



# **Some reflections on trends in STI**

**Council Dinner  
22 June 2022**

**Dr Thandi Mgwebi  
Research, Innovation and Internationalisation**

# Local trends in science, technology and innovation

- Fourth Industrial Revolution-related emerging technologies
- Implementation of science, technology and innovation policy: NDP targets
- Attaining the UN SDG's
- Global trends in science, technology and innovation
  - R&D expenditure
  - Intellectual property protection
  - The Global Innovation Index
  - World competitiveness
- The Research system

# South African share of world publications in 4IR related emerging technologies

TECHNOLOGIES	SOUTH AFRICAN PUBLICATIONS	WORLD PUBLICATIONS	SOUTH AFRICA'S SHARE OF WORLD PUBLICATIONS
Internet of Things	81	12 303	0.65%
Additive manufacturing	31	7 551	0.41%
Quantum computing	9	1 777	0.50%
Nanotechnology	1 424	220 207	0.64%
Robotics	85	25 863	0.32%
Artificial intelligence	8	11 509	0.72%
Autonomous vehicles	54	9 269	0.58%

4IR-related patent applications

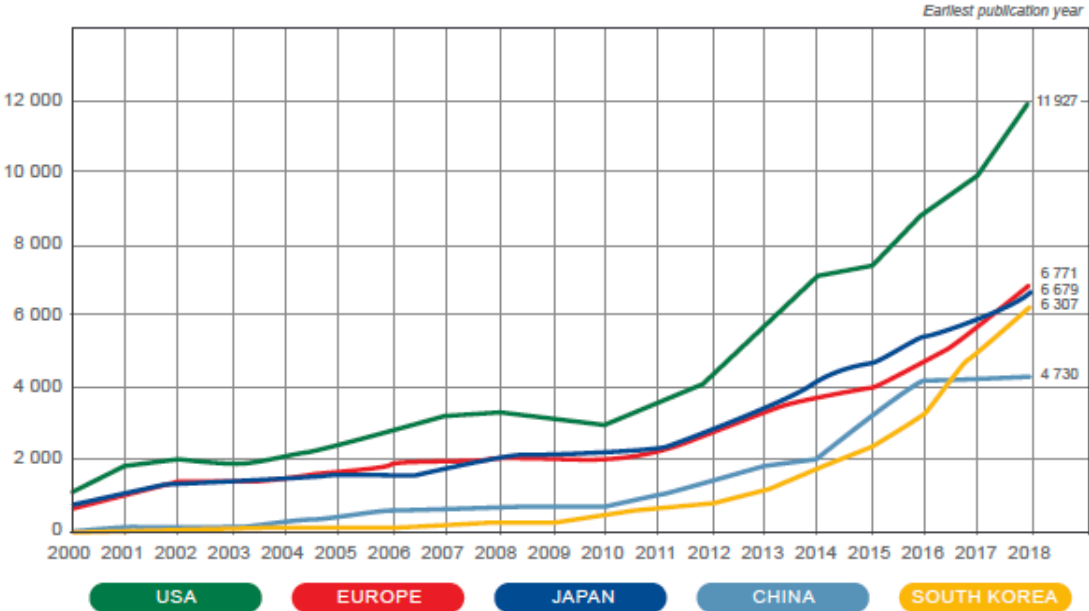


Figure 2.1: 4IR patents at the European Patents Office: leading countries  
Source: European Patents Office, 2020

TARGET FOR 2030	STATUS		TREND
Gross fixed capital formation to 30%	<ul style="list-style-type: none"> <li>• 19.1% (2011)</li> <li>• 17.9% (2019)</li> </ul>		Erratic; downward
Improve Grade 9 TIMSS score from 284 to 420 by 2023	<ul style="list-style-type: none"> <li>• 284 (2011)</li> <li>• 389 (2019)</li> </ul>		Up
At least 80% of students should complete 12 years of schooling	<ul style="list-style-type: none"> <li>• <math>\pm 45\%</math> (2019)</li> </ul>		Steady
Increase the number of students achieving 50% in Mathematical Literacy and Mathematics. (Scores >40%)	Mathematical Literacy <ul style="list-style-type: none"> <li>• 61.4% (2011)</li> <li>• 54.5% (2019)</li> </ul>	Mathematics <ul style="list-style-type: none"> <li>• 35.9% (2011)</li> <li>• 35.0% (2019)</li> </ul>	Down; steady
Bachelor entry requirement met by 300 000 by 2024	<ul style="list-style-type: none"> <li>• 188 058 (2019)</li> <li>• 4.3% compound annual growth rate (CAGR) <math>\geq</math> 230 000 in 2024</li> </ul>		Upward
Strengthen and expand the number of further education and training (FET) colleges to increase the participation rate to 25% (1 250 000)	Technical and vocational education and training (TVET) colleges consolidated to 50, with 200 associated campuses; enrolment 688 028 (2017)		Slow rise
Increase the graduation rate of FET colleges to 75%	Data unavailable		
Produce 30 000 artisans per year	<ul style="list-style-type: none"> <li>• 21 551 (2017)</li> </ul>		
Increase the participation rate at universities from 17% to 30% (from 950 000 to $\pm 1.62$ million)	<ul style="list-style-type: none"> <li>• 22% (2018)</li> </ul>		
Provide full funding assistance covering tuition, books, accommodation and living allowance to students from poor families.	Reduced university fees for needy students phased in from 2018		
Build new universities in the Northern Cape and Mpumalanga, and a medical school in Limpopo	New medical school under development in Nelson Mandela Bay		Exceeded
Increase proportion of black students graduating from universities. (International African $\pm 6\%$ )	<ul style="list-style-type: none"> <li>• 76% of 160 000 (2011)</li> <li>• 84% of 227 188 (2019)</li> </ul>		Upward
More than 5 000 doctoral graduates per year (1 420 in 2010)	<ul style="list-style-type: none"> <li>• 3 344 (2018), of which 40% international</li> </ul>		Slow rise
Increase percentage of PhD qualified staff in the higher education sector from 34% to over 75%	<ul style="list-style-type: none"> <li>• 49% (2018)</li> </ul>		Slow rise

## 2030 NDP Targets

# NDP Targets

Students from abroad who graduate from South African universities should qualify for a seven-year work permit	–	Not implemented
Spend more on R&D (2010 rands)	<ul style="list-style-type: none"> <li>• R20.8 billion (2011)</li> <li>• R23.7 billion (2018)</li> </ul>	Flat
Double number of graduate and postgraduate scientists (researchers)	Rise of 29% by 2018	Slow rise
Increase broadband speed to 2 Mps by 2020	Average speed 40 Mps	Steeply up
Reduction of high domestic cost of broadband internet connectivity	Cost of broadband internet ranked 101 <sup>st</sup> out of 206 countries in 2020	Flat
Peak carbon-fuel use by 2025 (Integrated Resource Plan (IRP) target)	IRP projects no decrease out to 2035	No

## Ten-year innovation plan targets

TARGET FOR 2018	STATUS	TREND
Science, engineering and technology graduates are 35% of total	• 28.6% (2018)	Not attained
20 000 full-time equivalent researchers	• 24 618 (2018)	Exceeded
2.6 full-time equivalent researchers per 1 000 of workforce	• 1.8 (2018)	Not attained
GERD: GDP of 1.5%	• 0.76% (2019)	Not attained
1% share of world science publications	• 0.83% (2020)	Not attained
More than 50% of firms use technology to innovate	• 69.9% innovative (2014–2016)	Attained
250 USPTO awards	• 224 (2019)	Not attained

Source: Department of Science and Innovation 2008–2018 Ten-Year Innovation Plan

# Sustainable Development Goals: South Africa

SDG	GOAL	TREND
1.	No poverty	Flat
2.	Zero hunger	Up
3.	Good health and wellbeing	Up
4.	Quality education	Up
5.	Gender equality	Up
6.	Clean water and sanitation	Up
7.	Affordable and clean energy	Flat
8.	Decent work and economic growth	Flat
9.	Industry, innovation and infrastructure	Up

SDG	GOAL	TREND
10.	Reducing inequality	N/A
11.	Sustainable cities and communities	Flat
12.	Responsible consumption and production	N/A
13.	Climate action	Up
14.	Life below water	Flat
15.	Life on land	Down
16.	Peace, justice, and strong institutions	Flat
17.	Partnerships for the goals	Up

Source: Sustainable Development Solutions Network 2020

2022

<https://dashboards.sdindex.org>

## SOUTH AFRICA

### Performance by Indicator

#### SDG1 – No Poverty

	Value	Year	Rating	Trend
Poverty headcount ratio at \$1.90/day (%)	26.7	2022	●	↓
Poverty headcount ratio at \$3.20/day (%)	37.1	2022	●	↓

#### SDG2 – Zero Hunger

Prevalence of undernourishment (%)	6.5	2019	●	↑
Prevalence of stunting in children under 5 years of age (%)	21.4	2017	●	→
Prevalence of wasting in children under 5 years of age (%)	3.4	2017	●	↑
Prevalence of obesity, BMI ≥ 30 (% of adult population)	28.3	2016	●	↓
Human Trophic Level (best 2–3 worst)	2.3	2017	●	→
Cereal yield (tonnes per hectare of harvested land)	4.9	2018	●	↑
Sustainable Nitrogen Management Index (best 0–1.41 worst)	0.5	2015	●	→
Exports of hazardous pesticides (tonnes per million population)	98.8	2019	●	●

#### SDG3 – Good Health and Well-Being

Maternal mortality rate (per 100,000 live births)	119	2017	●	→
Neonatal mortality rate (per 1,000 live births)	10.6	2020	●	↑
Mortality rate, under-5 (per 1,000 live births)	32.2	2020	●	↑
Incidence of tuberculosis (per 100,000 population)	554.0	2020	●	↑
New HIV infections (per 1,000 uninfected population)	4.6	2020	●	→

#### SDG9 – Industry, Innovation and Infrastructure

	Value	Year	Rating	Trend
Population using the internet (%)	70.0	2020	●	↑
Mobile broadband subscriptions (per 100 population)	102.2	2019	●	↑
Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1–5 best)	3.2	2018	●	↑
The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0–100 best)	51.1	2022	●	●
Articles published in academic journals (per 1,000 population)	0.5	2020	●	↑
Expenditure on research and development (% of GDP)	0.8	2017	●	→

#### SDG10 – Reduced Inequalities

Gini coefficient	63.0	2014	●	●
Palma ratio	6.9	2017	●	●

#### SDG11 – Sustainable Cities and Communities

Proportion of urban population living in slums (%)	26.4	2018	●	↓
Annual mean concentration of particulate matter of less than 2.5 microns in diameter (PM2.5) (µg/m³)	24.3	2019	●	→
Access to improved water source, piped (% of urban population)	98.2	2020	●	↑
Satisfaction with public transport (%)	66.0	2021	●	↑

#### SDG12 – Responsible Consumption and Production

# Global trends in R&D expenditure

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>WORLD</b>	1.65	1.62	1.64	1.65	1.67	1.68	1.69	1.69	1.72	–
<b>Low-income countries</b>	0.25	0.27	0.28	0.29	0.31	0.30	0.30	0.30	0.29	–
Tajikistan	0.09	0.09	0.12	0.11	0.12	0.12	0.11	0.11	0.12	0.10
<b>Lower middle-income countries</b>	0.49	0.48	0.49	0.47	0.45	0.44	0.43	0.44	0.43	–
Egypt	0.43	0.43	0.53	0.51	0.64	0.64	0.72	0.71	0.68	0.72
India	0.83	0.79	0.76	0.74	0.71	0.70	0.69	0.67	0.67	0.65
Tunisia	0.71	0.69	0.71	0.68	0.67	0.65	0.63	0.60	–	0.60
<b>Upper middle-income countries</b>	1.10	1.13	1.16	1.24	1.31	1.36	1.41	1.45	1.48	–
Brazil	1.12	1.16	1.14	1.13	1.20	1.27	1.34	1.26	1.26	–
China	1.66	1.71	1.78	1.91	2.00	2.03	2.07	2.12	2.15	2.19
Russia	1.25	1.13	1.01	1.03	1.03	1.07	1.10	1.10	1.11	0.99
South Africa	0.84	0.74	0.73	0.73	0.72	0.77	0.80	0.82	0.83	0.75
<b>High-income countries</b>	2.33	2.30	2.34	2.33	2.36	2.38	2.37	2.37	2.42	–
Singapore	2.13	1.93	2.07	1.92	1.92	2.08	2.18	2.08	1.94	–
South Korea	3.29	3.47	3.74	4.03	4.15	4.29	4.22	4.23	4.55	4.81
United States	2.81	2.74	2.77	2.68	2.71	2.72	2.72	2.76	2.82	2.84

Source: UNESCO Institute for Statistics

# Intellectual property protection: global trends in patent applications per million inhabitants

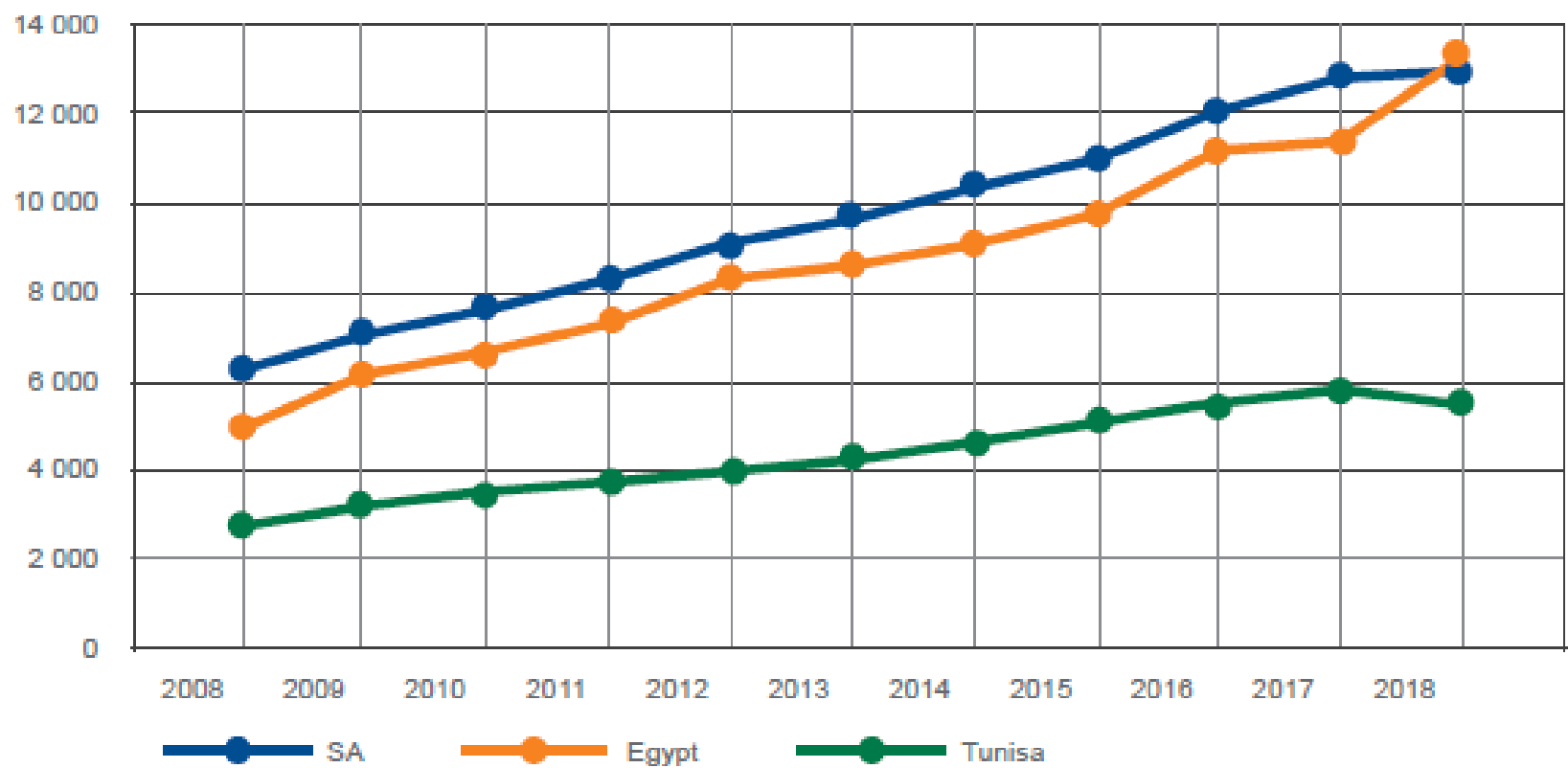
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>WORLD</b>	<b>289</b>	<b>308</b>	<b>333</b>	<b>357</b>	<b>368</b>	<b>392</b>	<b>420</b>	<b>421</b>	<b>438</b>	<b>420</b>
<b>Low income</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
Mozambique	1	0.3	1	1	1	1	1	1	1	1
<b>Lower middle income</b>	<b>24</b>	<b>25</b>	<b>25</b>	<b>25</b>	<b>24</b>	<b>25</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>28</b>
Egypt	8	9	9	9	10	9	11	12	12	12
Eswatini	70	7	60	21	32	11	15	68	84	28
India	1	13	14	16	17	2	20	21	22	25
Nigeria	0.3	0.5	0.3	0.4	0.1	0.3	1	1	1	0.1
Tunisia	12	14	18	20	16	19	24	16	17	1
<b>Upper middle income</b>	<b>199</b>	<b>250</b>	<b>299</b>	<b>360</b>	<b>394</b>	<b>457</b>	<b>536</b>	<b>545</b>	<b>596</b>	<b>542</b>
Botswana	1	2	18	10	7	3	1	3	0,4	1
Brazil	29	32	33	34	33	3	35	36	33	35
China	230	324	416	541	614	737	912	942	1 048	950
Russia	230	220	240	237	198	235	221	192	212	206
South Africa	39	34	32	41	42	38	36	38	32	26
<b>High income</b>	<b>1 184</b>	<b>1 192</b>	<b>1 236</b>	<b>1 256</b>	<b>1 261</b>	<b>1 271</b>	<b>1 272</b>	<b>1 269</b>	<b>1 265</b>	<b>1 289</b>
Singapore	833	882	919	1 013	1 084	1 117	1 201	1 239	1 315	1 289
South Korea	7 313	7 648	8 261	9 013	9 248	9 505	9 284	8 954	9 124	9 723
United States	140	1 415	1 509	1 586	160	1 655	1 617	1 617	1 577	1 588

Source: Computed from the World Intellectual Property Office's IP Statistics Data Centre



# Innovation framework conditions

The Research system: number of fractional publications for selected African countries



# Seven key trends

1. SDGs: shared focus, increases potential for collective impact
2. Rise of approaches which consider complexity: Understanding complex systems and how to grapple with these is key, as is the importance on research questions and instrument design.
3. From evaluating impact to evaluative thinking: Evaluative thinking has been defined as a practice of critical reflection, which integrates systematic modes of enquiry, and the use of data, into the way an organisation works. It is the difference between finding evidence, and becoming evidence driven.
4. Developing Globally comparable datasets
5. Open data sharing to responsible data sharing
6. The rise of impact investment: social and financial lenses
7. Tech solutions

# Nelson Mandela Annual Research Report:

<https://www.mandela.ac.za/flipbooks/Research%20Report/mobile/index.html>

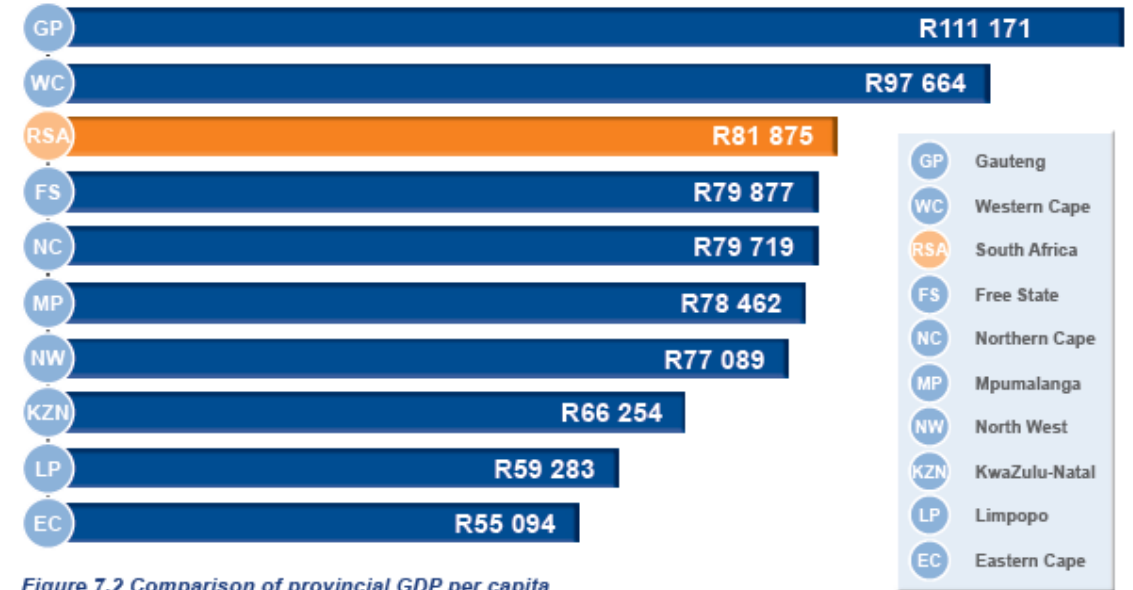
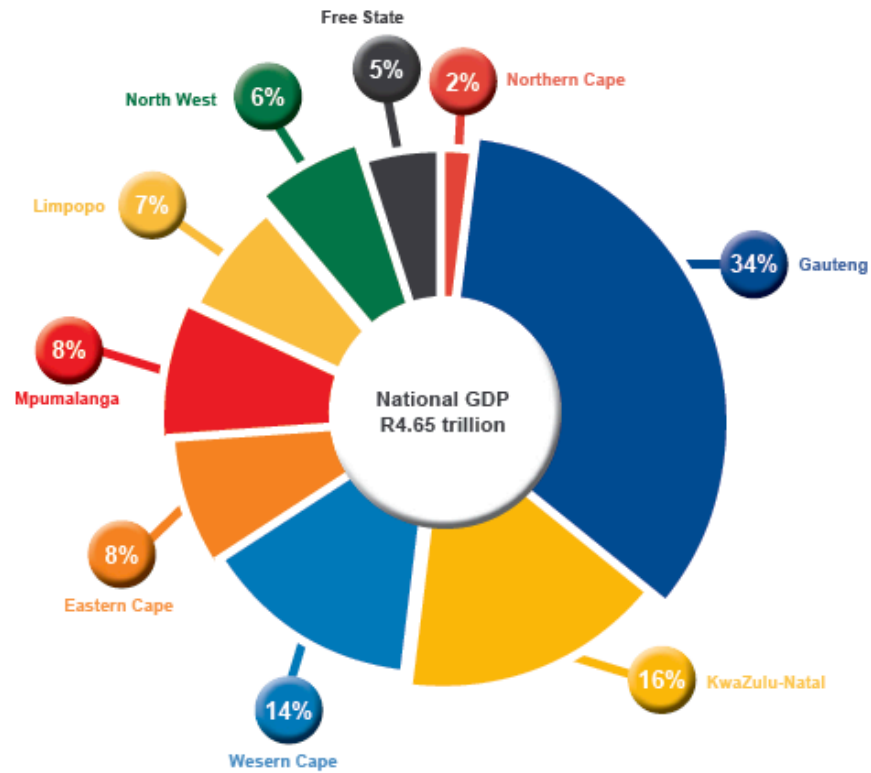
# Entities at a glance

Institutional	Centres	Centres	Units
ICMR	InnoVenton	African Centre for Coastal Palaeoscience	Family Business Unit
AEON	Built Environment Research Centre	Centre for Broadband Communication	Unit for Positive Organisations
CANRAD	Centre for Community Technologies	Centre for Philosophy in Africa	Unit for Economic Development and Tourism
CWGS	Centre for Information and Cyber Security	Centre for Women and Gender Studies	Unit for Visual Methodologies for Social Change
MISF (In progress)	Centre for African Conservation Ecology	Raymond Mhlaba Centre for Governance and Leadership	Drug Utilisation Unit
	Centre for High Resolution Transmission Electronic Microscopy		Sustainability Research Unit
	Centre of Expertise in Forecasting		Marine Robotics Unit
	Centre for Rubber and Science Technology		
	Telkom Centre of Excellence		

Institutional	Centres	Centres	Units
ICMR	InnoVenton	African Centre for Coastal Palaeoscience	Family Business Unit
AEON	Built Environment Research Centre	Centre for Broadband Communication	Unit for Positive Organisations
CANRAD	Centre for Community Technologies	Centre for Philosophy in Africa	Unit for Economic Development and Tourism
CWGS	Centre for Information and Cyber Security	Centre for Women and Gender Studies	Unit for Visual Methodologies for Social Change
MISF (In progress)	Centre for African Conservation Ecology	Raymond Mhlaba Centre for Governance and Leadership	Drug Utilisation Unit
TIMS	Centre for High Resolution Transmission Electronic Microscopy		Sustainability Research Unit
	Centre of Expertise in Forecasting		Marine Robotics Unit
	Centre for Rubber and Science Technology		

@Mandela: University Chairs and entities

Name of Chair	Detail
Prof. Andrea Hurst	SARChi in Identities and Social Cohesion in Africa
Prof. Mandy Lombard	SARCHi in Marine Spatial Planning
Prof. Janine Adams	SARCHi in Shallow water ecosystems
Prof. Paul Watts	SARCHi in Microfluidic Bio/Chemical Processing
Prof. Patrick Vrancken	SARCHi in Law of the Sea
Prof. Mike Roberts	NRF/Newton Fund Bilateral Chair in Food Security
Prof. Andre Keet	Chair for Critical studies in Higher Education Transformation
Prof. Sijekula Mbanga	Chair in Human Settlements
Prof. Ivor Gorlach	Isuzu Chair in Mechatronics
Mr K Du Preez	merSETA Chair Engineering Development
Prof. Salim Vally	DHET/SARCHi Chair in Community Adult and Worker Education (with UJ)
Prof. Cheryl Walter	UNESCO Chair in Physical Activity and Health in Educational Settings (with Univ. of Basel)
Dr Lesley Powell	Chair in Youth Unemployment, Employability and Empowerment
Prof. Rose Boswell	SARCHi in Ocean Cultures and Heritage
Prof Pumla Gqola	SARCHi in African Feminist Imaginations
Dr Steven Mufhamadi	DSI Chair in Nanomedicine



**Figure 7.2 Comparison of provincial GDP per capita**  
Source: Statistics South Africa

## Sizes of provincial economies

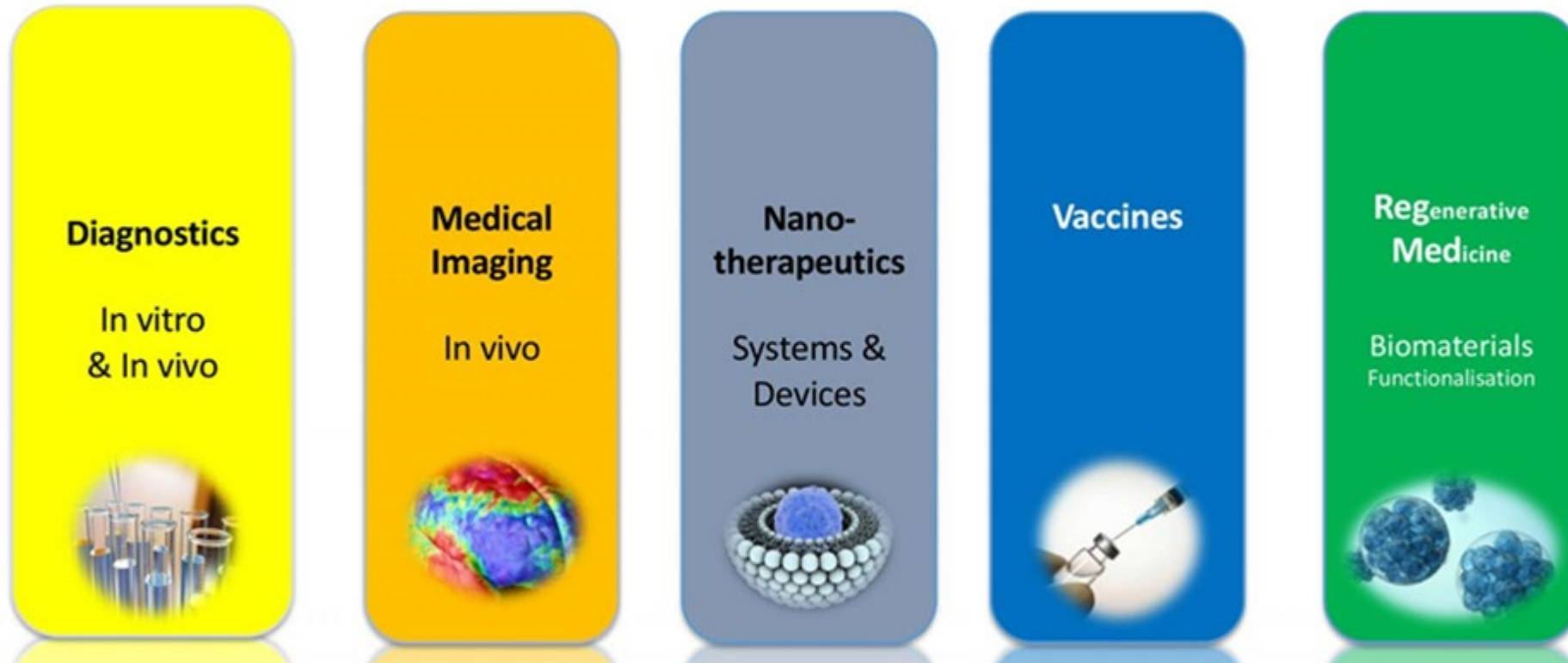
# **NMU-DSI Nanomedicine Platform**

**Dr Maluta Steven Mufamadi**

Research Chair in Nanomedicine

Faculty of Health Sciences

- Nanotechnology is the manipulation of matter on atomic or molecular scale (1-100nm) to produce new structures, materials and devices
- Nanomedicine is the application of nanotechnology to achieve innovation in healthcare





# Nanocomposite Hydrogel System



Nano-Bandage  
“Biodegradable”



Nano-Spray

## Diabetic Foot Ulcers

**Nanocomposite Hydrogel System** for antibacterial and wound healing applications in patients with DFU. The nanocomposite hydrogel system will consist of **polymer hydrogel materials impregnated with green nanoparticles and/or drug-loaded nanoparticles.**



Nano-Socks



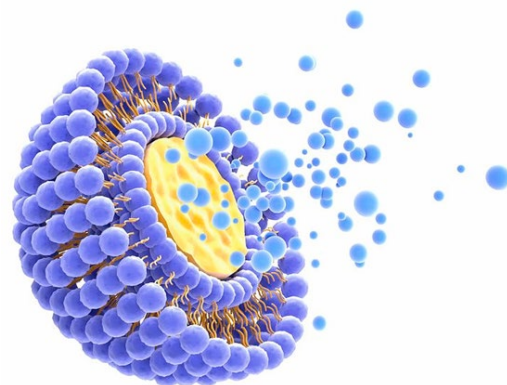
Nano-Cream



Nano-Innersoles

**NMU Prof Jan Neethling & Swedish partners**  
**NMU Prof Roux and Dr Luvuno-Keele**  
**InnoVenton Dr Dugmore and Ms Hamilton**

# Triple Negative breast cancer (TNBC) Projects

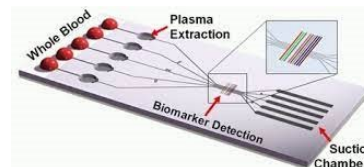


## 1. Nanoparticles Vehicle

- Green nanoparticle using **Cannabis sativa extracts**
- Nano based chemotherapy e.g. Doxorubicin and/or Paclitaxel



Depletion of the transcription factor **KAISO** attenuates the proliferation of, and increases apoptosis in, the TNBC cell lines MDA-231 and Hs578



## 2. Nano-biosensor for fast and accurate diagnosis of TNBC

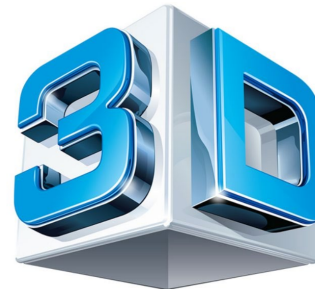
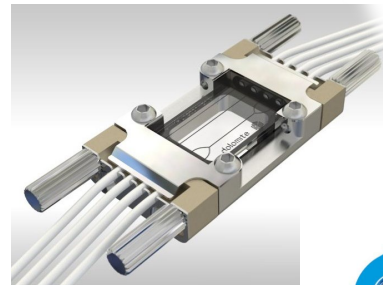
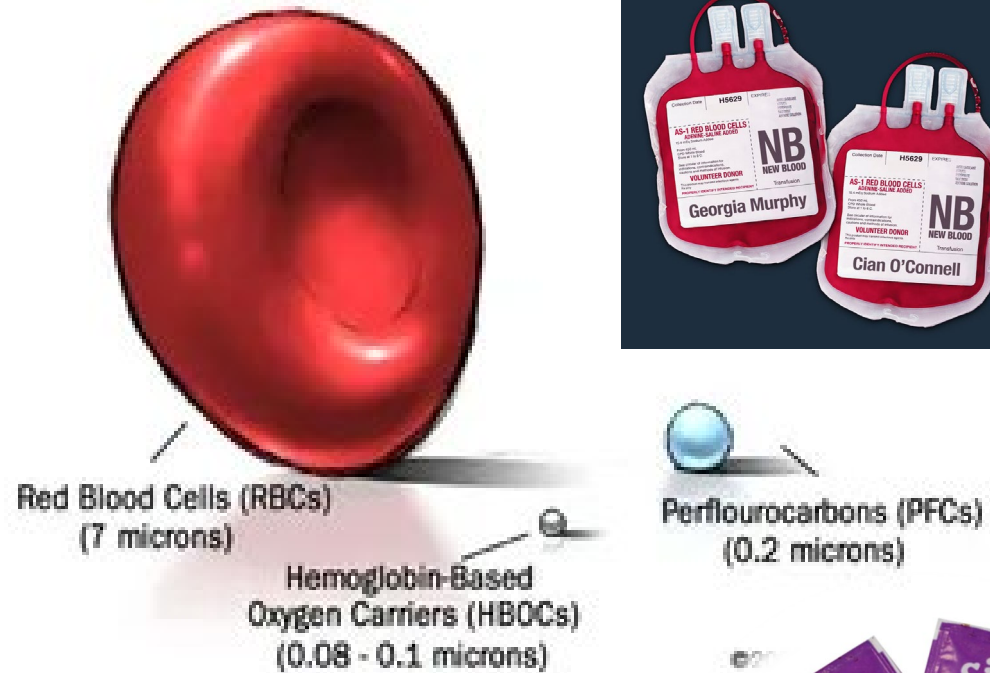
# Blood Transfusion Projects

## Artificial Blood

Haemoglobin-Based Nanomaterials as a potential blood substitute/ acute anemia

Using natural polymers and lipid materials as carriers on Haemoglobin

NMU Potential Prof Watts



## What Are the Benefits of Artificial Blood?



Reduces dependency on blood donors



Eliminates the risk of contamination



Universally matched to all blood types



Longer shelf-life than natural blood



Quick and effective response to mass trauma events



Accessible to patients in rural areas



Attainable blood bank for countries who can not maintain a natural blood bank

## Air Purifier (Robotic)

**Nanotechnology-based air purifier (robotic)** that is capable of **capturing, deactivate, neutralise and inhibiting** the growth of bacteria and viruses e.g. M. tuberculosis, influenza virus and coronavirus & many more) **in the air and on the surface environment**

**NMU \_Prof Melariri [Environmental Health]  
Dr Wouter le Roux [CSIR]**

