure during the Covid-19 pandemic. Despite this difficult economic climate, the Waste RDI Roadmap was able to maintain its total investment in waste research through grant projects (transfers). While the total value of grant projects on the books in 2021/22 declined, the number of grant projects funded increased to its highest number since implementation in 2015. This is largely because of the number of micro-grant funded projects that started in 2021.

The increase in the number of grant projects funded translated into an increase in the number of both researchers and students supported on projects. Thankfully, the dip in the number of students completing studies, experienced in 2020/21, recovered this year as universities opened after lockdown restrictions. The number of scientific publications published and technology packages registered was maintained.

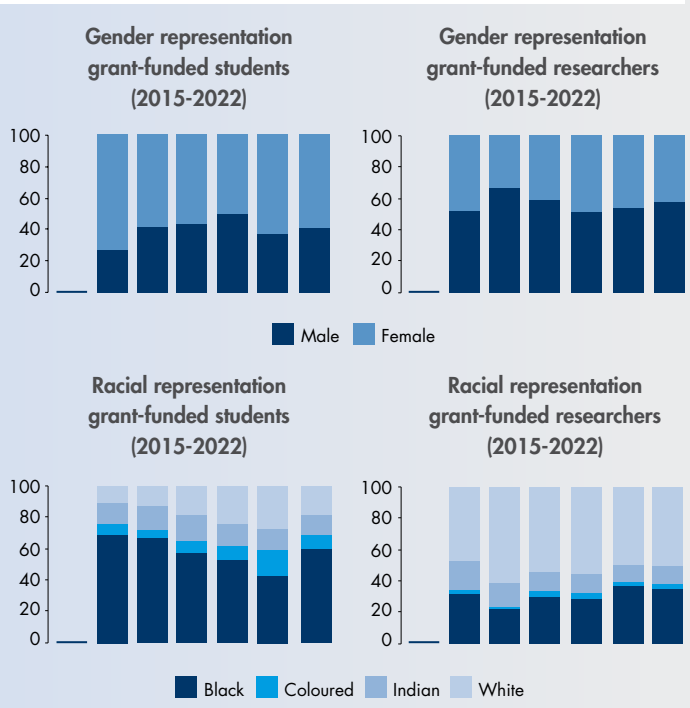
EQUITY

In line with national imperatives, including the White Paper on Science Technology and Innovation, which calls for a responsible research and innovation approach to support ethical science, technology and innovation, and an inclusive National System of Innovation (NSI), the Waste RDI Roadmap is committed to supporting gender and racial equity.

TRENDS



* *New Scientific Publications represents final dissertations, technical reports and peer reviewed journal papers*



Mapping of the Waste RDI Roadmap investment in post-graduate students and researchers, over the past six years, shows very good transformation of the sector, although noting the differences in representation between the students and the more experienced researchers. The micro-grant funding awarded in 2020/21 was a step towards addressing this.

INVESTMENT

The split in grant funding across the Roadmap's six clusters over the past seven years is very much in line with the original intention of the Waste RDI Roadmap. The largest share of funding (55%) was planned for investment in 'Technology Solutions'. The actual spend to date is 61%. 'Waste Logistics Performance' remains an underfunded area (4% compared to 8% ask), with the WRIU struggling to find waste-logistics research projects that meet the criteria for funding under the Waste RDI Roadmap.

While the trend in funding per cluster is in line with the original intention of the Roadmap, the total investment amount in the Waste RDI Roadmap, from all partners, has not been realised (see financial section).

WASTE RDI ROADMAP CLUSTERS AND PERCENTAGE OF TOTAL INVESTMENT PER CLUSTER EXPECTED (2015-2025)

		PLANNED	ACTUAL
STRATEGIC PLANNING	Build and strengthen the basis and application of strategic analysis and advice for the purposes of evidence-based decision-making to inform strategy formulation, planning and its execution and management	6%	8%
MODELLING AND ANALYTICS	Develop and use methods, tools, techniques, platforms, systems and frameworks for the analysis, monitoring and evaluation of technical, economic, social and environmental opportunities and impacts associated with secondary resources	10%	9%
TECHNOLOGY SOLUTIONS	Design, development, evaluation, demonstration, localisation and deployment of technologies – both local and inbound – for customer-driven performance improvement	55%	61%
WASTE LOGISTICS PERFORMANCE	Optimisation of strategic, tactical and operational decision-making in respect of logistics objectives, assets and resources	8%	4%
WASTE AND ENVIRONMENT	Strengthen the ability to identify, monitor, evaluate and report on environmental impacts of waste and its management, in order to inform better targeted and more effective responses	10%	6%
WASTE AND SOCIETY	Deepen understanding of waste-related opportunities and threats, to increase the success of influencing perception and practice positively	11%	13%

REFLECTING ON 2021/22

HUMAN CAPITAL DEVELOPMENT

60 students supported through grant projects

8 post-graduate students supported through scholarships

49 post-graduate students mentored under the SARChI Chairs

18 post-graduate students mentored under the coursework degrees

WEBSITE

168 277 pages visited

22 128 number of visits

12 060 unique visitors

2 704 number of documents downloaded

Top downloaded publications

- Waste Picker Integration Guidelines
- Integrating the informal sector: Briefing Note
- Trends in waste management: Report
- Food losses and waste: Report
- Valorisation of waste chicken feathers: Dissertation

COMMUNICATIONS IMPACT

15 print articles highlighting the Waste RDI Roadmap*

16 presentations made

5 radio interviews

4 television interviews

TOP 5 COUNTRIES ACCESSING THE WASTE RDI ROADMAP WEBSITE

RESEARCH, DEVELOPMENT AND INNOVATION

49 FINAL DELIVERABLES PRODUCED

162 researchers supported on grant projects

R25.8m committed funding for new and ongoing grant projects

R43.1m new grant proposals received

R7.5m allocated to new grant projects

34 research grant projects funded (new and existing)

14 successful recipient research institutions (new and existing)

11 new grant projects awarded

** While every effort is taken to identify print articles referencing the Waste RDI Roadmap, there may be articles that have not been picked up by the CSIR or DSI's media services.*

"Research and science have a fundamental role to play in the circular economy: providing fact based knowledge that can help dictate policy and business decisions, as well as propelling technological and know-how development" (CMCC, 2020)

Unlocking opportunities through Research, Development and Innovation

Supporting the generation of new scientific evidence relevant to South Africa, which will inform policy, planning, decision-making

Supporting the development of new technology and adapting technology to South African conditions through RDI

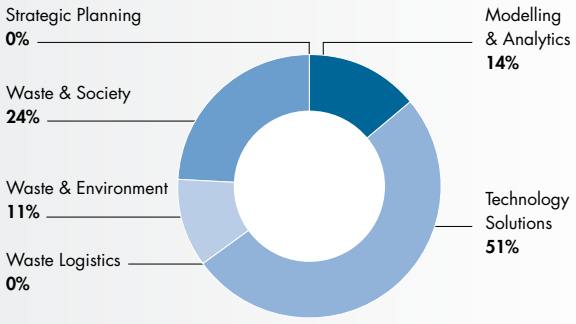
PROJECT PORTFOLIO

The DSI's investment in waste RDI, together with other local and international public and private sector partners, is aimed at supporting the generation of new, relevant, scientific evidence that will inform policy, planning and decision-making and fast-track the development and uptake of new technological and social innovations in South Africa.

CURRENT PROJECTS

The WRIU held 34 grant projects under its portfolio in 2021/22, consisting of 23 ongoing projects and 11 newly awarded projects that started in January 2022. The largest funding allocation (51%) was under the Technology Solutions cluster. With grant projects under the Strategic Planning cluster ending in 2020/21, no grant projects were funded under this theme in 2021/22. Good representation was, however, achieved across the remaining clusters of the Roadmap.

ALLOCATION OF GRANT FUNDING TO THE SIX CLUSTERS FOR CURRENT GRANT PROJECTS (EXISTING AND NEW)



In addition to the grant projects funded by the DSI, the WRIU also managed a portfolio of grant projects funded by other organisations.

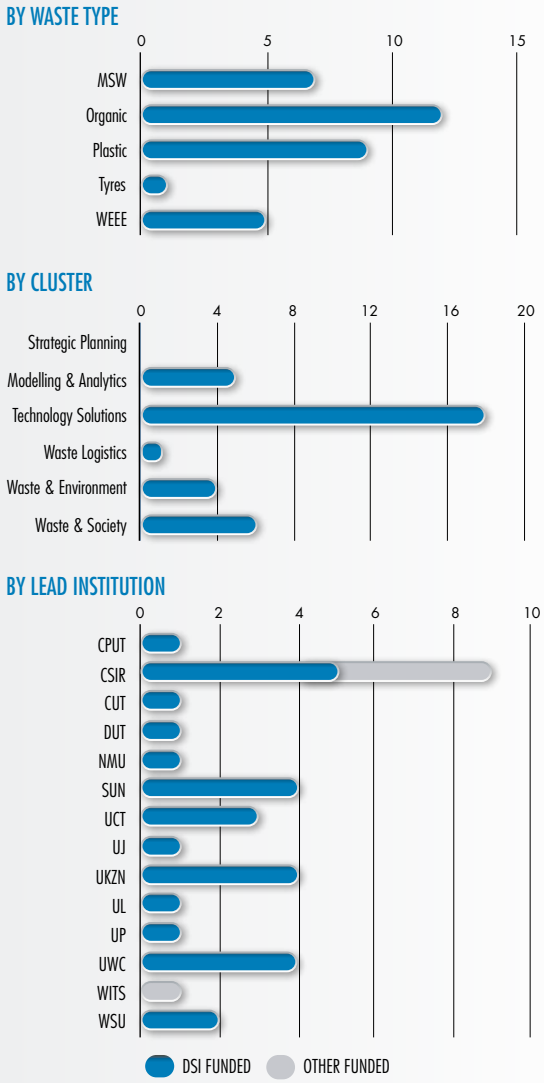
The profile of the current grant projects against the Waste RDI Roadmap clusters and priority waste streams is shown to the right.

Organic waste remains the dominant waste stream in terms of grant-funded research projects (12), followed by waste plastic, with the majority of grant projects (18) aligned with the Technology Solutions cluster of the Roadmap.

The micro-grant call issued in 2020 brought a number of new research institutions into the portfolio, which was built on in 2021 – institutions that had not previously received funding under the Waste RDI Roadmap. A total of 14 universities and science councils received grant funding in 2021/22.

A brief outline of the 34 grant projects supported during 2021/22 is provided in the following pages.

THEMATIC SPREAD OF CURRENT GRANT PROJECTS (EXISTING AND NEW)



PROJECTS ENDING

Three grant projects were successfully completed in 2021/22. The final research deliverables have been made available on the Roadmap website under each of the respective project pages:

- Organic waste: A bioresource for production of novel cellulose nanocomposites (Prof. A. Chimphango, SUN)
- Understanding societal behaviour in order to reduce and divert waste going to landfills (Prof. C. Schenck, UWC)
- Assessing economy-wide prospects for a more sustainable circular economy in South Africa (Prof. H. von Blottnitz, UCT)

FOOD AND NON-FOOD BIOMASS

In 2021/22, there were 10 Roadmap-funded research projects aimed at supporting greater circularity for food and non-food biomass waste

Increasing reliable, scientific data and information of food losses and waste in South Africa

Dr Suzan Oelofse – CSIR

Non-recoverable grant:	2018/17
Project duration:	4/2018 – 3/2021
Students supported on project:	0

Medicinal and economic potentials of citrus waste

Prof. A Oyedeji – Walter Sisulu University

Non-recoverable grant:	2020/031
Project duration:	1/2021 – 3/2023
Students supported on project:	2

Production of high-value dissolving wood pulps from sawdust waste material

Dr J Andrew – CSIR

Non-recoverable grant:	2019/25
Project duration:	4/2020 – 3/2023
Students supported on project:	1

Curbing post-harvest losses using methane from anaerobic digestion of organic waste to drive the cold chain

Dr E van Rensburg – Stellenbosch University

Non-recoverable grant:	2019/27
Project duration:	1/2020 – 3/2023
Students supported on project:	3

Bioplastics from local agri-industrial residues

Dr P Welz – Cape Peninsula University of Technology

Non-recoverable grant:	2020/033
Project duration:	1/2021 – 3/2023
Students supported on project:	2

Evaluation of supermarket food waste as partial replacement of commercial feed in Mozambique tilapia

Prof. G Okuthe – Walter Sisulu University

Non-recoverable grant:	2020/036
Project duration:	1/2021 – 3/2023
Students supported on project:	1

Waste-to-energy practices on small-scale farms

C du Plessis – University of Limpopo

Non-recoverable grant:	2020/039
Project duration:	1/2021 – 3/2023
Students supported on project:	2

Converting sugarcane waste into mannosylerythritol lipids

Prof. R Pott – Stellenbosch University

Non-recoverable grant:	2021/050
Project duration:	1/2022 – 12/2023
Students supported on project:	1

Engineering an antimicrobial yeast as industrial platform for non-sterile bioprocesses

Prof. R den Haan – University of the Western Cape

Non-recoverable grant:	2021/053
Project duration:	1/2022 – 12/2023
Students supported on project:	2

Impact of food literacy on household food waste

Dr A Naicker – Durban University of Technology

Non-recoverable grant:	2020/040
Project duration:	1/2021 – 3/2023
Students supported on project:	2

(#) Post-graduate students supported on the grant project during the 2021/22 financial year..

Projects starting in January 2022 may not yet reflect verified students due to delays in the start of the academic year and registration of student.

PLASTICS AND TYRES

In 2021/22, there were 10 Roadmap-funded research projects aimed at supporting greater circularity for plastic and tyre waste

Modelling South Africa's approach to near zero plastic leakage to our oceans

Dr Suzan Oelofse – CSIR

Non-recoverable grant:	2021/046
Project duration:	4/2021 – 4/2022
Students supported on project:	0

End-of-life options of biobased plastic materials and its biocomposites in landfill, compost and marine water conditions

Dr S Muniyasamy – CSIR

Non-recoverable grant:	2019/29
Project duration:	1/2020 – 12/2022
Students supported on project:	3

Valorisation of non-recyclable mixed plastic waste by low temperature pyrolysis

Dr K Moodley – University of KwaZulu-Natal

Non-recoverable grant:	2020/034
Project duration:	1/2021 – 3/2023
Students supported on project:	3

Compatibilization of polyethylene – waste tyre crumb rubber blends for usable TPEs

Dr S Hlangothi – Nelson Mandela University

Non-recoverable grant:	2020/035
Project duration:	1/2021 – 3/2023
Students supported on project:	5

Beneficiation of used textiles in a circular economy

Prof. B Sithole – CSIR

Non-recoverable grant:	2021/047
Project duration:	8/2021 – 12/2024
Students supported on project:	1

Research outputs for projects using plastic waste in road construction

G Mturi – CSIR

Non-recoverable grant:	2021/048
Project duration:	6/2021 – 12/2023
Students supported on project:	1

Studies on changes in chemical structure and emissions of volatile organic compounds

Dr M John – CSIR

Non-recoverable grant:	2021/049
Project duration:	4/2022 – 12/2023
Students supported on project:	0

Booms, grids and nets: intercepting macroplastic debris in rivers

Prof P Ryan – University of Cape Town

Non-recoverable grant:	2020/041
Project duration:	1/2021 – 3/2023
Students supported on project:	1

Optimisation of the Umgeni River/estuary litter-boom system for climate change resiliency and sustainability

Prof. C Trois – University of KwaZulu-Natal

Non-recoverable grant:	2020/042
Project duration:	1/2021 – 3/2023
Students supported on project:	5

Towards understanding the impacts of marine plastic debris on ecosystem services and the economy in South Africa

Dr W de Lange – CSIR

Non-recoverable grant:	2020/043
Project duration:	1/2021 – 3/2023
Students supported on project:	1

CIRCULAR CITIES

In 2021/22, there were eight Roadmap-funded research projects aimed at supporting greater circularity for various waste streams generated in cities and towns, or at a cross-sectoral level

Assessing economy-wide prospects for a more sustainable circular economy in South Africa (Material Flow Analysis)

Prof. H von Blottnitz – University of Cape Town

Non-recoverable grant:	2019/24
Project duration:	1/2020 – 3/2022
Students supported on project:	1

A comprehensive waste management model for promoting effective decision-making and sustained climate change stabilisation

Prof. C Trois – University of KwaZulu-Natal

Non-recoverable grant:	2021/051
Project duration:	1/2022 – 12/2023
Students supported on project:	2

Municipal waste at household level: Demand estimation and service design

Prof. J Joubert – University of Pretoria

Non-recoverable grant:	2019/28
Project duration:	1/2020 – 3/2022
Students supported on project:	2

Assessing the impacts of burning of waste on communities in the vicinity of landfills in the Free State

Dr H Roberts – Central University of Technology

Non-recoverable grant:	2020/036
Project duration:	1/2021 – 3/2023
Students supported on project:	1

Understanding societal behaviour in order to reduce and divert waste going to landfills

Prof. C Schenck – University of the Western Cape

Non-recoverable grant:	2018/19
Project duration:	1/2019 – 12/2021
Students supported on project:	4

Development of a South African Informal Waste Reclaimer Registration system

E Ramphine – CSIR

Non-recoverable grant:	2021/044
Project duration:	5/2021 – 5/2022
Students supported on project:	0

Piloting of a national Informal Reclaimer Registration System to inform reclaimer integration in South Africa

Prof. M Samson – University of the Witwatersrand

Non-recoverable grant:	2021/045
Project duration:	5/2021 – 5/2022
Students supported on project:	0

Exploring disposable diaper usage and disposal practices in rural areas

Prof. C Schenck – University of the Western Cape

Non-recoverable grant:	2021/054
Project duration:	1/2022 – 3/2023
Students supported on project:	2

ELECTRONICS

In 2021/22, there were four Roadmap-funded research projects aimed at supporting greater circularity for electrical and electronic equipment

Co-processing of PCB leach solutions with effluent streams from PCB manufacturing

Prof. J Petersen – University of Cape Town

Non-recoverable grant:	2019/26
Project duration:	1/2020 – 3/2023
Students supported on project:	3

Urban mining of Nd, Dy and Sm from rare earth magnets

Dr K Moodley – University of KwaZulu-Natal

Non-recoverable grant:	2020/032
Project duration:	1/2021 – 3/2023
Students supported on project:	1

Metal recovery from Li ion battery waste

Prof. B Bladergroen – University of the Western Cape

Non-recoverable grant:	2021/052
Project duration:	1/2022 – 12/2023
Students supported on project:	3

Training of the informal sector and household participation in the e-waste sector

Dr T Schoeman – University of Johannesburg

Non-recoverable grant:	2020/038
Project duration:	1/2021 – 3/2023
Students supported on project:	4

"The transition to the circular economy will depend on the skills available, as well as shape the skills that are needed in the labour market. Skilling for the circular economy requires both practical and academic education pathways, across all fields of knowledge"
(Circle Economy, 2020)

Building national capability through human capital development

Providing a pipeline of qualified post-graduate students into the waste and secondary resources sector with the skills to drive alternative waste treatment and unlock opportunities

Increasing the supervisory capacity to mentor post-graduate students and post-doctoral researchers

PORTFOLIO OF STUDENTS

The DSI recognises the importance of investing in skills to support South Africa's transition to a more circular and sustainable economy. A capable public and private waste sector creates a strong foundation from which to achieve the objectives of national waste policy, including the National Waste Management Strategy (NWMS), and transform the South African waste economy. Strengthening skills in waste management is, therefore, a cornerstone of the Waste RDI Roadmap.

The Roadmap has adopted the following funding instruments to support skills development in South Africa:

- Direct scholarships for post-graduate students
- Partial or full funding under Waste RDI grant projects
- Partial or full funding under SARChI Research Chairs
- Internships

Students have two routes to consider when furthering their studies in the field of waste management in South Africa, namely, a Master's degree by coursework or a Master's or PhD by research.

POST-GRADUATE DEGREE BY COURSEWORK

Both North-West University (NWU) and the University of KwaZulu-Natal (UKZN) successfully offered their coursework Master's degrees specialising in waste and resources management in 2021.

- Master's in environmental management, specialising in waste management (NWU) (M.Env.Man.)
- Master of science in engineering: waste and resources management (UKZN) (MSc. Eng.)

Post-graduate scholarships

The Waste RDI Roadmap provided targeted scholarships to students undertaking one of the dedicated coursework Master's degrees in South Africa. The Roadmap provided funding for eight (8) scholarships in the 2021 academic year. Of the eight scholarships awarded, 63% were to young female students.

POST-GRADUATE DEGREE BY RESEARCH

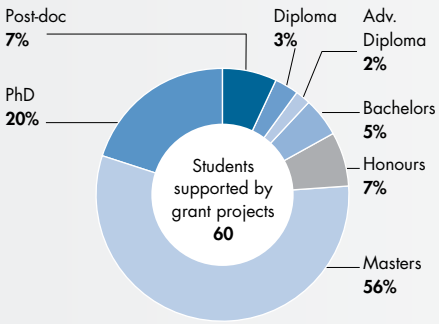
Students are able to undertake waste-related Honours, Master's or Doctoral degrees by research at most universities in South Africa. There are also opportunities available for post-doctoral training.

Grant-funded students

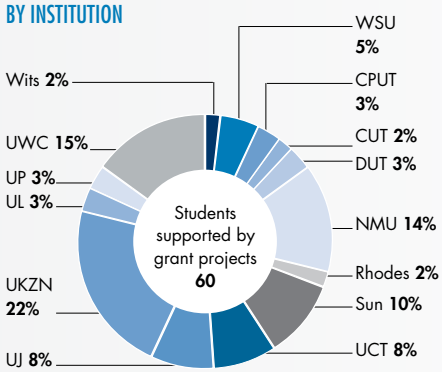
The 34 Waste RDI grant projects funded during the 2021/22 financial year supported 60 undergraduate and post-graduate students (partially or fully). The grant projects remain an important mechanism for building capacity at the post-graduate level in South Africa. While the Waste RDI Roadmap scholarship funding is

GRANT FUNDED STUDENTS

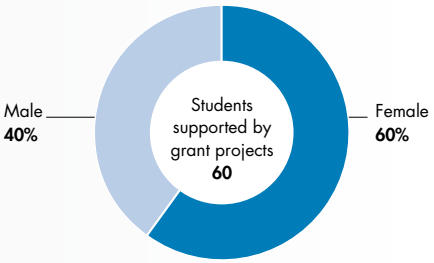
BY DEGREE



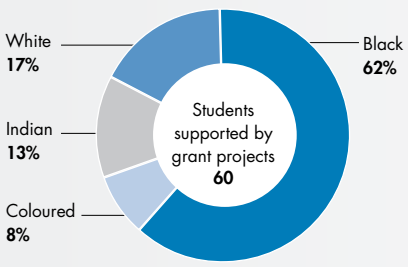
BY INSTITUTION



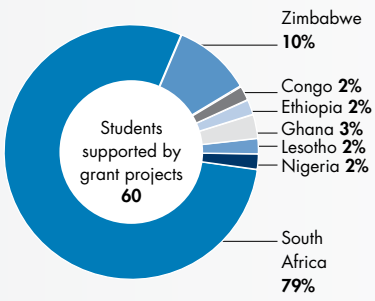
BY GENDER



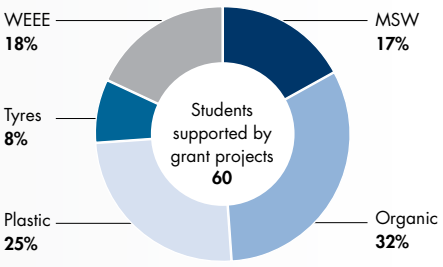
BY RACE



BY NATIONALITY



BY PRIORITY WASTE STREAM



only open to South African citizens and South African permanent residents, the grant projects are able to fund any student studying at an accredited, public higher education institution in South Africa. In this way, the Waste RDI Roadmap is able to support the strengthening of waste skills, not only of South Africans, but of students from across Africa and beyond. In addition to the 47 South African post-graduate students (79%) supported on grant projects, an additional six (6) students from other African countries were financially supported under the Waste RDI Roadmap. Grant-funded students were hosted across 14 academic institutions.

Previous years have seen a large percentage of post-graduate students working on organic waste-related research projects. The focus started to shift in 2019/20, with the majority of grant-funded students working on municipal solid waste (MSW) and WEEE, the direct result of the targeted grant calls that were published in 2016 (on WEEE) and 2018 (on MSW). Student research in waste plastic has grown significantly from ~3% in 2017/18 to 25% in 2021/22 as the interest in and awareness of the environmental impacts of waste plastic has grown.

INTERNSHIPS

The DSI, in partnership with the Human Sciences Research Council (HSRC) and the WRIU, launched a targeted post-graduate waste-sector internship programme in 2021 – an initiative of the Waste RDI Roadmap, aimed at supporting the placement of specialist waste-sector graduates with industry and business. Through this programme, graduates are offered an opportunity to acquire practical workplace experience and transfer their specialist waste knowledge to host institutions. Nine (9) graduates received internships with waste-related companies in 2021.

Some of the students supported partially or fully by the Waste RDI Roadmap, who graduated in 2021-22

PORTFOLIO OF RESEARCHERS

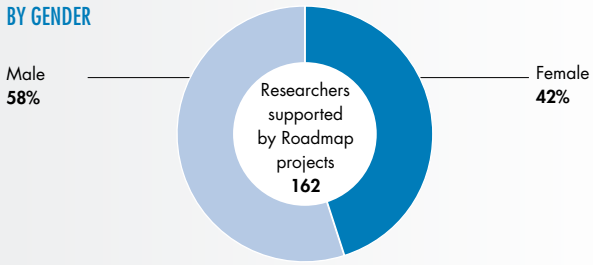
Developing, strengthening and embedding South Africa's waste research, development and innovation capability and capacity within and between research institutions, academic institutions, industry and government, will enable the sector to make more effective decisions, insert context-appropriate technologies and create opportunities for the export of know-how and technology into the African continent and beyond.

The 34 Waste RDI grant projects funded in 2021/22 provided support to 162 researchers and collaborators (non-unique). This is the highest number of researchers supported on grant projects since the implementation of the Waste RDI Roadmap.

Researchers supported on grant projects stem predominantly from South Africa (78%), but there are also some from other African countries, the Americas, Asia and Europe. This is positive for the South African waste sector, as not only is the Roadmap helping to build international capability and networks, but it is also ensuring that new ideas are introduced into the South African research community.

GRANT FUNDED RESEARCHERS

BY GENDER



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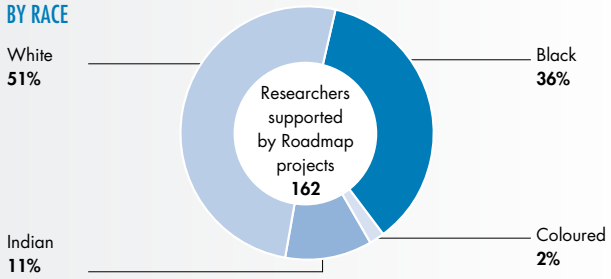
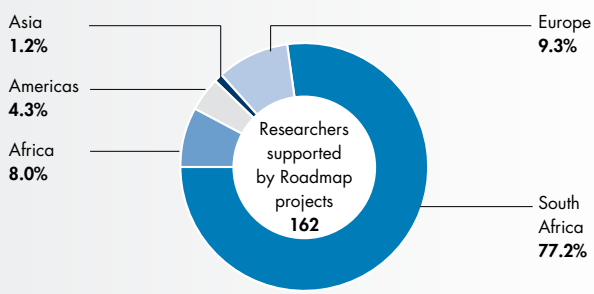


BY NATIONALITY

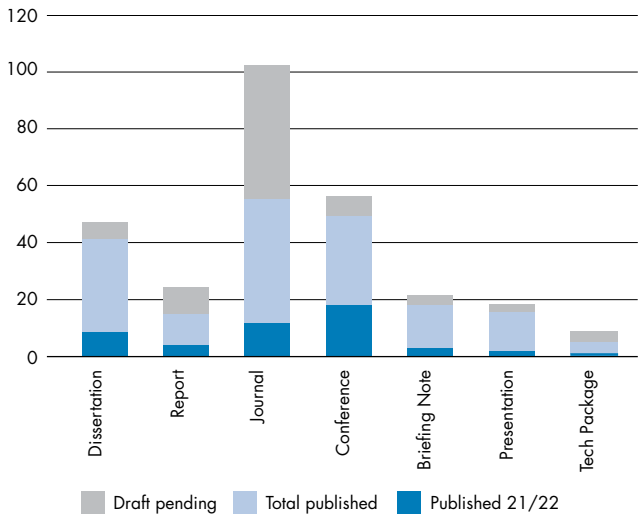


RESEARCH OUTPUTS

The portfolio of grant projects produced 49 final deliverables during 2021/22. This includes post-graduate dissertations, journal papers, technical reports, conference papers and presentations, and briefing notes.

- 9 Dissertations
- 4 Technical reports
- 12 Journal papers
- 18 Conference papers and presentations
- 3 Briefing note
- 2 Summary presentation
- 1 Technology package

The current status of published RDI Roadmap project deliverables and draft deliverables is shown in the figure below.



All grant project deliverables can be accessed on the Waste RDI Roadmap website, under the respective grant project pages. Select Roadmap funded deliverables published during 2020/21 include:

Bello, F. and Chimphango, A. (2022). Tailor-made conversion of mango seed husks to obtain hemicellulose suitable for the production of thermally stable films. *Waste and Biomass Valorization*, 13:719-737

John, M.J., Lefatle, M.C. and Sithole, B. (2022). Lignin fractionation and conversion to bio-based functional products. *Sustain. Chem. Pharm.* 25: 1-14.

Mturi, G.A.J., O'Connell, J.S. et al. (2021). The use of plastic waste in road construction. *Sustainability Handbook*, 98-107.

Muniyasamy, S. and Patnaik, A. (2021). Biodegradable behavior of waste wool and their recycled polyester preforms in aqueous and soil conditions. *J. Renew. Mater.*, 9(10): 1661-1671.

Volschenck, L., Viljoen, K. and Schenck, C. (2021). Socio-economic factors affecting household participation in curb-side recycling programmes: Evidence from Drakenstein Municipality, South Africa. *AJBER*, 16(1): 143-162.

SARChI RESEARCH CHAIRS

The Roadmap co-funded SARChI Chairs in Waste and Climate Change, and Waste and Society, continue to make good progress in achieving their objectives. Research Advisory Committee meetings were held with each Chair in October 2021 and provided an opportunity for the Chairs to present their progress for 2021 and plans for 2022.

PROF C TROIS

Waste and Climate Change
Tier I SARChI Research Chair
University of KwaZulu-Natal
https://sarchiwasteandclimate.ukzn.ac.za/

The objective of the Waste and Climate Change Research Chair is to develop and implement a research programme that delivers evidence to support the improved understanding of the:

- Climate impacts associated with the generation and disposal of waste in South Africa
- Measures (including technologies) to mitigate these impacts
- Impact of climate change on the waste sector

The group published a number of scientific publications in 2021, including three ISI journals, one refereed conference paper, two chapters and one report on micro-digesters (IEA Bioenergy) and served as co-editor of the upcoming Springer Book: *"Waste Management in Developing Countries – Global Perspectives"* (to be published in 2022). A number of MoUs, collaborations and projects were signed or renewed in 2021, including Development of a Waste to Energy Roadmap for South Africa (SANEDI); Monitoring GHG emissions from landfills and open dumps in Southern Africa using remote sensing (SANSA/US EPA); the application of biodigestors and biogas appliances for rural South Africa (National Lottery Commission, Defy MoU); and Investigating waste and climate change from space (Placemarks-Africa, Italy). The SARChI Chair was co-opted by the Presidential Climate Commission to be part of a multi-disciplinary Climate Change Community of Practice.

Recent publications by the Chair include:

- Mani, T., Gutsa, T., Khan, M., Lebreton, L., Trois, C. (2021). CAPTURE Climate Change Adaptation amid Plastic Waste Transport in the Umgeni River Environment. In Proceedings of Sardinia 2021 Waste Management Symposium, Santa Margherita di Pula, Sardinia, Italy 2021.
- Naidoo, D., Nhamo, L., Lottering, S., Mpandeli, S., Liphadzi, S., Modi, AT., Trois, C., Mabhaudhi, T. (2021). Transitional Pathways towards Achieving a Circular Economy in the Water, Energy, and Food Sectors. *Sustainability*, 13 (17), 9978.
- Trois, C., Kalina, M., Ogwang, J. and Reale, G. (2021). Case study on decentralised micro-digester systems for rural South Africa. International Energy Agency. IEA Bioenergy: Task 36, November 2021.

PROF C SCHENCK

Waste and Society
Tier II SARChI Research Chair
University of the Western Cape
http://wasteandsociety.co.za/

The objective of the Waste and Society Research Chair is to develop and implement a research programme that delivers evidence to support the improved understanding of the:

- Opportunities to create jobs and improve livelihoods through the transition away from landfilling
- Business models to support a secondary resources economy, with a focus on SMMEs
- Required behaviour change to drive the transition away from landfilling, including appropriate behaviour change interventions, such as awareness and communication strategies for South Africa as a developing country

Despite the ongoing disruptions caused by the Covid-19 pandemic, the group delivered another successful year. In total, eight papers in peer-reviewed journals, two conference papers, two technical reports and one book chapter were produced. A number of research projects were completed, including the Waste RDI Roadmap grant-funded Clean Cities/Towns project; IUCN-funded mini drop-offs in Drakenstein Municipality project; and Buy-back centres in the City of Cape Town project. The group also interviewed over 900 informal e-waste collectors in eight of the nine provinces, as part of the NRF/COP-funded e-waste informal sector project.

The Chair continues to strengthen its research networks and collaborations, having also received research funding from the University of KwaZulu-Natal (Prof. Sutherland) (2021-2023) to further explore the waste/water nexus. In addition, the interest in waste studies by post-graduate students is growing, which is very encouraging.

Recent publications by the Chair include:

- Schenck, R., Grobler, L., Viljoen, K., Blaauw, D. and Letsolao, J. (2021). Double whammy wicked: Street vendors and littering in Mankweng Township and Paarl, South Africa – Towards People-centred Urban Governance. *Urban Forum*.
- Niyobuhungiro, R.V. and Schenck, C.J. (2021). The dynamics of indiscriminate/illegal dumping of waste in Fisantekraal, Cape Town. *J Environ Manage*, 293.
- Viljoen, J.M.M., Schenck, C.J., Volschenk, L., Blaauw, P.F. and Grobler, L. (2021). Household waste management practices and challenges in a rural remote town in the Hantam Municipality in the Northern Cape, South Africa. *Sustainability*, 13, 5903.

FUNDING INSTRUMENTS

RDI GRANTS

Over the past seven financial years, the WRIU has issued three open grant calls (2015, 2019, 2021) and three targeted grant calls (WEEE, 2016; MSW, 2018; marine plastic pollution, 2020). The WRIU also published an open micro-grant call in 2020, targeting historically disadvantaged institutions, universities of technology, and universities that had not previously been awarded grant projects under the Waste RDI Roadmap in previous years. The intention was to expand national research capability in the waste sector. No grant call was issued in 2017 due to a lack of funding.

GRANT APPLICATIONS RECEIVED

For the 2021 open grant call, a total of 32 proposals were received, with a funding ask of R43.1 million for projects commencing in 2022. Applications were received from 11 universities and science councils.

The grant proposals included a large number of academic, business and government partners. In addition to the 11 applying institutions, another 36 research partners were included in the proposals – 18 from academia, 17 from business or non-governmental organisations and one from local government. This is very encouraging as it creates opportunities for impact through research collaboration with potential implementation partners.

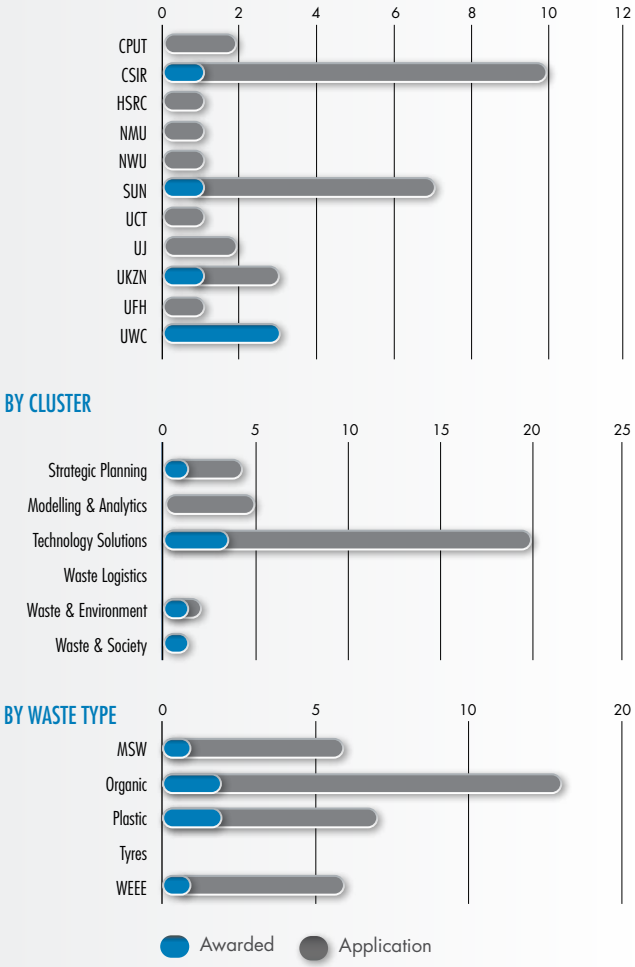
In line with previous years, the grant proposals were evaluated by an independent panel of experts from government, business and academia.

AWARDED GRANTS

Of the 32 proposals received under the grant call, six (6) projects were awarded to South African public research institutions. The number of grants awarded was limited by the available funding, and not by the quality of proposals received.

In addition to the six new grant projects awarded through the open grant call, an additional five (5) new grant projects, funded through other funding organisations, were also awarded. This brought the total number of new grant projects awarded in 2021/22, and managed by the WRIU, to 11.

THEMATIC SPREAD OF GRANT PROPOSALS AND AWARDS UNDER THE 2020 GRANT CALL



PARTNERSHIPS

"Waste research, development and innovation cannot, on its own, transform the waste sector. The Roadmap is one mechanism being implemented by government, through the Department of Science and Innovation, to move waste away from landfilling. To ensure success, the Roadmap must be adopted as part of a suite of public and private sector responses aimed at addressing the challenges currently facing the waste sector."

Building local, regional and international partnerships with government, academia and business is important to achieving the long-term objectives of the Waste RDI Roadmap. The following section highlights just some of the engagements with key stakeholders during the 2021/22 financial year.

SOUTH AFRICA

Government

Collaboration with national government departments remains an important element of ensuring the Waste RDI Roadmap research outputs support decision-making, policy development and implementation. As the line department responsible for waste, the Department of Forestry, Fisheries and the Environment (DFFE) is an important partner in this regard. The WRIU has had active engagement with DFFE over the past year through various waste and circular economy-related meetings and workshops, including requests to provide specialist review/input on DFFE-funded waste projects.

The WRIU also engaged with the Department of Trade, Industry and Competition and its entities during 2021/22 regarding the opportunities to transition to a more circular economy.

The WRIU worked closely with National Treasury this past year, who provided funding support through the Cities Support Programme to further the integration of informal waste pickers in South Africa. The WRIU is also represented on National Treasury's Solid Waste Management Advisory Group, that oversees a number of funded waste projects in South Africa.

The WRIU had various engagements with provincial government departments this year, discussing matters related to both waste and the circular economy, particularly regarding unlocking much-needed local development and job opportunities, for example, Gauteng, Limpopo, Mpumalanga.

Business

As an intended recipient of much of the research directed and funded under the Waste RDI Roadmap, business has been instrumental to the activities of the WRIU in 2021/22. Researchers from universities and science councils have also, in many instances, worked closely with private sector partners this past year to ensure relevance and uptake of the research.

In July 2021, the Institute of Waste Management of Southern Africa facilitated an engagement with business to discuss a planned waste internship programme. The successful workshop resulted in a targeted internship call for the waste sector in 2021, under the DSI-HSRC internship programme. A number of businesses in the waste sector have also initiated their own funded internships.

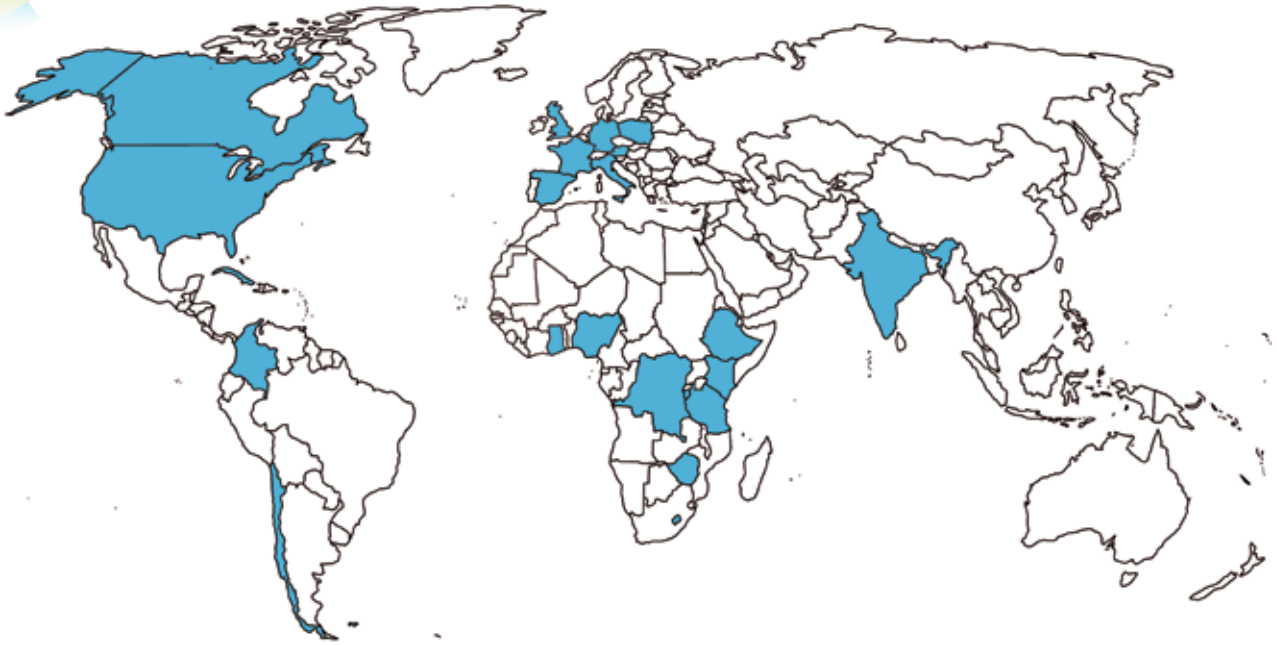
Meetings were held between the WRIU and a number of businesses, sector associations, professional services companies, and financiers this past year to discuss waste-stream-specific solutions, for example, for waste plastic, packaging, tyres, e-waste, etc.

Academia

Universities and science councils are core to the Waste RDI Roadmap, undertaking much of the RDI necessary to evidence national decision-making and inform policy development and implementation. The response of academia to the Waste RDI Roadmap calls remains very positive and of a high standard. The WRIU currently has a network of over 140 researchers working in solid waste management and associated fields across South African public research institutions.

INTERNATIONAL

International and regional partnerships are important to ensure that waste issues facing South Africa and Africa are appropriately represented on the international stage, and to bring international thinking and experience into the African context. In addition to direct research collaboration between South African researchers and their international counterparts, the WRIU continues to develop and strengthen international relationships in support of the Roadmap. Some of the engagements during 2021/22 include:



South Africa-international waste RDI partnerships (researchers and students) active in 2021/22

NON-PROFIT, NON-GOVERNMENTAL ORGANISATIONS

The PEW Charitable Trusts, USA

Following the successful completion of the global 'Breaking the Plastic Wave' study in 2020, the WRIU approached Pew to pilot the application of the Plastics-to-Ocean data-driven coupled ordinary differential equation model at the country level, in this case to South Africa. Through application of the model, the WRIU, CSIR, SA Plastics Pact and Plastics SA are pleased to be partnering with Pew and Oxford University in 2021/22 to develop a local evidence-based strategy to address plastic leakage in South Africa.

Alliance to End Plastic Waste, Singapore

The WRIU is represented on the Advisory Council of the Alliance to End Plastic Waste. Meetings held during 2021/22 provided insights into the planned strategic approach to addressing plastic pollution by the Alliance, as well as global funding opportunities. There is currently a project in South Africa being funded by the Alliance, but with the potential to support further local projects through upcoming funding calls.

Royal Academy of Engineering, UK

Prof. Godfrey, from the WRIU, was invited by the Royal Academy to stay on as a member of the Technical Advisory Group (TAG) as it expands to the full Safer End of Engineered Life (SEEL) programme. Prof. Godfrey also took on the role of Chair to this TAG. Participating in this TAG has direct benefit to South Africa. One of the current focus areas of the programme is on the open burning of waste, a very real issue facing Africa and South Africa. The WRIU was able to provide input to the SEEL programme through a series of meetings and workshops in 2021/22.

United Nations (UN) Agencies (UNIDO, UNEP)

The WRIU participated in a number of engagements with UN Agencies during 2021, on various topics relating to waste or the circular economy. These engagements are important for ensuring that current global thinking and policy development are integrated back into local activities.

- Member of the UNEP International Environmental Technology Centre (IETC) Advisory Board
- Participation in Action Track 2 Leadership Team *"Shift to sustainable consumption patterns"*, Workstream 3 *"Food waste"*, in preparation for the UN Food Systems Summit, 2021
- Invited expert input to the UNIDO "*Global consultations on circular economy"*, May 2021
- Invited expert input to UNIDO *"Expert meeting as part of the preparations for 2021 United Nations High Level Political Forum on Sustainable Development"*, May 2021
- UNEA 5.2 Side Event: *Accelerating a Just Transition to a Circular Economy in Africa*, Feb 2022

Academia

PISCES, UK

The WRIU is represented on the PISCES Advisory Board. The PISCES project is a UK-funded project, hosted by Brunel University, London, aimed at addressing plastic waste pollution (initially) in south-east Asia. There are interesting insights under this project that have relevance to other countries, including South Africa.

The WRIU would also like to acknowledge the many local, regional and international organisations with which it has had the privilege of engaging this past year, and which are not mentioned here by name. These engagements have been invaluable in strengthening our shared understanding of the waste sector and the opportunities within a more circular economy.

SCIENCE COMMUNICATION

PLATFORMS FOR LEARNING AND KNOWLEDGE EXCHANGE

South Africa has developed considerable expertise in waste and resources management in the context of a developing country and a circular economy, which is of growing interest to the local, regional and international waste community. Science communication by the WRIU and its partners provides an opportunity to:

- Showcase South Africa's waste RDI locally and internationally
- Build local and international capacity based on South African learning
- Strengthen local and international partnerships

Creating and participating in platforms for knowledge exchange and learning is important to achieving the objectives of the Roadmap, in particular, strengthening human capital.

Publications

The WRIU worked with a number of researchers in the past year to produce the following publications:

- Godfrey, L. *et al.* (2021). Unlocking the opportunities of a circular economy in South Africa. In: Ghosh & Ghosh (Ed). Circular economy: Recent trends in global perspective. Springer
- Godfrey, L. (2021). The circular economy. Development Opportunity for South Africa's economic sectors. CSIR

WRIU ENGAGEMENTS

The WRIU also had the opportunity to share the South African perspective on waste management at a number of events in 2021/22. Some of the highlights include:

- *"An internship programme for the South African waste sector?"*, Waste RDI Roadmap workshop, 8 July 2021
- *"Overview of waste management in South Africa"*, ILASA Webinar, 14 July 2021
- *"Municipal solid waste management – current state and strategy for municipalities"*, NWU Webinar, 5 August 2021
- *"Strengthening capacity in South Africa's waste sector through the Waste RDI Roadmap: The role of HEIs"*, UNISA Indaba, 15 November 2021
- *"Waste, the circular economy and fashion"*, Design Future Lab, 15 March 2022

The WRIU also continues to play a mentorship role to local and international post-graduate students in shaping their research projects. This includes identifying potential research topics of local, regional or international importance to ensure impact through research.

MEDIA ENGAGEMENT

A summary of the media engagement over the past year is provided in the section "Reflecting on 2021/22". Engagement with the media is an important element of supporting knowledge transfer to key stakeholders, including the public.

OPERATIONS AND FINANCE

WASTE RDI ROADMAP FINANCIAL STATEMENT

The total revenue for the Waste RDI Roadmap in 2021/22 was down from the previous 2020/21 financial year. However, the WRIU was able to maintain the funding support to grant projects through savings in other areas, and with co-funding from the CSIR and other funding organisations. This allowed the WRIU to issue a new grant call in 2021.

The funding is still significantly below that outlined in the Waste RDI Roadmap. This has a direct bearing on the extent and magnitude of the activities of the Roadmap.

All financial figures are exclusive of VAT.

REVENUE	2021/22	2020/21
DSI seed funding	14 782 608.71	13 691 573.91
Other revenue	3 929 306.62	6 417 413.09
Total Revenue	**18 711 915.32**	**20 108 987.00**
EXPENSES		
Communications	35 950.00	42 620.00
CSIR Project Management Unit	3 090 935.76	2 670 290.65
Non-recoverable innovation grants	0.00	0.00
Non-recoverable R&D grants	13 090 830.40	12 988 363.37
Targeted RDI projects	0.00	206 640.00
Post-graduate scholarships	350 000.00	310 000.00
SARChI Research Chairs	1 705 200.00	1 705 200.00
Travelling	3 739.16	1 055.37
Workshops and general running	0.00	0.00
Total Expenses	**18 276 655.32**	**17 924 169.39**
Income for continuing operations [1]	**435 260.00**	**2 184 817.61**
Net Income	**0.00**	**0.00**

Notes to financial statement:

1 Income for continuing operations is committed funding for grant projects awarded during 2018-2021, for which disbursements will be made in the 2022/23 financial year. This includes CSIR co-investment into the Waste RDI Roadmap.

MONITORING AND EVALUATION

STRUCTURES

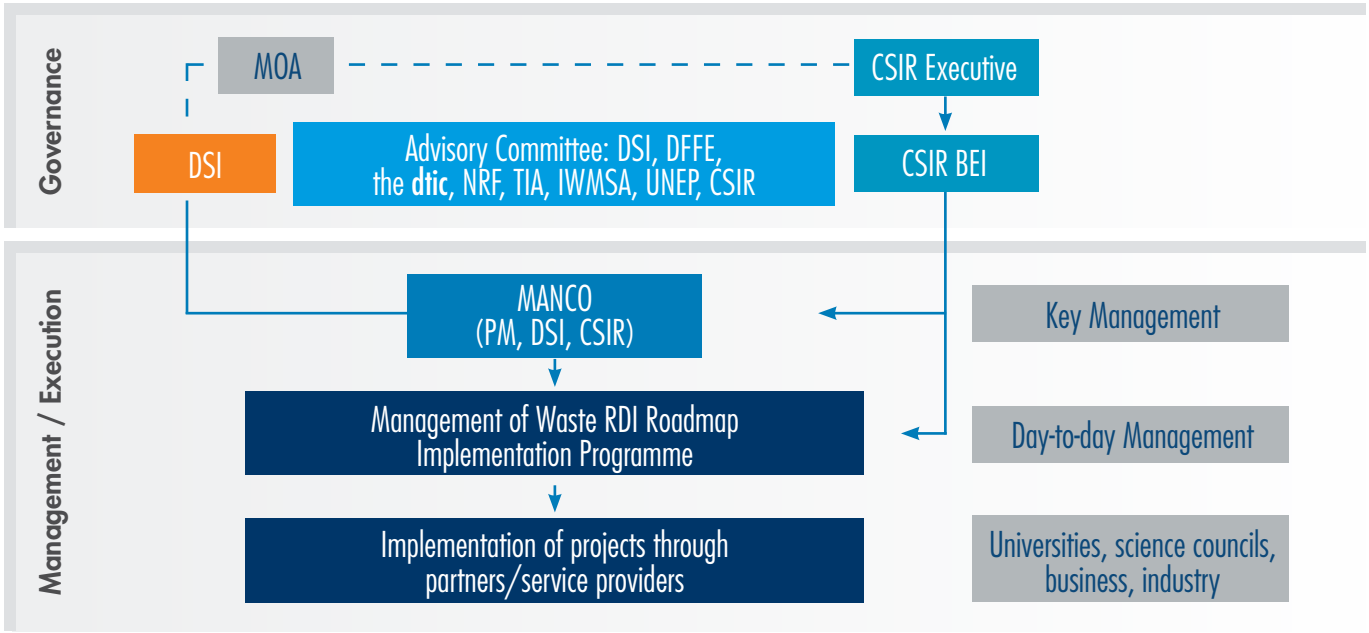
The Waste RDI Roadmap is implemented by the CSIR's WRIU in partnership with the DSI, DSI entities, other government departments, universities and science councils, business and industry. Effective governance and oversight of activities within the WRIU is important to the Roadmap's successful implementation. The Waste RDI Roadmap governance structure is as follows:

- An **Operations Committee**, made up of the DSI Director: Environmental Services and Technologies and the WRIU Manager
- A **Management Committee**, made up of senior representatives of the DSI and CSIR-hosted National Programmes
- An advisory **Steering Committee**, made up of representatives of government, government entities and the waste sector

REPORTING

The Waste RDI Roadmap portfolio of funding is monitored through regular reporting. All grant holders are contractually required to submit quarterly progress reports to the WRIU. These reports cover technical, operational and financial progress for the quarter. Twice a year, grant holders are required to submit proof of registration for all post-graduate students supported on grant projects. All information is consolidated by the WRIU and reported quarterly to the DSI on the overall implementation of the Waste RDI Roadmap. In addition to the quarterly reporting, annual progress meetings are also held with all grant holders.

The Waste RDI Roadmap governance structure is as follows:



WASTE RDI ROADMAP IMPLEMENTATION UNIT

PRETORIA

Council for Scientific and Industrial Research (CSIR)
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