



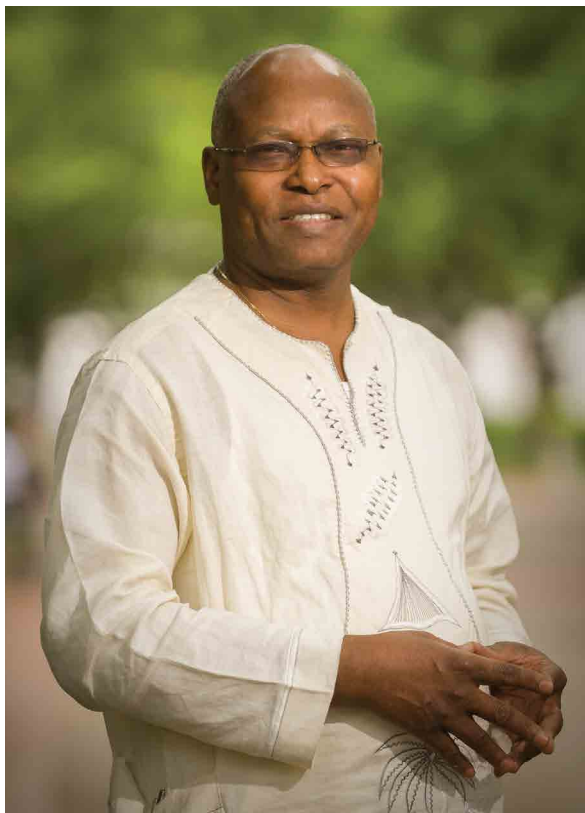
UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences

Fakulteit Natuur- en Landbouwetenskappe
Lefapha la Disaense tša Tlhago le Temo

Research Focus Areas





Message from the Dean

The Faculty of Natural and Agricultural Sciences at the University of Pretoria is one of the largest and most diverse of its kind in South Africa. It consists of 16 departments grouped into the following four academic and research clusters: Agricultural and Food Sciences, Biological Sciences, Mathematical Sciences and Physical Sciences.

The Faculty has substantial research capabilities, underpinned by a pool of excellent researchers, top-class research institutes and centres, and a well-established international collaboration network. The Faculty hosts more than 40% of the National Research Foundation (NRF)-rated researchers at UP and more than half of the A-rated researchers and highly cited academics listed on the Thomson Reuters' Essential Science Indicators (ESI) database. It also generates more than 20% of accredited publication journal units at UP.

The undergraduate and postgraduate study programmes follow this legacy of research excellence by aligning with leading education and research trends. The Faculty contributes to the intellectual and material enrichment of society through highly relevant community engagement projects.

Should you wish to excel and make a difference in the natural and agricultural sciences, this faculty is where you belong and you will indeed be most welcome.

During the second cycle of the five-year implementation plan of the UP 2025 Vision, which strives to become a leading research-intensive university in Africa, the Faculty will focus on several activities related to the following strategic goals:

- To enhance access and successful student learning through excellent teaching and relevant curricula
- To strengthen the University's research and international profile
- To foster and sustain a diverse inclusive and equitable university
- To optimise resources and enhance institutional sustainability
- To strengthen the University in social responsiveness and impact on society

In summary, the following quote by Gerhard Casper describes how the Faculty will distinguish itself: "A commitment of building steeples of excellence in research, learning and teaching; viewing the combination of teaching and research as what we are about, despite innumerable temptations; having the freedom to set agendas; seeking industry partnerships as enrichments to, not distractions from, the research process; maintaining porous boundaries; and being open to chance and serendipity in research...."

Prof Jean Lubuma

Dean: Faculty of Natural and Agricultural Sciences

Cover photo courtesy WC Oosthuizen

UP at a glance

The University of Pretoria (UP) provides an intellectual home for a rich diversity of South African academic talent across the following nine faculties and a highly respected business school:

- Economic and Management Sciences
- Education
- Engineering, Built Environment and Information Technology
- Health Sciences
- Humanities
- Law
- Natural and Agricultural Sciences
- Theology
- Veterinary Science (the only faculty of its kind in South Africa)
- Gordon Institute of Business Science (GIBS)

Many of the faculties are subdivided into schools, of which there are 21, each headed by a chairperson. The University's diverse academic programmes are offered through 140 academic departments and 85 centres, institutes and centres.

Each year, UP offers 230 different qualifications to more than 60 000 students – the majority of whom are contact students attending classes at the University's six Pretoria campuses and Johannesburg-based business school.



Faculty of Natural and Agricultural Sciences

The Faculty of Natural and Agricultural Sciences, based at the Hatfield Campus of the University of Pretoria, rates among the most diverse and best science faculties in South Africa.



Research- intensive

Research at the University of Pretoria, and therefore also at the Faculty of Natural and Agricultural Sciences, is at the heart of our long-term plan, UP 2025, and our vision to be a leading research-intensive university in Africa, recognised for making a difference. Our progress towards achieving this vision and identity is evident in the diversity of research undertaken in the different faculties and a business school, and in the many institutes, centres and units.

Challenges

The major challenges we face in Africa and globally – from the need to expand access to education, food and water security, to the promotion of social justice and sustainable development – all give direction to the research that we conduct. Since it is evident that these challenges are increasing in complexity and that life at the local level is more and more influenced by global trends, there has been a growing emphasis on multidisciplinary, collaborative work across knowledge and geographic boundaries at the University. Rapid advances in communication and technology have enabled faster and more effective flows of information and knowledge dissemination, and this is manifesting in a growing number of international collaborations and partnerships.

UP a leader

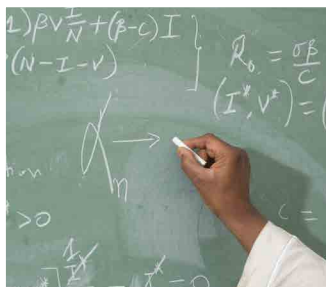
Among South African universities, UP was the leader in the 2015 QS field rankings in the field of Agriculture and Forestry, and in the fields of Computer Science, Engineering, Genetics and Immunology, Mathematics and Molecular Biology. The citation impact of our research exceeded international norms. We take pride in the diversity and quality of our research activity.

Future Africa

The University's new Future Africa campus on the Hatfield Experimental Farm will be the place where Africa's leading scientists and scholars from across the world and from a broad range of disciplines will come together to leverage the benefits of transdisciplinary research to address the grand challenges that face Africa and the world.

The Faculty of Natural and Agricultural Sciences is closely involved in the Future Africa project. The Future Africa campus will provide a dynamic living, learning and research environment where a community of scholars and other societal role players will engage to advance excellence in scholarship, dialogue and impact.

Future Africa will host a community of fellows and will attract local, African and international scholars, representing a range of disciplines. It will also be home to a number of postgraduate students, as well as postdoctoral and research fellows. Future Africa will support innovative, frontier research projects from conceptualisation to execution. The ultimate aim is to have a dynamic programme on the new frontiers of research, with a special focus on the adaptability, resilience and co-design of systems for sustainable and equitable development in Africa.



Research Matters

The Research Matters website showcases and highlights some of the University's research and innovation output, and emphasises the impact of this work in South Africa, Africa and globally. On these pages, you will find case studies on interesting research projects by University staff, infographics and videos that will provide an overview of high-impact projects at a glance, as well as information about various institutes, centres and units.

Science Leadership Programmes

The Africa Science Leadership Programme (ASLP) aims to grow excellent mid-career African academics in the areas of collective leadership, team and research development and science-society engagement, with the intention of enabling them to solve the complex issues facing both Africa and the global community.

The programme creates a lasting network of science leaders on the continent, spanning not only across countries, but also across disciplinary boundaries. It develops an awareness and curriculum for leadership development in academia that can be applied in other institutions in Africa and beyond, and will create a focal point for connection with science leadership training programmes in other parts of the world.

Research productivity

The Faculty contributes substantially to the building of research and teaching capacity in South Africa by producing highly skilled graduates, as well as generating new scientific knowledge through our research publications. A significant number of our scientists are evaluated internationally and acknowledged by the NRF as researchers of high international standing – and in some cases as world leaders in their fields.

The Faculty is proud to host half of the A-rated NRF researchers and 40% of all the NRF-rated researchers at the University.

Here we constantly push the frontiers of knowledge and develop new technology that will help the Faculty to stay in step with the challenges of a constantly changing world.

World-class study programmes

A variety of three- and four-year undergraduate degrees are offered. These range from basic natural sciences to applied sciences, including agricultural, biological, mathematical and physical science degrees.

Postgraduate studies are offered in all disciplines at honours, master's and doctoral level. Of the more than 6 500 registered students in the Faculty, more than 30% go on to register for postgraduate studies. In this environment of academic excellence, our postgraduate students have the opportunity to participate in research teams that can compete with the best in the world.

All the degrees are accredited by the South African Qualifications Authority (SAQA) to ensure quality education, and provide access to a multitude of career opportunities for dynamic and creative people.

The content and structure of qualifications are continuously revised and adapted and new, more focused programmes are developed to keep abreast of global trends. The Faculty trains versatile problem solvers who can easily adapt to changing circumstances and take the lead in their fields of specialisation.

The diversity and excellence of the education and research activities offered by the Faculty enhance the global network for cooperation and collaboration with industry and other tertiary education institutions, offering our students exciting possibilities for international exposure and interaction with global peers in their respective fields.





Relevant, real-world academic departments

The Faculty consists of 16 departments specialising in highly relevant programmes within the Agricultural and Food Sciences, Biological Sciences, Mathematical Sciences and Physical Sciences. It comprises the following departments:

Actuarial Science

(<http://www.up.ac.za/insurance-and-actuarial-science>)

Agricultural Economics, Extension and Rural Development

(<http://www.up.ac.za/agricultural-economics-extension-and-rural-development>)

Animal and Wildlife Sciences

(<http://www.up.ac.za/animal-and-wildlife-sciences>)

Biochemistry

(<http://www.up.ac.za/biochemistry>)

Chemistry

(<http://www.up.ac.za/chemistry>)

Consumer Science

(<http://www.up.ac.za/consumer-science>)

Food Science

(<http://www.up.ac.za/food-science>)

Genetics

(<http://www.up.ac.za/genetics>)

Geography, Geoinformatics and Meteorology

(<http://www.up.ac.za/geography-geoinformatics-and-meteorology>)

Geology

(<http://www.up.ac.za/geology>)

Mathematics and Applied Mathematics

(<http://www.up.ac.za/mathematics-and-applied-mathematics>)

Microbiology and Plant Pathology

(<http://www.up.ac.za/microbiology-plant-pathology>)

Plant and Soil Sciences

(<http://www.up.ac.za/plant-science>)

Physics

(<http://www.up.ac.za/physics>)

Statistics

(<http://www.up.ac.za/statistics>)

Zoology and Entomology

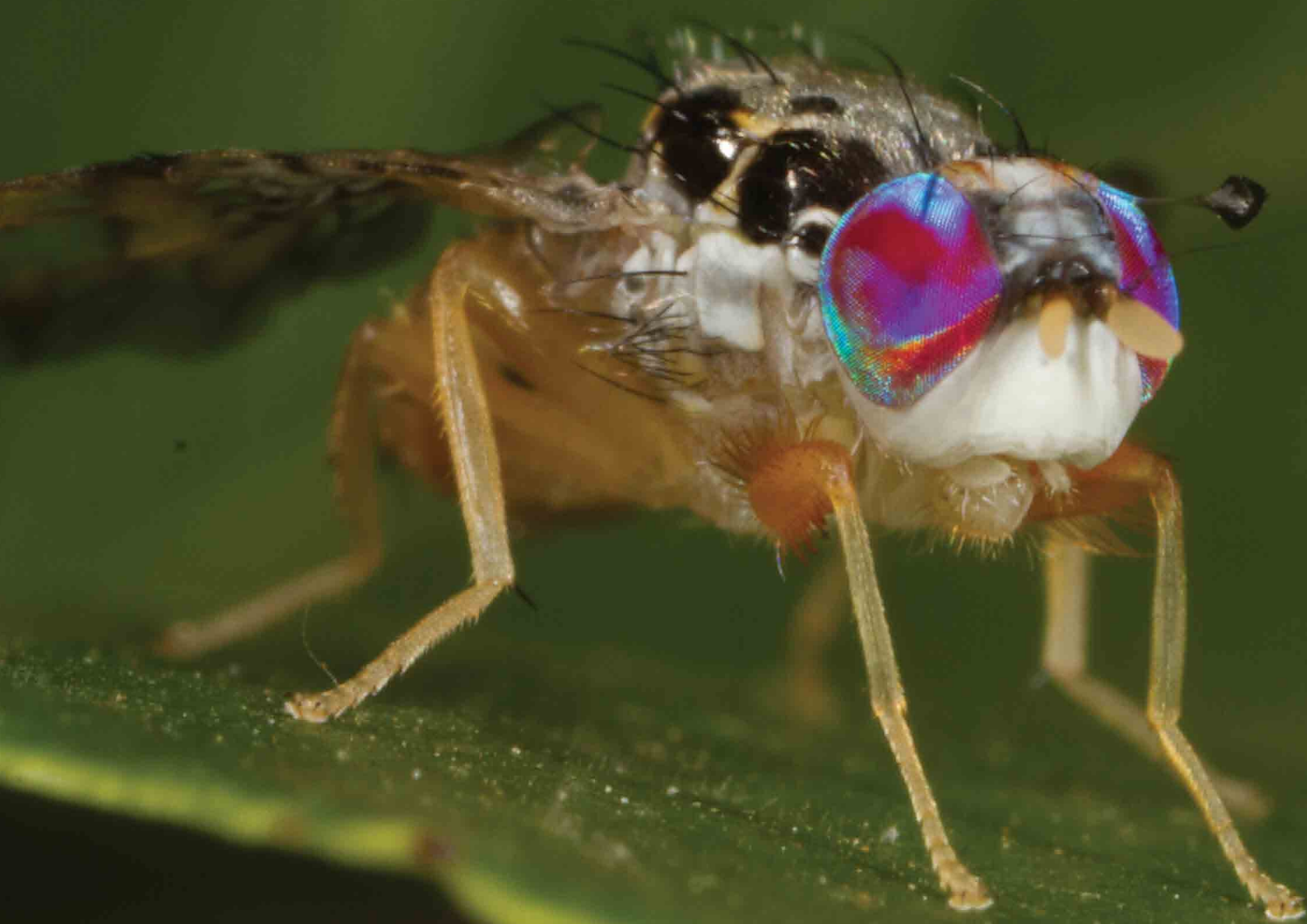
(<http://www.up.ac.za/zoology-entomology>)

Integrated within the various departments are quite a few world-renowned institutes and centres where research groups with excellent equipment and facilities – including two experimental farms – work on a range of multidisciplinary research programmes. In addition to this, the Faculty is actively involved in a number of entities jointly owned with other faculties.

The internationally acclaimed institutes, centres and units aligned to the Faculty address global challenges, such as sustainable energy, safe water, biodiversity and conservation, climate change and natural disasters, through a range of multidisciplinary research programmes.







Institutes

Forestry and Agricultural Biotechnology Institute (FABI) (<http://www.fabinet.up.ac.za>)

FABI is a postgraduate research institute where research and education are largely – but not exclusively – focused on adding value to the forestry, citrus and subtropical fruit industries. The Institute has an impressive national and international reputation and is one of just six government-supported centres of excellence in South Africa. Established in 1997 on the back of the highly successful Tree Protection Cooperative Programme, FABI currently runs research projects in South Africa, Africa, South America, South-east Asia, Europe, Australia and North America.

Genomics Research Institute (GRI) (<http://www.up.ac.za/the-genomics-research-institute>)

The Genomics Research Institute (GRI) is a virtual platform that facilitates and hosts the Institutional Research Theme (IRT) for Genomics at UP. The University is at the forefront of the current genomics revolution, and the GRI has a core membership of 45 academic staff and over 120 associated researchers at MSc, PhD and postdoctoral levels across the faculties of Natural and Agricultural Sciences, Health Sciences and Veterinary Science. The principal aim of the GRI is to bring together staff and projects from across these faculties in order to develop new, cutting-edge interdisciplinary research projects. Reflecting the breadth of research interests across the University, the research activities of GRI members are divided into three major sectors: Environmental Genomics, Plant and Animal (Agricultural) Genomics, and Human Genomics.

Institute of Applied Materials (IAM) (jointly with EBIT) (<http://www.up.ac.za/institute-of-applied-materials-iam>)

The IAM is an interdisciplinary materials research group that has been established to provide research training in carbon materials, particularly those relevant to the Pebble-bed Modular Reactor and related industries. The Institute is strengthened through the participation of the departments of Physics, Chemistry, Chemical Engineering, and Materials Science and Metallurgical Engineering, and has an active working relationship with the Leibniz Institute for Polymer Research in Dresden, Germany.

Institute for Food, Nutrition and Well-being (IFNuW) (<http://www.up.ac.za/institute-for-food-nutrition-and-well-being>)

The IFNuW was officially launched in 2012 and is essentially a virtual platform that facilitates and hosts the IRT for Food, Nutrition and Well-being (IFNuW). The IFNuW gives momentum to the fight against hunger, malnutrition and disease by offering more than 100 researchers from seven faculties and more than 30 academic departments, units and centres an opportunity to work beyond traditional knowledge boundaries. These researchers, the largest collaborative group of its kind, are all actively contributing to diverse fields of study ranging from food production, animal diseases, African crops and probiotics to diabetes, laws on consumer protection and schools as agents of behavioural change.

Mammal Research Institute (MRI) (<http://www.up.ac.za/mammal-research-institute>)

The MRI, which celebrated its 50th anniversary in 2016, is the only institute in Africa that is specifically dedicated to mammal research, and is focused on conserving the diversity of our indigenous mammal fauna in the context of sustainable human development. The mission of the MRI is to be internationally recognised for research and teaching on the biology and ecology of African mammals, and to maintain a focus that is relevant to Africa, and to southern Africa in particular. As evidence of the Institute's local and international recognition, five former and current MRI associates were among the Top 100 Leading Minds of the past century, as recognised by UP in its centenary celebrations. The Institute attracts students and academics from around the globe, including Europe, North America and Australasia, while student enrolment from a variety of African countries – including Sudan, Mozambique and Tanzania – has grown strongly in recent years.

University of Pretoria Water Institute (UPWI) (<http://www.up.ac.za/water-institute>)

The UPWI's network of water professionals brings together six faculties, including Engineering, Built Environment and Information Technology, Natural and Agricultural Sciences, Law, Humanities, Health Sciences and Veterinary Science, covering all facets of the water cycle. The University of Pretoria has a proven track record in water research and education, and during the past decade, more than 40 internationally recognised researchers and their students have completed successful research projects related to water supply, sanitation and integrated water resource management, and provided state-of-the-art technology to the water sector.



Centres

African Centre for Gene Technologies (ACGT with the CSIR and Wits University) (<http://www.acgt.co.za/>)

The ACGT is focused on gene and genome analysis and the real-world applications of this research. The Centre is structured to create a collaborative network of excellence in advanced biotechnology initiatives at a national and regional level. Currently operating as a joint initiative between the University of Pretoria, the University of the Witwatersrand (Wits University) and the Council for Scientific and Industrial Research (CSIR), the Centre is seeing increasing involvement from the universities of Johannesburg and Limpopo, and interactions with other African countries are being strengthened.

Centre for Bioinformatics and Computational Biology (<http://www.up.ac.za/centre-for-bioinformatics-and-computational-biology>)

Bioinformatics is the integration of mathematical, computer, statistical and biological sciences to analyse biological data and is used for a variety of tasks. Some of the most common are the following:

- Analysing and comparing protein and nucleic acid sequences
- Annotating genomes
- Studying gene expression patterns
- Investigating molecular structures
- Simulating metabolic pathways

The Centre's function is training, support and research in the areas of bioinformatics and computational biology. It functions as part of the following:

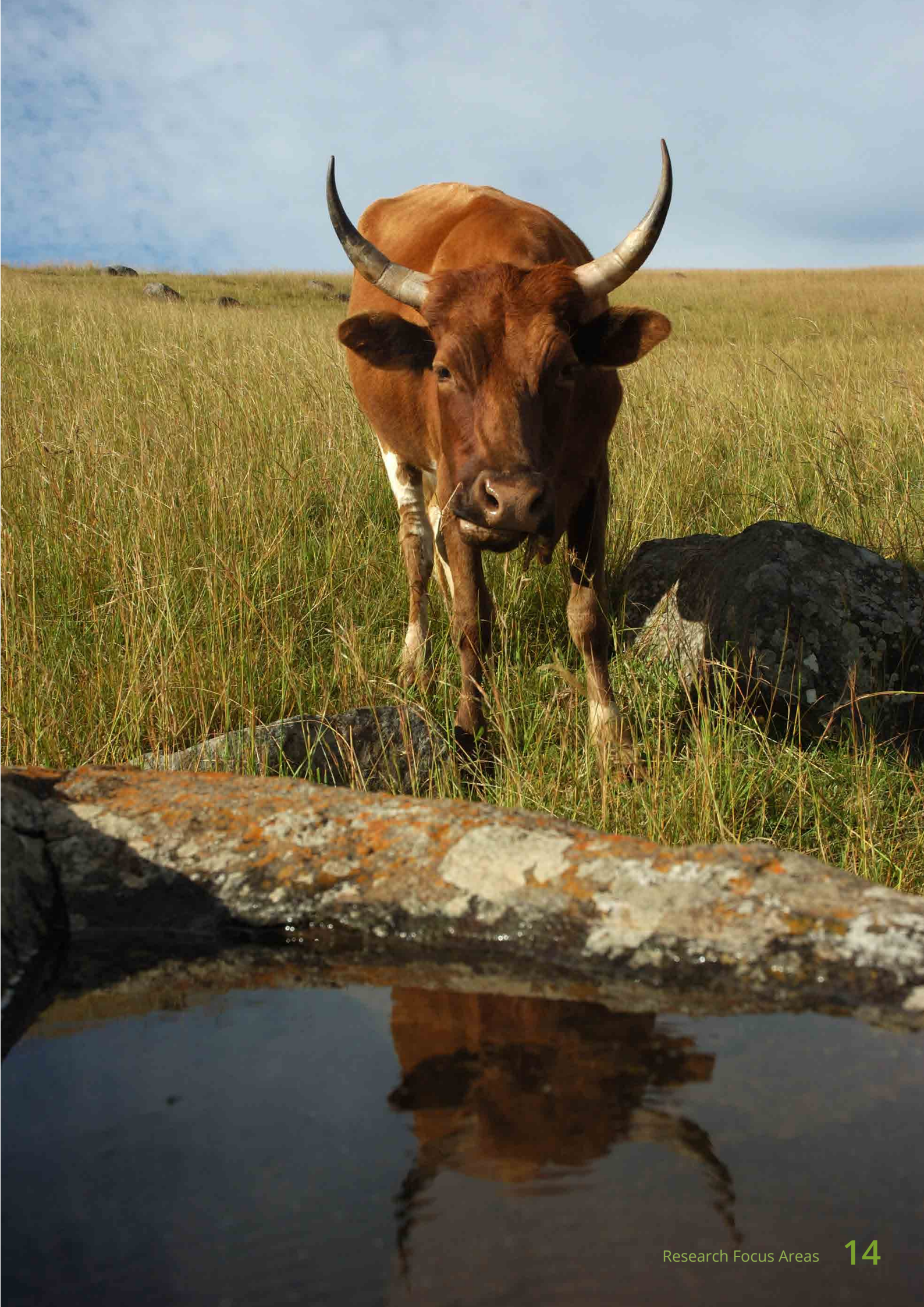
- The Genomics Research Institute
- The Department of Biochemistry
- The School for Biological Sciences
- The African Centre for Gene Technologies

Centre for Environmental Economics and Policy in Africa (CEEPA) (<http://www.ceepa.co.za>)

CEEPA is located within the Department of Agricultural Economics, Extension and Rural Development. Its mission is to enhance the capacity of African researchers to conduct environmental economics and policy inquiry of relevance to African problems and to increase the awareness of environmental and economic managers and policy makers of the role of environmental economics in sustainable development. CEEPA strives to achieve and provide quality degree and non-degree training in environmental economics and policy and excellence in research in the field of environmental economics and policy. It also strives to increase awareness among practitioner managers, planners and policy makers in the public and private sectors of the role of environmental economics in the optimal and sustainable exploitation and development of environmental resources, as well as to increase collaboration and exchange of experiences for cross-fertilisation, augmentation of capacity and reduced professional isolation of peer academics in participating regional universities.

Centre for Environmental Studies (CFES) (<http://www.up.ac.za/centre-for-environmental-studies>)

The CFES recognises that the emerging discipline of environmental studies requires a new generation of graduates capable of facing the challenges posed by this multidisciplinary subject, as well as expanding and rapidly changing market requirements. The latest developments in national environmental legislation, together with increased consumer-driven environmental awareness, have generated a strong need for suitably qualified professionals. The CFES seeks to equip and empower such professionals with the right balance between subject-related specialisation (research expertise) and a thorough, but broad understanding of the varied and interacting dimensions of general environmental challenges facing the planet.





Centre for Geo-information Science (CGIS) **(<http://www.up.ac.za/centre-for-geoinformation-science>)**

The CGIS is an internal platform from where the excellence of UP individuals and teams involved in geographic information science (GISc) research, education and training, professional development and community engagement is supported and strengthened. The CGIS aims to facilitate UP GISc research collaboration, education and training, and professional alliances within South Africa and abroad, and to be a partner to the South African geo-information industry in support of GISc research, education and training, professional development and community engagement.

Centre for Microbial Ecology and Genomics (CMEG) **(<http://www.up.ac.za/microbial-ecology-and-genomics>)**

The CMEG was established in September 2012. The Centre is housed in a newly refurbished and equipped 1 000 m² laboratory suite. As of March 2014, CMEG comprised 25 researchers, including research fellows, postdoctoral fellows, PhD and MSc students. The Centre will expand as research funding opportunities arise. Virtually all projects within CMEG fall within the fields of ecogenomics and functional metagenomics, with a strong emphasis of microbial diversity, microbial function and adaptation, and microbial applications.

Centre for Wildlife Management **<http://www.up.ac.za/centre-for-wildlife-management>**

The Centre for Wildlife Management was established to provide students with the necessary knowledge to develop and implement comprehensive management strategies to achieve the sustainable utilisation of our natural resources. UP has been training graduates in Wildlife Management since 1965, and many leaders in the field of wildlife conservation and management feature among the more than 550 postgraduate degrees awarded in this field. Research projects undertaken by the Centre have featured in some 20 local and international documentaries. In addition to its teaching and research functions, the Centre is also contracted to provide advice and to make recommendations on wildlife management for game reserves, game parks or game ranches.

DST-NRF Centre of Excellence for Food Security **(co-hosted with University of the Western Cape)** **(<http://www.foodsecurity.ac.za/>)**

The Department of Science and Technology-National Research Foundation Centre of Excellence in Food Security (CoE-FS) was launched on 15 April 2014 to undertake innovative research to enable South Africa to tackle the challenge of food security and nutrition. The Centre – hosted by the University of the Western Cape and co-hosted by the University of Pretoria – is a virtual organisation that brings together the expertise of numerous South African and international institutions and over 100 researchers across various disciplines.

DST-NRF Centre of Excellence for Tree Health Biotechnology (CTHB) **(<http://www.fabnet.up.ac.za/research-groups/dst-nrf-centre-of-excellence-in-tree-health-biotechnology>)**

The CTHB is hosted by FABI at the University of Pretoria. Within FABI, it is intimately linked to the Tree Protection Cooperative Programme (TPCP), a research programme that has a track record of more than two decades in dealing with the pests and diseases of commercially important forestry species. The CTHB is structured as a virtual Centre of Excellence that conducts scientific research via a collaborative network, with the node of the network represented by researchers at UP. In addition to the UP group, this network involves researchers and their postgraduate students from other higher education institutions in South Africa. These institutions include the Agricultural Research Council, the University of Stellenbosch, the University of Cape Town, the University of the Witwatersrand, the University of the Free State and Rhodes University.

UP Natural Hazard Centre Africa **(<http://www.up.ac.za/university-of-pretoria-natural-hazard-centre-africa>)**

The Centre promotes research into natural hazards and serves as a harbour of information for the engineering, disaster management and insurance industries. The network of associates at the Centre has extensive skills in earthquake hazard modelling, mining catastrophes, and flood and meteorological risks, and offers independent advice, opinions and analyses on all aspects of African natural perils. Relevant natural peril information is made available to the South African insurance community.



Units

Conservation Ecology Research Unit (CERU) (<http://www.ceru.up.ac.za/>)

The CERU focuses on ecological issues and the application of science to conservation in southern Africa. In addition to traditional scientific output in the form of papers and postgraduate students, CERU also provides a platform for the effective development and communication of new information to relevant industries and the broader community. CERU's aims include providing the conservation, health, agriculture, mine and forestry industries with the expertise to implement and sustain sound ecological processes and practices, and developing community awareness on the importance of natural ecosystems for their own sustainable future.

Chairs

The Faculty is also very proud to host various research chairs as part of its strategic research focus. The chairs include the following:

DST-NRF SARCHI chairs

- Fungal Genomics
- Indigenous Knowledge Systems
- Mammal Behavioural Ecology and Physiology
- Mathematical Models and Methods in Bioengineering and Biosciences
- Non-parametric, Robust Statistical Inference and Statistical Process Control
- Sustainable Malaria Control

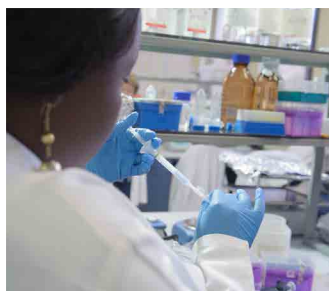
Industry chairs

- Barclays Chair in Actuarial Sciences
- Aon Benfield Chair in Geology
- Austin Roberts Chair of African Mammalogy
- Exxaro-Kumba Chair in Geodynamics
- Mondi Chair in Tree Pathology
- Rand Water Chair in Water Microbiology
- SAFCOL Chair in Forestry Sappi and Mondi Chair in Forest Genomics and Biotechnology

Enhancing our global and African impact

In the past few years, the Faculty has embarked on a process to identify research themes and focus areas where its outputs generate higher numbers of citations. It has identified new research fronts with potential within themes it believes should be further developed and strengthened. The Faculty continued on this path in 2015, with the strategy to focus on "strengthening the base in high-impact research fields (research frontiers)" as a means to improve the number of its highly cited (ESI listed) individuals and the number of citations in general.

These research themes and focus areas were recently embedded into the research frontiers of the institutional Science, Engineering and Technology (SET) cluster in order to bring together leading research in the faculties of Natural and Agricultural Sciences, Veterinary Science, as well as Engineering, Built Environment and Information Technology. In what follows, the research frontiers of the SET cluster are listed, with a breakdown of sub-themes where the Faculty of Natural and Agricultural Sciences can be directly involved.



Theme A: The environment, natural resources and societal impact

- Sub-theme A1: Forestry and agriculture
- Sub-theme A2: Biodiversity research in plant and animal sciences
- Sub-theme A3: Social insects and insect bio-control
- Sub-theme A4: Cleaner new energy
- Sub-theme A5: Food, nutrition and well-being
- Emerging sub-theme A7: Mining resilience and mineral resources beneficiation
- Sub-theme A8: Plant, animal and microbial bio-prospecting
- Sub-theme A9: Material and computational science

Theme B: Promoting human and animal health and well-being in African communities

- Sub-theme B1: Sustainable malaria control
- Emerging sub-theme B5: Neuroscience
- Emerging sub-theme B7: Wildlife health and conservation

Theme C: Digital and computational opportunities and data science

- Sub-theme C3: Genomics and bioinformatics (21st century biotechnologies)
- Sub-theme C4: Computational methods in science and engineering

Theme D: Future intelligent transportation

- Sub-theme E1: High-sensitivity astronomy with large baselines (high-resolution)
- Sub-theme E2: Receiver and antennae technology to meet the sensitivity challenge
- Sub-theme E4: Precision geodesy

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