ARC • LNR
Excellence in Research and Development

Annual Report 2020-2021

AGRICULTURAL RESEARCH COUNCIL

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PART A: GENERAL INFORMATION

1. GENERAL INFORMATION

REGISTERED NAME:	Agricultural Research Council
REGISTRATION NUMBER:	Agricultural Research Act 86 of 1990 (as amended)
PHYSICAL ADDRESS:	1134 Park Street, Hatfield, 0001
POSTAL ADDRESS:	PO Box 8783, Pretoria, 0001
TELEPHONE NUMBER:	+27 12 427 9700
FAX NUMBER:	+27 12 430 5814
EMAIL ADDRESS:	enquiry@arc.agric.za
WEBSITE ADDRESS:	www.arc.agric.za
EXTERNAL AUDITORS:	Auditor General of South Africa
BANKERS:	Standard Bank
COMPANY/BOARD SECRETARY:	Sandile Tshabalala

2. LIST OF ACRONYMS

4IR	Fourth Industrial Revolution
A&R	Audit and Risk
AGP	Antibiotic growth promoters
AgriSETA	Agricultural Sector Education Training Authority
AGSA	Auditor General of South Africa
ARC	Agricultural Research Council
B-BBEE	Broad-Based Black Economic Empowerment
BG	Boer Goat
BtMV	Beet Mosaic Virus
CEO	Chief Executive Officer
CERMC	Corporate Enterprise Risk Management Committee
CFO	Chief Financial Officer
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CoC	Collaborative Centre for Economics of Agricultural Research & Development
Code	Code of Ethics and Business Conduct
COVID-19	Coronavirus disease-19
CREA	Council for Agricultural Research and Economics
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DDM	District Development Model
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DIVAGRI	Revenue Diversification in Africa through bio-based and circular Agricultural Innovations
DNA	Deoxyribonucleic Acid
DPME	Department of Planning, Monitoring and Evaluation
DS	Diagnostic Services
DSI	Department of Science and Innovation
DT	Duration Determinate
EE	Employment Equity
EMC	Executive Management Committee
EPs	Extension Practitioners

EPV	Epidemiology Vectors and Parasites
EU	European Union
EVMS	Electronic Visitor Management System
FAMWES	Fall Army Worm Monitoring and Early Warning System
FAO	Food and Agricultural Organisation
FAW	Fall Army Worm
FBIB	Foundational Biodiversity Information Programme
FCM	False Codling Moth
FHB	Fusarium Head Blight
FMD	Foot-and-mouth Disease
FPAR	Fraction of Photosynthetically Active Radiation
FRAC	Fungicide Resistance Action Committee
FS	Financial Statements
FTB	Fig Tree Borer
GM	Genetically Modified
GPS	Global Positioning System
GWAS	Genome Wide Association Study
IA	Internal Audit
I-CAIRE	Integrity, Commitment, Accountability, Innovation, Respect, Excellence
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IIA	Institute of Internal Auditors
IITA	International Institute of Tropical Agriculture
INRAE	French Institut National de Recherche Pour l'agriculture, l'alimentation et l'environnement
IINTERGIS	Integrated Registration and Genetic Information System
IP	Intellectual Property
IPL	Insect Pathology Laboratory
IPM	Integrated Pest Management
IRM	Insect Resistance Management
IRRI	International Rice Research Institute
IUCN	International Union for Conservation of Nature
IVG	Indigenous Veld Goat
KM	Knowledge Management
KyD	Kaonafatso ya Dikgomo
LSD	Lumpy Skin Disease
LST	Land Surface Temperature
LST-TA	Difference of Surface and Air Temperature
MaYMV	Maize yellow mosaic virus
MD	Medium Duration
MDP	Management Development Programme
MIG	Maize Information Guide
MLND	Maize Lethal Necrosis Disease
MoA/U	Memorandum of Agreement/Understanding
MOLM	*Moringa oleifera* leaf meal
MTAs	Material Transfer Agreements
NARS	National Agricultural Research System
NARYSEC	National Rural Youth Service Corps
NCEP	National Cultivar Evaluation Programme
NDT	Duration Non-Determinate
NDVI	Normalised Difference Vegetation Index

NGOs	Non-Governmental Organisations
NHLS	National Health Laboratory Services
NICD	National Institute for Communicable Diseases
NRF	National Research Foundation
NKPs	National Key Points
OBP	Onderstepoort Biological Products
OFSP	Orange Fleshed Sweet Potato
OHSA	Occupational Health and Safety Act
OIE	Office International des Epizooties
OL	Organised Labour
OVR	Onderstepoort Veterinary Research
P&DM	Public & Development Management
PBR	Plant Breeders' Rights
PC4IR	Presidential Commission on the Fourth Industrial Revolution
PCR	Polymerase Chain Reaction
PDP	Professional Development Programme
PFMA	Public Finance Management Act (no1 of 1999)
PG	Parliamentary Grant
PHZ	Public Health and Zoonoses
PKI	Public Key Infrastructure
POPI	Protection of Personal Information
QC	Quality Control
QTL	Qualitative Trait Loci
R&D	Research and Development
RNA	Ribonucleic acid
ROI	Return on Investment
RPL	Recognition of Prior Learning
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SADC	Southern African Development Community
SAID	South African Identity Document
SANAS	South African National Accreditation System
SANBio	Southern Africa Network for Biosciences
SARCC	South African Rhizobium Culture Collection
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SAVL	South African Vehicle License
SCM	Supply Chain Management
SET	Sector Education Training
SIM	Strategic Information Management
SKA	Square Kilometre Array
SMME	Small, Medium and Micro Enterprise
SPCA	Society for the Prevention of Cruelty to Animals
SPVGA	Sweet Potato Vine Growers Association
SRAP	Sequence-Related Amplified Polymorphism
TA	Air Temperature
VDD	Vaccines and Diagnostics Development
VP	Vaccine Production
WEMA	Water Efficient Maize for Africa
WRC	Water Research Commission

3. ARC 2020/21 COUNCIL MEMBERS (1 APRIL 2017 - 30 JUNE 2020)

Prof Sibusiso Vil-Nkomo
Chairperson *

Dr Joyce Chitja
Deputy Chairperson *

Dr Shadrack Moephuli
President & CEO

Prof Phatu Mashela
Member #

Dr Saskia van Oosterhout
Member #

Dr Mnqobi Ngidi
Member *

Adv. Edwin Mphahlele
Member *

Mr Sipho Mthombeni
Member *

Dr Moraka Makhura
Member *

Ms Joyce Mashiteng
Member *

Mr Allan Bishop
Member *

Ms Bongiwe Kali
Member *

Mr Michael Brinkhuis
Member *

Dr Mokgadi Ngoepe-Ntsoane
Member *

Mr Mlulami Mahanjana
Member *

Mr Andrew Makenete
Member *

Dr Aldo Stroebel
Member *

** 1 April 2017 until 30 June 2020*

 # 1 April 2017 until current

ARC 2020/21 COUNCIL MEMBERS (COMMENCEMENT: 1 JULY 2020)

Ms Joyene Isaacs
Chairperson

Dr Shadrack Moephuli
President & CEO

Dr Monodowafa
Mashaba

Prof Phatu Mashela

Prof Raymond Auerbach

Dr Poncho Mokaila

Prof Nic Olivier

Dr Saskia van Oosterhout

Dr Konanani Liphadzi

Ms Nalini Maharaj

Dr Naudé Malan

Dr Steven Cornelius

Mr Goodman Gcaba

4. ARC 2020/21 EXECUTIVE MANAGEMENT

Dr Shadrack Moephuli
President and CEO

Ms Maureen Manyama
Chief Financial Officer (CFO)

Dr Andrew Magadlela
Group Executive: Animal Sciences

Dr Nthabiseng Motete
Group Executive: Crop Sciences

Dr Thulasizwe Mkhabela
Group Executive: Impact & Partnerships

Ms Makgomo Umlaw
Group Executive: Human Resources and Legal Services

Date of resignation: 31 October 2020

Dr Tebogo Sethibe
Group Executive: Information Systems

Dr Hilton Vergotine
Acting GE: Human Resources and Legal Services

Acting GE: Human Resources and Legal Services, 1 November 2020 - 30 April 2021

Vacant: Group Executive: Research & Innovation Systems

5. FOREWORD BY THE CHAIRPERSON

The mission of the ARC is to conduct research, develop partnerships and human capital, and foster innovation for a sustainable agriculture sector. The intended outcome is sustainable agricultural systems for agrarian transformation, food and nutrition security.

Ms Joyene Isaacs
Chairperson of the ARC Council
(With effect 1 July 2020)

The ARC conducted research and development and other services in accordance with the Annual Performance Plan for financial year 2020/21 and pre-determined outcomes outlined as follows:

1. Increased agricultural production and productivity;
2. Sustainable ecosystems and natural resources;
3. Improved nutritional value, quality and safety of agricultural products;
4. Skilled and capable agriculture sector;
5. Enhanced resilience of agriculture; and
6. A high performing and sustainable organisation.

High-level overview and performance

Research outputs and services were executed with some of the targets set, exceeded by far. However, where targets required the interface with clients, especially farmers, these targets were not reached as the implications of the Covid-19 pandemic made it nigh impossible. Researchers had to be innovative when implementing their projects in order to achieve the set APP targets and that made it an exciting and productive year despite all the Covid-19 restrictions. The combination of a crisis and the 4IR opportunities made for excellent technology development to ensure the execution of required functions for the organisation.

The pre-determined outcomes all received attention, albeit from a distance, but the benefits accrued to clients (smallholder and commercial farmers, stakeholders in the different agricultural value chains, students, commodity groups, formal organised agriculture, academic institutions and provincial governments, and international partners) makes research relevant and useful in the production food.

The ARC has continued during the financial year under review to demonstrate the importance of using sound scientific research as the basis to develop information for training, extension, improved crop production and innovation. The ARC has a vast portfolio of capabilities to add value to the South African agricultural sector, the African Continent and internationally. The ARC is better placed to continue in its work to present amazing opportunities to enable the agriculture sector to increase its contribution to the country's economic growth to overcome current economic challenges that have worsened by the Covid-19 pandemic.

Dissemination of the research results creates the platform for the ARC to showcase what has been done, and where new partnerships can be formed to enhance and strengthen research as the fundamental building block for the agricultural economy.

The audit outcome for ARC has remained unchanged (Qualified). The entity received a modified audit opinion on property, plant and equipment. The errors identified in the property, plant and equipment balance impacted on the accuracy and completeness of the financial statements. As the Accounting Authority, Council is disappointed with the outcomes of the external audit but the ARC has reduced the number of matters (i.e. irregular expenditure and consequence management) that affected the previous year's audit opinion.

The ARC has been able to report a surplus as thus remains in complaint with Section 53(3) of the Public Finance Management Act. Further information on the calculation of the surplus and retention of surplus funds, appears on page 21 of the Annual Report and Note 37 (page 230) of the Annual Financial Statements, respectively. The organisation has ensured that the cost optimisation opportunities are pursued amidst the challenging economic environment.

Despite a huge reduction in its external income revenue and the reduction of Parliamentary grant during the year under review due to the negative impact of Covid-19 on its field services and government revenue, the organisation was able to achieve a surplus as reflected in the audited financial statements contained in this Annual Report during the year under review. This was made possible because of the vigorous implementation of the turn-around plan that is starting to gain traction and produce the desired results. Work is ongoing also to ensure that other areas of the work of the ARC that can be commercialised, be commercialised to supplement external revenue, and reduce dependence on PG as the main source of revenue.

The outputs presented in this Annual report was achieved because of the work done in enhancing strategic relations and partnerships with local and international stakeholders. The agricultural sector and specifically organised agriculture and commodity organisations play a critical role in funding the ARC. The clients of the ARC supports the organisation to generate income by using the services provided. Funders, especially the international ones provide opportunities to address the South African agricultural problems so that solutions can be shared with farmers, for improved production.

The ARC depends on its professional and support staff to achieve the targets set in APP 2020/21 to realize on the human resource capacity and the delivery of its services. The pandemic forced the ARC to rethink the manner in which its staff execute work and deliver on services and projects successfully. The organisation will continue to enhance its ICT infrastructure to enable staff to continue to execute their responsibilities under the prevailing environment and enhance its service delivery to its local national and international clients. The ARC will also accelerate the implementation of the Professional Development Programme and concomitant succession planning to offset any capacity challenges to deliver on the outcomes.

Our heartfelt condolences to the families of those staff members that passed on during the year under review due Covid-19 or other diseases. It's a great loss to the ARC, which will be felt for many years to come.

Council will continue to work on mitigating against the following challenges that will continue to pose a risk on the ARC viability and ability to execute its mandate effectively and efficiently:

- the impact of the pandemic;
- improving audit outcomes;
- increasing the funding available to execute projects;
- maintaining the required human capacity;
- managing the demands from clients and stakeholders;
- maintaining relevancy of research results and the efficient outputs to realise the outcomes for the next 5 years; and
- improving stakeholder relations across the agricultural value chain.

The ARC is embarking on a institutional review process to ascertain the purpose and viability of the organisation. This process will started with a review of the implementation of recommendations of previous reviews and ensure the participation of a broad range of stakeholders. This review presents the Council with a unique opportunity to rethink, reimagine and re-plan where necessary the trajectory of the ARC.

The medium to long-term plans will be centred on the committed outcomes for the next five years with governance central all endeavours.

We would like to thank the Executive Management team and all the staff of the ARC who delivered excellent research, technologies and solutions for farmers in the agricultural sector. Thank you for all your hard work and the adjustments you made during this very difficult year.

Our appreciation to the CEO, Dr Shadrack Moephuli, for the last 14 years at the helm of the ARC. This is his last Annual Report and wishing him the best in his future endeavours.

Ms Joyene Isaacs
Chairperson of the ARC Council

6. CHIEF EXECUTIVE OFFICER'S OVERVIEW

On behalf of the Executive and Senior Management of the Agricultural Research Council, we hereby submit through the ARC Council, to the Executive Authority, the Minister of Agriculture, Land Reform and Rural Development (DALRRD): Hon. Ms. A. Thoko Didiza, this annual report, associated performance information and the audited annual financial statements of the organisation for the financial year ending 31 March 2021.

Dr Shadrack Moephuli
ARC President and CEO

As stipulated in the mandate of the ARC, the Agricultural Research Act, 1990 (Act No. 86 of 1990), and as required in accordance with the Public Finance Management Act, 1999 (Act No. 1 of 1999), the organisation has delivered its outputs.

Secondly, this annual report serves as part of delivering towards the achievement of the ARC Vision 2050, particularly the outcomes and priorities in the approved five-year strategic plan for the period 2020/21 to 2024/25. It is a report of the first year of implementation of the five-year strategic plan.

The mission of the ARC is to conduct research, develop partnerships and human capital, and foster innovation for a sustainable agriculture sector. The intended outcome is sustainable agricultural systems for agrarian transformation, food and nutrition security.

The ARC conducted research and development and other services in accordance with the Annual Performance Plan for the financial year 2020/21 pre-determined outcomes outlined as follows:

1. Increased agricultural production and productivity;
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4. Skilled and capable agriculture sector;
5. Enhanced resilience of agriculture; and
6. A high performing and sustainable organisation.

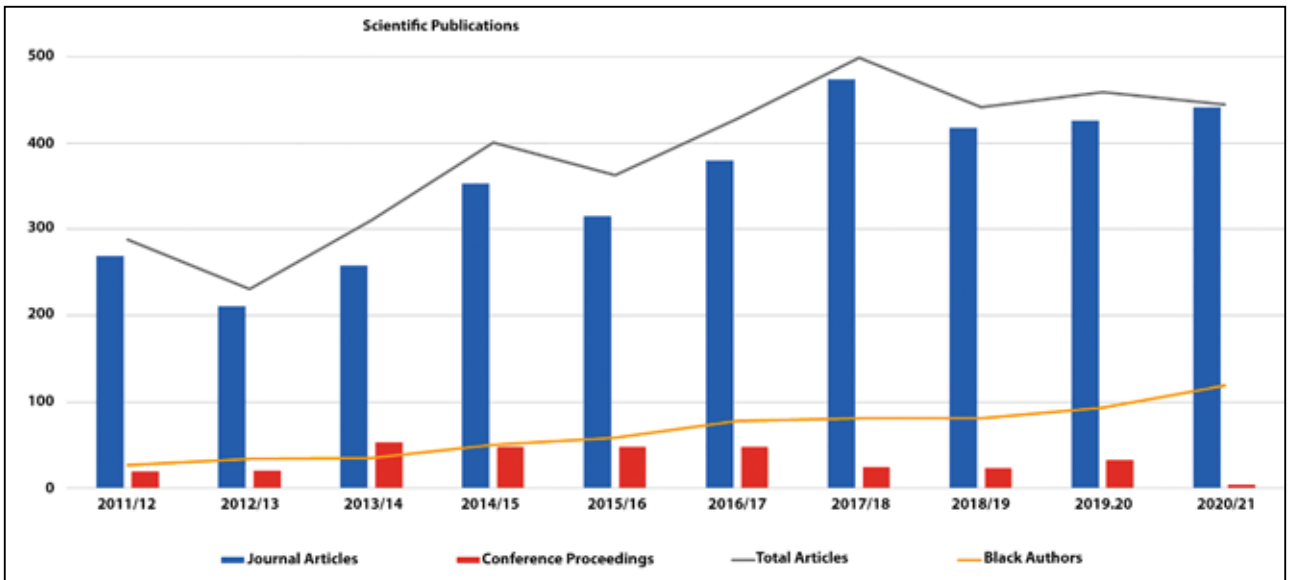
Briefly, the analysis of performance for the financial year 2020/21 indicates that the ARC successfully delivered towards the attainment of the above-mentioned outcomes. Although successful, the organisation operated with reduced resources (skills, finances, aged equipment and infrastructure, etc.) under constrained conditions of the outbreak of the COVID-19 pandemic and associated Disaster Management Act lockdowns.

RESEARCH AND DEVELOPMENT FOR SUSTAINABLE AGRICULTURE

Agriculture production and productivity are essential to fulfil the food and nutrition security demands of the population. However, agriculture production and productivity in South Africa is often subjected to a wide range of biotic and abiotic constraints such as soil health, water, temperature, pests and diseases, climate change and other factors of production (e.g. input such as labour, financial resources, technology, skills etc.) to name a few.

Research and innovation serve as the basis to provide scientific solutions for improved yields, productivity and quality of agricultural products throughout the value chain. It is important to note that outcomes of research and development often require long lead periods prior to dissemination, including generating the scientific information and knowledge for better production and productivity. Trend analysis indicates that the ARC has successfully contributed to the scientific knowledge base of our economy as per peer reviewed publications emanating from research and development.

In the last 10 years the ARC has more than doubled the number of peer reviewed scientific publications from 212 in 2010/11 to 445 in 2020/21. This includes a significant increase in the number of peer reviewed publications by previously disadvantaged authors (black scientist as per South African definition) from 60 in 2011/12 to 215 in 2020/21. Furthermore, the ARC achieved these impressive results through research collaborations with a broad range of external partners from domestic and international organisations. Of particular significance is the improved quality of science reflected through publications with ISI rating (impact factor) of 2.0 or better. These peer reviewed scientific publications were achieved to address ARC Outcomes 1 to 5. These Outcomes suggest increased likelihood of scientific information that will be utilised towards technology and product development; with greater influence on possible new innovations.



	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Journal Articles	269	211	258	353	315	380	474	418	426	441
Conference Proceedings	19	20	53	48	48	48	25	24	33	4
Total Articles	288	231	311	401	363	428	499	442	459	445
Black authors	27	34	35	51	59	78	81	81	94	119

10 Year Review of Scientific Publications.

Applications of scientific data, information and knowledge are essential towards developing solutions, technologies and innovation for sustainable agriculture. In this regard a number of examples are hereby provided demonstrating the success of the ARC in delivering applicable solutions and technologies for the sector.

For example, the ARC collaborated with the Onderstepoort Biological Products (Pty) (OBP) to study the efficacy of the attenuated heartwater vaccine. Study results indicated that the vaccine is safe and effective in cattle, goats and sheep; thus providing important data and scientific insights towards enabling regulatory approval for use by farmers.

In response towards providing possible solutions to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes the Coronavirus-19 (COVID-19) diseases in humans, the ARC initiated a study of identifying and determining the effectiveness of therapeutic extracts from indigenous plants in collaboration with the National Institute for Communicable Diseases (NICD). Through the use of genomics, genotyping, phytochemistry and virology techniques, the ARC screened a number of medicinal bioactive compounds against SARS-CoV-2. To date three medicinal plant species have been identified and bioactive extracts were subjected to drug – screening bioassays. Further scientific analysis continues in the financial year 2021/22.

Recently, the ARC conducted studies to assess potential benefits of the use of *Moringa oleifera lam* (Moringa) as an additive for poultry feed. ARC analyses in this project are continuing with promising results on broiler-feeding to improve the quality and safety of meat.

Food safety remains an important public health concern for South Africa. Metagenomic studies at the ARC Biotechnology Platform showed evidence of diverse and highly variable microbial communities in products of animal origin that could not be identified through traditional laboratory culture techniques. This is an important achievement for managing food safety, labelling and shelf life.

Poor agricultural productivity among smallholder farmers is a serious concern for food and nutrition security and sustainable livelihoods. A multidisciplinary collaborative study to enhance resilience through integrated maize-legume rotations, intercropping and conservation agriculture along with improved seed varieties of maize and beans resulted in improved yields among smallholder farmers. This study suggested a need to scale up sustainable agriculture intensification practices as a mechanism for increased production and productivity among smallholder farmers.

Climate change has been estimated to reduce yields of wheat by 5.5% globally and projected to decline by a further 1.6%, mainly due to trends in temperature, precipitation and carbon dioxide. Working with partners in Poland, the ARC has successfully developed models for in-field monitoring of crop growth and yield assessment, which serves as an important tool to estimate crop yields prior to harvest.

The ARC's Cultivar Development Programme serves as a critical element towards crop improvement for productivity, resilience, competitiveness and growth of agricultural enterprises. In the last 10 years the ARC has successfully developed and released more than 200 cultivars of wheat, maize, dry beans, groundnuts, citrus, macadamia, soybean, potato, grapes, litchi, pears, apples and peaches, to mention a few. Analysis of ARC's cultivar development programme for various selected crops has indicated significant impact on yield, productivity and resilience to abiotic and biotic stress, while also fulfilling the needs of producers and agro-processors.

Broadly, economic impact analysis studies of a number of ARC cultivars developed and released for use in commercial settings indicate a net benefit to farmers for adoption, competitiveness and sustainability of enterprises.

DISSEMINATING SCIENTIFIC SOLUTIONS FOR SUSTAINABLE AGRICULTURE

To ensure food and nutrition security, sustainability and competitiveness of the agriculture sector, it is essential that outcomes of research and development are disseminated for utilisation in production and agro-processing environments.

As assigned by the Minister, the ARC has successfully implemented the Animal Improvement Scheme. The purpose of the scheme is to disseminate scientific information and technologies by enabling animal breeders and commercial producers to inculcate innovation for genetic improvement and economic productivity while ensuring sustainable use of natural resources. In particular, animal recording is a key element of the schemes that is complemented by genetic analysis. Farmers are trained to utilise their farming practices to improve the genetic potential of their animals towards profitable production and enhanced value chains for food and nutrition security. Although adversely impacted by the COVID-19 pandemic, the ARC working with partners in the private sector such as Farmer's Weekly, GMPBasic, Molatek and the Red Meat Producer Organisation, successfully delivered animal improvement services to farmers in the year under review.

During the financial year 2020/21, the ARC successfully provided training, quantitative genetic analysis and advice for breeding to more than 4800 smallholder farmers who participated in the Kaonafatso ya Dikgomo (KyD) Animal Improvement Scheme. This included support for participation in the livestock value chain, such as auctions to create market opportunities for smallholder farmers. For example, at a livestock auction held at Kwafuduka in KwaZulu-Natal 121 farmers, including 45% women sold 295 head of cattle to the tune of R2.3 million.

In addition, the ARC has successfully initiated community-based animal breeding programmes to enable smallholder farmers to benefit from research efforts in animal improvement through the application of advanced scientific methods and technologies such as genomics and bioinformatics. For example, the ARC investigated growth performance profiles of indigenous goats from various villages in comparison to Boer, Nguni and Xhosa breeds. Outcomes of the genetic merits and management were identified as key to improve growth performance in rural goat production – information that is essential for communities to understand how to manage their animal breeding programmes.

To ensure resilience in agricultural yields, productivity and technology transfer require skilled people. The ARC successfully provided training to extension officers and seed company representatives on the accurate identification of the Fall Armyworm (FAW) and best practice to use the Refugia Strategy for insect resistance management; which is a concept for combating and delaying the development of stem borer resistance to Bt maize. Additional training was provided in Limpopo and Mpumalanga provinces as part of the United Nations Food and Agriculture Organisation (FAO) Farmer Field School to smallholder farmers, including women on the identification and monitoring of FAW in their communities.

Due to the outbreak of the COVID-19 pandemic, a number of training events were conducted through electronic media and distance learning. For example, the ARC hosted a number of webinars aimed at disseminating research results, sharing scientific knowledge, particularly on climate change and animal health.

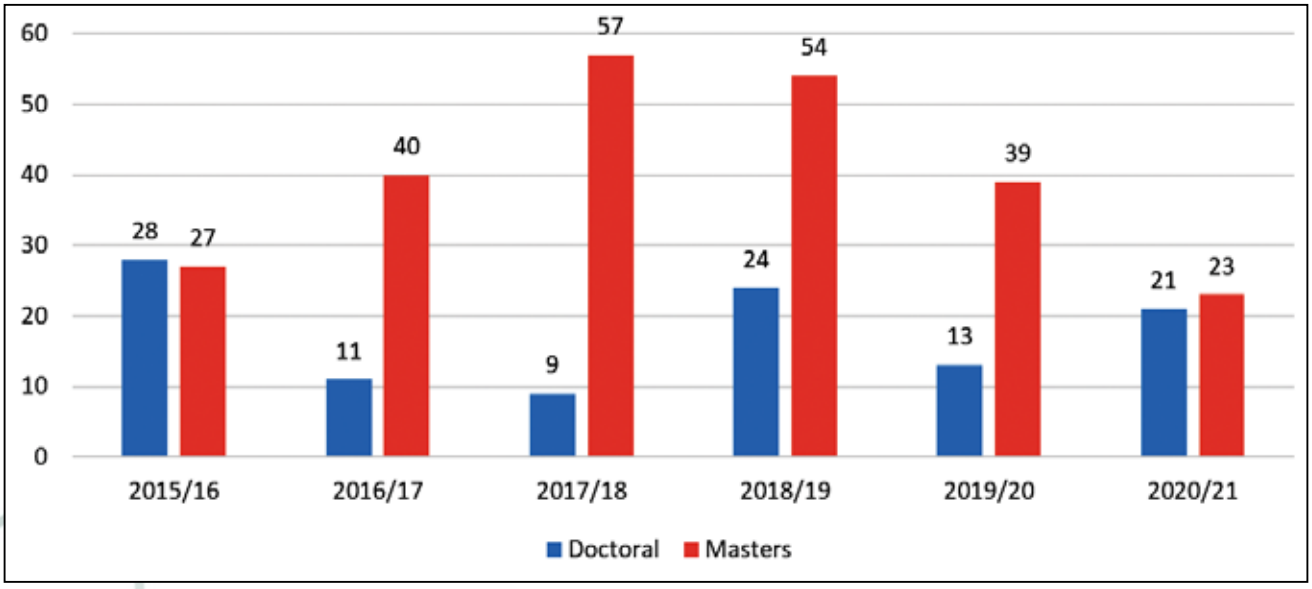
The ARC hosted jointly with McCain Foods, the International Potato Centre (CIP) and the Southern Africa Network for Biosciences (SANBio) in a virtual workshop promoting shelf-stable orange-fleshed sweet potato puree.

One of the challenges that results in stunted growth and poor learning outcomes is malnutrition and chronic hunger among school children, often dubbed, the "*hidden hunger*". In response, the ARC implemented school-based participatory vegetable gardens that complement food supplementation and bio-fortification. This included education and training in horticultural practices in collaboration with the Water Research Commission at schools in Mamelodi, Gauteng Province. The project provided AgriSETA accredited vegetable production training using the orange-fleshed sweet potato (biofortified sweet potato), morogo and kale to promote consumption of healthy foods at the schools.

To enable the success of land reform, the ARC trained 280 National Rural Youth Service Corps (NARYSEC) participants from eThekwini (KwaZulu-Natal), Waterberg (Limpopo) and OR Tambo (Eastern Cape) as part of the District Development Model on various aspects of agricultural production. This programme served as part of the collaboration with the Department of Agriculture, Land Reform and Rural Development (DALRRD). Due to the COVID-19 pandemic lockdown, virtual training was provided in many instances.

As a mechanism to ensure a skilled and capable agricultural sector, the ARC implemented the Professional Development Programme (PDP) starting in 1996. The primary focus of the PDP is to provide postgraduate training and skills development in the application of research and development as well as technology transfer. Although the PDP students undertake applied training by the ARC, universities in South Africa and elsewhere certify the educational qualifications. Such applied research and development training by the ARC provides a unique opportunity for participants to conduct their studies under practical social and economic conditions of commercial enterprises and communities.

Briefly, over the last 10 years the ARC has successfully trained and supervised a total of 1880 PDP students who completed the programme. The chart below shows the number of PDP students who graduated in each of the last six years (2015 to 2021). During the last five years the ARC graduated per annum an average of 40 PDP students with MSc degrees and 21 with PhD degrees, with a combined average of 58 PDP graduates per year. Furthermore, available information indicates that no less than 90% of the graduates from the PDP are in employment by various organisations including the ARC, private agricultural sector companies, universities and other employers throughout South Africa, demonstrating the significant impact of skills transfer among the youth.



ARC Professional Development Programme (PDP) Graduations.

MANAGING OUR HUMAN RESOURCES FOR A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

Human resources are considered highly valuable and essential for the sustainable success of the ARC and the agriculture sector. During the year under review, the ARC implemented a number of initiatives to provide the best working environment that would encourage excellence in performance.

The outbreak of COVID-19 pandemic imposed constraints that required changes in working arrangements, the environment and associated tools. In response, the ARC implemented a number of policies and procedures aimed at securing employee health and well-being. Employees were provided with remote work tools (laptops and associated internet connectivity) to enable them to work from home, and were encouraged to comply with all health and safety protocols. To ensure a safe working environment, the ARC strengthened the use of appropriate tools for employee daily screening, including employee wellness service, digital support and self-care resources. Furthermore, the ARC, in collaboration with the employee wellness service provider, facilitated a safe return to work with COVID-19 testing and advice.

To ensure a continuously skilled workforce for succession planning and effective service delivery, ARC employees are encouraged to enrol for further education and training. Employee education and training varies from short, informal courses to formal certificated training whereby qualifications are granted. During the year in review approximately 400 employees undertook training in various forms, paid through the ARC's parliamentary grant and in some instances the AgriSETA (skills development fund).

Effective talent management enables organisational transformation, recruitment, retention of skilled and high performing employees. In the year under review the ARC's recruitment and talent management efforts were effective as the organisation's turnover rate remained below 10%, despite the outbreak of the COVID-19 pandemic. Although the ARC did not pay performance bonuses for the reporting period, employee recognition was implemented for long service of 5 years or more with associated rewards (monetary or additional leave). Due to the COVID-19 pandemic, researchers couldn't engage in scientific conferences in person, but participated through virtual events hosted throughout the world.

MANAGING OUR FINANCES FOR A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

Impact of the COVID-19 pandemic

COVID-19 is an unprecedented challenge for humanity, businesses, including the ARC and the economy.

Detailed effects of COVID-19 remain uncertain in the long term, but some have been observed with the ARC and listed below:

1. Impact of the continued outbreak and spread of infections among the community and employees without vaccination, with associated work stoppage/s and lack of outputs;
2. Additional costs arising from the COVID-19 pandemic estimated at 60% of the planned levels due to delayed spending on research and development, research, analytical, diagnostic and advisory services;
3. Implications of reduced business arising from adverse impact of COVID-19 pandemic on agriculture enterprises, including non-payment of invoices;
4. Implications of delayed implementation of the ARC's Financial and Sustainability Turnaround Plan; resulting in the non-achievement of projected employee related costs in financial year 2022 and 2023 respectively; and
5. Implications of possible reductions in government grants due to revised priorities as a response to the COVID-19 pandemic.

Despite the potentially considerable impact of this pandemic on 2021, the ARC will be able to continue its operations for at least the next six to twelve months. Accordingly, the 2021 Annual Financial Statements have been established on a going concern basis.

GENERAL FINANCIAL OVERVIEW

Overview of ARC Financial Performance

Figures in Rand Thousands	FY2021	FY2020	VARIANCE (R)	VARIANCE %(*)
FINANCIAL PERFORMANCE OVERVIEW				
Revenue from Exchange Transactions	393 352	374 061	19 291	5,2%
Government Grants	985 817	978 340	7 477	0,8%
Total Expenditure	1 216 701	1 287 308	70 607	5,5%
Operating Surplus	**162 468**	**65 093**	**97 375**	**149,6%**
Surplus/(Deficit) for the year	**161 564**	**66 111**	**95 453**	**144,4%**
FINANCIAL POSITION OVERVIEW				
Current Assets	662 160	403 042	259 118	64,3%
Non-Current Assets	2 031 714	2 049 913	-18 199	-0,9%
Current Liabilities	262 012	320 937	58 925	18,4%
Non-Current Liabilities	383 760	261 495	-122 266	-46,8%
Net Assets	**2 048 101**	**1 870 523**	**177 578**	**9,5%**
CASH FLOW OVERVIEW				
Net Cash Flows from Operating Activities	299 529	260 661	39 969	14,9%
Net Cash Flows from Investing Activities	43 302	91 074	-447 722	-52,5%
Cash balance at the end of the year	**502 163**	**245 936**	**256 227**	**104,2%**

(-) Negative variance means unfavourable variance

(+) Positive variance means favourable variance

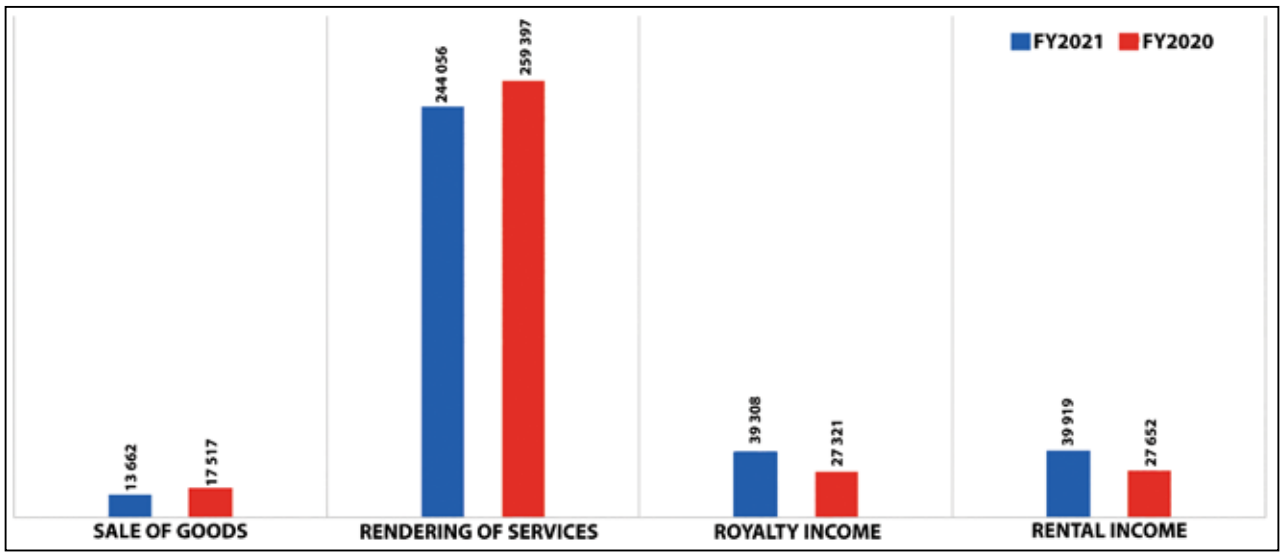
FINANCIAL PERFORMANCE OVERVIEW

Revenue

Government grants of R985 million which represents a 0.76% growth compared to prior year due to budget cuts of R18.7m and R26.0m (excl. VAT) from DALRRD and DSI respectively, which were implemented during the year. The impact of the aforementioned unfavourable events were mitigated by the recognition of the ECSP [Economic Competitiveness Support Package] project that has been completed during the past financial years and the final recognition was processed during the FY2021.

The Revenue from exchange transactions reported R393.3m during the period under review which represents a 5% year-on-year growth as compared to the FY2020 performance. The performance on the top revenue drivers is outlined below:

ARC Top Revenue Drivers:

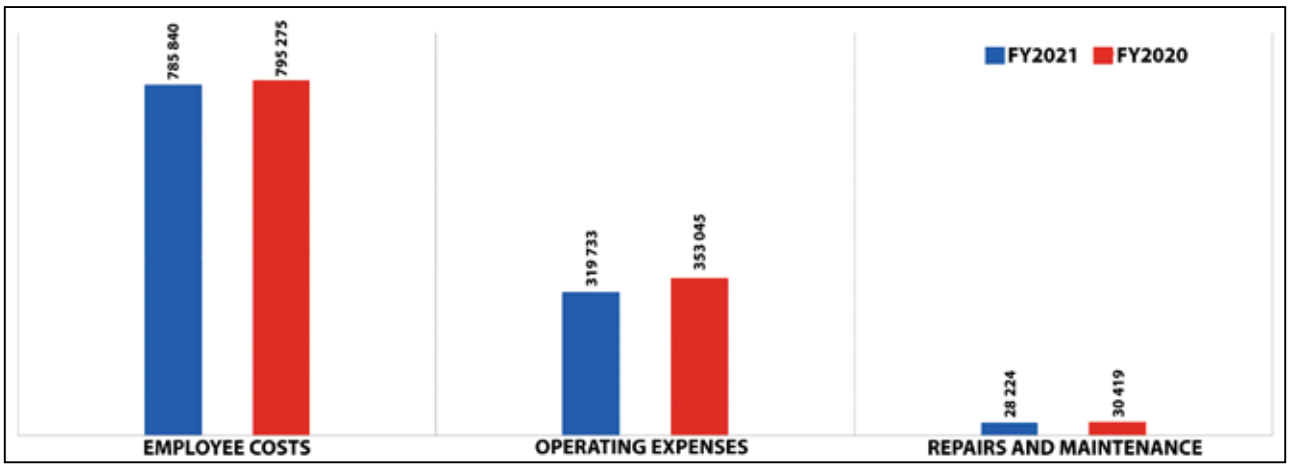


Top Revenue Drivers (R' 000).

The performance has been influenced positively by the performance on the following revenue streams namely: (a) Rental of facilities and equipment (R40m), impacted positively by recoveries from the tenants; (b) Royalty income performed better than anticipated and reported growth of 44%; (c) Interest received reported an 11% growth; and (d) Recoveries and other Income was largely influenced by bad debts recovered of R16.9 million from Trade debtors and S&T recovered from employees. The performance on the following revenue streams has lagged the prior year performance largely due to the impact of COVID 19: (a) Sale of goods in agricultural activities (-22%) and (b) Rendering of Services (-6%).

Expenditure

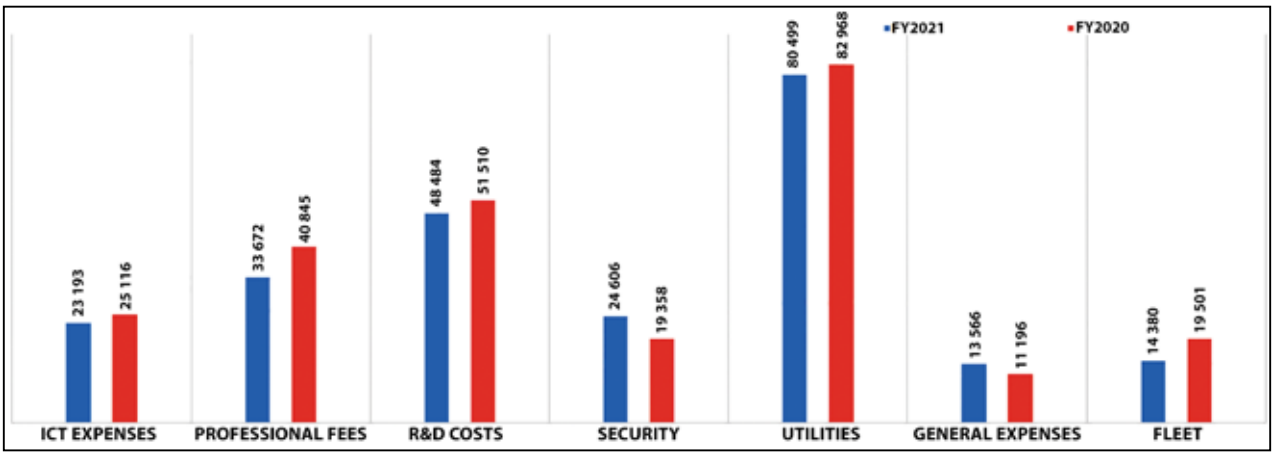
The total Operating Expenditure reported is R1.2 billion which represents a 5,5% (R71 million) year-on-year saving. The spending trend compares as follows on the key expense drivers:



ARC Key Expenditure (R' 000).

The saving is mainly attributable to: (a) Employee related costs. The cost saving is attributable to salaries and wages due to reprioritisation of vacancies and moratorium on recruitments on vacancies that could be recruited for internally. The travel and accommodation has reported a 60.7% year-on-year savings which is attributable to the impact of the COVID-19 lockdown and related restricted travelling.

The Operating and Administrative expenses reported of R319,7m represents a 10% year-on-year savings. The trend on the key expenses drivers is outlined below:



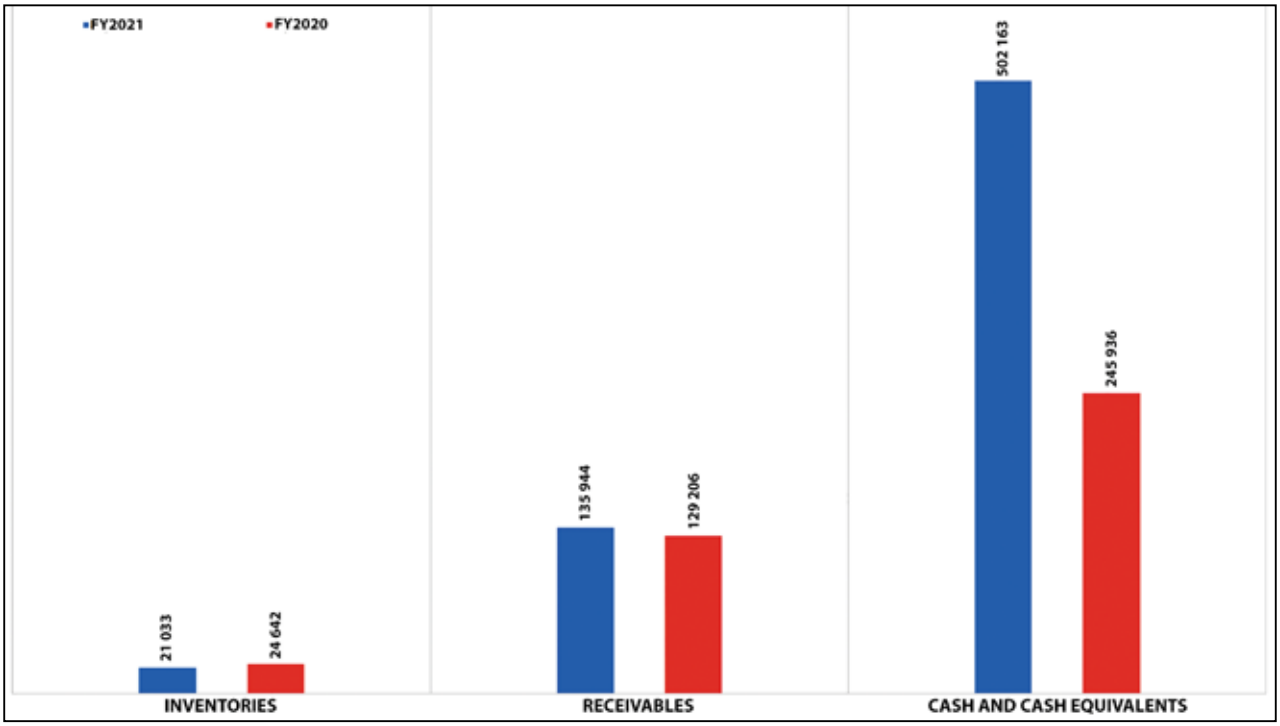
ARC Key Operating and Administrative Expenses (R' 000).

The overall Surplus for the year achieved is R161 million which represents a more than 100% year on year growth.

FINANCIAL POSITION OVERVIEW

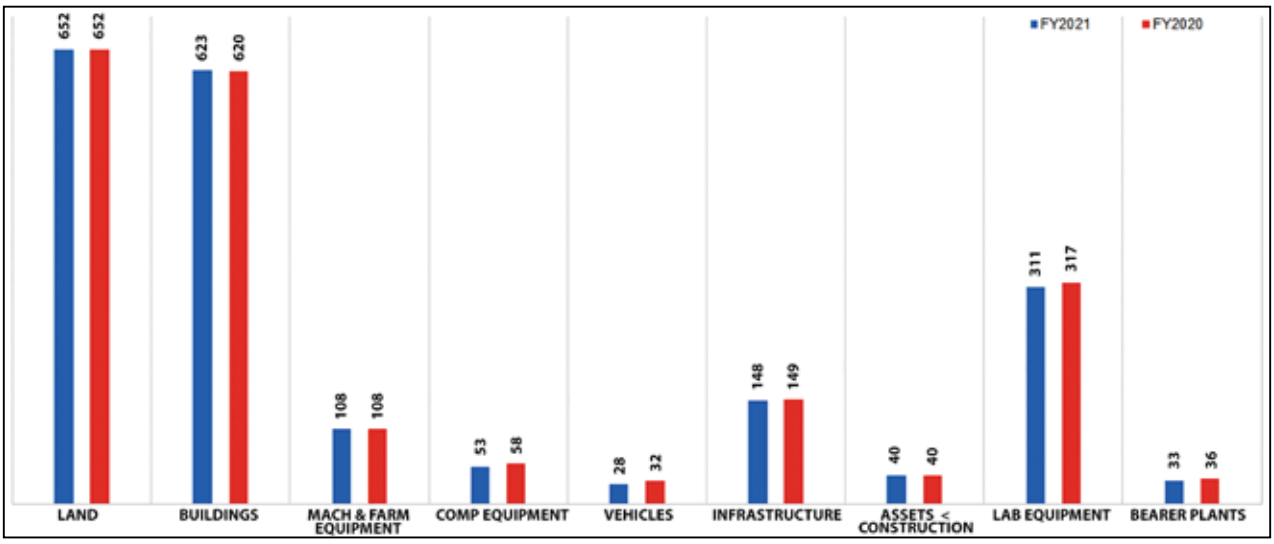
The Net Assets of the Agricultural Research Council as at R2 billion and the year-on-year results have been influenced by the following:

The Current Assets balance of R662m represented a 64% year-on-year growth as compared to the 2020 financial year. The results are significantly influenced by the cash and cash equivalents with a reported year-on-year growth of 104%. The graph below depicts the year-on-year comparison:



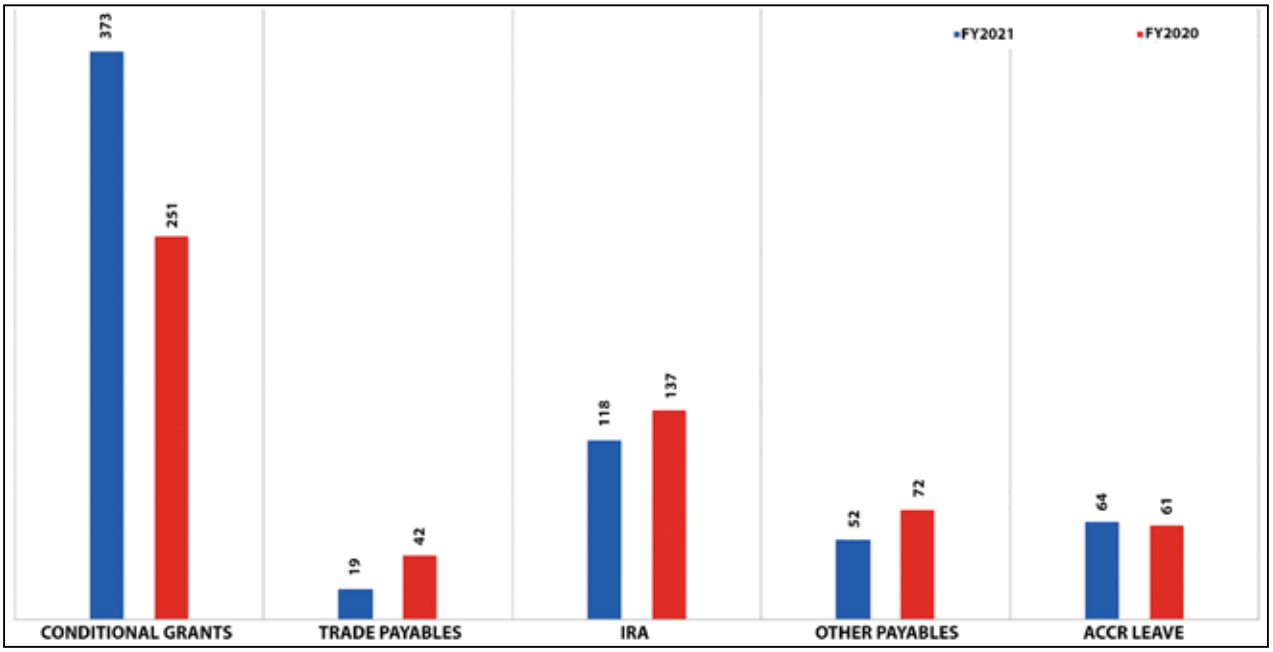
Overview of ARC Current Assets (R' 000).

The non-current assets remained largely flat at R2 billion and the results are mainly influenced by the Property, Plant and Equipment (PPE). The PPE year-on-year comparison is outlined below:



ARC Key Asset Classes (R' million).

The total liabilities of the organisation were at R645.8m balance, which represents an 11% growth year-on-year. The growth is significantly influenced by the unspent Conditional Grant relating to the Foot and Mouth Disease (FMD) project. The FY2021 represents the 2nd financial year of the MTEF period which the ARC had received additional funding for the FMD project. The impact was mitigated by a 54% year-on-year decline on the Payables from exchange transactions.



ARC Key Liabilities (R' million).

REQUESTS FOR ROLL-OVER OF FUNDS

Section 53(3) of the Public Finance Management Act (PFMA) requires a public entity, which submit a budget in terms of section 53(1) of the PFMA, not to budget for a deficit and not to accumulate surpluses, unless prior written approval of the National Treasury has been obtained. The ARC will submit a request to the National Treasury for the roll-over of surplus funds. It should however be noted that 74% of the Cash and Cash Equivalents at the end of the year, represents the FMD funds which has been ring-fenced at the CPD. The unspent conditional grant relating to the FMD project was R367.7m and R246.1m for the FY2021 and FY2020 respectively.

ARC Surplus Calculations

CALCULATION OF SURPLUSES	FY2020/21	FY2019/20 (Restated)
Cash and Cash Equivalents at end of the year (#)	502 162 930	245 935 648
Add: Receivables	135 943 741	129 205 930
	635 106 671	**375 141 578**
Less: Current Liabilities	-262 012 422	-320 937 235
Surplus	**376 094 249**	**54 204 343**
FMD Deferred Income Grant (Ring-fenced)	372 532 347	250 924 785
NET SURPLUS AFTER CONDITIONAL GRANTS	**3 561 902**	-196 720 442

SUPPLY CHAIN MANAGEMENT

The ARC has a council approved Supply Chain Management Policy in place. The Standard Operating Procedures as approved by the Executive Management Committee (EMC) are in place. The organisation has submitted the FY2020/21 Procurement Plan and related addendums within the prescribed timelines as outlined in the National Treasury instruction no. 2 of 2016/17. The performance on the Procurement Plan was reported on a quarterly basis to the DALRRD and National Treasury. The FY2020/21 Procurement Plan had 87 items with an estimated value of R230.9 million. Only 44 items were procured during the financial year under review. 21 tenders to the estimated value of R95.3 million were rolled over for advertising in FY2021/22 partly due to the challenges experiences with the government tender platforms/portals and the COVID-19 pandemic.

AUDIT REPORT MATTERS IN THE PREVIOUS AND CURRENT YEAR

The Agricultural Research Council had in place an Audit Improvement Plan, which has been approved by Council. The Audit Improvement Plan has been monitored by the Audit and Risk Committee. The progress on the Audit Improvement Plan has been audited by the Internal Audit Department. The ARC prepared the Interim Financial Statements for the period ended 30 September 2020, which has been subjected to an interim audit by the Auditor General.

The audit qualification matters relating to FY2019/20 have been addressed as follows during the year under review:

2019/20 Audit Qualification Matters

REFERENCE TO THE AUDIT REPORT FY2019/20	BASIS FOR QUALIFICATION	PROGRESS OR STATUS
3	**Property, Plant and Equipment** Land Revaluation opening balance. Revaluation of prior year figures on land was considered an issue. Lack of sufficient and appropriate/ acceptable documentation.	Resolved
4	**Rendering of Services** Revenue incorrectly recognised, as it should have been accounted for as Income Received in advance.	Resolved
5	**Commitments** Commitments overstated due to the delayed cancellation of Invalid Purchase Orders and partial GRNs not effected in the Open Purchase Order report received.	Resolved

OUTLOOK/PLAN FOR THE FUTURE TO ADDRESS THE FINANCIAL CHALLENGES

The ARC has developed a Sustainability and Financial Turnaround Plan which was approved by Council during February 2019, which outlines the initiatives required for improving the financial position of the organisation. The Plan is monitored by Management and Council on a continuous basis. As at 31 March 2021, the ARC is considered to be solvent as its assets exceeded the liabilities by R2 billion. The liquidity assessment conducted also concluded that the ARC will be able to meet its financial obligations as and when they are due. As thus it was affirmed that the ARC will continue as a going concern for the foreseeable future. The ARC has budgeted an operational surplus for the MTEF period FY2021/22 to FY2023/24 which has been articulated in its Annual Performance Plan and which is based on the assumptions that the targeted external income and cost efficiencies will be achieved as planned.

TO OUR CLIENTS AND STAKEHOLDERS

We, the people at the ARC, hereby express our utmost appreciation and gratitude for your support and assistance during the financial year. We trust and hope you will continue to collaborate with the ARC in various ways to ensure that we fulfil your needs and expectations, particularly enabling innovation, competitiveness and sustainability as well as improved livelihoods.

Executive and Senior Management hereby express appreciation for the dedicated contributions of all employees of the ARC. It is the individual and collective contributions of all employees, working as a team, that enable a high performing organisation such as the ARC. The successful performance of the ARC has contributed towards enabling the attainment of national priorities, particularly food nutrition security for all.

Re a leboha, le ka moso

Re a leboga, le kamoso

Re a leboga, le gosasa

Siyabulela, nangamso

Siyabonga, naksasa

Siyathokoza, nangamoso

Ha khensa, aswive tano na mudzuku

Ria livhuwa, khazwiralo na matshelo

Baie dankie

Thank you

Dr Shadrack Moephuli compiled this Chief Executive Officer's overview, but due to his departure from the ARC on 31 July 2021, the current Acting President and CEO is signing it off within his current delegations.

Dr Hilton Vergotine
Acting President and CEO
Date: 31 August 2021

7. STATEMENT OF RESPONSIBILITY AND CONFIRMATION OF ACCURACY FOR THE ANNUAL REPORT

To the best of my knowledge and belief, I confirm the following:

- All information and amounts disclosed in the Annual Report are consistent with the Annual Financial Statements audited by the Auditor-General;
- The Annual Report is complete, accurate and is free from any omissions;
- The Annual Report has been prepared in accordance with the guidelines for the Annual Report as issued by National Treasury and Department of Planning, Monitoring and Evaluation (DPME);
- The Annual Financial Statements (Part E) have been prepared in accordance with the Public Finance Management Act, 1999 (Act No.1 of 1999) (PFMA) standards applicable to the public entity;
- The accounting authority is responsible for the preparation of the Annual Financial Statements and for the judgements made in this information;
- The accounting authority is responsible for establishing and implementing a system of internal control that has been designed to provide reasonable assurance as to the integrity and reliability of the performance information, the Human Resources information and the Annual Financial Statements; and
- The external auditors are engaged to express an independent opinion on the Annual Financial Statements.

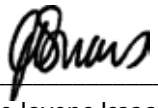
In our opinion, the Annual Report fairly reflects the operations, the performance information, the Human Resources information and the financial affairs of the public entity for the financial year ended 31 March 2021.

Yours faithfully,

31 August 2021

Dr Hilton Vergotine
Acting President and CEO

Date



31 August 2021

Ms Joyene Isaacs
Chairperson of the ARC Council

Date

8. STRATEGIC OVERVIEW

8.1. VISION

"Excellence in research and innovation for sustainable agricultural systems and economic development"

8.2. MISSION

"The Agricultural Research Council (ARC) is a premier science institution that conducts research, develop partnerships and human capital, to foster innovation for a sustainable agriculture sector"

8.3. VALUES

ARC Values.

9. LEGISLATIVE AND OTHER MANDATES

The ARC was established as a Public Entity on 1 December 1990, under the then Ministry of Agriculture (now reconfigured as the Ministry of Agriculture, Land Reform and Rural Development).

- The ARC is listed as a Schedule 3A Public Entity in terms of the Public Finance Management Act (No.1 of 1999) (PFMA), and is required to ensure full compliance with all prescripts and regulations arising from the PFMA.

Specifically, the ARC was established in terms of the Agricultural Research Act (No. 86 of 1990, from which it derives its core mandate. The objectives of the ARC outlined in the Act are to conduct research, drive research and development, drive technology development and transfer (dissemination) information, in order to:

- promote agriculture and industry;
- contribute to better quality of life;
- facilitate/ensure natural resource conservation; and
- alleviate poverty.

The Act defines:

- *Research* as the furtherance, accumulation and improvement of knowledge in the agricultural and related sciences through original and other investigations and methods of a scientific nature with the advancement of agriculture as its object;
- *Technology Development* as activities by which knowledge acquired through research is utilised; and
- *Technology Transfer* - transfer of knowledge, techniques and processes for application thereof.

Further, the Act states that in order to achieve its objectives, the ARC may:

- undertake and promote research, development and technology transfer in connection with:
  - ◊ the optimal utilisation of the agricultural resources and the improvement of the production capacity of such resources;
  - ◊ the rehabilitation and improvement of the agricultural resources;
  - ◊ the opening of possibilities and the generation of new knowledge to solve particular problems;
  - ◊ the improvement of the nutritional value and quality of agricultural products;
  - ◊ the pollution of the environment and the prevention thereof in respect of agriculture; and
  - ◊ the improvement of existing techniques and the creation of new techniques for the processing of agricultural products, and to improve the keeping quality of perishable agricultural products;
- utilise the technological expertise in its possession and make it generally available;
- publish information concerning its objectives and functions, and establish facilities for the collection and dissemination of information in connection with research and development;
- establish and control facilities in those fields of research, development and technology transfer which the Council may from time to time determine;
- promote cooperation between the Republic and other countries with regard to research, development and technology transfer; and
- cooperate with persons, institutions and associations undertaking research, development and technology transfer in other countries.

The ARC performs its functions through several research campuses that are predominantly commodity-based and are strategically located throughout the country. Further, research at these facilities is complemented by on-field experimental sites distributed throughout every province of South Africa. In addition, selected farm fields are utilised to study the performance of ARC research technologies under actual farm production environments.

The Council of the ARC is the Accounting Authority in terms of the PFMA, and provides strategic direction and leadership to enhance shareholder value and ensure the long-term sustainable development and growth of the Entity. In fulfilling its responsibilities, the Council is supported by the ARC Chief Executive Officer and the Executive and Senior Management team in implementing the approved strategic and corporate plans and policies. The ARC seeks to operate on sound business principles and practices, and to this end, strives at all times to comply with the principles contained in the King Code on Corporate Governance in South Africa (2016) (King IV) and other corporate governance guidelines and standards.

LEGISLATIVE MANDATE

In delivering on its core mandate, the ARC is responsible for performing its functions in line with the following key legislation, which thus directly informs the various day-to-day operations of the organisation:

Legislative Mandates

LEGISLATION	OBJECTIVE OF THE ACT	ARC RESPONSIBILTY
Animal Disease Act, 1984 (Act No. 35 of 1984)	This Act provides for control measures for the prevention of diseases and parasites, and for schemes to promote animal health. The Directorate of Veterinary Quarantine and Human Health is responsible for the enforcement thereof.	No specific delegation in terms of the Act. However, the ARC provides various services (diagnostic and analytical) to fulfil the aims of the Act, including through OIE reference laboratories.
Animal Identification Act, 2002 (Act No. 6 of 2002)	Provide for the identification of animals and procedures to be followed when applying for an identification mark. The Directorates Animal Production and Veterinary Quarantine, and Human Health are responsible for the administration of this Act.	No delegation to ARC. However, certain aspects of animal identification are contained in the implementation of an Integrated Registration and Genetic Information System (INTERGIS). The INTERGIS is delegated to the ARC.
Animal Improvement Act, 1998 (Act No. 62 of 1998)	To provide for the breeding, identification and utilisation of genetically superior animals in order to improve the production and performance of animals in the interest of the Republic. The Directorates Animal Production and Veterinary Quarantine, and Human Health are responsible for the administration of this Act.	Certain services that are discharged under this act are managed by the ARC: • Animal improvement services, including collection of animal data, as well as management of National Databank (INTERGIS); • Section 20 of the Act on the establishment of the Schemes; • Declaration of the Schemes Notice 29516 of 2007 Section 5(1)(a)(iii) - the Schemes shall ensure that all recorded data must be submitted to the Integrated Registration and Genetic Information System (INTERGIS); Furthermore, Section 44 of the Declaration stipulates that: • The Schemes will be managed by the ARC, a statutory body established in terms of Section 2 of the Agricultural Research Act, 1990 (Act No. 86 of 1990); • The ARC will exercise the powers and perform duties conferred to it in terms of the Schemes; and • The ARC may make rules relating to the Schemes in consultation with the Department.

LEGISLATION	OBJECTIVE OF THE ACT	ARC RESPONSIBILTY
Agricultural Pests Act, 1983 (Act No. 36 of 1983)	This Act introduces measures for the prevention and combating of agricultural pests. The Directorate of Plant Health is responsible for the enforcement thereof.	ARC serves on the National Steering Committees to address specific pest problems. Responsibilities include: • Calibration of aircraft for control of migratory pests; and • Identification services and registered testing laboratories; The insect quarantine service is rendered through a contract with the DALRRD.
Animal Protection Act, 1962 (Act No. 71 of 1962)	This Act provides for the maintenance of proper standards of hygiene, and in the handling of animals and the prevention of cruelty to animals. The SPCA is responsible for the enforcement thereof. The Directorate Animal Production is responsible for the administration of this Act.	There is no delegation to ARC. However, the organisation has to comply with the requirements of the Act.
Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)	This Act provides for control over the utilisation of natural agricultural resources in order to promote the conservation of soil, water sources and vegetation, and the combating of weeds and invader plants. The Directorate of Land Use and Soil Management and the Engineering Directorate are responsible for the enforcement thereof.	No delegation. Certain aspects of the Act are contained within the mandate of the ARC.
Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No. 36 of 1947)	The registration of fertilisers, farm feeds, agricultural remedies, stock remedies, sterilising plants and pest control operators are regulated by this Act. Provision is also made for control over the acquisition, disposal, sale and use of fertilisers, farm feeds, agricultural remedies and stock remedies. The Directorate Food Safety and Quality Assurance is responsible for the administration of this Act.	There is no specific delegation for the ARC. However, on assignment, the organisation conducts analytical, testing and advisory services to enable regulatory decisions by the Department of Agriculture, Land Reform and Rural Development (DALRRD).
Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997)	To provide measures to promote the responsible development, production, use and application of genetically modified organisms; to ensure that all activities involving the use of genetically modified organisms (including importation, production, release and distribution) shall be carried out in such a way as to limit possible harmful consequences to the environment; to give attention to the prevention of accidents and the effective management of waste; to establish common measures for the evaluation and reduction of the potential risks arising out of activities involving the use of genetically modified organisms; to lay down the necessary requirements and criteria for risk assessments; to establish a Council for genetically modified organisms; to ensure that genetically modified organisms are appropriate and do not present a hazard to the environment; and to establish appropriate procedures for the notification of specific activities involving the use of genetically modified organisms. The Directorate Bio-Safety is responsible for the administration of this Act.	No delegation to ARC. However, ARC expertise, facilities and scientific data/information are utilised to support decision-making.
Intellectual Property Rights from Publicly-funded Research and Development Act, 2008 (Act No. 51 of 2008)	Seeks to ensure that all publicly-funded research gets intellectual property protection for the purposes of commercialisation. It further places an onus on the ARC to establish an Intellectual Property Management Office.	The ARC has established a functional Intellectual Property Management Office, along with associated internal policies to ensure compliance to licensing agreements.

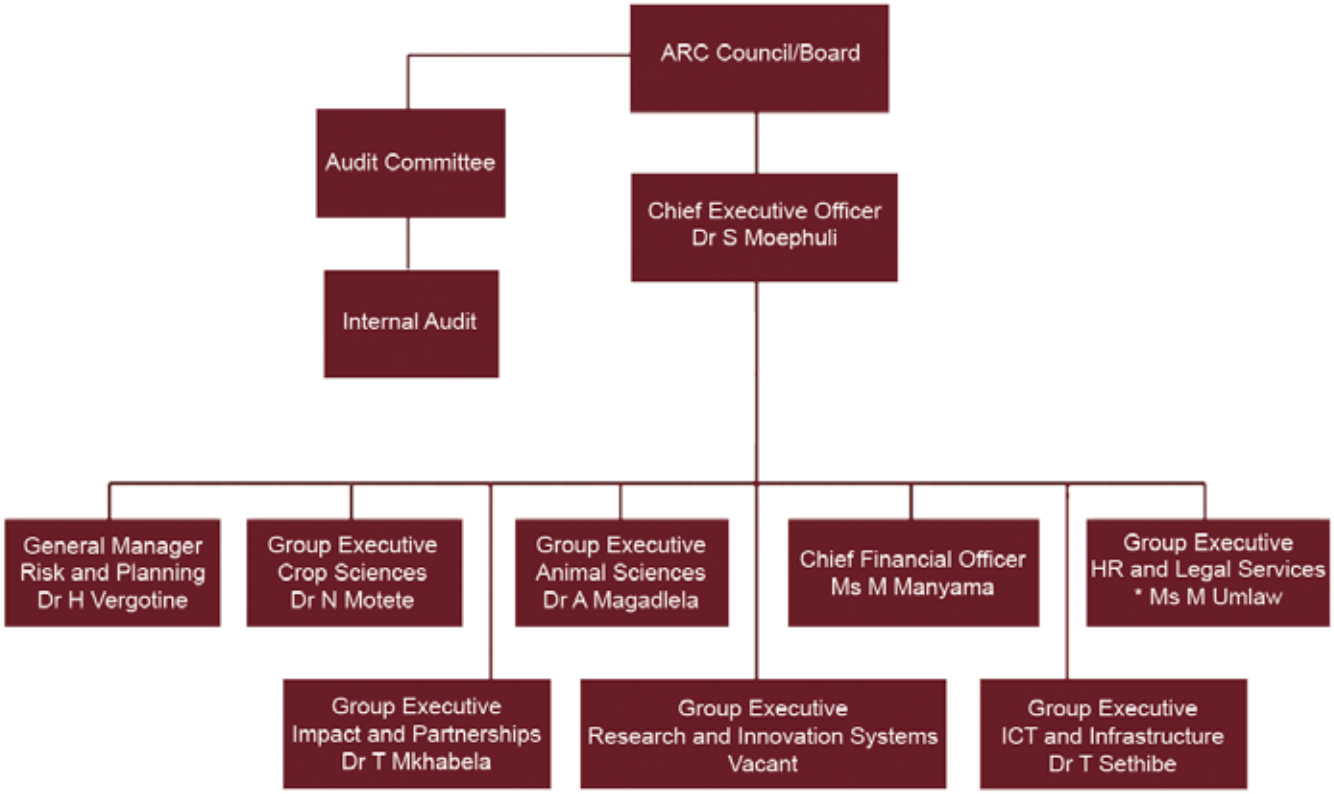
LEGISLATION	OBJECTIVE OF THE ACT	ARC RESPONSIBILTY
National Environmental Management Act, 1998 (Act No. 107 of 1998)	Provide for measures to prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development. The Department of Forestry, Fisheries and the Environment (DFFE) is responsible for the administration of the Act.	ARC supports by hosting of national collections and developing data used for conservation and management of natural resources. Baseline biodiversity data is essential for policy-makers regarding conservation and sustainable use of natural resources.
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)	To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources. The DFFE is responsible for the administration of the Act.	As outlined above in respect of NEMBA.
Plant Breeders' Rights Act, 1976 (Act No. 12 of 2018)	This Act regulates the granting of certain rights relating to the new varieties of certain kinds of plants, the protection of such rights and the issue of licences in respect of the exercising of the rights. The Directorate of Plant Production is responsible for the enforcement thereof.	The ARC provides services to the registrar to enable evaluation of material for granting of Plant Breeders' Rights in recognition of new varieties. The ARC must comply with the requirements of the Act.
Plant Improvement Act, 1976 (Act No. 53 of 1976)	This Act provides for the registration of establishments where plants and propagation material are sold and packed; for the introduction of schemes for the certification of certain propagation material; for the requirements to which plants and propagation material sold for the purposes of cultivation must conform; and for quality control over plants and propagation material imported or exported. The Directorate of Plant Production is responsible for the enforcement thereof.	Registered testing laboratories (nematology, mycology, virology, bacteriology - American Foulbrood Disease) provide diagnostic services to government in terms of seed/plant quality (free from pests and pathogens), as well as nurseries and other plant propagation material.
Public Finance Management Act, 1999 (Act No. 1 of 1999)	To regulate financial management in the national government and provincial governments; to ensure that all revenue, expenditure, assets, and liabilities of those governments are managed efficiently and effectively; to provide for the responsibilities of persons entrusted with financial management in those governments.	Adherence to all sections of the PMFA relevant to the ARC.

The above-mentioned legislation is not exhaustive, and it is recognised that the ARC is subject to, and must comply with, all national and provincial legislation and regulations, and all municipal by-laws, applicable to its functions or the areas in which it operates.

POLICY MANDATE

Whereas the above legislation and regulations define the scope of the mandate and regulate how the ARC must operate, various national policy and strategy frameworks give effect to how the mandate should be implemented, and have direct bearing on the priorities and focus areas of the ARC for the 2020/21-2024/25 period of its Strategic Plan.

10. ORGANISATIONAL STRUCTURE



ARC Organisational Structure.

Resigned 31 Oct 2020

PART B: PERFORMANCE INFORMATION

1. AUDITOR'S REPORT: PREDETERMINED OBJECTIVES

The AGSA/auditor currently performs the necessary audit procedures on the performance information to provide reasonable assurance in the form of an audit conclusion. The audit conclusion on the performance against predetermined objectives is included in the report to management, with material findings being reported under the Predetermined Objectives heading in the Report on other legal and regulatory requirements section of the auditor's report. Refer to page 165 of the Report of the Auditor-General, published as Part E: Financial Information.

2. SITUATIONAL ANALYSIS

2.1. SERVICE DELIVERY ENVIRONMENT

The ARC continuously strives towards deriving optimal value from all resources (financial, human, infrastructure, natural etc.) available to conduct research and development as well as associated services towards fulfilment of its mandate.

Conducting business in the financial years 2016/17 to 2020/21 was difficult for the ARC as there were various limitations, particularly resources. As a national public entity, the ARC is exposed to many factors that adversely impact upon its performance, such as the state of the economy, underperforming agriculture enterprises, unfavourable climatic conditions (e.g. severe drought in parts of the country, delayed summer rainfall, locust outbreaks, plant and animal diseases) and ageing infrastructure, to mention a few. These challenges directly impacted upon the ARC's ability to fulfil its mandate and resulted in reduced external revenue for research and advisory services.

The ARC operating environment during financial year 2020/21 included the following risks:

1. Sustainability as a going concern (with potential risk of loss of skilled personnel, inability to fulfil financial obligations that could have consequences for existence of the organisation);
2. Inability to fulfil mandates, particularly withdrawal of funding of the National Public Good Assets by the Department of Science and Innovation;
3. Increased risk of poor agricultural production and productivity as a consequence of frequent, uncontrollable outbreaks of pests and diseases (e.g. FMD, Fall Armyworm, drought, locust swarms, etc.);
4. Increased risk of food insecurity, particularly malnutrition); and
5. Increased risk of failed agricultural enterprises, particularly commercial agriculture with concomitant unemployment among others.

In addition to the above risks, the operating environment for the ARC was further jeopardised by the outbreak of the COVID-19 pandemic. Although long term effects of the COVID-19 pandemic remain uncertain, the disease has adversely impacted upon the performance of the ARC during the reporting period. For example, the ARC experienced the following:

1. Infection rates among employees with associated work stoppage/s and resultant lack of service delivery;
2. Delayed achievement of project milestones resulting in reduced revenue generation from research and development, analytical, diagnostic and advisory services;
3. Delayed implementation of the ARC's Financial and Sustainability Turnaround Plan; resulting in the non-achievement of projected employee related cost reductions in the financial year 2021 to 2022;
4. Reprioritisation of services to provide diagnostic services for COVID-19 in support of the National Institute for Communicable Diseases (NICD); and
5. Inability of scientists and technicians to conduct visits at agricultural enterprises or experimental sites and provide farmer training, mainly due to limitations imposed by regulatory management of the pandemic.

Notwithstanding the challenges of COVID-19 pandemic, the ARC continued its operations during financial year 2020/21. Such operations were in accordance with the mandate of the ARC.

2.2. ORGANISATIONAL ENVIRONMENT

This annual report serves as the first year of implementation of the approved five-year (2020 to 2025) Strategic Plan in pursuit of the ARC Vision 2050. Research focus areas serve as the organising framework towards the attainment of ARC Vision 2050 and are outlined as follows:

1. Genetic improvement of crops and livestock to enable increased productivity;
2. Anticipation and mitigation of agricultural risks to enable resilience to climate change;
3. Promotion of ecosystem sustainability to enable effective natural resources conservation;
4. Solutions, processes and technologies to reduce post-harvest losses and develop new products; and
5. Inclusive market-oriented agricultural development to reduce malnutrition and hunger.

Performance was, in accordance with pre-determined outcomes, outlined as follows:

1. Increased agricultural production and productivity;
2. Sustainable ecosystems and natural resources;
3. Improved nutritional value, quality and safety of agricultural products;
4. Skilled and capable agricultural sector;
5. Enhanced resilience of agriculture; and
6. A high performing and sustainable organisation.

During the financial year, the ARC considered and conducted business cognisant of the challenges outlined above. Further, reduced financial resources during the year had the following impact on the organisation:

1. ARC scientists reduced their time conducting laboratory or field research, instead focused on data analyses, that resulted in high quality peer reviewed scientific publications;
2. Reductions in field and laboratory research activities limited the outputs of technologies, resulting in reductions in the number of cultivars released or registered for Plant Breeders' Rights (PBR);
3. There was limited output in vaccine research and development;
4. The ARC was subjected to in-year reductions in the Parliamentary Grant of R21 million and non-payment of R26 million for the management of National Public Goods Assets;
5. In the same period, the ARC implemented a moratorium on vacancies for unskilled personnel, and reprioritised recruitment of highly skilled scientists that are essential to fulfil its mandate; and
6. To ensure organisational viability, the ARC continued to implement the Financial Sustainability and Turnaround Plan to the extent possible.

2.3. KEY POLICY DEVELOPMENTS AND LEGISLATIVE CHANGES

During the financial year, the ARC has not been subject to policy changes to its mandate as stipulated in the approved five-year Strategic Plan. As a public entity, the ARC must comply the constitution of the Republic of South Africa 1996, national and provincial legislation, municipal by-laws and subordinate legislation applicable to the organisation's business.

2.4. STRATEGIC OUTCOMES

ARC Strategic Outcome and Research Delivery Outputs

RESPONSIBLE ARC OUTCOME	RESEARCH AND/OR DELIVERY OUTPUTS
OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY	1) Generation of knowledge through research; 2) Development of new technologies; 3) Scientific services rendered; and 4) Information dissemination.
OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES	1) Generation of knowledge through research; 2) Development of new technologies; 3) Scientific services rendered; and 4) Information dissemination.
OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS	1) Generation of knowledge through research; 2) Development of new technologies; 3) Scientific services rendered; and 4) Information dissemination.
OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR	1) Generation of knowledge through research; 2) Development of new technologies; 3) Scientific services rendered; and 4) Information dissemination.
OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE	1) Generation of knowledge through research; 2) Technologies released to agriculture sector; 3) Scientific services rendered; 4) Agriculture skills and capacity development; 5) Agriculture R&D information communicated/disseminated to stakeholders; and 6) Stakeholder management.
OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION	1) Improved post-graduate SET base; 2) Improved staff profile; 3) Optimal investment in training and development; 4) Funding and revenue generation; 5) Applied Information technologies; and 6) Optimal utilisation of assets.

3. PERFORMANCE INFORMATION BY OUTCOME

3.1. OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY

The focus of Outcome 1 is to generate knowledge and technologies (intellectual property and tools) that will diversify, improve the quality and increase the value of crop and animal based agricultural production and related processes and products; enhance productivity towards increased food security, commercial exports and income for the agricultural sector, and enabling farmers and producers to maximise their efficiency and productivity.

The Outcome focuses on improving the productivity, competitiveness and sustainability of both commercial and smallholder agriculture through research and development in:

1. **Crop research and development**: including a wide range of grains, vegetables, indigenous ornamental plants, medicinal plants, deciduous fruit and grapes, tropical and subtropical fruits and niche crops, such as herbal teas. Industrial crops research and development will focus on fibre crops, such as cotton and hemp.

2. **Livestock-based agriculture**: through research and technology in areas related to animal health, production and improvement, as well as secondary production processes. The research and development is focused on both production and companion animals, and increasingly in the areas of aquaculture and wildlife.

Outcome 1 is the focus of the following ARC Divisions:

- ◊ Crop Sciences; and
- ◊ Animal Sciences.

Outcomes, Outputs, Output Indicators, Targets and Actual Achievement

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19 *	AUDITED ACTUAL PERFORMANCE 2019/20 *	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT FOR 2020/21	REASON FOR DEVIATIONS
Crop technologies developed and information dissemination.	Number of cultivars registered.	7	9	11	2	(9)	Registration of cultivars beyond control of ARC.
	Number of field trials.	235	197	215	311	96	More field trials due to favourable weather conditions.
	Number of technical reports.	362	267	258	271	12	Higher number of reports generated for ARC clients.
	Number of cultivar evaluations.	0	0	60	68	8	Higher demand for cultivar evaluations by ARC.
Animal improvement services.	Number of farmers participating in each of the animal improvement schemes.	465	253	200	190	(10)	Lower than anticipated participation in the animal improvement schemes.
	Number of technical reports.	0	0	1000	781	(219)	Fewer reports generated for ARC clients.

**** Indicators form part of the previous Strategic Plan period (2015/16 – 2019/20)***

Significant achievements of targets:

Despite the fact that the targets for the animal improvement services were not achieved because of travel restrictions that came with the various COVID-19 lockdown measures, the services provided to livestock farmers participating in the National Animal Improvement Schemes enabled these farmers to improve the genetic potential of the national herd, which boosted milk and meat production and productivity. These improvements contribute to the country's all important ideal of national and household food security.

Crop research and development achievements in the period under review were across a wide range of grains, vegetables, deciduous fruit, grapes, as well as tropical and subtropical fruits. Appreciable outputs were also recorded under industrial crops research and development, including cultivar evaluation trials on cotton as a fibre crop. Specific achievements include evaluation of cultivars and crops to determine the yield potential under certain farming environments/conditions on various farms across South Africa.

The ARC surpassed set targets on cultivar evaluations, field trials and technical reports under Outcome 1. Furthermore, the ARC awaits feedback from the regulator on registration of Plant Breeders' Rights for 10 cultivars of a variety of crops including wheat, potatoes, sweet potato, and hemp.

At the time of publication of this report, there were only two Plant Breeders' Rights approvals that had been received from the regulator for two fruit cultivars. In this regard, the ARC Crop Breeding Programmes remain committed to deliver crop cultivar development through genetic improvement and modification.

Some of the reasons the over-achievement of targets occurs, as a result of the ARC receiving more cultivars to be entered into national cultivar evaluation trials. A case in point is the National Cultivar Evaluation Programme (NCEP) for wheat that received more cultivars for independent evaluation by the ARC. The significance of this programme is that the planting of evaluated cultivars or crops by farmers is informed by the ARC's production guidelines to ensure increased production and productivity.

In the case of the wheat NCEP, publication of the Wheat Production Guidelines for the 2021 Cropping Season was finalised during Q4 of the financial period under review. This publication provides information on all production aspects of small grains in South Africa, and it is updated annually with cultivar information that empowers small grain producers to make informed production decisions for respective production seasons.

With this knowledge available, small grains producers can maximise profitability by making correct cultivar choices by looking at agronomic characteristics, disease resistance, physiological tolerance, as well as pest resistance that can contribute to lowering input costs and management of risks.

These Guidelines are also a useful tool for resource poor or emerging farmers when training is performed. The Guidelines are available in English and Afrikaans. There are two Guidelines for the summer and winter rainfall regions, respectively, that highlight the different cultivars and production practices for specific regions. All Guidelines can be accessed online from the ARC website. This high level performance overview illustrates that the ARC uses research and development outputs to disseminate solutions, processes and technologies to enhance the agriculture value chain and to support inclusive market-oriented development for smallholder farmers, agri-businesses and enterprises in the agriculture value chain.

Prioritisation of women, youth and persons with disabilities in the delivery of increased agricultural production and productivity:

The participation of women, youth and persons with disability remains a challenge in commercial livestock agriculture, especially in the stud breeding sector. The ARC through the KyD Scheme works closely with livestock farmer organisations to enhance the commercialisation of smallholder livestock farmers in order to ensure inclusivity with special emphasis on the designated groups, women, youth and persons with disabilities.

The ARC collaborates with provinces through provincial departments of agriculture on the Agronomic Seed Programme, including Training of Youth in Agriculture for Seeds Programme. This enables collaborating provinces to produce own certified seeds and supply smallholder farmers and vulnerable households with an objective to make seeds available for food security, and to assist in the development of black farmers and entrepreneurs, including women and young people who participate meaningfully in the seed industry value chain. The seed programme has potential to make agriculture fashionable for young people, as it encourages the youth to link farming with entrepreneurship and business.

Strategy to overcome areas of under performance:

The ARC will implement an aggressive marketing drive to enhance participation of livestock farmers in the animal improvement schemes.

The ARC offers producers a one-stop technology service to meet production requirements across the value chain, and this unique value proposition will continue to be enhanced as a leverage to overcome under performance. All services provided by the ARC are critical to support agricultural transformation programmes, including land reform decision making tools. The Marketing and Communication Strategy of the ARC is therefore an important vehicle for increased visibility of services offerings among clients and stakeholders. Campuses also conduct stakeholder outreach programmes by hosting annual open-day events, including online promotion of their services. The ARC continues to broaden collaboration networks locally, in the Southern African sub-region and internationally. All these interventions contribute to key drivers of the ARC Vision 2050 and the ARC Financial Sustainability and Turnaround Plan.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome1	91 736	79 854	11 882	83 627	84 143	(516)
Total	91 736	79 854	11 882	83 627	84 143	(516)

3.2. OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES

The focus of Outcome 2 is to generate knowledge and technologies (intellectual property and tools) that will conserve natural resources and sustain agriculture.

The Outcome focuses on improving the productivity, competitiveness and sustainability of both commercial and smallholder based agriculture through research and technology in areas related to efficient energy utilisation, water management and irrigation practices; the rehabilitation, utilisation, development and protection of natural agricultural resources; new and improved conservation and climate smart agriculture systems; improved monitoring and characterisation systems for natural resources and genetic material; and mechanised farming and irrigation practices, techniques, equipment and machinery.

Outcome 2 is the focus of the following ARC Divisions:

- ◊ Crop Sciences; and
- ◊ Research and Innovation Systems.

Outcomes, Outputs, Output Indicators, Targets and Actual Achievement

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES

KEY OUTPUT	PERFORMANCE INDICATOR	AUDITED ACTUAL PERFORMANCE 2019/2019 *	AUDITED ACTUAL PERFORMANCE 2019/2020 *	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Natural Resource Management	Number of technical reports.	71	73	89	86	(3)	Fewer reports generated for ARC clients.
	Number of field trials.	61	52	59	76	17	More field trials due to favourable weather conditions.
	Number of services rendered.	166	105	117	436	239	Higher demand for ARC services.
Soil Science	Number of samples analysed for soil health.	416	481	628	157	(471)	Lower demand for ARC services.
	Number of scientific solutions.	0	0	0	0	0	-
	Number of technical reports.	28	17	29	62	33	More reports generated for ARC clients.
	Number of services rendered.	0	0	356	488	132	Higher demand for ARC services.
Weed Science	Number of biocontrol agent species.	0	0	0	0	0	-
	Number of technical reports	0	0	12	7	(5)	Lower demand from clients.
	Number of services rendered.	12	10	10	13	3	Higher demand for ARC services.
	Number of bio pesticide solutions.	0	0	0	0	0	-
Ecosystem Services	Number of technical reports.	1	1	1	11	10	More reports generated for ARC clients.
	Number of scientific solutions.	0	0	0	0	0	-
	Number of services rendered.	0	0	2	7	5	Higher demand for ARC services.

Indicators form part of the previous Strategic Plan period (2015/16 – 2019/20)

Significant achievements of targets:

This is one outcome where ARC is engaging directly with farmers who are submitting samples for testing and, in return get a test and technical report from the BTP core facility. There has been an increase in the number of farmers requesting this service. This support is given to the sector and contributes to ensuring soil health and sustainable natural resources in agriculture. However, in the year of reporting, travel restrictions during the first phases of the pandemic limited the number of services requested and as such the annual target was not met.

A range of research and development outputs delivered by the ARC includes natural resources management, soil science and weed science. These services are largely rendered on a demand driven basis to address production risks facing the agriculture sector. Common risks include (i) new and emerging pests and diseases, and (ii) climate change; and invariably, demand for services would skew in the direction of production risks that require most urgent attention.

A key highlight in this regard is the collaborative project between the ARC, the Department of Agriculture, Land Reform and Rural Development and Food and Agriculture Organisation (FAO) of the United Nations on the monitoring, surveillance, reporting and management activities on the Fall Armyworm (FAW) *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) through Farmer Field Schools (FFS) in South Africa.

The ARC delivered an upscaled research and technology-transfer training intervention on various aspects of FAW. These interventions resulted in increased awareness about FAW through workshops, media interactions and the development of technology transfer products. Specifically, two sites that were selected for the upscaling of the FAW activities through Farmer Field Schools were chosen due to their close proximity to the borders of South Africa because FAW is a known transboundary pest and is now well established throughout the maize growing areas of all Southern African Development Community (SADC) member countries.

The two sites were selected in two different FAW hotspot areas within smallholder farming communities. The one site is in Mpumalanga province, in the Nkomazi district (Magogeni Village) very close to the border with eSwatini. The land on this site is under the jurisdiction of the local chief. The second site is in Limpopo Province, near the town of Thohoyandou in Mianzwi within the Tshiombo irrigation scheme in Vhembe District, and it is on land that belongs to the provincial Department of Agriculture.

The new knowledge gained by beneficiaries and participants of Farmer Field Schools, as well as the future lead-role of these trainees within their communities is essential to help produce better crops and improved food and nutrition security, as well as local livelihoods. It is also important that the trainees share their newly-gained crop production and protection knowledge for future application. Indeed, the ARC is well positioned to continue partnering with DALRRD, provincial Departments of Agriculture and the FAO to upscale FAW awareness activities in South Africa, as well as other crop protection collaborations for sustainable ecosystems and natural resources management.

Prioritisation of women, youth and persons with disabilities:

Community based projects represent some of the best vehicles to reach significant numbers of women and youth in service delivery. The FAW Farmer Field School project reached a large number of women and youth in Limpopo and Mpumalanga provincial sites where the project was implemented. Follow-up projects that are in the pipeline aim to reach more women and youth in different communities; and intend to also introduce green energy solutions with regards to how community irrigation systems are run. This approach introduced communities to alternative, sustainable energy and also reduces dependency on high long-term costs such as diesel and generators to irrigate household crops. Overall, the youth, women and the ARC team that implemented the Farmer Field School project learnt much from each other and this knowledge is invaluable to projects that support household food security.

Strategy to overcome areas of under performance:

More stakeholder (farmers and industry) engagements to bring awareness about the need to work to ensure soil health and sustainable natural resources. Extensive marketing of services offered to promote soil health.

Furthermore, sector risks present opportunities from a perspective of solutionist thinking through research services, and this is how the ARC markets its services to clients. There is also increasing innovation on enhancing digitisation of service solutions for clients.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome 2	**267225**	**229 127**	**16 787**	**220 800**	**242 124**	**(21 325)**
Total	**267225**	**229 127**	**16 787**	**220 800**	**242 124**	**(21 325)**

3.3. OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS

The focus of Outcome 3 is to generate knowledge, solutions and technologies for food safety, quality and improve efficiencies in the agriculture value chain, with particular focus on agro-processing, pre- and post-harvest processing biotechnology and informatics, each cross-cutting across different areas of the agricultural value chain and intended to be applied to the full value chain of crops, animals and agricultural system research.

Outcome 3 is the focus of the following ARC Divisions:

- ◊ ARC-Crop Sciences Divisions; and
- ◊ Research and Innovation Systems Divisions.

Key Performance Indicators, Planned Targets and Actual Achievements

OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFOR-MANCE 2018/2019 *	AUDITED ACTUAL PERFOR-MANCE 2019/2020 *	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVE-MENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT FOR 2020/21	REASON FOR DEVIATIONS
Broadening the food base	Number of cultivars registered.	50	61	61	0	(61)	Registration of cultivars beyond control of ARC.
	Number of field trials.	12	2	5	5	0	-
	Number of technical reports.	162	125	112	131	19	More reports generated for ARC clients.
	Number of cultivar evaluations.	0	0	4	105	101	Higher demand for culti-var evaluations by ARC.
	Number of new products devel-oped.	0	0	1	1	0	-
	Number of services rendered.	0	0	16	16	0	-
Post-harvest handling and agro-pro-cessing	Number of cultivars developed with improved shelf life.	0	1	6	0	(6)	Registration of cultivars beyond control of ARC.
	Number of new post-harvest solutions developed.	4	4	2	2	0	-
	Number of solutions for con-trolled atmosphere.	0	0	1	1	0	-
	Number of products registered under Act 36.	0	0	0	0	0	-
	Number of services rendered.	0	0	15	59	44	Higher demand for ARC services.

Indicators form part of the previous Strategic Plan period (2015/16 -2019/20)

Significant achievements of targets:

This relates predominantly to work done through research contract with DALRRD to characterise indigenous goat and chicken populations and develop genomic tools to support and mainstream them as sources of household and national food security. Most projects in this outcome are based in communities and, because participation was not possible due to travel restriction, this resulted in the annual target not being met.

Niche crop research and development activities undertaken in Outcome 3 include indigenous food crops and ornamental plants, medicinal plants, African leafy vegetables and roots and tubers, herbal teas, as well as aromatic plants. This research area enables the development of niche products among high value crops and value chains through post-harvesting handling and agro-processing technologies; as well as broadening the food base for enhanced nutrition security. Broad output areas include cultivar development and evaluation, field trials conducted and technical reports produced and released to clients as a means of disseminating advisory services.

The ARC targeted to register four sweet potato cultivars as an output to broaden the food base, and these were submitted to the regulator, even though no approval for Plant Breeders' Rights has been granted to date. Clearly this is outside of the control of the ARC. There was also a plan to register six cultivars developed for improved shelf-life, and again no feedback was received from the regulator at the end of the financial period under review. The ARC planned to deliver 61 cultivar evaluations in this area of research and surpassed that target by delivering 105 cultivar evaluation. Other areas of services including technical reports and field trials were attained or surpassed.

Prioritisation of women, youth and persons with disabilities:

The projects work with smallholder livestock communities and as such included a diverse set of farmers participating in the programmes including women and youth.

The ARC has been instrumental in the establishment of the Sweet Potato Vine Association of South Africa, as part of the effort to supply disease-free vines to smallholder farmers without charging royalty fees, in order to combat Vitamin A deficiency among vulnerable communities. It is generally accepted that Vitamin A deficiency is a public health challenge in South Africa. Most vulnerable households, including those headed by women and youth have benefited from this intervention by the ARC. There is also a very robust sweet potato enterprise development initiative that the ARC delivered in collaboration with provincial departments of agriculture. With regards to post harvest and agro-processing technologies, the ARC Commercial Wine Cellar has been positioned as a hub for the development and support of young wine makers, thus contributing to the transformation of the wine industry.

Strategy to overcome areas of under performance:

To increase research programmes on under-utilised crops and animals and in order to achieve that, considerable funding is required to broaden the scope of the projects. The ARC is making an effort to secure funding for under-utilised crops and animals which will contribute to broadening the food base.

The negative impact of COVID-19 was most profound on service delivery during the first and second quarters of the financial period under review. However, even though the constraints on service delivery eased somewhat during the Q3 and Q4, the challenges have not completely disappeared, and the ARC is collaborating closely with industry partners and farmers to determine the most sustainable solutions to mitigate negative impacts on performance. Partnerships and improved stakeholder engagement has been identified as a key strategy in this regard.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome 3	38 315	33 345	4 973	34 938	35 159	(221)
Total	38 315	33 345	4 973	34 938	35 159	(221)

3.4. OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR

The focus of Outcome 4 is to provide strategies, analysis and information to develop and grow a competitive, productive and diverse agricultural sector, and provide a support service to identify and develop the commercial potential of agricultural research and development, so as to address smallholder and commercial farmer constraints.

Agricultural excellence depends on the organisation's skilled human resources and this is important for establishing sustainable growth in the South African agricultural economy. In order for the ARC to achieve this, specialist and postgraduate training of students and staff is crucial and underpins the diagnostic and research activities of the ARC. This knowledge enhancement ensures that the ARC has a critical mass of scientists to contribute to the continuity of the research and development agenda of the organisation.

The Outcome further focuses on the implementation of initiatives to address smallholder farmer constraints in terms of access to resources (technology, information, etc.). This includes the packaging, exploitation and licencing of ARC research and development outcomes to enhance the capacity and skills of farmers, extension personnel, processors and enterprises through facilitating the utilisation of ARC intellectual property.

The ARC is dedicated to providing unparalleled personalised, practical education and training for the farming sector in addition to conveying management solutions to assist the wide spectrum of veterinary and associated professions.

This will ensure that the ARC is better placed to disseminate and transfer the knowledge generated to farmers and extension agents for a sustainable agricultural sector and a food secure South Africa. The dissemination of the generated knowledge through scientific and other popular publications are a key output of the ARC, and will ensure an informed society, thereby enhancing the visibility of the organisation.

Outcome 4 is the focus of the following ARC Divisions:

- ◊ Crop Sciences;
- ◊ Animal Sciences;
- ◊ Research and Innovation Systems;
- ◊ Impact and Partnerships; and
- ◊ Human Resources and Legal Services.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR							
OUTPUT	**OUTPUT INDICATOR**	**AUDITED ACTUAL PERFORMANCE 2018/2019 ***	**AUDITED ACTUAL PERFORMANCE 2019/2020 ***	**PLANNED ANNUAL TARGET 2020/21**	**ACTUAL ACHIEVEMENT 2020/21**	**DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT FOR 2020/21**	**REASON FOR DEVIATIONS**
Skills development	Number of people trained.	712	525	417	1 808	1 391	Higher demand for training by ARC.
	Number of Postgraduate students supported by ARC.	42	30	38	44	6	More students completed their degrees than anticipated.
Technology Transfer	Number of technologies/ IP registered/developed.	6	6	9	2	(7)	Delays in registration beyond the control of ARC.
	Number of scientific solutions disseminated.	0	0	0	0	0	-
	Number of enterprises supported.	0	0	4	6	2	Higher demand from industry.
	Number of technologies transferred under license.	0	0	30	12	(18)	Lower demand for ARC technologies.
Smallholder farmer supported	Number of farmers trained.	1 023	792	700	851	151	Higher demand for farmer training by ARC.
	Number of technical assessments for commercial readiness.	0	0	20	25	5	Higher demand for technical assessments.
	Number of smallholder farmers participating in KyD.	1 726	3 000	3 500	4 834	1 334	Increase manpower resulted in more participation.
	Number of services rendered.	110	125	132	191	59	Higher demand for ARC services.
	Number of farmer field days	0	0	2	5	3	-
Farmer Support	Number of farm assessments.	0	0	53	0	(53)	Lower demand from farmers.
	Number of farmers supported.	2 096	380	211	311	100	Higher demand from farmers.
	Number of farmer field days.	30	28	37	26	(11)	Lower demand from farmers.
	Number of services rendered.	8	5	20	379	359	Higher demand for ARC services.
Knowledge generated and dissemination	Number of scientific publications.	265	227	237	446	209	Manuscripts were accepted earlier than anticipated.
	Number of popular publications.	175	171	203	317	114	More publishing houses extended an opportunity for ARC researchers to publish their work.
	Number of public awareness events.	0	0	169	96	(73)	Fewer opportunities than expected.

Indicators form part of the previous Strategic Plan period (2015/16 -2019/20)

Significant achievements of targets:

The ARC exceeded its annual targets for skills development, smallholder farmer support and knowledge generated and disseminated. Postgraduate students supported, and the number of people trained by the ARC, provided the much-needed skills for the sector. The new skills developed, are essential for successful implementation of the economic recovery plan in the agricultural sector. More smallholder livestock farmers were supported through the KyD Scheme than anticipated even though the financial support for KyD was not optimal. The support provided enhanced market access, thereby stimulating the rural economies as most of the farmers supported, are based in the most rural parts of the country.

Key outputs delivered by the ARC included skills development or number of people trained, technology transfer, smallholder farmers supported and general farmer support, as well as knowledge generation and dissemination. The ARC performed exceptionally well in the number of people trained, especially in the latter part of the financial year. Clearly slow uptake of training programmes at the beginning of the financial period of 2020/21 was due to the on-set of COVID-19, which compelled research teams to develop new ways of offering training services under the new normal.

The ARC is also pleased to report on 10 PhD and 10 post-graduate degrees awarded to students supported by the ARC. The ARC PDP is one of the most successful programmes of the ARC that develops skills for the agriculture sector in South Africa. Another area of outstanding performance is knowledge generation and dissemination in the form of peer-reviewed scientific publications, as well as popular publications in industry media outlets and public awareness events.

Prioritisation of women, youth and persons with disabilities:

The ARC prioritises women, youth and persons with disabilities in its smallholder development scheme known as Kaonafatso ya Dikgomo (KyD). Women constituted 24.4% of KyD participants in 2020/21 while youth constituted 6%. The proportion of women ranged from 17.8% in Mpumalanga to 31% in the Eastern Cape while Limpopo had the lowest proportion of youth (3.6%) and North-West had the highest (9.7%). The ARC has not been disaggregating demographic data for persons with disabilities in the past but has started a process to capture this dimension on the database system known as INTERGIS to reflect the demographic make-up of the recipients of our services under KyD.

The ARC is very deliberate in targeting women and youth in the delivery of a skilled and capable agriculture sector. All training initiatives such as the selection and training of crop estimate surveyors, and training of smallholder farmers and other variety of training interventions prioritise women and youth.

Strategy to overcome areas of under performance:

While the ARC has made some inroads towards active participation of women, youth and persons with disability, this remains an area of improvement as the support of these designated groups is far less than their demographic representation in the population. The ARC will be working closely with livestock farmer associations and other relevant stakeholders to enhance support for women, youth and persons with disabilities in its smallholder farmer development programme. The adjustment to virtual training is one aspect that will be adopted and implemented alongside physical training even when the lockdown regulations are relaxed. The ARC also aims to increase the number of popular publications as a way to effectively communicate research findings to the general population.

More and more training services are being configured for online delivery as a matter of necessity and strategy to mitigate impacts of COVID-19 on performance targets.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome 4	245 146	265 583	22 183	258 917	280 461	(21 544)
Total	245 146	265 583	22 183	258 917	280 461	(21 544)

3.5. OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE

The focus of Outcome 5 is to enhance the resilience of the agriculture sector to factors such as climate change. The weather variability and climate change have a direct impact on food security, especially in semi-arid and arid countries.

The Outcome focuses on climate monitoring for agriculture and the effective maintenance of an operational national agro-climate weather station network for effective provision of weather and climate related services.

In addition, infectious animal disease agents including bacteria, viruses and parasites, evolve in response to pressures that include immunologic and antimicrobial agents. We provide effective and efficient diagnostic and analytical services and a wide range of applied research and consultancy services on livestock diseases at local, provincial, national and regional levels. The ARC world-class veterinary research focuses on the development and improvement of diagnostic and analytical services and applying the latest biological techniques. The development of vaccines to improve the health of the national herd through the prevention of key important diseases for the region, is vital.

Outcome 5 is the focus of the following ARC Divisions:

- ◊ Crop Sciences;
- ◊ Animal Sciences; and
- ◊ Research and Innovation Systems.

Key Performance Indicators, Planned Targets and Actual Achievements

OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19 *	AUDITED ACTUAL PERFORMANCE 2019/20 *	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Climate Resilient Solutions	Number of climate resilient solutions adopted.	3	3	3	3	0	-
	Number of drought tolerant cultivars.	0	0	3	0	(3)	Registration of cultivars beyond control of ARC.
	Number of services rendered.	0	0	5	6	1	Higher demand for ARC services.
	Number of technical reports.	14	9	10	31	21	More reports generated for ARC clients.
	Number of field trials.	0	0	105	105	0	-
	Number of tools for measuring climate change.	0	0	401	433	32	Higher demand for climate change tools.

OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19 *	AUDITED ACTUAL PERFORMANCE 2019/20 *	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Vaccine Production	Number of blood vaccine doses produced.	186 555	241 215	235 200	198 052	(37 148)	Lower demand for ARC vaccine doses.
	Number of different types of vaccines developed.	0	0	4	0	(4)	The delay in procurement of mid-scale production equipment have impacted on the development and production of Foot-and-mouth Disease (FMD) vaccines.
	Number of FMD vaccine doses produced.	0	50 000	50 000	0	(50 000)	The delay in procurement of mid-scale production equipment have impacted on the development and production of FMD vaccines.
	Number of vaccine clinical trials.	0	0	2	0	(2)	A trial to assess the effective duration of protection of the commercial Onderstepoort Biological Products (OBP). Lumpy Skin Disease (LSD) vaccine was cancelled by the funder due to COVID-19.
Laboratory Services	Number of tests performed for animal health.	17 255	12 416	215 350	16 781	(198 569)	Lower demand for ARC services.
	Number of tests performed for food and feed.	3 632	3 000	2 006	3 293	1 287	Higher demand for ARC services.
	Number of services rendered.	0	0	0	139	139	Higher demand for ARC services.
	Number of tools developed for diagnostic/analytical services.	0	0	0	0	o	-
	Number of technical reports.	0	0	5	13	8	More reports generated for ARC clients.

Indicators form part of the previous Strategic Plan period (2015/16-2019/20)

Significant achievements of targets:

The ARC exceeded the annual targets for tests performed for food and feed analysis. These services allowed business continuity for food and feed companies despite the pandemic as most of these companies operate in the agricultural space and are classified as essential services. Without these services, most of these companies would not have been able to operate which would have negatively impacted the food and feed industry with direct consequences for the sector.

Blood vaccine production targets were met, whereas FMD vaccines trials were delayed due of prolonged regulatory permit procedures. However, other aspects of the FMD vaccine factory progressed according to plan.

The ARC met its annual target for tests performed for food and feed. These included tests requiring next generation sequencing of food borne pathogens and anti-microbial resistance profiles in food items. These tests demonstrate the capabilities of using advanced technologies in routine testing of samples as was advocated by the WHO.

The ARC struggled to meet the target for tests for animal health. However, there has been an increase in the request for sequence-based tests in animal health, which as in food and feed are comprehensive with an advantage of having the capacity to investigate novel disease pathogens and outbreaks as well as mutations emanating from re-emerging diseases.

Climate resilient solutions that were successfully delivered by the ARC to the agriculture sector include promoting adoption of conservation agriculture among grain farmers in provinces like the North West, Gauteng and Mpumalanga. Advisory services were also delivered in the form of technical reports, which surpassed the set target by a large margin. Field trials were also successfully conducted on target. However, the ARC did not receive feedback from the regulator regarding cultivar registration of drought tolerant varieties submitted for registration of Plant Breeders' Rights.

The main reason for variance is that the distinctness, uniformity and stability (DUS) tests are still being conducted by the regulator on four new varieties of drought tolerant maize, following delays caused by monkey damage on field trials conducted by the regulator. The ARC also received great interest from clients seeking laboratory services within this area of focus, and this presented a fresh opportunity for new business within the portfolio of plant health and protection.

Prioritisation of women, youth and persons with disabilities:

The ARC works actively with livestock farmer associations and other relevant stakeholders to enhance support of women, youth and persons with disabilities especially in its smallholder farmer development programme.

Women farmers and young farmers are not sparred from the devastating impacts of climate change on the agriculture sector. These groups of farmers have particularly benefited from the ARC's drought tolerant varieties. Specific attention is also given to the participation of women and youth in establishment of seed companies that produce and distribute drought tolerant varieties.

Strategy to overcome areas of under performance:

The ARC will increase its stakeholder engagements to bring awareness about new and comprehensive sequence-based tests that the ARC offers. The ARC will also intensify its engagement with marketing to more aggressively market its services.

This is an area of great interest and focus among beneficiaries and stakeholders in the agriculture sector, and in many instances it is an area of excellent performance output. The ARC is therefore working closely with the regulator to find solutions that will address challenges of damage to field trials for testing of distinctiveness, uniformity and stability of for varieties submitted for Plant Breeders' Rights registration.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome 5	452 703	394 661	36 732	384 251	403 997	(19 746)
Total	452 703	394 661	36 732	384 251	403 997	(19 746)

3.6. OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

Outcome 6 is the platform for delivery against the ARC mission and the realisation of the ARC impact. The focus of Outcome 6 is to ensure:

1. Addressing the current working capital gap and financial position through the implementation of a targeted and robust Sustainability and Turnaround Plan; and
2. Ensuring excellence in scientific research and development through enhanced capacity, capabilities and appropriate organisational technology and infrastructure.

The Outcome focuses on improving organisational effectiveness and efficiency towards a sustainable ARC. It includes promoting public accountability, achieving high standards of corporate governance and efficient resource utilisation, strengthened revenue generation and productivity, and good stakeholder engagement to ensure optimal organisational performance, visibility and service delivery.

Outcome 6 is delivered by the Corporate Support Divisions of the ARC, namely:

- ◊ Office of the CEO;
- ◊ Human Resources and Legal Services;
- ◊ Impact and Partnerships;
- ◊ Finance; and
- ◊ ICT and Infrastructure.

OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19	AUDITED ACTUAL PERFORMANCE 2019/20	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Infrastructure Management	Number of business cases developed for implementation of assets management plan.	5	4	3	1	(2)	COVID-19 restricted a lot of engagements with external stakeholders for the finalisation of business cases.
	Increase in Rand value of rental income.	14.5 %	3%	3%	3.48%	0.48%	Active engagement to increase rental income.
ICT Strategy Implementation	Number of information and processes digitised.	Not measured	3	3	5	2	Digital transformation gave these favourable results.
	ICT Master Plan approved.	Not measured	Not measured	Approved Plan	Approved Plan	-	-
	Number of initiatives implemented towards the development of a Knowledge Management (KM) Platform.	3	3	3	10	7	There is need for more workspaces as employees wants to collaborate and share documents electronically.
	Number of 4IR integration technologies developed.	Not measured	Not measured	1	2	1	-
Human Resources Management	Vacancy rate.	Not measured	Not measured	5.77%	9.72%	(3.95%)	Recruitment process was slow due to the current financial situation, the ARC focussed on only filling prioritised positions.
	Support employees as percentage of total staff.	Not measured	Not measured	20.60%	22.70%	(2.1%)	Recruitment process was slow due to the current financial situation.
	Percentage increase of Employment Equity ratio in the designated groups in core business, in respect of: - Women at Senior Management level. - People with Disabilities Employed.	Not measured Not measured	Not measured Not measured	46% 1.55%	46% 0.57%	0 0.98%	- Recruitment process was slow due to the current financial situation.
International Partnerships	Number of new international partnerships.	Not measured	Not measured	2	2	0	-
Exhibitions and Sponsorships	Number of exhibitions, sponsorships.	Not measured	Not measured	30	0	(30)	COVID-19 regulations prohibited exhibitions.

OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19	AUDITED ACTUAL PERFORMANCE 2019/20	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Performance Management	Improve the leadership dimensions of 360 degree results of Management, Senior and Executive Management.	Not measured	Not measured	3.5%	3.42%	0.08%	Assessment took place at 3 levels (Executive, Senior Management and GG13).
	Alignment of organisational values.	Not measured	Not measured	100%	93.51%	(6.49%)	Assessment was conducted on ARC newly reviewed values.
	Improve culture of performance within ARC.	Not measured	Not measured	Culture Survey	Culture survey completed	-	-
Human Resource Development	Number of employees appointed with Masters degrees.	9	20	20	8	(12)	Recruitment process was slow due to the current financial situation.
	Number of employees appointed with Doctoral degrees.	12	10	10	9	(1)	Recruitment process was slow due to the current financial situation.
	Number of employees with Masters degrees.	219	268	268	199	(69)	Reduced number of employees obtaining Masters degrees & staff turnover.
	Number of employees with Doctoral degrees.	250	240	240	232	(8)	Reduced number of employees obtaining Doctoral degrees and staff turnover.
	Percentage staff turnover.	2.65%	3.50%	3.50%	3.32%	0.18%	-
	Total spend on PDP stipend and registration.	R15.7mil	R21.1mil	R21.1mil	R8.85mil	12.25	Saving due to external funding sourced and secured.
	Training spend as a % of salary bill.	1.57%	2%	2%	0.4%	1.6	Less training opportunities due to COVID-19 regulations.
Commercialisation of ARC Solutions	Establishment of an ARC commercialisation entity.	Not measured	Not measured	Entity Approval	Not approved	-	Entity was approved by ARC Council only. The process of appointing the service provider for the strategy is ongoing. Ministerial approval has not been obtained for the entity.

OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION

OUTPUT	OUTPUT INDICATOR	AUDITED ACTUAL PERFORMANCE 2018/19	AUDITED ACTUAL PERFORMANCE 2019/20	PLANNED ANNUAL TARGET 2020/21	ACTUAL ACHIEVEMENT 2020/21	DEVIATION FROM PLANNED TARGET TO ACTUAL ACHIEVEMENT 2020/21	REASON FOR DEVIATIONS
Governance	Audit opinion.	Not measured	Not measured	Unqualified audit	To be contained in the Finance Report.		
Funding and Revenue Generation	Zero Deficit.	Not measured	Not measured	Zero deficit			
	B-BBEE rating.	Level 8	Level 6	Level 6	Level 8	(2)	The ARC has over years struggled to attain a decent score on two areas namely Supplier Development Programme and Enterprise Development. Assessment on these two codes is not feasible as the ARC is a public entity and not in a position to sponsor or assist suppliers financially.
	External income as % of total revenue.	Not measured	Not measured	30%	To be contained in the Finance Report.		
	Development of a process that will outline growth through partnership.	Not measured	Not measured	Process Developed			
	Rand value of royalty income.	R33mil	R17mil	R20mil			
Cost efficiencies	Reduction in fixed cost.	Not measured	Not measured	5%			
	Personnel costs as % of Operational PG.	Not measured	Not measured	80%			

Significant achievements of targets:

The ARC implemented a number of projects that aim to assist the organisation to achieve its mandate. These include amongst others the following:

- ***Digital Signature*** - to increase efficiency, the ARC introduced the SigningHub solution to allow employees to sign or approve documents securely from anywhere and anytime. The introduction of SigningHub reduced the approval process by approximately 80%.

- ***R&D applications for farmers*** - the ICT team developed various applications to support farmers. These applications includes, Dairy Dash Board Mobile App, PLAS Toolkit, Maize Information Guide (MIG), and Cactus Pear Application (Cacti-Grow), to name but a few.

- ***Collaboration*** - to minimise the negative impact of COVID-19 on productivity, the ARC-ICT team implemented Microsoft Teams to provide effective communication, collaboration, and meetings solution to enable employees to continue performing their duties from home.

Prioritisation of women, youth and persons with disabilities:

Rigorous transformation in the public sector demands continued long-term commitment on creating a human capital pool through investing in people, employment equity and skills development, especially the prioritisation of women, people with disabilities and youth. The ARC will endeavour to achieve the following:

- **Prioritisation: Women**

Broaden its search criteria in reaching critical mass to attract women, people with disabilities and youth in its recruitment drive. We are currently prioritising designated group when conducting our recruitment processes.

- **Prioritisation: Youth**

Increase more youth intake in the internships, Professional Development Programmes and other programmes thereby building a pool to draw from when filling roles in ARC, where possible.

- **Prioritisation: People with Disability**

The ARC will continuously improve its environment to be friendlier to people with disabilities and to partner with organisations that can assist in the development of industry specific learnerships and programmes suitable for people with disabilities, thereby increasing a pool of fully trained PWD's that can be absorbed. Additionally, in reference to our HR Operational Plan and as indicated in our Talent Acquisition Plan, HR will partner with line management to identify available, suitable positions and facilities for people with disabilities at ARC to help in mapping the labour market to define the nature and availability of people with disabilities required at ARC. The recruitment office has engaged with some disability organisations such as Disability People S.A (DPSA), Albinism S.A and some Educational Institutions with the aim of determining the nature and availability of people with disabilities.

Strategy to overcome areas of under performance:

The ARC under-performed on the number of the business cases developed to support the implementation of asset management strategy. The key reason the ARC under-performed was mainly due to COVID-19. To overcome this challenge, stakeholder engagements will be virtual. It is however important to note that this target is based on the solicited requests and not necessarily ARC going out on tender, nor aggressive marketing.

Linking Performance with Budgets

OUTCOME	2020/2021*			2019/2020		
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)
Outcome 6	**320 192**	**215 035**	**105 156**	**304 001**	**240 406**	**63 595**
Total	**320 192**	**215 035**	**105 156**	**304 001**	**240 406**	**63 595**

Beef Cattle, Brahman Bull

ARC-ANIMAL PRODUCTION

The ARC-Animal Production (ARC-AP) Campus conducts research and development in many areas of animal production at its Irene research site and several satellite stations strategically located in different agro-ecological regions distributed nation-wide. The aim of the Campus is to develop and transfer new technologies and agricultural knowledge in order to ensure sustainable livestock production in the era of climate change and other emerging threats such as pandemics. The Campus' work covers the entire value chain from primary production to tertiary agriculture. Animal Production research is organised along the following disciplines: Animal Nutrition; Germplasm Conservation and Reproductive Biotechnology; Animal Breeding and Genetics; Meat Science and Technology; Range and Forage Sciences; and Quantitative and Qualitative Analysis.

In addition to research and development, the Campus manages the National Animal Recording and Improvement Schemes (e.g. Beef, Dairy, Smallstock and Kaonafatso Ya Dikgomo (KyD), and the National Animal Database, INTERGIS) on behalf of the Department of Agriculture, Land Reform and Rural Development (DALRRD). ARC-AP is also a custodian of herds and flocks of adapted indigenous livestock, the national forage genebank and animal biobank as well as national culture collection of beneficial gastrointestinal and food fermenting organisms. These national public good assets are key for future scientific discoveries and agricultural solutions for the livestock sector and the bio-economy. The work of the Campus is aligned with the following outcomes of the ARC:

- OUTCOME 1: Increased agricultural production and productivity;
- OUTCOME 4: A skilled and capable agriculture sector; and
- OUTCOME 5: Enhanced resilience of agriculture.

The Animal Production Campus has made significant progress with regard to the delivery of the mandate of the ARC in the year under consideration despite the challenges relating to the COVID-19 pandemic. This annual report presents highlights of the key achievements of the Animal Production Campus that contributed towards addressing food security as well as the triple challenges facing South Africa, inequality, poverty and unemployment. The highlights are presented in accordance with Outcomes of the ARC.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

ARC NATIONAL BEEF PERFORMERS AWARDS HOSTED VIRTUALLY ON 26 NOVEMBER 2020

The National Beef Improvement and Kaonafatso Ya Dikgomo (KyD) Schemes hosted a very successful virtual 2020 ARC National Beef Performers Awards on 26 November 2020 at 18:00 in partnership with Plaas Media. This event acknowledges and recognises commercial and smallholder livestock farmers who have excelled in their quest to manage their enterprises and breed animals that will ensure sustainable and profitable operations.

The ARC President and CEO, Dr Shadrack Moephuli, delivered the welcoming address while Mr Joel Mamabolo, Director: Animal Production from DALRRD gave the keynote address.

More than 60 farmers entered the competition and the farmers received awards in the following eight Award categories:

- The ARC National Best Elite Cow Awards Winners sponsored by Farmer's Weekly;
- The ARC National Platinum Bull Awards Winners sponsored by GMP Basic;
- The ARC National KyD Province of the Year Award Winners sponsored by Molatek;
- The ARC National Emerging Beef Farmer of the Year Award;
- The ARC National Mentor of the Year Award Winner sponsored by Molatek;
- The ARC National Special Performance Test Class Winners;
- The ARC National Beef Cattle Improvement Herd of the Year Award; and
- The ARC National Commercial Beef Producer of the Year sponsored by Molatek.

A representation of commercial livestock agriculture.

The virtual event enabled the local and international livestock industries to view the event free of charge. This provided a unique platform for marketing and exposure for the ARC, Awards, sponsors and broader industry stakeholders. The event was viewed by more than 1 200 delegates.

A representation of smallholder livestock agriculture.

THE 2020 ARC VIRTUAL NATIONAL MASTER DAIRYMAN AWARDS

The ARC's National Milk Recording and Improvement Scheme has been the main driving force for dairy cattle recording and improvement in South Africa for 100 years and will continue to fulfil this function into the future. The overarching objective of the Improvement Scheme is to enhance the sustainability and profitability of production, ultimately contributing to food security, job creation and human capital development.

The purpose of the Master Dairyman competition is to acknowledge South Africa's most outstanding achievers in breeding genetically superior animals, using performance recording and performance testing as tools. Recognition was given to superior commercial and small scale herds and awards were allocated to winners of the specific categories.

This year's ARC Annual National Master Dairyman Awards ceremony was presented virtually on Wednesday the 21st October 2020 in partnership with the Agri-Expo.

The ceremony was opened by Dr Shadrack Moephuli, ARC President and CEO. In his keynote address, he stressed the importance of continued investment in R&D to ensure development of technologically advanced animal improvement tools for efficient selection and breeding in an era of increased agricultural risks.

Award	Recipient	Province
2020 ARC National Master Dairyman	PE Loubser (Johannes Loubser)	Durbanville, Western Cape
2020 ARC National Small-scale Dairyman	MJ Zim (the late Jan Zim)	Harrismith/Kestell, Free State
2020 ARC Special Award for innovative development by a Dairy Producer	Fort Hare Dairy Trust	Fort Beaufort, Eastern Cape
2020 ARC National Herd with the Best Somatic Cell Count	E Zeeman (Etienne Zeeman)	Swellendam, Western Cape
2020 ARC National Herd with the Best Inter Calving Period	Tweekop Boerdery (Pieter Steenkamp and Dirk van Papendorp)	Swellendam, Western Cape

Dr Andrew Magadlela, ARC Group Executive: Animal Sciences, in his vote of thanks, acknowledged all the strategic partners of the event, the DALRRD, Nova Feeds, Meadow Feeds, Afgri Feeds, Allflex, Warwick Estate, OK Foods, Darling Creamery and Vredenheim Wines.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR-KNOWLEDGE GENERATED AND DISSEMINATED.

DETERMINATION OF SLAUGHTER CONDITIONS TO OPTIMISE CHEVON VISUAL AND EATING QUALITY

Although goats were among the first farm animals to be domesticated, research and development investments to improve goat productivity do not match their potential importance in providing skins, meat and milk especially in future harsh climate conditions.

A group of typical indigenous veld goats.

Despite its potential, goat production remains generally informal with no formal value chains in comparison to other livestock species, e.g. sheep, cattle and pigs. Many misperceptions exist around goats and their meat products. Nonetheless, chevon has long been touted as healthy meat because of its low carcass fat content, which generally has a fatty acid profile deemed healthy.

However, little effort has been placed into promotion of chevon production in South Africa despite their popularity in certain communities and a greater demand in those communities. This study aimed to describe and compare carcass characteristics of same-aged young wethers and bucks of Boer Goat (BG) and large frame Indigenous Veld Goats (IVG). Weaner male BG (BG; n = 36; 21 bucks and 15 wethers) and large frame IVG (IVG; n = 41; 21 bucks and 20 wethers) were raised on hay and natural grass *ad libitum* and the recommended amount of commercial pelleted diet to a live weight between 30 and 35kg.

Carcass quality characteristics (live weight, carcass weights, dressing percentage, chilling loss and eye muscle area) were measured. The right sides of the carcasses were divided into wholesale cuts and dissected into subcutaneous fat, meat and bone.

Large frame IVG wethers were slightly lighter than the IVG bucks with no significant difference observed with BG bucks. Wethers compared to bucks had higher dressing percentage, subcutaneous fat percentage in all primal cuts, intramuscular fat percentage, kidney fat percentage and, overall, slightly less bone percentage.

Some breed-wether interactions were noticed: IVG wethers were slightly lighter than the IVG bucks, but the IVG bucks tended to produce higher percentage meat compared to other test groups. Judged on the intramuscular fat percentage characteristics, it seems as if wethers should produce juicier and more flavoursome meat compared to bucks.

The carcass quality studies showed that under the same production conditions, IVG could have a similar potential for meat production as BG. Carcass characteristics differed more between wethers and bucks than between breed types. Large frame IVG bucks seemed particularly suited for meat production, due to higher meat yield that is leaner with lower subcutaneous and intramuscular fat, compared to the BG bucks and, in particular, to the wethers of both breed types.

The wethers meat with increased subcutaneous and intramuscular fat could satisfy another consumer market segment that prefers a somewhat juicier and flavoursome meat - these aspects warrant further research.

Development of the formal commercial market for goat meat would offer more diversity of species for red meat producers and especially benefit smallholder farmers who typically produce most of the goats in the world.

The left side of a goat carcass subdivided into retail cuts.

MEGA-HERBIVORE RESPONSE TO DROUGHTS UNDER DIFFERENT MANAGEMENT REGIMES: LESSONS FROM A LARGE AFRICAN SAVANNA

Droughts are predicted to increase in frequency and intensity for large parts of Africa. It is unclear how this may impact native grazers in protected areas, and how these outcomes may differ under contrasting management approaches. Reducing artificial water sources and increasing the size of protected areas have been proposed as management responses that could possibly increase system resilience and buffer herbivores against large-scale mortality during droughts.

Long-term spatially explicit buffalo, elephant and hippo census data from the Kruger National Park and adjacent private protected areas during three droughts (1982/1983, 1991/1992 and 2015/2016) provided a unique opportunity to explore how a range of management actions influenced mega-herbivore responses across six regions.

Drought responses varied significantly at a regional scale for all three mega-herbivores, supporting the notion that size, and the associated emergent property of spatio-temporal heterogeneity, provides a buffer during droughts.

Furthermore, regional buffalo population declines (as a function of mortality, movement and birth rates) were highest in areas with high waterhole density and concomitant low levels of herbaceous biomass, compared with areas that experienced similar rainfall, but had lower waterhole density and higher herbaceous biomass.

Elephant mortalities were negligible, but elephants displayed regional movement patterns, seemingly attracted to higher water provision densities during the drought. Our results highlight that drought interacts with spatio-temporal environmental gradients and management actions and illustrates how the Greater Kruger National Park is increasingly functioning as an integrated ecosystem for mega-herbivores.

Degraded rangeland at Kruger National Park.

Aerial survey at Kruger National Park.

GENETIC DIVERSITY AND POPULATION STRUCTURE OF THREE NATIVE CATTLE POPULATIONS IN MOZAMBIQUE

This project was executed as part of ARC's regional collaboration with neighbouring countries. The main objective was to assess the genetic constitution of indigenous cattle breeds in Mozambique. This is directly relevant for programmes of conservation, restocking or utilisation of animal genetic resources. Characterisation of animal genetic resources is necessary for the proper assessment of the value of farm animal genetic resources in order to guide decision making processes in livestock development and breeding programmes.

A major strategic priority area addressed by the project was enhancing the sustainable use, development and conservation of animal genetic resources throughout the Southern African Development Community (SADC) region. This can contribute significantly towards achieving regional development goals such as eradication of extreme poverty and hunger as well as ensuring environmental sustainability.

Outcomes of the project include providing support to the SADC food security programmes, as well as empowering farmers across the SADC region to become more competitive. The knowledge generated through the project will contribute towards the development of effective plans for sustainable use and conservation of the region's animal genetic resources.

Indigenous cattle in Mozambique are an important genetic resource due to their adaptive traits, their capability to convert low-quality pasture into an animal protein of high biological value, and their resistance to a variety of endemic subtropical diseases. Cattle production in Mozambique is mostly communal, resulting in random mating and indiscriminate crossbreeding. This poses a threat to indigenous populations as it results in the erosion of unique genetic resources.

An important prerequisite for the formulation and implementation of a comprehensive conservation programme is knowledge of the population genetic structure of the available livestock in a given country. Therefore, the study aimed to evaluate the population structure and diversity of three Mozambican indigenous cattle populations.

A herd of Landim cattle at Chobela Research Station, Mozambique.

The results revealed moderate genetic variability and limited genetic differentiation among Mozambican indigenous cattle, but also indicated some genetic erosion, probably due to indiscriminate crossbreeding between the populations. Although poorly differentiated, Mozambican indigenous cattle retain their genetic identity that could be exploited for further genetic improvement of especially adaptive traits, to face the future challenges of climate change.

To maintain the high genetic diversity in Mozambican indigenous cattle, comprehensive conservation programmes are needed. These could include the development of structured breeding schemes that incorporate the *in-situ* conservation centres that are already available in the country (e.g. Chobela, Angonia, and Impaputo breeding Stations).

GROWTH AND MEAT QUALITY OF BROILER CHICKENS FED *MORINGA OLEIFERA* LEAF MEAL, A PROBIOTIC AND AN ORGANIC ACID

Antibiotic growth promoters (AGP) have been used in the poultry industry, having several benefits that include increasing prime cuts yield and decreasing the deposition of intramuscular fat, resulting in lean cuts that satisfy the demands of modern consumers.

On the other hand, the same consumers are rejecting the use of synthetic chemicals because of their association with human and animal health risks. Scientific evidence revealed that antibiotic-resistant pathogenic bacteria could be directly transmitted to humans by their use of retail meat and egg products, thus posing a major threat to human public health.

Although the European Union (EU) totally banned the use of AGP in broiler chicken production in 2006, several other countries including South Africa continue to use AGP in poultry diets as in-feed additives. Large-scale poultry producers make efforts to alleviate the effect of AGP by feeding an AGP-free "withdrawal" diet five to seven days before chickens are slaughtered. This is done to enable the withdrawal of AGP residues from the chickens' muscle tissue.

Due to the increasing concern over AGP use in poultry nutrition, avenues for the use of natural phytogenic feed additives were opened. Several alternative products such as probiotics and organic acids are currently in use; however, there is no report on any product that has been efficient in replicating the relatively consistent and vigorous effects of AGP.

Experimental chickens in poultry house.

Moringa oleifera Lam (Moringa) is a highly valued nutritious plant distributed in various climatic zones and countries. Moringa has been commercialised in South Africa as nutritional and health supplement for humans.

Recently, several studies have been conducted to assess its potential benefits as an additive for animals, in particular poultry. Plants such as Moringa are perceived as safe and environmentally friendly, thereby satisfying consumer demands for healthier value-added meats.

With recent consumers growing health consciousness, the inclusion of *Moringa oleifera* leaf meal (MOLM) as a feed additive in poultry diets can be a promising solution to addressing public health concerns regarding the safety and quality of meat. Broiler producers can improve broiler-feeding strategies through utilisation of available feed additive resources.

Grounded *Moringa oleifera* leaves.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

SMALLHOLDER FARMER SUPPORTED

The ARC continues to make significant strides in supporting smallholder livestock farmers to actively participate in the mainstream agri-value chains through the KyD Animal Improvement Scheme. More than 4800 farmers received scientific support from the KyD scheme during the 2020/2021 financial year. This is quite an achievement given that these services were provided during the pandemic.

The Scheme hosted a number of livestock auctions to create market access opportunities to smallholder farmers in partnership with communal livestock association and the provincial departments of agriculture.

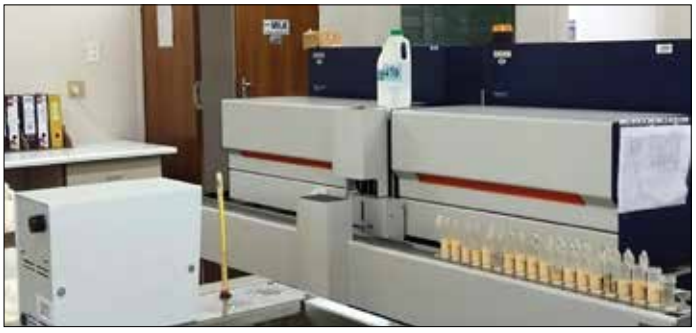
Even under constrained conditions caused by the pandemic, KyD farmers managed to execute some of their commercial activities. After a successful livestock auction in 2019 in Kwafuduka, outside Vryheid in KwaZulu-Natal, KyD held a record-breaking auction involving 121 farmers on 29 May 2020. The 121 farmers comprising 45% women sold 295 head of cattle to the tune of R2.3 million.

Animals ready for the sale at Kwafuduka during the auction on the 29 May 2020.

OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE.

LABORATORY SERVICES

The ARC Analytical Services Laboratories for food and feed analysis continue to work closely with the South African National Accreditation System (SANAS) as part of compliance to ensure accurate and credible test results to the clients. The Elsenburg Laboratory received SANAS approval for new Technical Signatories.



Infrared laboratory - CombiFoss instrument - samples in process.

Microbiology laboratory: research technician performing sample analysis.

JOURNAL ARTICLES

Adegoke, A.A., Madu, C.E., **Aiyegoro, O.A.**, Stenström, T.S., & Okoh, A.I. 2020. Antibiogram and beta-lactamase genes among cefotaxime resistant *E. coli* from wastewater treatment plant. *Antimicrobial Resistance and Infection Control* (2020) 9:46 https://doi.org/10.1186/s13756-020-0702-4.

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THESES AND DISSERTATIONS

Masters

Kgari, R.D. 2020. Genetic analysis of heifer and cow fertility for South African hoisteins using artificial insemination records. Master of Science in Agriculture (Animal Science), University of Stellenbosch.

Maake, M.E. 2021. Population genetic structure and admixture analysis of Small holder Dairy cattle herds in South Africa using SNP markers. Masters of Science (Agriculture), University of Limpopo.

Masondo, P.R. 2020. Exploring the nutritive value of ten woody species and improving intake of *Euclea crispa* by Nguni goats ina semi-arid savanna. Masters of Science (Agriculture), Tshwane University of Technology.

Ramoroka, M.P. 2020. Evaluation of non-genetic factors affecting birth weight of Kalahari Red goats in South Africa. Supervisors: Prof CB Banga & Dr O Tada. Master of Science (Animal Production), University of Limpopo.

Ratshivhombela, P.M. 2021. Estimation of genetic and phenotypic parameters for stillbirth in South African Holstein cattle. Masters of Science (Animal Production) , University of Limpopo.

Tlablela, M.N. 2020. Heterogeneity of variance for milk production traits between the low and high input dairy production systems of South Africa. Supervisors: Prof CB Banga, Dr B Dube & Dr O Tada. Master of Science (Animal Production) University of Limpopo.

Doctoral

Abin, S.A.M. 2020. A deterministic evaluation of alternative management options for the smallholder dairy cattle production system in South Africa. Doctor of Philosophy (Animal Science),University of Pretoria.

Mani, S. 2020. Effects of Lactic Acid Bacteria fed as putative probiotics and host genetic profile on rumen microbial ecology of two sheep breeds in South Africa Doctor of Philosophy (Genetics), University of KwaZulu-Natal.

Mdyogolo, S. 2021. Detection of selection signatures and genes associated with fitness in South African Afrikaner and Brahman cattle. Doctor of Philosophy (Animal Science), University of the Free State.

Mndela, M. 2020. The assessment of the extent and effects of bush encroachment and its control on forage production, herbaceous vegetation composition and soil properties. Doctor of Philosophy (Pasture Science), University of Pretoria.

Moshidi, P.M. 2020. Potential of extracts from *Vangueria infausta, Peltophorum africanum* and *Eucalyptus globulus* to modulate ruminal microbes, and their effects on fermentation and productivity in dairy cows. Doctor of Philosophy in Agriculture (Animal Science), University of Fort Hare.

Muller, F. 2021. Native legume species from the northern Cape province of South Africa and their potential use as forage crops. Doctor of Philosophy (Plant eco-physiology), University of Western Cape.

CHAPTERS IN BOOKS

Jonker, A., Chagunda, M.G.G., **Grobler, M.**, Waghornd, G.C., & van Wyngaarde, J.D. 2020. Hand held laser methane detector to determine methane plume concentrations from ruminants. In: Guidelines for estimating methane emissions from individual ruminants using: GreenFeed, 'sniffers', hand-held laser detector and portable accumulation chambers, Publisher: Ministry for Primary Industries (New Zealand Agricultural Greenhouse Gas Research Centre); pg. 41–47. December 2020.

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Transboundary Animal Diseases facility, healing FMD tongue lesion

ARC-ONDERSTEPOORT VETERINARY RESEARCH

The ARC-Onderstepoort Veterinary Research (ARC-OVR) plays an important role in maintaining the health of our national herd and wildlife. It focuses on executing veterinary research to improve existing vaccines, diagnostic products and to develop new ones; diagnostic services for enhanced disease prevention, control and surveillance (which plays a significant role in maintaining the required animal health status and facilitating trade in animals and animal products in South Africa and beyond) and producing foot and mouth disease and blood vaccines. It provides scientific support for the National and Provincial Veterinary Services in effective risk management for quality of life for all in South Africa. It strives to be a world-class veterinary research institute in providing scientific support. Research activities focus on the development and improvement of vaccines and diagnostic tests, applying the latest molecular biological techniques.

The ARC-OVR promotes animal health and welfare by providing an effective and efficient diagnostic service and producing vaccines against foot-and-mouth and tick-borne diseases. ARC-OVR is the collaborating centre for both the Office International des Epizooties (OIE) surveillance and control of animal diseases in Africa and the Food and Agriculture Organisation (FAO) of the United Nations for the emergency preparedness for transboundary animal diseases for Africa. It hosts seven OIE reference laboratories for economically important viral diseases namely: African Horse Sickness, Bluetongue, Foot-and-Mouth Disease, Lumpy Skin Disease, Rift Valley Fever, Rabies and African Swine Fever. Through its diagnostic and research activities the ARC-OVR plays a key role in the One Health space.

Research programmes at the ARC-OVR include Epidemiology Vectors and Parasites (EPV), Vaccines and Diagnostics Development (VDD), Public Health and Zoonoses (PHZ), Vaccine Production (VP) and Diagnostics Services (DS).

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

THE EPIDEMIOLOGY, PARASITES AND VECTORS (EPV) DIVISION

The division was severely affected with regard to diagnostic service delivery due to the negative impact of COVID-19 lockdowns that prohibited clients from travel and trading. However, the division managed to publish 22 scientific papers in international journals that showcased the diversity of work performed in the division.

This included a study on the vaccine efficacy of the attenuated heartwater vaccine that is currently in the registration process in collaboration with OBP that showed that the vaccine is safe and effective in cattle, goats and sheep. It included three papers on the epidemiology of Corridor disease, an important controlled disease in South Africa with one paper published in Genomics (impact factor 6.2) that details a method to sequence whole genomes of this parasite which will enable larger scale population studies on genomic level.

The incidental finding of A*rmillifer armillatus*, a parasite of snakes, in a leopard highlights the importance of necropsies in expanding our knowledge of wildlife diseases and the role that helminths play in host morbidity and mortality.

Ticks are important vectors of various parasitic diseases of domestic life stock and wildlife, including Corridor disease, theileriosis and heartwater. Accurate and sensitive diagnostics and effective vaccines enable effective control of ticks and tick-borne diseases.

It also included 11 papers published on ticks that include systematics and transcriptomics and highlights the important role that tick taxonomy and the National Collection for Ticks (Gertrud Theiler Tick Museum) play in research aimed towards control of ticks and tick-borne diseases. The National Collection of Animal Helminths contributed four papers that show how helminths impact on the wildlife, host ecology and the interactive and complex networks that parasites and their hosts have.

The National Collection of Insects of Veterinary Importance published three papers that detail important work on tsetse flies, (specifically male sterile technique that may be in future used to control the tsetse population and Nagana) as well as work performed on *Culicoides* midges, the vectors of African horse sickness, that assessed blood volume as potential indicator of infection risk as well as the confounding effects that symbionts may have on *Culicoides* systematics (a very important implication for mitochondrial based systematics).

ARC ROLE DURING THE GLOBAL PANDEMIC

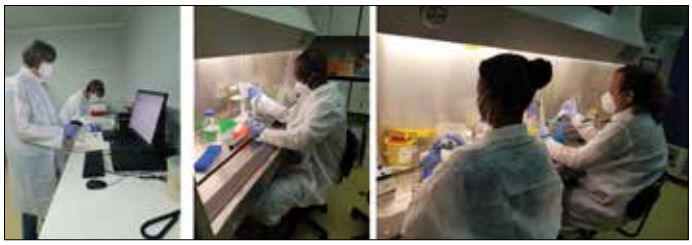
The COVID-19 pandemic has put considerable pressure on public health services across the globe and highlighted the need for a One Health approach to dealing with the pandemic. Veterinary services in many countries were called upon to go beyond collaborative research and contribute in various ways towards building a common response to the pandemic.

Veterinary laboratories supported diagnostic testing by using their experience and expertise in high throughput testing capacity of infectious diseases to aid in surveillance screening, and the testing of human samples as the need for a diagnostic laboratory to be able to provide accurate and timely diagnostic results is imperative for disease control. Veterinary laboratories are well known for their capacity to handle large sample numbers during outbreaks.

In South Africa, in early 2020 the pandemic resulted in the National Health Laboratory Services (NHLS) becoming overwhelmed with samples due to the high demand and global reagent shortage. The NHLS thus took the decision to outsource some of the diagnostic services required to laboratories with adequate capacity and knowledge in managing large sample numbers in outbreak situations.

The ARC was recognised as having the capabilities to assist the NHLS during this pandemic through a collaboration between the ARC-OVR and the ARC-Biotechnology Platform (ARC-BTP). Over 30 staff members from both ARC-OVR and ARC-BTP volunteered to assist with the testing of COVID-19 samples. The workflow was divided between the two campuses with ARC-OVR trained personnel being responsible for sample receipt, sample preparation, PCR assays as well as the analysis of the results and the reporting back to the NHLS.

A few of the volunteers from ARC.



Volunteers from ARC receiving and preparing samples for extraction.

Sample extraction and PCR setup was performed with the aid of trained staff and liquid handlers at ARC.

Members of the ARC volunteer team.

Volunteers from ARC preparing the liquid handler for extraction of samples.

The ARC was able to assist the NHLS by testing up to 3500 samples a week. The NHLS utilised the capacity at the ARC during both the first (mid 2020) and the second wave (late 2020 - early 2021) of COVID-19 in South Africa. To date the ARC has assisted the NHLS in testing over 5000 samples. The unprecedented nature of this pandemic has developed a fruitful collaboration between the NHLS (as a public health service provider) and the ARC-OVR (as a veterinary centre of excellence) in South Africa and has shown the power of a One Health collaboration.

DEVELOPMENT OF NOVEL PLANT-DERIVED PREVENTATIVE AND THERAPEUTIC MEDICINES FOR COVID-19 IN SOUTH AFRICA

The ongoing disruptive and destructive effects of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing coronavirus-19 (COVID-19) disease on human life and the global healthcare system coupled with socioeconomic well-being is hard to quantify. Currently, there are no targeted therapeutics for the effective treatment of the virus causing the disease, SARS-CoV-2.

A screening programme to identify new or existing drugs that have the potential to inhibit SARS-CoV-2 replication will contribute to the current knowledge base of antiviral therapeutics. Researchers from ARC received a support grant to identify plant extracts from the ARC's extensive collection of selected plant species.

The ARC has experience in plant cultivation technology, phytochemistry, eukaryotic cell culture and virological techniques necessary to perform these drug-screening assays. Research findings on the therapeutic potential of medicinal plants have illustrated and amplified the need for more studies on the efficacy and safety of indigenous therapies used in treating different diseases.

Three medicinal plant species were identified based on available uses and previous research results and in discussion with stakeholders and project members. The plant materials were cultivated, collected, dried and various extracts prepared. During the next step, the plant extracts were fractionated and fingerprinted using electrospray ionisation mass spectrometre. The obtained mass spectral indicated numerous mass-to-charge ratio of different compounds specific to each plant extracts.

Toxicity testing is a vital component of biological activity screening programmes to exclude the possibility that general toxic effects may result in false positive bioactivity effects or potential hazardous effects.

Both cytotoxicity and genotoxicity assays will be used to detect potential toxic effects of plant extracts with high antiviral activity. We will perform a virus inhibition assay using SARS-CoV-2 and an appropriate mammalian cell culture in partnership with our collaborators at the National Institute for Communicable Diseases (NICD). Potential antiviral extracts will be tested in a small animal model.

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

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THESES AND DISSERTATIONS

Masters

Malesa, R.P. 2020. Evaluation of strategies to determine an African Swine Fever virus full genome. Masters of Technology (Veterinary Technology), Tshwane University of Technology.

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CHAPTERS IN BOOKS

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Tissue culture propagation

ARC-BIOTECHNOLOGY PLATFORM

Located on the ARC-OVR Campus, the Biotechnology Platform (ARC-BTP) was established in 2010 as a major strategic priority of the ARC. The mandate of the ARC-BTP is to create high-throughput resources and technologies required for applications in genomics, metagenomic- or next generation sequencing based diagnostic applications, quantitative genetics, genomics assisted selection and breeding, plant phenomics and bioinformatics to support participants in the agricultural sector, i.e. from smallholder and commercial producers, to seed companies, food processing facilities and universities working in associated fields.

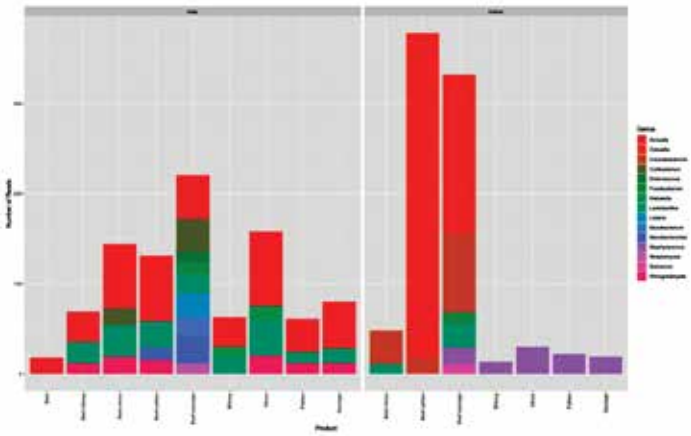
The ARC-BTP established itself as both a research and service driven institution, providing an environment in which highly skilled researchers and postgraduate students can be hosted and trained. The technologies established within the platform are accessible as services to the ARC, higher education institutions, private companies, science councils and researchers across the continent.

USING METAGENOMIC APPROACHES TO PROFILE MICROBIAL COMMUNITIES OF MEAT AND MEAT PRODUCTS: AN EXPLORATORY ANALYSIS OF THE PRODUCT QUALITY AND SAFETY AT SELECTED ENTERPRISES IN SOUTH AFRICA

Consumption of food that is contaminated by microorganisms, chemicals, and toxins may lead to significant morbidity and mortality, which has negative socio-economic and public health implications. Monitoring and surveillance of microbial diversity along the food value chain is a key component for hazard identification and evaluation of potential pathogen risks from farm to the consumer.

The ARC has developed next generation sequence-based pipelines to determine the microbial diversity in meat and meat products across meat value chains. The method complements culture based methods having sequencing and computational methods able to reconstruct individual genomes from the respective samples The metagenomics methods revealed the presence of diverse bacteria, viruses, and fungi some of which are difficult to identify by traditional culture techniques.

The analyses provide evidence of diverse and highly variable microbial communities in products of animal origin, which is important for food safety, food labelling, biosecurity, and shelf life limiting spoilage by microorganisms.



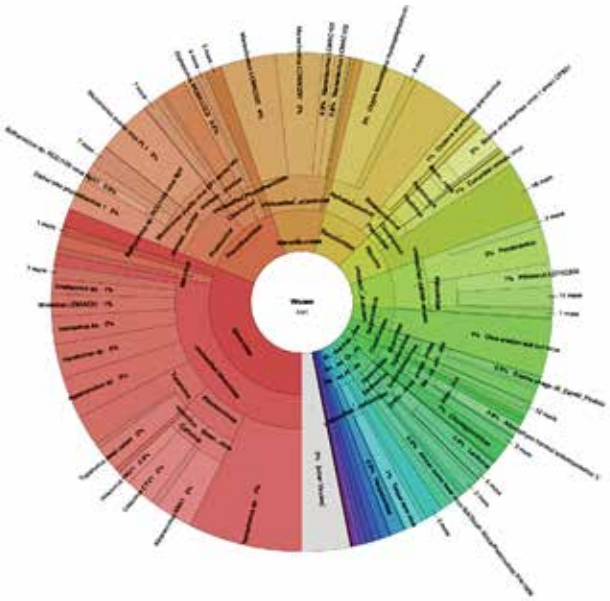
Different microbial genera identified from various meat and meat products.

NEXT GENERATION SEQUENCING REVEALS PAST AND CURRENT WIDESPREAD OCCURRENCE OF MAIZE YELLOW MOSAIC VIRUS IN SOUTH AFRICA

Maize yellow mosaic virus (MaYMV) is a single-stranded RNA polerovirus first identified in China. MaYMV was recently reported from West and East Africa, however it had not yet been reported from southern Africa.

RNA-seq data from South African field-grown fungal-infected maize was mined for viral sequences by *de novo* assembly of reads that did not map to the maize or fungal genomes. Predicted proteins from the *de novo*-assembled unmapped reads matched MaYMV proteins with regions of 96-100 % identity. MaYMV was detected in maize RNAseq data from 2009, 2012 and 2013. Complete South African MaYMV genome sequences (5642 nt) were determined by RT-PCR and Sanger sequencing of samples from two different maize genotypes in KZN. Phylogenetic analysis confirmed the species identity as MaYMV, and showed separate clustering of isolates between Africa, Asia and South America. Some MaYMV positive samples had reads matching Potyviridae (Johnson grass mosaic virus and Sugarcane mosaic virus), and mycoviruses (*Setosphaeria turcica* hypovirus 1, *Bipolaris maydis* partitivirus 1, and *Pleospora typhicola* fusarivirus 1).

A 2016/2017 RT-PCR survey of maize plants exhibiting virus-like symptoms, such as yellowing and streaking patterns, revealed MaYMV in 39 samples from six provinces in South Africa. This report documents the earliest known MaYMV infection world-wide, and indicates that the virus is widespread throughout Africa.



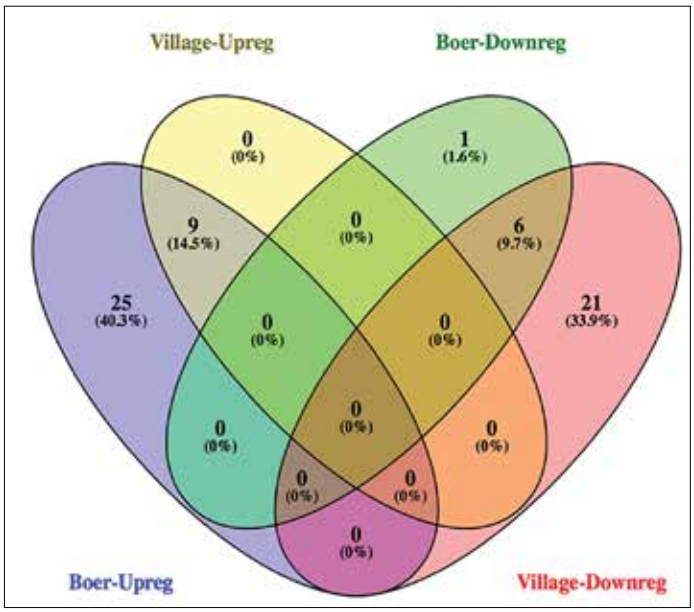
Global representation of all identified viruses in the analysed maize samples.

CAPACITY BUILDING FOR SMALLHOLDER AND COMMERCIAL FARMERS

The ARC-BTP initiated community programmes bring scientific and technological advances of genomics to resource-poor smallholder and commercial farmers. Community-based breeding programmes have been designed for smallholder farmers to directly benefit from research efforts on livestock improvement. In addition, the ARC has leveraged these community based projects to train postgraduate students (MSc's and Ph.D's) in advanced technologies such as genomics and bioinformatics and their applications to uplift smallholder agriculture.

A study by Dr Ncube (PhD studies) investigated growth performance profiles of indigenous goats from Pella village, North West and compared them to Boer, Northern Cape Skilder, Nguni (iMbuzi) and Xhosa lobbed goats. This study highlights the genetic merits and management as key to improved growth performance in rural goat production.

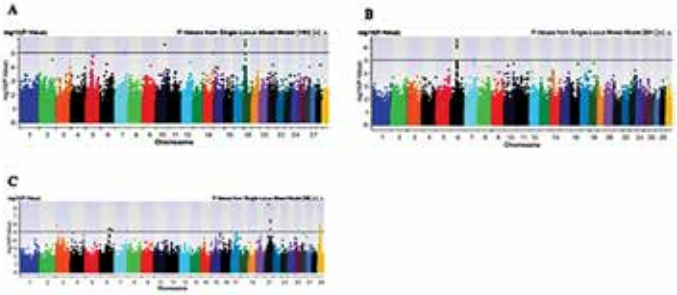
Smallholder goat farmers focus group discussions on ecotype standards.



Venn diagram indicating genes up and downregulated in Boer goats and Village goats respectively.

In another study, Ms Kunene (MSc) employed the Illumina Bovine 777KSNP panel to unravel genes associated with coat colour and variations in Nguni cattle from Bartlow Combine and Kokstadt research stations in KwaZulu-Natal. Genome Wide Association Study (GWAS) for base coat colours (black, brown and red) revealed a significant association with the MC1R gene which plays a crucial role in the MAPK signaling pathway and the overall melanogenesis pathway. The phenotype for coloursidedness and the white forehead stripe was significantly associated with five genes (MAPK10, EFNA5, PPP2R3C and PAK1) and are involved in the synthesis of melanin while TECRL has been reported to be associated with pigmentation patterns in Fleckvieh cattle.

Nguni coat colour phenotypes.



Manhattan plot showing chromosomal regions associated with
(A) base coat colour (eumelanin vs pheomelanin);
(B) colour-sidedness (colour-sided vs non-colour-sided); and
(C) white forehead stripe in Nguni cattle.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Hlongwane, N.L., Hadebe, K., Soma, P., Dzomba, E.F., & **Muchadeyi, F.C.**, 2020. Genome Wide Assessment of Genetic Variation and Population Distinctiveness of the Pig Family in South Africa. *Frontier Genetics,* DOI:10.3389/fgene.2020.00344,11:344.

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Muchadeyi, F. C., Ibeagha-Awemu, E. M., Sölkner, J., Javaremi, A. N., Reynoso, G.A.G., Mwacharo, J.M., Rothschild, M.F., eds. 2020. Why Livestock Genomics for Developing Countries offers Opportunities for Success. *Lausanne: Frontiers Media SA.* DOI: 10.3389/978-2-88963-944-1.

Wetlands

ARC-NATURAL RESOURCES AND ENGINEERING

Natural Resources and Engineering (ARC-NRE) is a newly created division comprising the Soil, Climate and Water (ARC-SCW) and Agricultural Engineering (ARC-AE) Campuses. It has the responsibility for areas of research and innovation that are crosscutting over the whole ARC, and can provide advanced research and technologies that are applicable across the full range of crops and animal systems. It creates opportunities for new interactions, approaches to training and development, and the application of a wide range of new technologies within the full value chain of different commodities. In addition, it provides a basis for the growth and development of a new generation of research staff suited to future needs of the ARC. It also provides a culture of continuous skills development based on a large postgraduate programme and a strong collaborative culture.

The ARC-NRE division follows a holistic approach towards natural resources utilisation and conservation. It promotes and collaborates in multi-institutional, cross-sectoral, bilateral and multi-lateral research teams. Its strength lies in the ability to provide innovative solutions to clients with respect to sustainable land use, conservation of the natural resources and environmental quality.

The division develops and applies agricultural engineering technologies that contribute to higher yields, increased income and lower input costs for agriculture and related industries in a sustainable way. It also develops and increases the efficient and sustainable utilisation of natural resources and human capacity in the field of agricultural engineering technology.

OUTCOME 5: ENHANCED RESILIENCE OF AGRICULTURE.

INTEGRATION AND UPSCALING OF MAIZE/BEANS CROPPING SYSTEMS TO IMPROVE THE FOOD AND NUTRITIONAL SECURITY OF SMALLHOLDER FARMERS

The low agricultural productivity of South African smallholder farmers is a serious concern to the government and other development agencies. This low productivity is due to poor soil fertility, degraded soils, inadequate access to extension services, inputs and climate information, as well as a lack of knowledge and awareness on sustainable agricultural production.

The low agricultural productivity is further worsened by climate risks such as rising air temperatures, high rainfall variability and droughts that are expected to increase due to predicted climate change. It triggers food and nutritional insecurities among most smallholder farmers who are primarily dependent on rainfed agricultural production for their livelihoods and have limited adaptation capacity.

Sustainable agricultural production is one of the key approaches towards increasing productivity, reducing the carbon footprint and improving the climate resilience of smallholder farmers through efficient use of available resources.

The InnovAfrica project funded by the EU's H2020 Research and Innovation Programme aimed to test and upscale the best sustainable agricultural practices through innovation platforms and improved dissemination strategies across six African countries (Ethiopia, Kenya, Malawi, Rwanda, South Africa and Tanzania). The goal of the project was to improve the food and nutritional security of smallholder farmers in Africa.

Farmer-led trials were established in five villages of Maluti-a-Phofung municipality in the Free State province. These trials aimed to demonstrate, validate and upscale the best sustainable agricultural practices along with improved seed varieties of maize-beans for improved food and nutrition security.

The results of the trials done in South Africa showed that sustainable agricultural intensification practices involving maize-legume rotations and intercrops, including conservation agriculture, increased crop yields and built climate-resilient farming communities while at the same time reducing adverse environmental impacts. Multi-Actor Platforms and participatory farmer engagements improved the dissemination of sustainable agricultural intensification practices.

Sustainable agricultural production is a vehicle through which national food and nutrition security, as well as the rural development goals, can be achieved in South Africa under expected weather-related risks attributed to climate change. However, the promotion of sustainable agricultural practices should be supported by development and government insitutions through conducive policies.

Left: Farmers were trained on different sustainable agricultural practices as well as good farm management practices. Right: Farmer-led experiments were supported by Multi-Actor Platforms consisting of different key stakeholders for wider adoption of the project's results and the dissemination of outputs.

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES.

MAPPING SMALLHOLDER MAIZE FARMS USING REMOTE SENSING TECHNIQUES

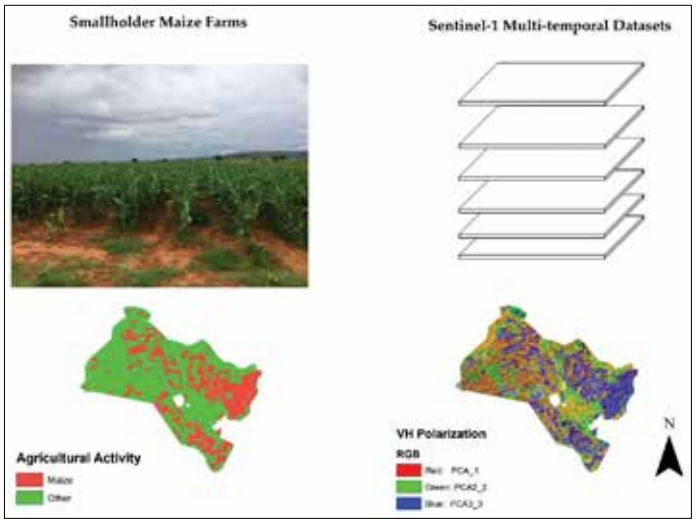
Smallholder farms, particularly maize farms, play a crucial role in village communities, which rely on these farms for subsistence. However, erratic climate variability and lack of substantial rainfall in recent times threatens food security for millions of South Africans. Local governments lack spatial agricultural information that is critical in combating food security in rural communities. Such information includes accurate production area estimates for different crops and their yield estimates.

This information is necessary for planning purposes and informing government policies. However, smallholder farms are notoriously difficult to identify using coarse spatial resolution satellite imagery mainly due to their small sizes (≤2 ha) and inter-cropping practices. These factors contribute towards pixel mixing, i.e. a spectral signature that observed by the satellite sensor and it contains reflections from different features or crop types. As a result, it is very difficult to differentiate these crops.

The current project focused on using multi-temporal Synthetic Aperture Radar remote sensing data at 10 m spatial resolution and applying the Principal Components Analysis Technique to enhance the spectral response of smallholder maize farms. Machine-learning algorithms were applied to the data to accurately classify land cover features including the maize crop. The results showed that smallholder maize farms can accurately be mapped using 10m spatial resolution satellite images with an accuracy of more than 90%.

The methodologies developed can potentially be applied to map other crops at large scale (provincially) to provide accurate crop production areas. Local governments can use the information to plan and provide necessary assistance to smallholder farmers.

Example of a smallholder maize farm in Limpopo province.



Generation of agricultural spatial information using remote sensing techniques.

CROP GROWTH MONITORING AND YIELD FORECASTING FOR WINTER WHEAT UNDER DROUGHT PRESSURE IN POLAND AND SOUTH AFRICA

Climate change impact accounts for a decline of 5.5% in wheat yields globally. The wheat yields are projected to further decline by 1.6% due to trends in temperature, precipitation and carbon dioxide. This study investigated crop growth and yield for winter wheat in two different geographically located countries; Poland and South Africa. Agriculture is assumed to be under pressure in both countries due to climate variation.

The average yield of main crops in Poland is much lower than in the majority of the west European countries. However, large areas under cultivation put Poland in third place in terms of the production of cereals. In contrast, cereal production in Africa is very low and wheat crop production accounts for less than 2% of all cereal crops grown in developing countries. South Africa and Ethiopia combined produce about 80% of the wheat crop on the continent. However, South Africa still remains a net importer of wheat.

Drought is one of the major natural disasters affecting agricultural production in both countries. Droughts occur almost every year, usually at different times of the growing season and in different locations. The impact on yield depends on the stage of crop phenology when the drought occurs.

Monthly *in situ* field data collection of soil moisture, leaf area index, plant biomass and height of winter wheat crop in Reitz, Free State province.

Monthly field spectral measurements of winter wheat crop for calibration of satellite remote sensing data analysis.

In a joint project between the Institute of Geodesy and Cartography in Poland and the ARC titled "SAPOL4Crop - SA Polish collaborative crop growth monitoring and yield assessment", crop growth conditions were investigated using Terra MODIS, Sentinel-2 and meteorological data to determine crop water requirements and timing for irrigation as well as crop yield prediction for winter wheat in both countries. The data acquired from the same period were used to set up the model for estimates of crop yield and irrigation requirements.

The MODIS database consisted of nine years of satellite imagery (between 2003 and 2019) and covered about 100 wheat crop fields. Ground observations of the winter wheat fields consisted of crop phenology and crop yield data. Air temperature data was incorporated into the crop yield model and rainfall data was used for validation. Thereafter, the model was modified for Sentinel-2 data.

The data were analysed using the accumulated eight days of Normalised Difference Vegetation Index (NDVI) and accumulated eight-day differences between land surface temperature (LST) and air temperature (TA) from meteorological data. A rapid increase in the accumulated NDVI curve occurred at lower accumulated difference between LST and TA (LST-TA), and this resulted in a higher yield value at the end of the season.

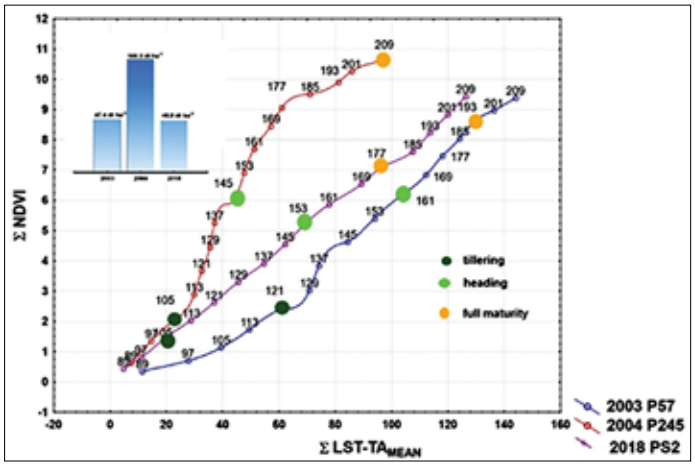
During a dry season, however, the accumulated difference between LST and TA increased enormously resulting in a lower rate of accumulated NDVI. Consequently, the crop phenology occurred at different times. In a good crop-growing season, crop heading occurred earlier at lower accumulated difference in temperature (LST-TA) than during a dry season and this had a direct effect on crop yield. Crop water demand at development stages was extracted from the analysis of crop growth conditions.

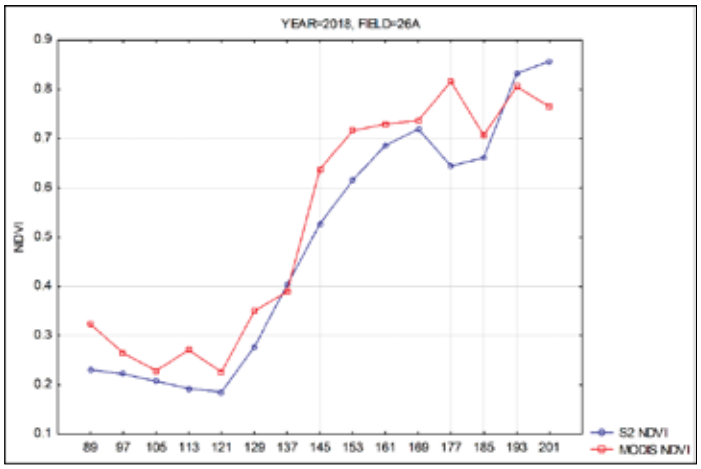
The fraction of photosynthetically active radiation (FPAR) was used to determine the different crop phenologies. The results were verified using meteorological data such as rainfall between the different crop phenologies, measured crop yield and ground truthing data.

The figure below presents the curves of three plots of winter wheat for the growing seasons in 2003 (a dry year), 2004 and 2018 in Poland (the analysis for wheat in South Africa is still in progress). On the Y-axis is the accumulated NDVI from MODIS while on the X-axis is the accumulated values of the difference of surface and air temperature (LST-TA). The numbers on the curves are Julian days.

Accumulated NDVI from the start to heading and from heading to maturity is important for the yield prognosis; the accumulated difference between surface temperature and air temperature is important for the modelling from the start to maturity.

At the end of the project, the models developed will assist with crop growth monitoring through different phenological stages and estimating crop yields before harvest. The latter can be used to determine food security in either country more easily compared to the traditional method of crop yield surveys.





Comparison of accumulated NDVI data using MODIS and Sentinel-2 imagery.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

DESIGN AND DEVELOPMENT OF AN IN-FIELD PROTOTYPE FUEL CONSUMPTION METER

Farmers and other stakeholders in the agricultural sector often enquire about information that can help them in determining the real-time fuel consumption of tractors in combination with various implements under different field operations.

Most tractor engines use diesel fuel. The total quantity of diesel supplied to a tractor engine is always more than the engine can utilise because part of the fuel flow is used for cooling the fuel system. In other words, the surplus diesel fuel returned to the fuel tank by the engine helps to bring its temperature down. In order to determine net fuel consumption, the backflow to the tank must be subtracted from the total fuel volume supplied to the engine by the fuel pump. The flow to the engine and return flow to the tank are measured separately.

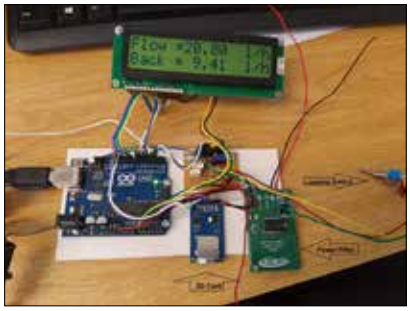
Although the fuel consumption metre that was available provided comprehensive data covering a wide range of parametres, the device was large and difficult to move from one tractor to another, especially during operation in the field.

In order to simplify the process for critical data collection, the research team developed a new fuel consumption metre prototype, which is compact, easily dismounted and easy to set up. The prototype makes use of Oval sensor to measure the fuel flow volume. The Oval sensor was selected based on experience. It is a reliable flow sensor used widely for accurate measurement of flow volume.

The basic output of the prototype is volume of fluid per pulse, where the specified volume is 0.65ml per pulse. A number of pulses are counted over a certain time interval to determine the flow rate (litres per unit time). The longer the time interval the more accurate the fuel flow volume measured. In order to achieve high accuracy at a constant pulse, the time interval should not be less than four seconds when measuring fuel consumption of a tractor in the field.

Therefore, the fuel consumption readings update every four seconds and are saved by a data logger. The data are processed automatically by a microprocessor and pre-programmed software before being downloaded after the in-field tests. The speed of the tractor is needed in determining the specific fuel consumption in litres per hectare. However, no speed measuring facility is built into the prototype at this stage. A GPS system can be used to measure the working speed of the tractor in km per hour.

The prototype fuel consumption metre developed provides a reliable, compact, easy-to-use tool for farmers, implement manufacturers and other stakeholders to measure real-time fuel consumption in order to monitor fuel efficiency and to evaluate tractor-implement performance. The potential fuel savings and reduction in mechanisation costs will help to build more sustainable agricultural production systems for agrarian transformation, food and nutrition security.



Fuel meter electronic components and assembly developed.

Researchers undertaking fuel meter calibration and measurements.

POSTHARVEST PROCESSING OF MACADAMIA NUTS: A SOLUTION FOR ISOLATED FARMERS IN THE VHEMBE DISTRICT, LIMPOPO PROVINCE

Macadamia nuts are rapidly becoming a significant crop in South Africa and probably the fastest growing tree crop industry. Macadamia is cultivated for its edible kernel with an oil content of 72% and above. Farmers in the Vhembe district of Limpopo use two major processors that act as market outlets for all commercial and smallholder macadamia enterprises in the area, namely Green Farms and Macridge processors. They store their produce on-farm until most of the harvest is collected.

Smallholder farmers are located between 25 and 85 km from the nearest processing facility, hence they limit trips to the facility to save on transport costs, most often using hired transport. This negatively affects nut quality at delivery, as high humidity and temperature causes mould development when nuts are stored in their husk for longer than 12 hours. The farmers realised this and tried to dry their crop but with limited success. Quality retention is critical in the macadamia value chain and rapid postharvest processing is a key success factor.

Quick harvesting, dehusking and drying within a day of nut drop is ideal to keep good quality, but seldom achieved by smallholder farmers in Vhembe district. The farmers did not have dehusking machinery; hence, they practised rudimentary manual dehusking and drying. That effectively meant suboptimal storage for prolonged periods, thereby compromising the nut quality. Postharvest treatment was the most important technically and economically significant limitation identified by the project.

The project addressed the macadamia nut processing challenges faced by the smallholder farmers through providing facilities for on-farm drying and storage.

The overall objective was to bring viable on-farm postharvest processing practices that increase productivity and sustainable livelihoods. The facilities were supplied to selected lead farmers, who work together with fellow farmers around them.

One solar drying and storage unit, three dehusking machines and some crates were supplied to the participating smallholder farmers in the district. A solar drying and storage unit, a dehusking machine and 100 crates were provided to Thulamela municipality in Mukula, to serve about 10 farmers. One dehusking machine and 50 crates were provided to Thulamela municipality in Phiphidi, to serve about 11 farmers. Another dehusking machine and 50 crates were provided to Makhado municipality in Elim, to serve six farmers. In total, there were 27 project beneficiaries, comprising 13 women, seven men and seven youth.

The equipment is helping farmers reduce macadamia losses during the harvesting season by speeding up the on-farm dehusking process to within 12 hours of harvest. Therefore, by addressing macadamia nut processing delays and quality related challenges through on-farm dehusking, drying and storage, the farmers are now able to sell their nuts at an optimum price.

Front of the solar drying and storage unit constructed in Mukula.

Dehusking machine and harvested macadamia ready for dehusking.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Abd Elbasit, M.A.M., Abu-Zreig, M.M., Ojha, C.S.P., Yasuda, H., & Gang, L. 2020. Estimation of surface depression storage capacity from random roughness and slope. *Water SA* 46: 404-409; https://doi.org.10.17159/wsa/2020.v46.i3.8650.

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Abubakar, H.B., **Newete, S.W.**, & Scholes, M.C. 2020. Drought characterisation and trend detection using the reconnaissance drought index for Setsoto municipality of the Free State province of South Africa and the impact on maize yield. *Water* 12, 2993; DOI:10.3390/w12112993, 16 pp.

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Summer Grain: Maize

ARC-GRAIN CROPS

The ARC-Grain Crops (ARC-GC) Campus was established in 1981 in Potchefstroom in the North-West province. Strategic and need driven research conducted by the campus involves cultivar evaluation, plant breeding, improvement of crop quality, weed control, conservation agriculture, plant nutrition, climate resilience, crop modelling, crop estimates, plant pathology, entomology and nematology.

The ARC-GC is mandated to serve the summer grain crops as well as oil and protein seeds sectors.

The Campus conducts research and development to enhance national productivity and the competitiveness of relevant producers and related industries. The ARC-GC researchers conduct field trials at both on-station and on-farm sites in all the nine provinces. In addition, the Campus is involved in training smallholder farmers, new commercial farmers and extension officers, and maintains genebanks of the mandated crops as national assets.

The mandated summer grain crops of ARC-GC are maize, sorghum and pearl millet. The oil and protein seed crops include bambara, cowpea, dry bean, groundnut, pigeon pea, soybean and sunflower. New crops currently under evaluation are pigeon pea, finger millet, lentil and rice.

In addition to other ARC Campuses, the ARC-GC collaborates with both local and international partners in International Agricultural Research Centres (CIMMYT, CIAT, ICRISAT, IITA, and IRRI), Universities, Private Seed Companies, NGOs, NARS, etc.

OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS.

PIGEON PEA: A MEANS OF IMPROVING FOOD SECURITY IN SOUTH AFRICA

The ARC has a mandate to work with partners to provide a sustainable way of producing food for the ever-increasing population and to manage the food security issues of the nation.

Pigeon pea is a pulse crop grown mainly in the tropics and sub-tropics of the world for human and animal consumption. In general, pigeon pea can be grown both as an annual crop or a perennial plant in homesteads and is consumed either as decorticated splits or in the form of green seeds as vegetables. It is rich in starch, protein, calcium, manganese, crude fibre, fat, trace elements and minerals, which makes it an ideal supplement for traditional cereals or tuber-based diets, which are generally protein deficient.

In South Africa, pigeon pea is produced mainly by smallholder farmers, and they use local landraces of which the yields are meagre, and most of them are not fully characterised. Despite the potential of pigeon pea as an important leguminous crop, there are few studies on the crop conducted in South Africa. Hence, the project aims to contribute to improving food security and export market through determining genetic variation within introduced germplasm as well as identifying the most adapted pigeon pea varieties and best agronomic management practices for the production of this crop under South African conditions.

Three field trials were carried out in eight locations representing different agro-ecological zones during the last season (2019/20) using 41 pigeon pea genotypes. The locations were Makhathini and Dundee in KwaZulu-Natal, Mahikeng and Potchefstroom in North West, Nelspruit and Burgershall in Mpumalanga, Syferkuil and Ga-Matlala in Limpopo province.

The trials consisted of 10 short duration determinate (DT) pigeon peas, 12 short duration non-determinate (NDT) short duration and 19 medium duration (MD) pigeon peas. Agro-morphological data were collected and recorded according to pigeon pea descriptor list including both quantitative and qualitative traits.

Results on genetic variation revealed that the DT, NDT and MD genotypes were dominated by highly vigorous plants at 50% flowering (73.3%). For the qualitative diversity, the DT were dominated by sun red, the NDT were predominantly green whereas the MD were a mix of green and sun red stems. The DT had erect and compact growth types with flat pods, the NDT showed semi-spreading genotypes with cylindrical pods whereas the MD consisted of spreading genotypes with both flats and cylindrical pods. For quantitative trait diversity, highly significant differences were observed with pod length, plant height, hundred seed weight, pod weight, seed number per plant and seed yield being the most contributors to the variation among the DT short durations.

Pod length, pod weight, plant height, days to flowering, seed number per plant and seed yield were the most contributors of variation in NDT short durations. The most variation in the MD durations was contributed by pod length, pod weight, seed number per plant, seed yield, stem diametre, days to flowering, plant height and branch number per plant.

Pigeon pea field trial at the ARC.

Flowering and podding of pigeon pea.

There was vast genetic diversity observed among the 41 pigeon pea genotypes within NDT and ND short durations and MD evaluated based on quantitative and qualitative traits. This variation is important for selection of parents for future use in the breeding programmes, development of various populations and transgressive segregants.

The trials for determining adaptation and best agronomic management practices are currently underway.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

EVALUATION OF SOYBEAN CULTIVARS

Soybean (*Glycine max* L Merr.) is one of the most widely grown crops in the world today, and its production in South Africa is rapidly growing due to an increase in the pressing capacity in the country.

The production area increased from 705 000 ha in 2019/20 to 827 100 ha in 2020/21 season. The number of cultivars submitted into the National Soybean Cultivar Trials depends on the submissions from seed companies. During the 2013/14, 2014/15, 2015/16, 2016/17, 2017/18 , 2018/19, 2019/20 and 2020/21 growing seasons 22%, 31%, 15.4%, 31% 40%, 15.6%, 10.7%, and 33.3% of the entries consist of new cultivars, respectively. From the above figures, it is clear that there is growing interest in the production of soybean as well as more adapted cultivars introduced to the market.

Food security and strategic protein supply is a relevant national policy and strategic frameworks of government on which the ARC key focus has been derived. Genotypic interaction with environmental factors such as temperature, water use, and soil and cultivation practices further necessitates on-site cultivar evaluation. Growing any soybean cultivar without knowing its potential in a particular environment may have dire consequences, even though such a cultivar may perform satisfactorily elsewhere.

Cultivar trials are scale neutral as emerging farmers should also have access to the best genetic material available on the market. Cultivar evaluation programme is therefore common practice in all soybean-producing countries. The aim of the project was primarily the following:

(i) to test the adaptability of cultivars and new releases for specific areas and cultivation practices; and

(ii) to compare cultivars for agronomic and economic performance.

The National Soybean Cultivar Trials were planted for the 42nd successive year during the 2019/20 growing season. Twenty-eight (28) commercially certified cultivars were included in the National Soybean Cultivar Trial and planted in 21 locations representing the cool, moderate and warm production areas. These cultivars were evaluated for seed yield and some agronomical characteristics.

The 2019/20 production season's results indicated that the mean yield (3 892 kg/ha^{-1}) of the best four cultivars (DM 5953RSF; PAN 1521R; P64T39R; DM 6.8iRR for the cool area) was approximately 840 kg/ha^{-1} higher than the mean yield (3 052 kg/ha^{-1}) of the poorest four cultivars (LS 6860R; P48T48R; NS 6448R; LS 6868R). This relates to R5 880/ha^{-1} at a grain price of R7 000/t^{-1}. The mean yield (3892 kg^{-1}) of the best eight cultivars (9.6%) for the cool area is 463 kg/ha^{-1} higher than the overall trial average (3429 kg/ha^{-1}) which resulted in higher income by R3 241/ha^{-1} at a price of R7 000/t^{-1}. Based on the 2019/20 cultivar trial results, the right cultivar choice can increase profitability.

Pannar Seed and ARC in a soybean cultivar trial grown at Delmas.

Soybean cultivar trial information day at Kroonstad High School - Blouskool, Kroonstad, the Free State.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

TRAINING-OF-TRAINERS ON INSECT RESISTANCE MANAGEMENT (IRM)

The first report of the fall armyworm (*Spodoptera frugiperda)* invading Africa was made in 2016. A year later, a positive identification was made that the fall armyworm (FAW) has also invaded South Africa. Since South Africa is one of the few countries in Africa making use of Bt maize to control stem borers, *Busseola fusca*, *Chilo partellus* and *Sesamia calamistis,* the first approach was to determine the susceptibility of FAW to Bt maize. Bt maize events planted in South Africa for over a decade contains Cry1Ab genes in Bt events MON810 and Bt11, or the stacked genes Cry2Ab2+Cry1A.105 in Bt event MON89034. More than 70% of maize planted in South Africa during the 2017/18 maize growing season contained Bt genes.

The Water Efficient Maize for Africa (WEMA) is a project aimed at producing drought tolerant and insect protected maize varieties for small-scale farmers in sub-Saharan Africa. In South Africa WEMA is using the MON89034 event since this event is known to control MON810 resistant *B. fusca* larvae.

In February 2017, WEMA launched the release of Bt maize varieties in South Africa branded as TELA, containing MON89034. The purpose of this project is to compare susceptibility of the first FAW population sampled in South Africa to the Bt maize events commercialised in South Africa, and to determine the susceptibility of FAW populations to TELA hybrids planted in South Africa. The same evaluation is conducted to evaluate *B. fusca* to be hands-on for any possible resistance development.

When planting GM maize such as TELA a great responsibility rest on the producers to know how to look after the technology.

Therefore, annual training is given to extension officers and seed company representatives to make sure that the producer knows how to make use of the high dose refuge strategy which is the insect resistance management practice to follow. The training focused on the Insect Resistance Management (IRM) concept that is used internationally to combat and delay the development of resistance to Bt maize.

During this training the matter of resistance development was explained and the issues around resistance development in South Africa. Since South Africa is the only country in the world that has reports of field resistance of the African stem borer (*Busseola fusca*) lessons learned from the past were discussed.

From this valuable information, the Bt event expressed in TELA can be looked after by not making the same mistakes. Since extension officers and seed company representatives were part of this training the importance of making use of the IRM plan and the need to comply were realised. People that attended this training will provide training to their colleagues as well as smallholder farmers.

Participants of the training conducted at ARC.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Craven, M., Morey, L., Abrahams, A., **Njom, H.S.**, & **Janse van Rensburg, B.** 2020. Effect of northern corn leaf blight severity on Fusarium ear rot incidence of maize. *South African Journal of Science.* https://doi.org/10.17159/sajs.2020/8508. Volume 116: Number 11/12:1-11 November/December 2020. 26 November 2020.

Kgatle, M.G., **Flett, B.**, Truter, M., & Avelinga, T.A.S. 2020. Control of Alternaria leaf blight caused by *Alternaria alternata* on sunflower using fungicides and *Bacillus amyloliquefaciens*. *Crop Protection*. 132 (2020)105146 pp 1- 6. June 2020.

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NchimbiMsolla, S., Miklas, P., **Fourie, D.**, Kilango, M., & Porch, T. 2020. Description of Baetao-Manteiga 41 and 'Yunguilla' superior Andean common beans for Tanzanian production environments. *Journal of Plant Registrations.* 2020. 14:234-241. 5 October 2020.

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Salegua, V., Melis, R., **Fourie, D.**, Sibiya, J., & Musvosvi, C. 2020. Screening Andean Diversity Panel Dry Bean Lines for Resistance to Bacterial Brown Spot Disease Under Field Conditions in South Africa. *Plant Disease* 2020:104(9) 2509-2514, September 2020.

Salegua, V., Melis, R., **Fourie, D.**, Sibiya, J. & Musvosvi, C. 2020. Grain yield, stability and bacterial brown spot disease of dark red kidney dry bean (*Phaseolus vulgaris* L.) genotypes across six environments in South Africa. *Australian Journal of Crop Science.* AJCS 14(9):1433-1442 (2020).

Sejake, T., Shargie, N., Christian, R., & **Tsilo, T.** 2021. Assessment of genetic diversity in sorghum germplasm using agro-morphological traits. *South African Journal of Plant and Soil* 2020: 37(5): 376-388.

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CHAPTERS IN BOOKS

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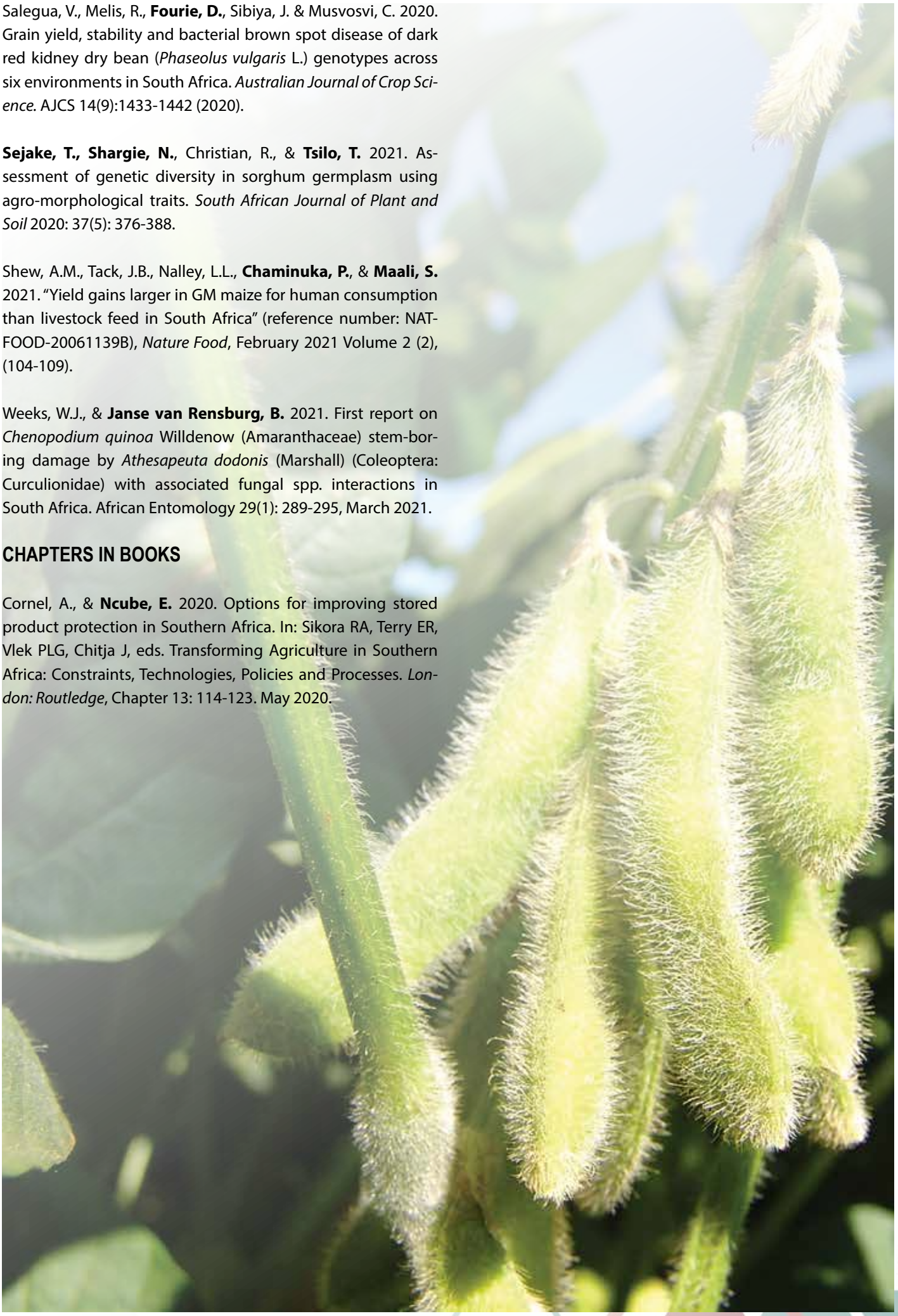


Barley Elite TGH

ARC-SMALL GRAIN

ARC-Small Grain (ARC-SG) serves the South African small grain commodity grouping, encompassing wheat, barley, triticale and oats. As South Africa strives to become less dependent on wheat imports (avg. 1.5 mil tons per annum), ARC-SG continues to render research in support of mainly four production pillars: 1. Pre-breeding for enhanced resistance/quality traits in locally-released cultivars; 2. Cultivar development for planting under dryland and irrigation conditions, nationally; 3. Cultivar evaluations under the National Cultivar Evaluation Programme (NCEP); and 4. Crop protection through the development of bio-insecticides and pest surveillance for early warning.

The Campus employs new state-of-the-art breeding technologies, including techniques for improved background selection and molecular markers. A meta-data analysis on wheat breeding research conducted by ARC-SG, has revealed a return on investment (ROI) ratio of 5.1:1. Cultivar evaluations under the NCEP are performed in all major production areas, supporting reliable, independent and annually-published Production Guidelines, used by small grain producers and policy makers. Several industry role players assisted with the task of gathering, combining and presenting these results to the small grain industry.

Crop Protection research focuses on pest surveillance and early warning systems as pre-emptive approach against insects and diseases. Research on insect-killing microbes and their development as bio-insecticides is a key focus; commercialisation of these beneficial microbes is pursued in collaboration with private industry. A molecular screening service for weed resistance to herbicides is rendered to producers, facilitating correct herbicide choice.

In essence, research activities at ARC-SG enable producers to be economically competitive, ensuring food security through the availability of high quality, affordable cereals. Innovative technologies are implemented to maintain and extend the contribution that the small grain industry makes to the wealth and social welfare of all South Africans.

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES.

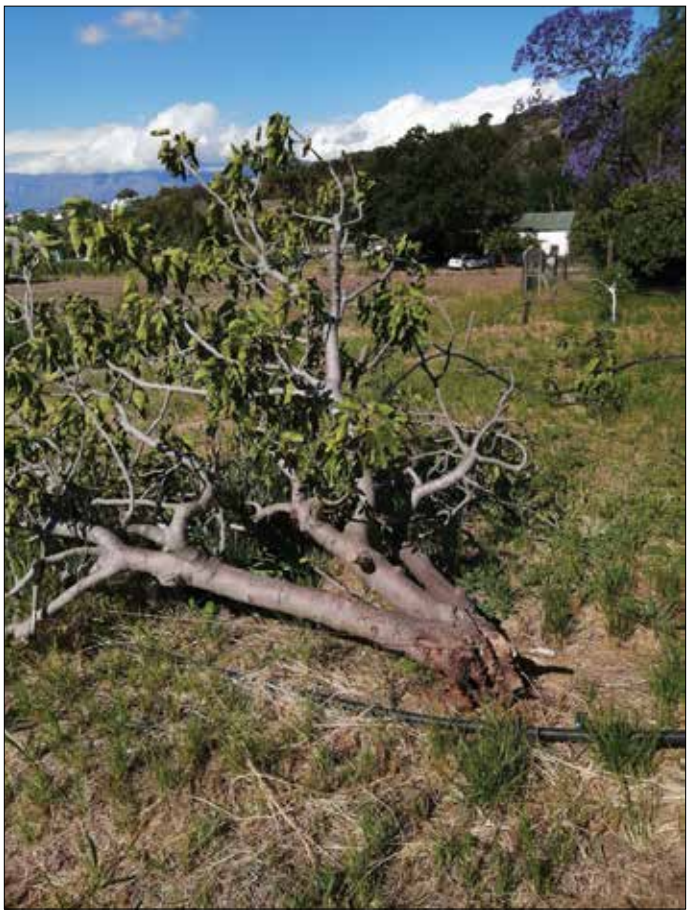
FIG TREE BORER

The ARC-Insect Pathology Laboratory (IPL) was recently approached for assistance on the development of an Integrated Pest Management (IPM) programme against the fig-tree borer, *Phryneta spinator*. This is an indigenous insect, boring into not only its native host plant, the Cape willow, *Salix mucronata*, but also into fig trees (*Ficus carica*) and occasionally peach (*Prunus* sp.), pear (*Pyrus communis*) and pecan (*Carya illinoinensis*).

Fig-tree borer beetle, *Phryneta spinator.*

The larval tunnels not only compromise the structural integrity of stems, but also affect nutrient transfer and may create entry-points for microbial pathogens. Such infestations cause a gradual decline in tree health and vigor, also rendering trees prone to wind-damage. The problem is prevalent in the Western Cape, where most of the fig-cultivation areas occur.

The cryptic habitat of the larval (borer) stage, inside the stems, complicates control thereof. Adult beetles are active during the summer months, with beetle flights occurring from December to March, annually. Beetles feed on bark, soft growth-tips as well as unripe figs, causing considerable damage. Although conspicuous, adults cannot be targeted with harsh chemicals close to summer harvesting as residue issues may negatively impact quality and exports.



Wind-toppled fig tree due to stem damage by larvae of *Phryneta spinator.*

Subsequently, an integrated approach, comprising the use of several control interventions, is being researched by the ARC-IPL. The principal strategies comprise the use of disease-causing microbes or entomopathogens and pheromones to lure and eliminate beetles during the mating season.

Entomopathogenic fungi in the genera *Beauveria* and *Metarhizium* are traditionally used as topical applications against insect pests. The spores (infective units) of these fungi germinate upon contact with the insect cuticle and penetrate the host to cause infection and eventually death. Prior to mortality, behavioural changes are often noted, of which a cessation in feeding brings immediate relief to the affected crop. In addition to topical applications, entomopathogenic fungi may also establish and grow inside plant tissue, then termed endophytic. Endophytes are therefore defined as microorganisms that live within a plant without causing any harm to the host.

This relationship is symbiotic; the endophyte acquires nutrition and shelter from the host plant while, in exchange, some endophytes can increase host resistance through the production of unique chemicals, which negatively affect insects and/or plant diseases. In addition, several studies have demonstrated enhanced plant growth, another advantage linked to endophytism by species of *Beauveria* and *Metarhizium* in various host plants.

For possible exploitation of fungal endophytism against this cryptic borer, surveys were initiated by the ARC during the 2020/21 summer season to investigate and characterise the naturally-occurring fungal endophytes in fig trees. In total, five fungal endophytes were isolated from leaf and stem material of healthy, borer-free trees. These cultures were submitted to the ARC South African National Collection of Fungi for identification. Two isolates were identified as *B. bassiana* (designated strain BRT17e) and *B. brongniartii* (designated strain STF176e), providing some baseline for further investigation of these species for induced systemic resistance to *P. spinator*.

These and other strains of *B. bassiana* and *M. anisopliae* were also tested in bioassays through topical application to beetles, confirming pathogenicity and secondary recycling through this host.

Beetle infected with the entomopathogenic fungus, *Beauveria bassiana* (white growth).

Following mass production and harvesting of fungal spores, selected strains will be used to artificially inoculate fig tree seedlings during the 2021/22 season. Confirmation of endophytic establishment, measurement of tree vigor and level of suppression of borer activity to follow. This is the first project of its kind investigating the possible deployment of entomopathogenic fungi as endophytes against *P. spinator*.

Pheromones are highly volatile chemicals produced by insects (usually females) to attract the other gender for mating; termed a sex-pheromone. Aggregation-pheromones, on the other hand, attract both sexes to induce group formation; thereby increasing the probability that mating can occur within that population. Pheromones can be used in lures to monitor insect activity (e.g. beetle flight patterns to indicate when egg laying is likely to commence), to disrupt mating (fewer offspring) and/or to attract one or both sexes to an area/device where they can be eliminated. Entrainment of beetles to collect such volatiles was initiated during the 2020/21 season and assistance with analyses rendered by a Chemical Ecology lab at the University of California, USA. In collaboration with this University (having previous experience with pheromones of African long-horned beetles), novel mixtures and a specialised trap design will be tested under field conditions during the 2021/22 summer season.

WHEAT BREEDING (IRRIGATION CULTIVARS)

The Eastern Free State was once labelled the 'bread basket' of South Africa, but climate change and a perceived low profit margin for dryland wheat production in this region, has placed increased pressure on the irrigation production areas to contribute to South Africa's food security.

Notably, the spring wheat-breeding programme of ARC has developed producer favourites such as Kariega, Steenbras, Duzi and many more. These reliable cultivars have proved their worth over the decades, but can no longer compete with the newer, higher yielding cultivars.

Feeding the growing South African population wheat-based products from local production has become increasingly challenging, with the country currently importing around 50% of its annual wheat requirement. Although the South African wheat industry has seen a gradual decline in the area planted to wheat (from about 3m/ha in the 1980's to 500 000 ha in 2017), cultivar performance (yield) has improved, thereby offsetting the impact of a reduced hectarage. This achievement is ascribed mainly to new/improved breeding technologies and superior cultivation practices. Such tools assist wheat breeders in developing new cultivars with high yield and excellent profit margins, able to compete with other crops in the market. Unfortunately, breeding for a new cultivar remains a long and labour intensive process.

The first step in breeding for a new cultivar starts with crossing two desirable parents. All crosses for the ARC breeding programmes are performed in glasshouses at the campus outside Bethlehem. Each crossing parent provides desirable traits that are beneficial to producers as well as the bakers and millers. International wheat nurseries are also utilised in order to diversify and improve South African lines. Traits that are of particular importance to the farmers in the irrigation areas include disease resistance, growth period, plant height, straw strength and yield. Breeding for improved yield is by far the most important trait that the breeders at this campus are pursuing. Certain quality traits are also of great importance to the bakers and millers. If a line does not meet these quality parameters set by industry, the cultivar will not be approved for release. Unfortunately, there seems to be an inverse relationship between grain yield and grain quality, further complicating the breeding process.

Before the progeny from the resulting crosses are evaluated in the field, the seed must be multiplied. This seed multiplication from the first filial generation (F1) is also performed in Bethlehem. The resulting F2 seed is sent to the respective production areas where the seeds will be planted in the field for further evaluation. Due to phenotypic plasticity, all material must be evaluated in the region where it will eventually be propagated. This is because phenotypic plasticity will cause the same line to exhibit different agronomic traits when exposed to different environmental conditions. Material for the irrigation wheat breeding programme is planted in the Vaalharts irrigation scheme. Similarly material for the dryland breeding program is planted either at Tygerhoek (for the winter rainfall region) or the Western and Eastern Free State (for the summer rainfall region). The early generations, that are still segregating (F2 to F5), are planted in the field as single rows. Each line is evaluated and selections are made based on performance and desirable agronomic traits. Each year thousands of single rows are screened that could potentially become new cultivars.

Selected lines sprayed red for easy recognition.

After four years of consecutive screening in the field, the selected lines are progressed to advanced trials. The entire row of the selected F5 lines are harvested and screened for yield and flour quality at the campus' Grain Quality laboratory. Only lines with adequate quality will be planted as Junior plot trials. Junior lines that exhibit improved yields, compared to standard cultivars, are advanced to Senior plot trials the following year. Using data collected from the Junior and Senior trials, lines which passed all selection criteria are finally planted as elite trials. Elite trials for the irrigation breeding programme are planted at multiple locations in the Northern Cape and for the dryland breeding programme at multiple localities in the Western Cape and Free State. During this time, the top lines will be evaluated by the South African Grain Laboratory (SAGL). After SAGL has completed quality analyses, the bakers and millers will discuss the quality results supplied by SAGL. If they are satisfied with the quality parameters, the line will be approved for final release. This will be approximately eight to nine years after the initial cross.

During 2020, two such periods ended in the release of the new irrigation cultivars Umgeni and Selons. These are set to surely develop into industry favourites! Umgeni will without doubt be the new flagship cultivar for the ARC in the irrigation areas. Umgeni has a short growth period and exceptional yield, averaging 12.5 t/ha. Apart from its superb yield potential, Umgeni is also moderately resistant to leaf rust and resistant to stripe rust. A third line, Usutu, was approved in 2019 and therefore ARC has three new irrigation cultivars that are currently being multiplied for industry.

ARC cultivars showcased during open day at Modderrivier in 2020.

With the addition of these three new cultivars, the small grain irrigation wheat package consist of a diverse range of cultivars to suit the specific needs of producers. ARC developed cultivars for the producers in the irrigation area with exceptional yield as well as a range of different growth periods. This allows producers to select cultivars best suited for their individual production practices in order to be profitable.

NATIONAL SMALL GRAIN GERMPLASM COLLECTION

The National Small Grain Germplasm Bank, curated by ARC, is the largest collection of its kind in Africa, south of the Sahara. It is a public germplasm bank, which means the accessions are freely available without any charge.

Plant genetic resources are a strategic resource at the heart of sustainable crop production. Their efficient conservation and use are critical to ensure food and nutrition security, now and in the future. The loss of genetic diversity reduces the options for sustainably managing resilient agriculture in the face of adverse environments, and rapidly fluctuating meteorological conditions. Well-managed germplasm banks safeguard genetic diversity and make it available to breeders and researchers.

On average, around 50 accessions from the National Small Grain Germplasm Bank are made available each year to universities, breeders, pathologists and entomologists from South Africa and abroad.

The National Small Grain Germplasm Bank holds a total of 20 107 small grain entries, which comprise 17 551 wheat (*Triticum* spp.), 1 113 oats (*Avena sativa*), 1 006 barley (*Hordeum vulgare*), 57 rye (*Secale cereale*) and 437 triticale (*Triticosecale*) accessions. Some of the accessions in this collection are unique and include more than 250 old South African cultivars as well as advanced breeding lines adapted to South African conditions. The oldest South African cultivar in the Germplasm Bank is Du Toits, released in 1876. An additional seven South African cultivars in this collection were released before 1900 and another 28 before 1925. The collection also contains a rye species (*Secale africanum*) which is indigenous to South Africa. In addition, the Germplasm Bank serves as a backup facility for other Small Grain Germplasm Banks worldwide because of the variety of accessions it contains. Importantly, accessions in this collection can be disseminated to requesters in South Africa within days, while it may take months to obtain the same accession from germplasm banks abroad.

Great care is taken to ensure that the identity of seed sample accessions conserved in germplasm banks is maintained throughout the various processes, beginning with acquisition through to storage and distribution. Proper identification of seed samples requires careful documentation of data and information about the material. After harvesting, the lines that are taken up in the Germplasm Bank are placed in a drying room to reduce the moisture content of the seed to between 4% - 6%. The seeds are then sealed in aluminium bags and placed in freezers at a temperature of -18˚C. Germination tests of the seeds in the Germplasm Bank are performed after the seeds had been in the freezers for a 15-year period to check the viability of the accessions and to determine when the accessions need to be planted in rejuvenation trials.

Germplasm. Seed in aluminium bag in freezers.

Meeting the challenge of sustainable crop production will require a continued stream of improved crops and varieties adapted to agroecosystem conditions; especially amidst current climate change. This requires new sources of germplasm with important agronomic traits, disease and pest resistance in order to enhance and fast-track the development of cultivars with high yield and durable resistance. To achieve this, ARC collaborates (germplasm exchange) with various international institutions such as the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, Turkey-CIMMYT-ICARDA (TCI), as well as breeding companies and universities in Uruguay, Australia, Germany and the USA. Nurseries from CIMMYT, TCI and an oat nursery are planted on an annual basis under quarantine conditions and breeders and researchers from ARC, universities and private plant breeding companies are invited to visit these at ARC-SG, Bethlehem, and make selections.

The wheat nurseries that ARC receives from CIMMYT Mexico have been instrumental in breeding South African cultivars. For example, the cultivar Tugela originated from early CIMMYT nurseries obtained in the 1970's. This cultivar is aluminium tolerant with strong dough characteristics. The cultivar Tugela-Dn, which was derived from Tugela, was the first Russian wheat aphid resistant wheat cultivar in South Africa. Tugela-DN also had stem and leaf rust resistance that made it an ideal parent in crossing block programmes of ARC. Many MSc and PhD studies were conducted on the pest and disease resistance as well as aluminium tolerance characteristics of Tugela-DN.

Testing of conserved accessions in the National Small Grain Germplasm Bank for resistance to new pests and pathogens, places a value tag to the accessions for breeding or pre-breeding programmes. The collection contains the differential sets for the testing of stem, leaf and yellow rust biotypes. Three accessions (SA463, SA1684 and SA2199) were used for the breeding of resistance to Russian wheat aphid, all obtained from the National Small Grain Germplasm Bank. Over a period of 30 years, 43 cultivars were developed by making use of these three accessions. Another set of accessions is being used for fortification of iron and zinc, to the benefit of the South African consumer.

The personnel at the National Small Grain Germplasm Bank render assistance in the searching for sources of cultivars or breeding lines with specific traits. They also help with the importation of cultivars and lines as well as exportation of cultivars and lines and make sure that all Phytosanitary requirements are met.

Germplasm Bank.

SWEET POTATO WEEVILS

Insect biocontrol is gaining rapid momentum amidst growing concerns over environmental pollution, insecticide resistance, residues and general human/animal health risks associated with harsh insecticides. One such group of biocontrol agents is entomopathogenic nematodes or EPNs. These are soil-inhabiting lethal insect parasites which occur in both natural and agricultural soil. They are classified as entomopathogens because of the deadly insect-killing symbiotic bacteria contained in their gut. Reproduction occurs inside the affected host cadaver, with thousands of infective juveniles or IJ's (a durable, non-feeding infectious stage) emerging from the host and capable of persisting in the soil to render sustainable pest control.

Although commercialised abroad, no EPN-based bio-insecticide has been developed locally for registration under Act 36 of 1947. Notably, the Pesticide Management Policy encourages the development and use of alternative products and techniques to reduce the dependence on chemical plant protection products (Notice 1120 of 2010, Government Gazette 24 December 2010), while the Agricultural Policy Action Plan (APAP) promotes climate-smart agriculture. Further supporting the concept of developing EPN-based bioinsecticides, is the recent launch of the South African National Bio-Economy Strategy, establishment of the South African Bioproducts Organisation (SABO) in 2013 and the publication (in 2015) of new Guidelines for Registration of Biopesticides under Act 36.

ARC currently curates the largest (>150 isolates) and most diverse collection of indigenous EPNs in South Africa, considered a National Asset. The collection comprises a number of newly described EPN species, including *Steinernema beitlechemi, S. biddulphi, S. innovationi* and *S. tophus*. The collection also serves as a source of exploitable biocontrol agents against various insect pests.

One such project, funded by the National Academy of Sciences (USA) and ARC, targets sweet potato weevils (*Cylas* spp.), a serious pest of *Ipomoea batatas*. This is one of the most widely cultivated root and tuber crops worldwide and an excellent source of carbohydrates and Vitamin A.

In South Africa, a national survey conducted in 2012, indicated that 43.6% of children one to five years of age are vitamin A deficient. Cultivation and supply of this crop can help alleviate such deficiencies, but is challenged by insect damage. Chemical control is complicated by the cryptic feeding behavior of weevil larvae (the most damaging stage), the nocturnal activity of adults and the high cost of pesticides.

This project proposes the use of EPNs in association with host plant resistance as efficient, cost-effective and environmentally-sound alternative to chemical insecticides.

Application of cadaver-formulated entomopathogenic nematodes in a field trial against sweet potato weevil.

The beneficiaries of the project include the entire sweet potato industry, but specifically, smallholder sweet potato farmers in Limpopo, North West and Gauteng; including stakeholders involved in the legislation of pesticides in South Africa. Ultimately, the project aims to reduce poverty, as well as food and nutrition insecurity in support of the National Policy on Food and Nutrition Security (passed by Cabinet in 2013 and subsequently gazetted in 2014). From an educational perspective, the project is also gauging farmer opinion towards EPN-based biopesticides and farmers' attitudes toward this new non-chemical approach.

Most of the farmers who were interviewed at the beginning of the project demonstrated a lack of knowledge regarding such product and also uneasiness in receiving EPNs, mainly due to a lack of awareness and knowledge of EPNs. This was anticipated, since EPN research is classified as scarce skill and still in its infancy in South Africa. Hence, this project will provide new insights, leading to potential acceptance of this pest control innovation.

Although still underway, this research is in direct support of smallholder farmers who sell through the informal market in their communities, improving food and nutrition security of the most vulnerable. Each farmer was provided with planting material and inputs to plant one hectare. Additionally, farmers were trained by the researchers and government extension officers on aspects of sweet potato production, including pest management. Income generation through sweet potato farming amounts to an average of R5 - R10 per kg with yields of about 15-20 tons per ha (Conservative), 25-30 tons per ha (Average) and 40 tons per ha (Target).

ARC researcher (left) engaging sweet potato farmers in Gauteng on the use of entomopathogenic nematodes for control of sweet potato weevils

The project also serves as platform for capacity building of farmers, extension officers and postgraduate students (three MSc candidates) on the use of EPNs. Several collaborations are accommodated within the framework of this project, including the United States Department of Agriculture (expertise in production and application of EPNs); University of Parakou, Benin (project principal investigator), Limpopo Department of Agriculture and Rural Development (DARD), North West DARD, Gauteng DARD (extension and advisory services) and ARC-Vegetable and Ornamental Plants (sweep potato breeding and cultivation) as well as ARC-CO Economic Analysis Unit (Socio-economic studies).

In future, research will focus on development of indigenous EPN strains for incorporation into integrated pest management programmes. Additionally, while current research is targeting sweet potato weevils, there is great potential (due to the wide host range of EPNs) to extend the application of this new technology for control of other insect pests of other crops.

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Bajgain, P., Jin, Y., **Tsilo, T.J.,** Macharia, G.K., Reynolds, S.E., Wanyera, R., & Anderson, J.A. 2020. Registration of KUWNSr, a wheat stem rust nested association mapping population. *Journal of Plant Registrations* DOI: 10.1002/plr2.20043.

Figlan, S., Ntushelo, K., Mwadzingeni, L., **Terefe, T., Tsilo, T.J.**, & Shimelis, H. 2020. Breeding wheat for durable leaf rust resistance in Southern Africa: Variability, distribution, current control strategies, challenges and future prospects. *Frontiers in Plant Science*, Vol 11. DOI: 10.3389/fpls.2020.00549.

Jankielsohn, A., & Prinsloo, G.J. 2020. *Sipha maydis* (Passerini) (Hemiptera: Aphididae) on wheat (*Triticum aestivum*) in South Africa. *African Entomology* 28(1), pp 192-194.

Kisten, L., Tolmay, V.L., Mathew, I., **Sydenham, S.L.,** & Venter, E. 2021. Genome-wide association analysis of Russian wheat aphid (*Diuraphis noxia*) resistance in Dn4 derived wheat lines evaluated in South Africa. *PLOS ONE, online publication* DOI. org/10.1371/journal.pone.0244455. December 2020.

Mamabolo, E., Makwela, M.M., & Tsilo, T.J. 2020. Achieving sustainability and biodiversity conservation in agriculture: Importance, challenges and prospects. *European Journal of Sustainable Development* (2020) 9(3), pp 616-625.

Miles, C.W., Booyse, M., Van Biljon, A., & Labuschagné, M. 2020. The effect of different milling procedures on dough mixing parameters of hard red bread wheat. *Cereal Research Communications* https://doi.org/10.1007/s42976-020-00065-6.

Motholo, L.F., Booyse, M., **Hatting, J.L., Tsilo, T.,** & Thekisoe, O.M.M. 2020. Pathogenicity of *Beauveria bassiana* (Hypocreales: Cordycipitaceae) against the Russian wheat aphid, *Diuraphis noxia* (Hemiptera: Aphididae). *African Entomology* 28(2): 455-461 (2020).

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THESES AND DISSERTATIONS

Masters

Bapela, T. 2020. Screening wheat (*Triticum aestivum* L.) landraces to use as donor lines of Russian wheat aphid resistance and the application of molecular markers to identify potential high yielding genotypes with minimal linkage drag to undesirable traits. Masters Degree (Agriculture), University of South Africa.

Lephuthing, M.C. 2020. Characterisation of South African wheat genotypes to improve nutritional quality and yield. Masters of Science (Life Sciences), University of South Africa.

Doctoral

Lamula, S.Q.M. 2020. Characterisation of wheat nematodes from cultivars in South Africa. Doctor of Philosophy, University of North West.

CHAPTERS IN BOOKS

Jankielsohn, A. 2021. Russian Wheat Aphid Distribution in Wheat Production Areas: Consequences of Management Practices [Online First], IntechOpen, DOI: 10.5772/intechopen.96375. Available from: https://www.intechopen.com/online-first/russian-wheat-aphid-distribution-in-wheat-production-areas-consequences-of-management-practices.

Black Olive, Olea europaea

ARC INFRUITEC-NIETVOORBIJ

The ARC Infruitec-Nietvoorbij (ARC INF-NVB) does research and development, as well as technology transfer on breeding, cultivation, pest and disease management and postharvest technology of stone and pome fruit, grapevines, alternative crops (such as olives and pomegranates) and indigenous herbal teas. Its main campus is situated in Stellenbosch, Western Cape, but cultivar development and research is conducted in all regions of South Africa where the crops are grown.

Research and development in the various divisions focus on different aspects of fruit and wine production to improve crop performance and productivity, ensure sustainable use of natural resources and increase the nutritional value, quality and safety of agricultural products. These aspects include breeding cultivars adapted to local conditions and able to cope with climate change, sustainable soil cultivation and management practices, water efficient irrigation, winery wastewater management, viticultural and horticultural practices to improve crop performance, integrated pest and disease management (pre- and post-harvest), winemaking and postharvest processing of fruit and herbal teas. During the last 12 years, more than 50 cultivars were developed and commercialised and 99% of fruit used by the canning industry are ARC cultivars.

Gene banks are valuable national assets and the Campus is the custodian of genetic resources for grapevine, pome and stone fruit, wine yeast, fynbos and indigenous teas (rooibos and honeybush), used by the ARC, private sector and government for breeding purposes, training and comparative descriptions of cultivars.

The Campus also provides a range of diagnostic and analytical services to growers, winemakers and technical advisors to assist with decision-making and to help ensure sustainable, economically viable farming.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

ARC REGISTERS NEW EARLY BLUSH PEAR

'Cape Blush' is a new, very early blush pear cultivar developed by the ARC as part of its strategy to supply South African fruit growers with new, competitive products suitable for overseas markets. The distinguishing trait of this cultivar is the fact that it ripens about two weeks earlier than the established early blush pear 'Rosemarie'. The blush on the skin of 'Cape Blush' pears is a striking bright red colour and the fruit has a classic pear shape, making it very attractive.

Independent evaluation also signifies that this cultivar is suitable for commercialisation, having reasonable eating quality and good storage ability – which makes it appropriate for export markets. It is foreseen that 'Cape Blush' will play an important role in expanding the blush range of South African pear cultivars.

'Cape Blush' is a new, very early blush pear cultivar developed by the ARC.

SUSCEPTIBILITY OF COVER CROPS TO LESION NEMATODES

Lesion nematodes (*Pratylenchus* spp.) are the most common plant-parasitic nematodes present in South African apple orchards. Lesion nematodes live and reproduce in the roots, causing them to be more easily accessible to soil-borne fungi. Direct and indirect damage to tree roots, especially of younger trees, results in poor growth and yield declines gradually. Benefits of cover crops in orchards include increased soil organic matter, weed suppression, decreased soil erosion, increased water infiltration, improved soil structure, improved nutrient cycling and management, promotion of beneficial soil micro-organisms, and pest and pathogen suppression. However, it is important to ensure that the cover crop is not a good host for lesion nematodes, in which case it could serve to increase populations rather than suppress them.

Pot trials to evaluate the susceptibility of various cover crops to the three main lesion nematode species occurring in South African apple orchards showed that some cover crops are poor hosts for the three species, but others are good hosts and their use as cover crops should be carefully considered.

Indian buckwheat and nasturtium are considered moderate to good hosts for all three species of lesion nematodes, and can cause an increase in nematode numbers. Pink serradella (cv. Margarita), rye (cv. Duiker Max) and subterranean clover (aarbei klawer) are considered good hosts for *Pratylenchus penetrans* only, while *P. hippeastri* has the potential to increase on certain crops (pink serradella, rye, Triticale, subterranean clover, medics) during spring and summer.

If the species of lesion nematode present in an orchard is known, an informed decision can be made with regard to the choice of cover crops. By limiting the numbers of harmful lesion nematodes in orchards the productive lifespan of trees can be prolonged, thereby helping to ensure the economic sustainability of apple farms.

Pot trial to evaluate the susceptibility of various cover crops to lesion nematodes.

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES.

IMPROVED IRRIGATION SCHEDULING FOR TABLE GRAPES

Irrigation water is a scarce resource, and agriculture has to compete with urban and industrial needs for water. If climate change reduces rainfall, it could put water resources under more pressure. Growers must, therefore, use irrigation water efficiently through sound scheduling practices. Calibration of instruments used for scheduling is not necessarily correct or accurate enough, because calibrations can differ between soil types and/or different soil layers. Refill points, i.e. when irrigation is required, are often selected haphazardly.

Consequently, many table grape vineyards are over-irrigated. Calibrating instruments against soil water content is tedious and requires specialised skills and equipment. Research done by the ARC showed that it is fairly simple to measure grapevine water status by means of the pressure chamber technique.

Instruments currently used for irrigation scheduling of commercial vineyards can easily be calibrated against grapevine water status. The research showed that producers can apply less irrigation and achieve the same table grape berry size and quality using the pressure chamber technique. This information is now being used to develop guidelines for improved scheduling of table grape irrigation.

A pressure chamber is used to measure grapevine water status.

OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS.

DEVELOPMENT OF A QUALITY GRADING SYSTEM FOR THE HONEYBUSH INDUSTRY

Development of the South African honeybush tea has faced a number of challenges since commercialisation commenced in the 1990s. Inconsistent and poor product quality has been a recurring challenge. The South African Honeybush Tea Association Business Plan 2010 identified the need for a "quality seal" for honeybush, relating to its sensory properties, amongst others, that could be used as part of a market strategy and to facilitate trade. As a result the industry prioritised the need for a research-based approach to set quality standards for honeybush, as inferior quality erodes consumer confidence in the product and can affect the competiveness of the industry.

The objective of the project was to develop an easy-to-use quality grading system for honeybush tea for use by industry to differentiate product quality. A grading scorecard that will form the basis of the quality grading system was developed. This scorecard has been converted into an electronic format (the app Qquest running on a Windows platform) for capturing of scores for appearance, aroma and palate attributes, automatic calculation of the quality grade of production batches and record-keeping.

Other tools that were also developed to assist industry quality control (QC) personnel include a colour reference card and a manual. The manual gives easy-to-use directions on the application of the quality grading scorecard and the colour reference card to classify infusions of fermented honeybush tea in terms of broad-based classes of sensory quality (poor, low, medium or high quality), and instructions for the training of industry QC personnel in sensory attributes. The training tools include the aroma and flavour wheels and lexicon. These capture and describe the generic positive and negative sensory attributes associated with fermented honeybush tea. Details of chemical reference standards and instructions for preparation of the chemical reference standards to train QC personnel in recognising the aroma notes are also provided. Aroma cards provide descriptions and details of chemical reference standards.

The Honeybush manual gives directions for using the quality grading scorecard and colour reference card.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

SUPPORTING EMERGING FARMERS IN THE NORTHERN CAPE

The ARC, supported by funding from Winetech, has an ongoing engagement to provide comprehensive agricultural support for the Eksteenskuil and Releaboga resource poor and emerging farmers in the Northern Cape. The ARC provides on-farm training and technology transfer, with the primary focus to enable these farmers to succeed with viticulture.

A workshop on the use of grapevine rootstocks was presented by ARC at Eksteenskuil on 16 November 2020. Forty-four emerging farmers from the Eksteenskuil Landbou Koöperasie attended this workshop and all attendees received an attendance certificate.

On 17 and 18 November, ARC visited 14 producers who asked for on-farm consultations to discuss their specific problems. These visits were very informative, as it shed light on how these farmers managed with limited resources and identified problems and training needs.

It was clear that these farmers are very eager to learn and that there is a great need for training in general farming practices like trellis systems, pruning of vines, plant quality and correct planting procedures. Because of financial constraints, weed control is a huge problem for these producers, particularly as most of them still use flood irrigation. This and poor growth of newly established vines are problems that need to be addressed.

Discussing pruning practices with emerging farmers in the Northern Cape.

HONEYBUSH - TRADITIONAL COMMUNITY DEVELOPMENT AND SKILLS TRAINING

Honeybush (*Cyclopia* spp.) is one of South Africa's unique indigenous teas with an immense commercial potential, but still a niche crop that needs several initiatives to make it a viable and sustainable crop. Five Small Micro Medium Enterprises (SMME) were established in traditional communities with funding from the Department of Science and Innovation (DSI).

The ARC honeybush team in Stellenbosch provides continued support and training to help them grow into sustainable enterprises. Two of the SMMEs focus on supplying commercial seed, two on nurseries and one on plantations producing wet-biomass, although the other four also invested in plantations of their own.

COVID-19 and lockdown restrictions had a direct negative impact on the SMMEs. The poor sales of honeybush tea in the markets resulted in farmers deciding not to replant or extend their current honeybush plantations. All SMMEs suffered economically during the pandemic and no sales of seedlings were made during the first six months, and very little in the past six months. The drastic decrease in the demand for seedlings had a severe impact on the ability of the nurseries to generate income, e.g. one company received orders for 60 000 seedlings with a possible income of R240 000 which they did not realise. Honeybush processing plants did not buy any wet biomass during the year, which is another source of income for the SMMEs.

SMMEs were encouraged to investigate cultivating alternative crops like vegetables and herbs to generate extra income. Extra funds from the DSI project were transferred to all the SMMEs to assist with their business expenses and to help them survive economically. Two permanent and 30 temporary jobs were created during this period, while the 34 beneficiaries worked without any payment or for a small wage.

A one-day short course on propagation of seedlings and cuttings for honeybush nurseries was held on 25 November 2020 at the Thornham Community Hall, close to Storms River in the Eastern Cape. It attracted beginners as well as more experienced honeybush nursery managers from across the honeybush region. The course was attended by 20 (10 women and 10 men) participants, of which seven were younger than 35.

The morning session lectures focussed on the importance of different horticultural aspects of propagating seedlings and cuttings. In the afternoon session participants had the opportunity to apply and practise their newfound skills. All participants received a certificate to acknowledge their participation.

Short course on propagation of seedlings and cuttings for honeybush nurseries.

The ARC honeybush team, with funding from the Foundational Biodiversity Information Programme (FBIP), compiled a pamphlet with information and photographs about the most common fungus diseases that cause dieback in plantations of *Cyclopia*. Symptoms like plant shoots developing black tips, the dieback of individual shoots and the development of dieback cankers are caused by fungal trunk pathogens, notably *Botryosphaeria* and *Diaporthe* species.

No fungicides are currently registered for use on honeybush, but infections can be managed by preventative and cultivation control measures used in nurseries and plantations, as explained in the pamphlet. Improved cultivation practices, such as the removal of infected plants, can also help to minimise the impact of pathogen infection in plantations. The pamphlet was distributed electronically and via printed copies to honeybush farmers.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Adetunji, A.T., Ncube, B., **Meyer, A.H., Mulidzi, R.,** & Lewu, F.B. 2020. Soil b-glucosidase activity, organic carbon and nutrients in plant tissue in response to cover crop species and management practices. *South African Journal of Plant and Soil.* https://doi.org/10.1080/02571862.2020.1718786.

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THESES AND DISSERTATIONS

Masters

October, F.M. 2020. Effect of yeasts and oenological parameters on acetaldehyde production during alcoholic fermentation of South African grape must. Master of Science (Biochemistry), Stellenbosch University.

Doctoral

Du Plessis, I.L. 2020. The diversity and epidemiology of Botryosphaeriaceae species associated with grapevine and woody host surrounding vineyards in South Africa. Doctor of Philosophy (Plant Pathology), Stellenbosch University.

Du Preez, BvP. 2020. Development of a quality grading system for the honeybush (*Cyclopia* spp.) tea industry. Doctor of Philosophy (Food Science), Stellenbosch University.

Hutchinson, U.F. 2020. The application of biochemical process engineering in Balsamic-styled vinegar production. Doctor of Engineering (Chemical Engineering). Cape Peninsula University of Technology.

Masowa, M. 2020. Assessment of maize productivity and soil health indicators following combined application of winery solid waste compost and inorganic fertilisers. Doctor of Philosophy (Agriculture), North-West University.

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Inspection of a bee-hive

ARC-PLANT HEALTH AND PROTECTION

The ARC-Plant Health and Protection (ARC-PHP) has a main campus at Roodeplaat, northeast of Pretoria, as well as satellite campuses at Cedara (KwaZulu-Natal) and Vredenburg (Western Cape). The business unit has the mandate to provide extensive and specialist knowledge of the organisms that threaten agricultural crops and plants in natural environments, to protect arable land, water resources, natural biodiversity, and food security.

Research is focused on promoting economic and environmentally acceptable management strategies for pests, plant and soil diseases and invasive plants, as well as developing and implementing fast and accurate diagnostic services for all matters relating to plant health in the agricultural sector.

The following strategic assets are maintained on behalf of the state:

- The National Collections of Arachnids, Fungi, Insects and Nematodes;
- The South African *Rhizobium* Culture Collection;
- The Plant Pathogenic and Plant Protecting Bacteria Culture Collection;
- Plant Virus and *Antisera* Collection; and associated databases as well as;
- Biological control quarantine facilities;
- Live collection of alien invasive control agents; and
- National registered diagnostic plant health laboratories.

These assets also form the basis of the Campus' strategic plan and turnaround strategy with the objective to develop sustainable agricultural solutions and are critical to on-going research and the delivery of essential services to the agricultural sector as a whole.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

ARC SUPPORTS FIGHT AGAINST FALL ARMY WORM IN SOUTH AFRICA

The ARC has been recognised by the Food and Agricultural Organisation of the United Nations as a training centre of excellence for Fall Army Worm (FAW), *Tuta absoluta* and Maize Lethal Necrosis Disease (MLND). With this, and a number of FAW projects for Department of Agricultural, Land Reform and Rural Development (DALRRD), the ARC was well suited to help upscale FAW related activities within South Africa.

One such project is the monitoring of FAW overwintering sites, a DALRRD funded project. The ARC surveyed the overwintering sites of the FAW and found viable populations throughout winter of 2017-2020 in numerous field sites in smallholder farming areas in the warmer lowveld areas of Limpopo, Mpumalanga and northern KZN Provinces. The FAW populations die out in the Highveld maize production areas during winter due to the cold temperatures.

However, the FAW is now considered as an endemic pest problem in these lowveld smallholder farming areas where conventional maize varieties are often planted throughout the year. These sites can provide refuge sites for FAW populations during winter. Once the spring rains fall, these sites act as sources for population expansion and FAW moth invasions into the commercial maize cultivation areas, which are the food basket of the country.

Maize in the Tshiombo planting site, Limpopo.

An event to handover essential FAW monitoring and management equipment by the FAO to DALRRD was held on the 31 August 2020. The equipment provided to agricultural departments ranged from cell phones, to make use of the FAO FAW Monitoring and Early Warning System (FAMWES) app, as well as traps to help monitor the movement of this pest on the ground.

Some equipment was shared between the various provinces and the ARC. This equipment was also used in the FAO FAW Farmer Field School, which was implemented by the ARC in the Limpopo and Mpumalanga provinces. It will be used by female and youth small-holder farmers to monitor FAW in their communities. During the FAO FAW Farmer Field School, two sites were selected to provide AgriSETA training and to do a trial aimed at testing different FAW control methods, such as GM maize, cultural control and chemical control.

At each site, 20 women and youth trainees were selected to participate. The first site is in the Mpumalanga Province, in the Nkomazi district, Magogeni Village. The second site is in Limpopo Province, near the town of Thohoyandou. Preliminary results from the trials indicate that the cultural control of applying ash to the growing points of maize proved to be a cheap and successful method to control FAW.

More formal training was also provided to representatives from provincial DALRRD offices and FAO at a national training event on five transboundary pests and diseases. A week long training event, known as the National Training Workshop Regional Agricultural Policy (RAP) EDF 11, was hosted by the ARC from the 23-27 November 2020. Training was provided on the FAW, *Tuta absoluta*, Oriental Fruit Fly and MLND and Panama disease.

These transboundary pests and diseases are a serious threat to food security within the SADC region. The aim of the training was to transfer technology to the delegates on effective surveillance, detection, sampling and identification of these transboundary pests and disease, understanding the biology of the pests and the disease vectors, and how to develop integrated strategies to control and manage them.

The workshop also focussed on the concepts of pest risk analysis and how pests should be mitigated within the international trade scenario. International standards for phytosanitary matter (ISPMS) played a crucial role, forming the background for training provided. The outcome of this training event was to develop capacity within provinces for increased pest surveillance, awareness and detection. The ARC also acts as a referral center for the identification of FAW, *T. absoluta* and MLND.

Delegates from around South Africa who attended the National Training Workshop Regional Agricultural Policy (RAP) EDF 11 held at the ARC-VOP Training Centre on the 23-27 November 2020.

Each of these different activities aims to improve a regional understanding of the FAW pest through research and training to both the formal and informal sectors in agriculture. These activities in the broader sense, support food security on a regional level.

ARC-PHP PROVIDES CRITICAL DIAGNOSTIC SERVICES ON PLANT PESTS AND DISEASES TO ENABLE TRADE AND SUPPORT FOOD SECURITY

Critical diagnostic and quarantine services were provided to DALLRD, as well as manufacturers of biological control products, suppliers of vegetative propagation material and seed, farmers and agrochemical companies. These services continued unabated during the COVID-19 lockdown in SA. Commodities analysed included vegetables, fruit, ornamentals, grains, and indigenous plants as well as soil, biological products, irrigation water, natural vegetation, grasses and weeds

Some of the diagnostic services delivered.

A number of nematode pests of importance were reported and include the lesion nematode *Pratylenchus scribneri* Steiner, 1943 which was found associated with raspberry, but is also a pest on various other commodities. These migratory endoparasites also have a symbiotic relationship with plant-pathogenic fungi responsible for dieback of host plants. Garlic samples submitted by DALLRD yielded the quarantine nematode *Ditylenchus dipsaci*, as confirmed with molecular analyses.

The nematode also serves as a vector for bacterial plant pathogens and can withstand desiccation for 20 years or more. The quarantine nematode *Aphelenchoides ritzemabosi* found on ornamental succulents was also reported. The pest is polyphagous and attacks the above-ground parts of at least two hundred plants species, such as ornamental plants and fruit crops (e.g. strawberry and black currants).

Various samples were tested for the quarantine fungus Karnal Bunt of which the most susceptible host is wheat. Wheat that contains more than 3% bunted kernels is considered unfit for human consumption. The fungus is a regulated pathogen and affects trade from SA. Various tests required identifications of the economically important fungal genus *Fusarium*. Amongst others, *Fusarium* strains identified from fodder is a threat to animal health and have been linked to kikuyu poisoning of cattle in the Eastern Cape.

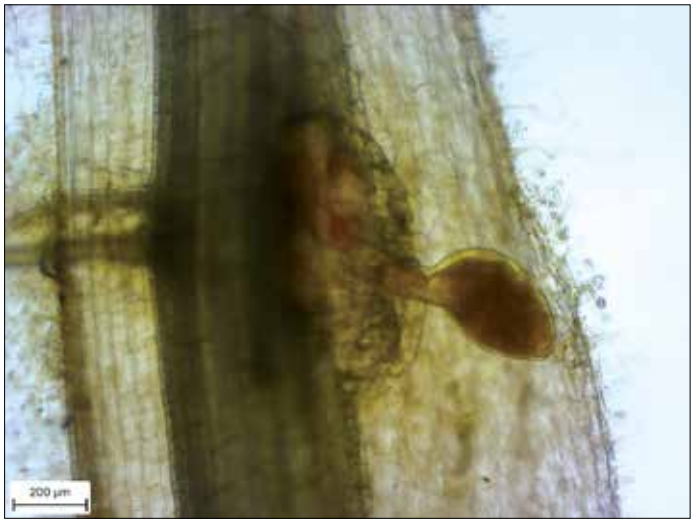
In a sample tested for *F. euwallaceae*, the *Fusarium* species associated with avocados and the polyphagous shot hole borer, was isolated. The papaya pathogen *Phytophthora palmivora* was reported for the first time in SA and can also cause significant damage and yield loss in other host plants such as citrus. Of interest is the simultaneous occurrence of the disease on papaya from two production regions which are more than 400 km apart, in the north-eastern parts of SA. This suggests that the disease may be linked to extreme climatic conditions, such as high temperature and severe drought, prevalent in both regions.

Phytophthora palmivora, a root and crown rot pathogen on papaya trees.

The first report for *Pectobacterium polaris* from potato was also recounted. Testing of honey and honey products continues unabated and support has been given to DALLRD on importation of such products from other countries. Information regarding the bacterial pathogen *Xylella fastidiosa*, a major threat to global trade of plant propagation material was provided to the National Plant Protection Organisation of DALLRD. The EU includes the pathogen in its lists of top quarantine organisms harmful to plants.

Due to the lack of curative products/strategies, the bacterium is able to destroy entire productions/sectors. The EU, originally dissatisfied with the reported status of the pathogen in South Africa, threatened a temporary ban on the importation of propagation material and fruits of citrus and grapevines

from SA. The ARC could provide information and results from samples destined for export that were tested and found free of the pathogen. Confirmation was done with prescribed molecular methods and therefore accepted by the EU.



Meloidogyne acronea, the first plant-parasitic nematode described from South Africa, female in the roots of sorghum.

The head (SEM) and anterior region (LM) of the sheath nematode, *Hemicycliophora typica*, a potential nematode parasite of macadamia trees.

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES.

WORKING TOWARDS SOIL HEALTH SOLUTIONS

The ARC has made significant progress in the development and delivery of integrated soil health solutions to commercial and smallholder farmers in South Africa. Collaborations with stakeholders, including the manufacturing of biological products, has enabled the screening of more than 50 nitrogen fixation strains for nodulation of leguminous crops under abiotic stress conditions anticipated as part of global climate changes currently being experienced. Preliminary results indicate that the SARCC collection contains a number of *Bradyrhizobium* strains able to significantly improve nodulation and nitrogen fixation efficiency under drought conditions when compared to products currently available on the market.

Investigations into the soilborne diseases of grain crops in cropping systems used by specifically black commercial farmers in the summer grain production areas are ongoing, with special emphasis on the development of management strategies. These include crop rotation/cover crops and seed treatments strategies. Preliminary results indicate that the correct identification of the disease complexes has important implications for the management strategies that will have to be developed during the second phase of this project.

Due to the interaction with farmers during sampling as well as the discussion and sharing of results of the previous surveys, an increased awareness is created of the importance of soilborne diseases such as crown and root rot in reducing yields of their crops and they are very positive about future research to develop management strategies. Such support to these farmers is extremely important to improve sustainable crop production and increased yield produced for summer grain crops.

Rhizobium screening trial with *Bradyrhizobium* strains from the rhizobium collection for nodulation and nitrogen fixation in soybean.

BIOCONTROL EFFORTS AGAINST ALIEN INVASIVE PLANTS CONTINUE TO DELIVER

The Weeds Research division of the ARC continued to evaluate and release new biological control agents against invasive alien plants (IAPs), as well as the field monitoring of the spread and impact of biocontrol agents previous released against IAPs.

Prosopis spp. ('mesquite') are thorn tree species native to South and North America that have become IAPs over vast areas of the drier western half of South Africa. Infestations of Prosopis spp. are especially a problem in the semi-arid Nama-Karoo biome of South Africa where impenetrable thickets of Prosopis soak up huge quantities of ground water and clog the inland drainage systems to the extent that it is now widely considered as South Africa's most important weed problem.

Biological control is considered to be the only cost-effective and sustainable method of managing the Prosopis infestations in these arid rangelands where extensive herbicide treatment or mechanical control is not economically viable. After over seven years of intensive host-specificity testing and evaluation in quarantine at ARC, approval was granted in December 2020 by DALRRD to release the leaf-tying moth biocontrol agent, *Evippe* sp. #1, against Prosopis spp. in South Africa. The release of >1000 *Evippe* moth caterpillars commenced in February 2021 at the Meerkat Reserve at the SKA site near Carnarvon in the Northern Cape province, and a further release of approximately 660 caterpillars was made in March in the North West province.

Other than the seed-feeding biocontrol agents previously released against Prosopis about 20 years ago, this is the first biocontrol agent that will physically damage and kill the plant, and therefore offers an important new weapon for the integrated management of invasive Prosopis spp.

The *Evippe* sp. #1, leaf-tying moth biocontrol agent released against invasive Prosopis spp. in South Africa.

An example of the ongoing war against IAPs was the importation of *Cochylis* flower-feeding moth as a biocontrol agent against pompom weed. This weed has the potential to greatly expand its range throughout the grassland biome in South Africa where it out-competes the native plants to negatively impact both biodiversity as well as stock grazing capacity. The ARC has already released a stem and flower deforming thrips, *Liothrips tractabilis*, as an effective biocontrol agent and has previously evaluated and obtained permission for the release of a second insect agent, the flower-feeding moth, *Cochylis campuloclinium*.

However, after more than seven years of delay due to problems in obtaining biodiversity export permits from Argentina, a new culture of the *C. campuloclinium* flower-feeding moth was finally imported in February 2021 and is currently being reared in the ARC quarantine facility. This is a major and important milestone for the biological control of pompom weed. This initial consignment consisted of 236 adult moths and 60 larvae that were transferred onto fresh bouquets of pompom flowers. The culture is being screened for parasitoids and the identity of the moth has been confirmed by the ARC.

The culture is now being nurtured through the diapause period during winter before releases can be considered in the late spring and summer season of 2021-2022. With no competitive interactions expected between *C. campuloclinium* and *L. tractabilis*, the two biocontrol agents should perform a complementary role of reducing both pompom flowering (*L. tractabilis* agent) and seed production (*C. campuloclinium* agent).

After new biocontrol agents are released, it is vital to monitor the establishment, spread and impact of the agent on the target IAP so that we know the value of the biocontrol agent for the management of the target IAP. An example of value of this long-term monitoring effort can be seen with the completion of thirty continuous years of post-release evaluations of the gall rust fungus, *Uromycladium morrisii* on *Acacia saligna*, in the Western Cape province.

This is the longest monitoring programme carried out on a pathogen biocontrol agent in the world. The Port Jackson gall rust fungus, first introduced in 1987, was renamed to *Uromycladium morrisii*, in recognition of the research undertaken on it by Dr Mike Morris (formerly ARC-PHP). During 1991, Dr Morris initiated the annual long-term monitoring of the impact of the rust fungus on Port Jackson, which continued until 2020, when 30 years of data had been collected.

Port Jackson killed by the gall rust fungus and galls on green wattle.

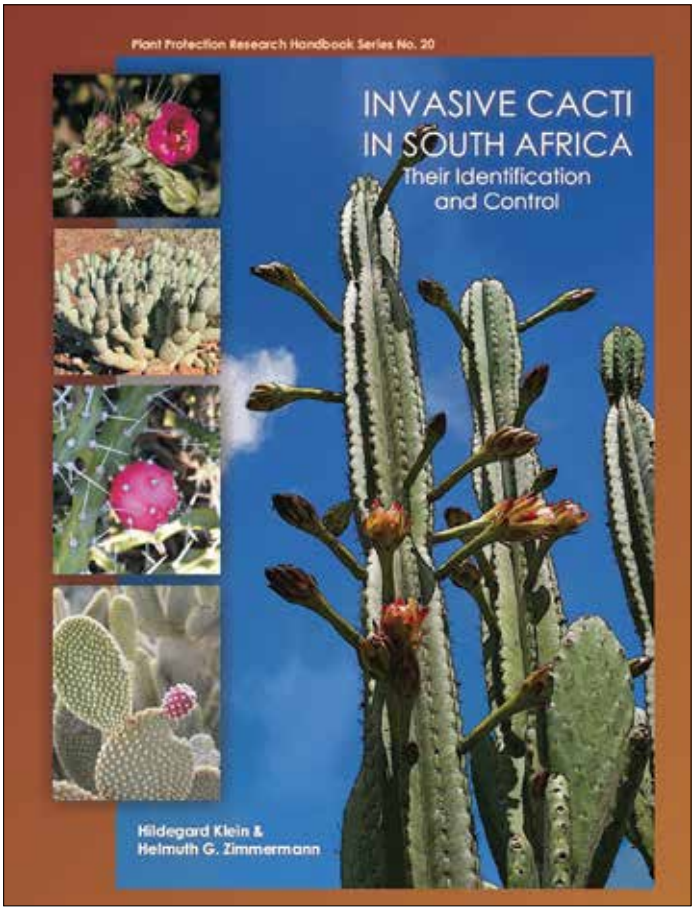
The average annual decrease in stand density across all sites and years currently stands at 8.8%, though this varies widely between sites and years. At most sites, stand density has declined by 80 to 97% over the course of monitoring.

Individual trees at four sites, which have been monitored since 2011, showed an average annual mortality of 11% by 2017. In another study that has been carried out annually for five years, it was shown that even healthy branches, which are not heavily impacted by stem galls from previous years, produced fewer pods as the number of galls on stems increased.

The ARC also has the responsibility to ensure that there is technology transfer of the results and biocontrol techniques of the ARC's biocontrol research against IAPs to the research community, conservation, Government agriculture and environment officials, landholders and the general public.

A recent example was the publication of a new book, 'Invasive Cacti in South Africa: their Identification and Control', (Plant Protection Research Handbook Series No.20. Hildegard Klein & Helmuth G. Zimmerman). The book was written by Hildegard Klein, who recently retired from her career in weeds biocontrol at ARC and Dr Helmuth Zimmerman, a former manager of Weeds Research and Assistant Director at ARC-PPRI. The main motivation for writing the book was to provide land managers with guidelines for controlling the invasive cactus species, which are a dominant group of invasive problem plants on both agricultural and conservation land in South Africa.

The book provides an introduction to the classification of invasive cacti found in South Africa, with excellent high-quality photographs and descriptive keys to the identification of species within three subfamilies and eleven genera, as well as six emerging invasive cactus species. The book bears testimony to the specialist expertise and dedication of the authors and will provide an enduring example of weed biocontrol in action.



New book on invasive cacti in South Africa.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

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Tropical and subtropical fruit

ARC-TROPICAL AND SUBTROPICAL CROPS

The main campus of ARC-Tropical and Subtropical Crops (ARC-TSC) is situated in Mbombela, Mpumalanga, in the heart of the Lowveld with its subtropical climate. The campus has several other research stations which are located in a wide range of agri-ecozones thus facilitating research on crop adaptation in different regions. The ARC-TSC campus develops and transfers a range of improved, sustainable and appropriate technologies right across the value chain for a variety of subtropical crops in order to enhance food and nutrition security, global competitiveness and wealth creation. This is achieved through harnessing national and international collaboration opportunities across multi-institutional, multi-disciplinary teams.

The campus is also custodian of several genebanks comprising several thousand accessions. New accessions are regularly added thus contributing towards genetic resource conservation, increasing genetic diversity for breeding new, improved cultivars as well as for the identification of tolerance to biotic and abiotic stressors, many of which are associated with climate change. The campus is also a post entry quarantine facility for plant material which is critical for ensuring biosecurity of the horticultural industry.

Analytical and diagnostic services are one of the cornerstones of the campus offering and various services are provided to a wide range of clients across a broad spectrum of disciplines. These services ensure that clients remain sustainable and competitive within their respective industries and enterprises. Critical to the sustainability of the tropical and subtropical crop industries, the ARC-TSC is actively involved in capacity development. Formal postgraduate development programmes allow young up-and-coming scientists to gain knowledge and experience while the more informal training programmes focus on smallholder and commercial sectors, the private sector as well as undergraduates and school learners.

The mandate crops of ARC-TSC include the following: (i) Macadamia, citrus, avocado, mango, litchi, banana, pineapple, papaya, granadilla, pecan, cashew, coffee and ginger; (ii) Medicinal plants, herbs and essential oil crops; (iii) Indigenous fruit; and (iv) Exotics such as carambola, surinam cherry, white sapote, annona and jaboticaba.

The ARC-TSC Campus research focus areas include: (i) Plant Breeding & Biotechnology; (ii) Pest and Disease Management; (iii) Horticultural Practices; (iv) Postharvest and Agro-Processing; (v) Smallholder Development; and (vi) Analytical and Diagnostic Services.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

MULTI-DISCIPLINARY APPROACHES ENSURE SUSTAINABILITY OF THE SOUTH AFRICAN LITCHI INDUSTRY

Although litchi is one of South Africa's smallest export commodities, volume-wise, the work carried out by the ARC has made a significant impact on the industry. The country's litchi breeding programme, which is led by the ARC, focuses on breeding and evaluation of litchi cultivars suited to South African conditions.

Almost 30 years ago, the industry relied on just two cultivars, however, with increasing competition from other litchi-producing countries in the southern hemisphere, it was critical that the litchi germplasm collection be expanded, so that new cultivars with improved traits such as colour, size and improved harvest date, could be developed.

Several litchi cultivars were sourced from various countries and genebanked with a view to not only evaluating their performance under South African conditions, but also using them as breeding parents. Research towards optimum pollen storage and efficient hand-pollination methodologies, as well as identification of appropriate male and female parents, has resulted in an effective breeding programme with a range of promising new selections and some cultivars already protected under Plant Breeders' Rights.

In order to release new, improved cultivars emanating from the breeding programme as quickly as possible, various methods for clonal propagation were considered including *in vitro* micropropagation and microcuttings. Clonal propagation is fraught with various challenges which must be overcome and furthermore, the success of these methods is also genotype dependent. Research showed that conditions for each genotype need to be optimised to ensure successful propagation. With the expansion of the litchi genebank, it became critical to ensure that a molecular tool be developed to assist in characterising genotypes.

Although litchi cultivars are usually identified using morphological characteristics these are not reliable. However, molecular markers can be used as a tool to assist in identification. A study by scientists at the ARC showed that sequence-related amplified polymorphism (SRAP) markers can be applied to litchi for assessing genetic relationships and molecular characterisation. The results provided evidence for the separation of cultivars based on maturation period i.e. harvesting time and fruit characteristics, two of the most important horticultural traits in litchi breeding.

Unfortunately, litchi is also particularly sensitive to temperature, and flowering requires low temperatures in winter to ensure good fruit set and yield. The various litchi cultivars also require a different number of cold units to stimulate flowering. With winter temperatures becoming increasingly warmer in subtropical regions where litchi is most suited, strategies to improve litchi flowering under warmer winter conditions are required.

Previous work has shown that ethephon applications can improve litchi flowering under these adverse conditions and subsequently, the gene expression studies have now revealed that ethylene, the breakdown product of ethephon, causes bud dormancy and delays bud break until such time when temperatures are more conducive to flowering.

These studies are the first of their kind that reveal the direct involvement of ethylene in the physiological and molecular regulations of dormancy and subsequent flowering. By using this strategy, growers are able to mitigate the adverse effects of climate change and ensure their competitiveness on export markets.

Rooted litchi micro-cutting showing vigorous vegetative flushing only eight weeks after planting.

By expanding the germplasm repository, litchi breeding parents are selected for the introduction of improved horticultural traits such as fruit colour or altered harvesting date.

Gene expression studies revealed the direct involvement of ethylene in the physiological and molecular regulation of dormancy and subsequent flowering.

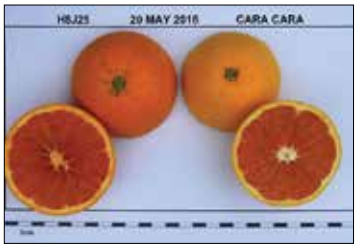
CITRUS AND SUBTROPICAL BREEDING PROGRAMMES FOCUS ON HIGH QUALITY CULTIVAR DEVELOPMENT FOR THE EXPORT MARKET

The ARC has well-established citrus and mango breeding programmes, both running for over 30 years, and which focus on the development of high quality cultivars targeted to meet specific market requirements. The breeding programmes use both conventional breeding methods as well as various mutation breeding and biotechnological tools to ensure high quality cultivars are bred. Mutation breeding allows the breeder to alter one or more negative characteristics of existing commercial cultivars, such as seediness, fruit shape, poor internal and external colour or time of ripening.

A new cultivar, ARCCIT2007 was granted Plant Breeders' Rights owing to its markedly improved fruit quality characteristics. This new cultivar, a 'Cara Cara' navel, is sweeter, has improved internal colour and is also of a size preferred by the EU markets. The mango breeding programme focuses on meeting both export and local market requirements and three open-pollinated selections were identified for commercialisation over the last two years! The latest selection is an attractive late mid-season fruit with a pink blush and good shape, high yield, excellent external colour and a sweet taste. Commercialisation of PBR-registered cultivars earn significant income in the form of royalties.

The new 'Cara Cara' cultivar, ARCCIT2007, produces uniformly-sized fruit which are ideal for the EU export market.

The latest mango selection bred by the ARC is an attractive late mid-season fruit with a pink blush, good shape and high yield.



ARCCIT2007 (left) has improved external and internal colour and has a sweet flavour.

Excellent internal and external colour as well as a sweet flavour are hallmarks of a quality mango selection.

NEMATODE HOST STATUS ASSESSMENTS ARE CRITICAL TO ENSURE SUSTAINABILITY

During the past two decades, synthetic nematicides have been increasingly withdrawn from markets due to environmental concerns. Alternative management strategies such as genetic host tolerance are needed to control plant-parasitic nematode infestation on soybean and follow-up crops. The host status of the commercially cultivated GM glyphosate-tolerant soybean genotypes in South Africa to the most common plant-parasitic nematodes (*Meloidogyne* and *Pratylenchus* spp.), was assessed.

36 Soybean genotypes (including 31 GM glyphosate-tolerant genotypes that are commercially available in South Africa) were assessed for tolerance to *Meloidogyne incognita* which is the predominant species locally. Under field conditions (pooled data), only 'PAN1583R' and 'PAN1521R' maintained less than 10% of the *Meloidogyne* spp. Pooled data for *Pratylenchus* spp. root densities were high for all genotypes, but varied substantially among them.

'PAN 1664 R' maintained the lowest lesion nematode densities, although not <10% of the most susceptible genotype, and it is suggested that this genotype will be the best choice to plant to limit increased lesion nematode infections. This is also the first study that gives an indication of the host status of soybean genotypes to lesion nematodes. The higher abundance of root-knot and lesion nematode species recorded for the field study compared with those reported 19 years ago when the first official nematode-soybean survey was undertaken, is extremely concerning.

It underlines that host status assessments of genotypes (GM glyphosate-tolerant-dominated) to economically important nematode pests should be carried out continuously to minimise the damage caused by these pests and ultimately enable the sustainable production of crops in nematode-infested soils.

This work showed how extremely important host status assessments are to ensure sustainable production. Such assessments could be applied to other nematode-susceptible horticultural crops to ensure their sustainability.

It is critical that host status assessments are carried out on soybean to ensure sustainable production.

Different soybean genotypes were assessed for their tolerance to *Meloidoigyne* and *Pratylenchus* spp.

OUTCOME 2: SUSTAINABLE ECOSYSTEMS AND NATURAL RESOURCES.

FRUIT FLIES ASSOCIATED WITH THE PEPPERBARK TREE (*WARBURGIA SALUTARIS*)

The ARC has actively been involved in, and is a key stakeholder, in the Pepperbark Conservation Programme and Working Group. The programme seeks to conserve the species by understanding the distribution and conservation status of the species within and outside protected areas. One of the key success factors is the propagation and distribution of plants to primarily traditional healers in communities adjacent to protected areas, for example the Kruger National Park, amongst others. This has markedly reduced incursions into protected areas.

Pepperbark, *Warburgia salutaris* (Family: Canellaceae), is one of the most highly prized indigenous tree species in southern Africa due to its high medicinal value. It is currently listed as Endangered in the IUCN red data list which describes the global conservation status of plant and animal species. Being a multi-use species, unsustainable bark harvesting has resulted in trees that are effectively ring-barked and then die several months after harvesting.

Unfortunately, flowering is generally sporadic and it was found that fruit set and development were exceptionally low in Mpumalanga and Limpopo provinces due to a high degree of parasitism by fruit flies and fruit fly larvae. The seeds are therefore unable to develop within the fruit and recruitment of new plants does not take place.

Scientists at the ARC sampled fruit and trapped fruit flies from various localities in Mpumalanga. While several insect species were trapped in close proximity to pepperbark trees, the only fruit fly species which emerged from the fruit was the marula fruit fly, *Ceratitis cosyra* (Walker) (Diptera: Tephritidae). The infestation index was extremely high with almost 3000 adult fruit flies per kg of fruit recorded at one of the localities!

Pepperbark fruit are typically infested with *Ceratitis cosyra* larvae making the seeds non-viable.

Traps were hung at various localities to determine which insect species were present during fruit development.

Ceratitis cosyra was the only fruit fly species to emerge from infested fruit.

Bait stations and sanitation can be used for the suppression of fruit fly numbers to reduce the infestation index and ensure viable seed development. Where seed production trees are cultivated, fruit can be covered with bags or sleeves to protect against fruit fly infestation. For propagation purposes, fruit fly trapping and fruit inspection should also be carried out to ensure quality seed production.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

ORGANIC SOIL AMENDMENTS AND PIT-COMPOSTING TREATMENTS ARE A NATURAL STRATEGY TOWARDS CONTROLLING NEMATODE PESTS

Vegetable crops are commonly grown by both commercial and resource-poor farmers in South Africa. They are widely used as fresh and processed products and as a result serve as an income for subsistence farmers. However, vegetables are subject to attack by a large number of pests, such as insects and nematodes. Plant-parasitic nematodes are among the most important pests of vegetables and cause substantial quality and quantity yield losses.

Soil amendments comprising various plant and animal sources were evaluated in-field for their effects on *Meloidogyne* spp. (root knot nematode) infecting tomato in comparison with a commercial nematicide (fenamiphos) and untreated control. Under field conditions, the plant-based pit-composting treatments decreased nematode population densities by up to 94% and significantly enhanced yield by up to 400%. By using non-chemical-based treatments, high costs and toxicity are significantly reduced, and naturally occurring biological control agents are also encouraged.

This natural pest control strategy has the potential to significantly increase yields, income and sustainability in home and community gardens. Higher production will ensure consistent food and nutrition security and improve health.

Organic soil amendments significantly decreased nematode population densities resulting in significantly enhanced plant growth and yield of tomato.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Cronje, R.B., Ratlapane, I.M., Rohwer, E.A., Hoffman, E.W., & Huang, X.M. 2020. Carbohydrate reserve dynamics as influenced by shoot control strategies and climatic conditions prior to flowering in 'Mauritius' litchi. *Acta Horticulturae.* 1293: 155-165.

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Mbatyoti, A., De Beer, A., Daneel, M.S., Swart, A., **Marais, M.**, De Waele, D. & Fourie, H. 2021. The host status of glyphosate-tolerant soybean genotypes to *Meloidogyne incognita* and *Pratylenchus* infection. *Tropical Plant Pathology.* DOI:10.1007/s40858-020-00416-y.

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THESES AND DISSERTATIONS

Masters

Mabirimisa, A. 2020. Morphology, reproduction, pollen viability and germination of imported litchi cultivars, Master of Science, University of the Free State.

Doctoral

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CHAPTERS IN BOOKS

Sippel, A. 2020. Mango production around the world - Republic of South Africa. In Al Kindi N.B. *et al.* (Eds) T*he Mango Tree Encyclopaedia.* Volume 4 (1), Chapter 17: 269-316. Royal Court Affairs, Muscat, Sultanate of Oman.

Potato flowers

ARC-VEGETABLE, INDUSTRIAL AND MEDICINAL PLANTS

For the ARC to achieve its constitutional mandate under a resource-constrained environment, it needed to undertake measures geared towards effective and rational resource utilisation. As part of the resource rationalisation initiative, the ARC took a decision to evaluate the feasibility of amalgamating campuses with similar R&D products and within a manageable geographic distance. As part of this initiative, the ARC-Industrial Crops (ARC-IC) Campus at Rustenburg was amalgamated with the ARC-Vegetable and Ornamental Plants (ARC-VOP) Campus at Roodeplaat. The name of the new business unit is the ARC-Vegetables, Industrial and Medicinal Plants (ARC-VIMP).

The ARC-VIMP Campus conducts innovative, needs-driven, applied and adaptive research, and environmentally-friendly research and technology development on commercial vegetables, African leafy vegetables, medicinal (including medicinal cannabis), and industrial crops, such as cotton, tobacco, hemp, flax, kenaf, cassava and sisal. Research involves a variety of disciplines, including crop science, agronomy, crop protection, breeding, genetics, biotechnology, agro-processing and product development. The aim is to conduct research and technology development and transfer for improving the productivity, competitiveness and sustainable production of vegetables, as well as industrial and medicinal plants for the agricultural industry.

The nutrient content of vegetables is a key factor in addressing malnutrition and the campus plays a significant role in the development of models for food and nutrition security. The ARC conducted an impact study of vegetable research and it was determined that for every R100 invested in vegetable research an improvement of R140 was realised in the industry as a whole, which clearly demonstrates the importance of vegetable research for South Africa.

The breeding programmes focus on the development of cultivars with improved resilience against agricultural risks, including improved drought tolerance, pest and disease resistance, as well as increased quality, including nutritional, and yield. It also maintains the genetic resources of the mandated crops as national assets. Crop Sciences focuses on the development of propagation and sustainable production systems for vegetables, industrial and medicinal plants, identifying crops with good water use efficiency and development of water and nutrient efficient production systems. Agro-processing and new product development from medicinal plants, indigenous/African vegetables, and industrial crops is a key programme of the campus. The crop protection research focuses on the development of integrated pest and disease management mechanisms for economically-important pests and diseases of vegetables, industrial and medicinal plants. The campus delivers several services to the industry, including diagnostic analyses and feasibility studies, training and enterprise development and rural development.

OUTCOME 1: INCREASED AGRICULTURAL PRODUCTION AND PRODUCTIVITY.

ARC POTATO BREEDING PROGRAMME 71 YEARS OLD

The potato breeding programme founded in 1950 turned 71 years old in 2021. Over the years it produced a number of varieties that assisted the potato industry to become world-class, allowing the industry to become competitive in global markets. To date, BP1 is the most successful variety from this programme to be planted in South Africa, with over 80% of the market share.

Mini tuber production eThekwini.

Since the development of BP1, the industry has changed and Plant Breeders' Rights have become the ultimate marketing tool. With the onset of the new millennium the newer varieties bred by the ARC reached 10% of the market share around 2007, thanks to partnerships with other role players. The ARC is now in a position to take charge of its own destiny through the marketing of its new varieties.

The breeding programme also embarked on a dedicated crossing programme to produce improved starch varieties. The starch industry is one of the new opportunities, with two varieties identified (ARC-PT1301 and ARC-PT1302) as key to the future success of this industry. Production of the seed for this industry has already started with the first mini-tubers of both varieties planted close to Springbok in the Northern Cape.

Two new breeding lines in the process of registration have already made their mark, with McCain Foods taking up the rights of one to produce frozen chips in South Africa. A further two new varieties are in the process of being described for release later in 2021/2022.

The breeding programme has now come full circle through the use of South African varieties dating back 70 years. As in the 1950's, the breeding programme, against huge odds, is again shaping the future of the potato industry. Not only is the future in the hands of breeders in South Africa, but all royalties earned with the new South African bred varieties will remain in South Africa, and will be utilised to breed improved varieties and train farmers in using these varieties.

With its new potato varieties and the willingness to share knowledge and resources, the ARC is changing the face of small farmer potato production in South Africa. Small farmers are now producing mini-tubers from *in vitro* plants in screen houses to reduce seed input costs.

Potato field production Springbok.

SWEET POTATO BREEDING AND COMMERCIALISATION OF ARC SWEET POTATO CULTIVARS

Sweet potato is the second largest root crop produced in South Africa, after carrots, with an estimated gross value of R270 million annually. The crop is popular amongst small-scale farmers because of its resilience and contribution to food and nutrition security.

The ARC has a reputation as a leader in sweet potato research and development. The sweet potato breeding programme aims to import, maintain, develop and evaluate breeding lines towards addressing food security and malnutrition, and for income generation. The sweet potato commercialisation strategy focuses on major commercial producers, companies supplying fresh produce to major retailers, emerging processors, the Sweetpotato Vine Growers Association (SPVGA), emerging entrepreneurs and international role players.

Four Material Transfer Agreements (MTA's) were signed towards royalty earnings for the ARC and five more are in progress. Three licensing agreements are in progress for the use of ARC varieties in agro-processing.

The major event of the year was the virtual orange-fleshed sweet potato stakeholder workshop hosted jointly with McCain, the International Potato Centre (CIP) and the Southern Africa Network for Biosciences (SANBio), attended by participants from as far as the USA. The workshop promoted shelf-stable OFSP puree and also served to highlight the ARC's significant contribution to research and development on sweet potato.

Taste benchmarking was conducted by Farmwise, which indicated that the market demand for fresh sweet potatoes is slowly changing to incorporate the availability of more types, specifically sweet tasting, dry-textured cultivars opposed to moist, soft types.

Twenty elite lines, with the flesh colour varying from cream to orange, were evaluated at various agro-ecology sites and production levels. The new lines offer good keeping ability, a medium dry texture and storage roots with a uniform round elliptical shape. It is an opportunity for the ARC to provide wider options to commercial companies in terms of varieties.

Furthermore, evaluation trials at three experimental stations (Tompi Seleka, Tovoomba and the University of Venda) and one on-farm demonstration trial in Bokfontein identified some promising orange-fleshed lines (2014-13-1, 2014-7-3 and 2015-1-6), and a cream-fleshed line (2014-14-5), therefore applications for Plant Breeders' Rights were submitted.

The sweet potato disease-indexed scheme issued plantlets in seedling trays and four-node cuttings to local commercial and small-commercial producers/vine growers and to two international clients. In this way the ARC ensures that the sweet potato industry remains profitable, since the destructive effect of viruses on sweet potato yields are curbed.

Cuttings from the foundation nursery at Roodeplaat were disseminated to six SPVGA members in three provinces in order to refresh their vine multiplication blocks. This process is critical to reduce virus and disease build-up in planting stock and to increase the availability of improved ARC varieties to small-scale farmers.

New ARC sweet potato lines 2014-14-5 and 2014-7-3 producing a large percentage of marketable roots per plant.

Collaborative sweet potato advanced yield evaluation trial being harvested at the Tovoomba research station, Bela-Bela.

FUNGICIDE TOLERANCE IN *ALTERNARIA* SPECIES ON POTATO IN SOUTH AFRICA

Brown spot and early blight of potatoes in South Africa are caused by the fungal pathogens *Alternaria alternata* and *A. solani*. Control of these pathogens is difficult due to their ability to develop tolerance to fungicides. Until 2020, no fungicides were registered for the control of brown spot and farmers used fungicides registered for the control of early blight on potato. Up-to-date information on the fungicide sensitivity of different *Alternaria* species from the various potato production regions in South Africa is lacking.

In a project funded by Potatoes South Africa, *Alternaria* species isolated from symptomatic potato leaves collected from the different potato production regions have been tested for sensitivity against five classes of fungicides registered for the control of early blight in South Africa. The Fungicide Resistance Action Committee (FRAC) groups fungicides with similar modes of action together under a numerical code.

Results confirmed wide-spread tolerance to azoxystrobin, a quinone outside inhibitor type fungicide (FRAC group 11), in *A. solani* and *A. alternata* isolates from the Eastern Free State, South Western Free State, North Eastern Cape, KwaZulu-Natal, Sandveld (Western Cape), Mpumalanga and the northern and southern areas of Limpopo. Isolates from the Eastern Free State, South Western Free State, North Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga also showed tolerance to fluopyram, a succinate dehydrogenase inhibitor type fungicide (FRAC 7).

Mpumalanga, KwaZulu-Natal and the Sandveld are thus far the only regions where isolates tolerant to procymidone, a dicarboximide fungicide (FRAC 2) have been isolated. While most isolates are still susceptible to organo tin (FRAC 30), some isolates do tolerate this fungicide. A single isolate from KwaZulu-Natal tested tolerant to fungicides from FRAC groups 7, 11 and 30, while another isolate from Mpumalanga tested tolerant to fungicides from FRAC groups 2, 7 and 11.

Isolates with tolerance to multiple groups of fungicides have the potential to cause severe crop losses if they become dominant in an area. Isolates that acquire tolerance in one region can be disseminated to other areas, thereby making fungicides used in all areas less effective.

Farmers and CropLife South Africa have been informed of these findings through various media to encourage proper fungicide resistance management on farms. This may require adjustments in current spraying programmes to avoid the use of those classes of fungicides for which tolerance already exists.

The widespread loss of sensitivity to fungicides commonly used to control early blight and brown spot is concerning, and the study highlights the importance of proper resistance management regimes by all producers to prolong the useful lifespan of fungicides used to control early blight and brown spot on potato in South Africa.

Healthy potato plants.

Potato plants infected with *Alternaria* species.

MOLECULAR CHARACTERISATION OF VEGETABLE VIRUSES

Swiss chard, beetroot, mustard spinach and other brassicas play an important role as food and nutrition security crops, and as crops that generate income for smallholder and emerging farmers throughout the country, mostly through the employment of youth and women.

Surveys conducted in 2015/2018 in different regions of the Gauteng Province (Germiston, Randfontein and Pretoria) indicated the need to identify the viruses causing production losses to develop effective control measures. Complete genome sequencing and further confirmation with cloning and sequencing of the coat protein gene, confirmed the infection of Swiss chard with the *Beet mosaic virus* (BtMV), a first report in South Africa. Co-infection of BtMV with other viruses, such as *Beet chlorosis virus*, causes severe stunting and production losses of between 30% and 40%. BtMV causes interveinal yellowing and mottling of leaves, making them unmarketable at fresh produce markets.

A molecular method for the rapid detection of BtMV was developed, enabling the timeous recommendation of control measures. Smallholder, emerging and commercial farmers can thus prevent production losses, which results in increased income generation and profitability.

A. Healthy Swiss chard leaf.

B. Swiss chard leaves infected with *Beet mosaic virus*.

OUTCOME 3: IMPROVED NUTRITIONAL VALUE, QUALITY AND SAFETY OF AGRICULTURAL PRODUCTS.

PARTICIPATORY SCHOOL-BASED VEGETABLE GARDENS IN MAMELODI, GAUTENG PROVINCE

School-based participatory vegetable gardens are a long-term strategy that complements supplementation and food fortification programmes to address hidden hunger. Running a school garden requires horticultural knowledge and enthusiasm, organisational capacity, and the ability to mobilise parents and communities in the area.

This project, commissioned by the Water Research Commission (WRC), established sustainable and productive vegetable school gardens at two schools (Bula Dikgoro and Mahlasedi Masana public primary schools) in Mamelodi East, Pretoria, Gauteng Province, South Africa, to improve access to vegetables, as these crops could potentially be used in the school meals or be sold as a source of income.

The project identified that training of educators and garden personnel, provision of gardening equipment and technical advice, infrastructure, the involvement of parents and other community members, and support by government and various role players are critical for the success of school gardens. The project, therefore, provided AgriSETA accredited vegetable production training to capacitate the school garden beneficiaries.

The vegetables were planted based on their suitability to the area and nutritional value. New biofortified crops (e.g. orange-fleshed sweet potatoes) and healthy new crops (e.g. morogo and kale) were introduced to promote consumption in the schools and the community. Open-field vegetable production systems were supplemented with vegetable tunnel production and bag production systems to improve vegetable accessibility, pest and disease management and optimise resource utilisation.

The adoption of climate-smart production systems (vegetable tunnel production and bag production systems) is also critical, as this can be implemented in combination with rooftop rainwater harvesting to mitigate the effects of climate change for maximum crop productivity and a reduced risk of crop failure. Rainwater can be stored in tanks for supplementary irrigation of crops at critical periods of the crop-growing season or in the event of prolonged dry spells. The metal roof tested in the study had a runoff collection efficiency of approximately 70% but the potential amount of rainfall collected through the rooftop rainwater harvesting technique is dependent on the availability of water storage tanks at the schools.

We also recommend implementing a bag production system due to its capability to cultivate a considerably higher number of plants per unit area, and resulted in a more than 30% increase in crop yield per m^2 of land utilised, and therefore higher crop water use efficiency. This has excellent potential to be rolled out to other schools. It was recommended that schools encourage children to report what they are doing at school, invite families to visit the gardens, create model gardens and distribute seedlings.

Rainwater harvesting in a Mamelodi school garden.

Vegetables from the school garden being served to learners.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

FARMER SUPPORT AND TECHNOLOGY TRANSFER

Although South Africa is considered a 'food-secure' nation, and is producing enough calories to adequately feed its 53 million people, there is still an aggravated level of hidden hunger, with one in four people in South Africa currently suffering from hidden hunger.

More than half of the population live in conditions of extreme poverty, without access to nutritious food that is particularly rich in micronutrients such as vitamins and minerals, which are required for adequate human growth and development. The situation has become even more serious due to the COVID-19 pandemic, resulting in increased unemployment rates and a greater number of people who are unable to access food to meet their daily needs.

The ARC is participating in the skills development of youth (18-35 years of age) in vegetable production and agro-processing as part of a broader contract that the ARC has with the National Rural Youth Service Corps (NARYSEC) programme of the Department of Agriculture Land Reform and Rural Development (DALRRD). Rural youth are recruited to equip them with agricultural skills needed for enterprise development.

The ARC trained 280 NARYSEC programme participants from eThekwini (KZN), Waterberg (Limpopo) and OR Tambo (Eastern Cape) as part of the District Development Model (DDM) on various aspects of agriculture. A new approach is for the ARC to collaborate with provincial agricultural colleges, such as Tompi Seleka, Cedara and Fort Cox, to present some of the modules.

Hand tools were purchased by the ARC and distributed to all trainees. The ARC also took part in a feasibility study to determine whether the identified land was suitable for production, and recommended crops to be planted and highlighted the risks that the youth should look out for.

During the COVID-19 lockdown, virtual training was conducted at all campuses. However, the challenge was that practical demonstration sessions could not be done, and this needs to be developed.

Other farmer supporting activities included the participation of farmers in an agrosylviculture survey, and training in rainwater harvesting and irrigation, potato and citrus disease management, sweet potato production challenges, organic farming and hydroponic vegetable production.

The ARC contributed to the successful launch of the Imvelo Urban Farms Food Systems project, established by the Department of Family Medicine, University of Pretoria, to assist in the fight against hidden hunger and malnutrition in the most vulnerable communities of South Africa.

As an agricultural partner, the ARC's role is to introduce vegetable production systems through vegetable garden demonstrations and beneficiary training sessions. During the launch, the ARC introduced household members to sweet potato, Moringa and mushroom production, product development, and resource-efficient vegetable production using the bag and bottle hydroponic systems. This increased community members' awareness of vegetable production systems and practices, as well as of the associated benefits in curbing food insecurity, and will improve dietary intake and strengthen family relationships.


Sweet potato vine dissemination and planting demonstration at Jericho, Northwest.

Demonstrating growing of vegetables in space-efficient production systems, such as the bag system at the Imvelo Food Garden Project, Cemetery View, Pretoria.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

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Doctoral

Naidoo, S.I.M. 2020. Enhancing the nutritional quality of sweetpotato (*Ipomoea batatas* L. Lam) through breeding. Doctor of Philosophy (Plant Breeding), University of KwaZulu-Natal.

Nkosi, B.Z. 2020. Characterisation of *Fusarium Oxysproum* species complex associated with fusarium wilt of sweet potato in South Africa. Master of Science, University of South Africa.

Pulele, L.B. 2020. Yield, pre- and post-harvest quality of sweet melon (*Cucumis melo* L.) cultivars grown in hydroponics system. Master of Technology (Agriculture), Tshwane University of Technology.

CHAPTERS IN BOOKS

Maponya, P., Venter, S.L., Du Plooy, C.P., Backeberg, G.R., Mpandeli, S., & Nesamvuni, E. 2020. Chapter 9: Timber-Based Mixed Farming/ 9 Agroforestry Benefits: A Case Study of Smallholder Farmers in Limpopo Province, South Africa. Book Chapter In: *Global Climate Change and Environmental Policy, Springer, Singapore* pp 275-302.

Maponya, P., Venter, S.L., Du Plooy, C.P., Oelofse, D., Van Den Heever, E., Manyaga, C., Nyirenda, O., Masuku P., & Mahlangu, M. 2020. Chapter 14: Mechanism for Improving the Sustainability of Homestead Food Gardens in the Gauteng Province, South Africa. Book Chapter In: S*ustainable Bioeconomy. Springer, Singapore pp* 303-323.

Maponya, P., Venter, S.L., Du Plooy, C.P., Van Den Heever, E., Manyaga, C., & Nyirenda, O. 2020. Chapter 3: The Status of Climate Variability and Food Accessibility: A Case of Households in Gauteng Province, South Africa: Book Chapter In: *Exploring Synergies and Trade-offs between Climate Change and the Sustainable Development Goals, Springer, Singapore* pp 55-82.

Seko, J., Bain, E., & **Maponya, P.** 2020. Chapter 9: Assessing the Impact of Indigenous Knowledge Systems on Sustainable Agriculture: A Case Study of the Selected Communities in the City of Tshwane Metropolitan, Gauteng Province, South Africa. Book Chapter In: *Sustainable Bioeconomy. Springer, Singapore* pp 183-208.

CONFERENCE PROCEEDINGS

Gerrano, A.S., Van Rensburg, W.J., Bairu, M., Amoo, S., & Venter, S. 2020. Selection of okra (*Abelmoschus esculentus*) collections based on seed minerals and total phenolic content. *Acta Hortic.* 1282. ISHS 2020. DOI 10.17660/ActaHortic.2020.1282.65 XXX IHC – *Proc. II Int. Symp. on Plant Breeding in Horticulture* Eds.: N. Sari *et al*. page 433-440, 11-16 August 2018, Turkey, Istanbul.

Honeybush Nursery

ARC-IMPACT AND PARTNERSHIPS

The ARC-Impact and Partnership Division predominantly focuses on the translation of research outputs to generate knowledge, facilitate decision-making and contribute to the transformation in the agriculture sector, whilst applying sound resource management practices towards a high performing and visible organisation.

Dedicated programmes of the Division include:

The ***Agricultural Economics*** unit conducts research to establish the impact of ARC programmes (return on investment) and integrates socio-economic analysis into ARC projects. It specifically deals with market intelligence; impact assessment; business plans; policy and baseline studies.

Biometry provides statistical services as quality audit of scientific information disseminated. Services include planning, analysis and interpretation of results, training and scientific publication review.

Intellectual Property Management and Commercialisation's role is to ensure that research and development outputs are identified, protected and commercialised.

International Relations pursues partnerships to enhance our international credibility by promoting ARC capabilities with global role-players, through strategic partnerships and engagements.

Marketing and Communications develops and implements strategies to raise the organisation's profile and visibility, and improve internal communication to foster a strong, positive ARC brand.

Smallholder Agricultural Development entails extension support, farmer training and support to facilitate smallholder farmer access to ARC information thereby contributing to sector productivity and transformation; diagnostic and analytical services; targeted development initiatives; and farming systems research.

Strategic Information Management targets data capture, storage and use related to monitoring and evaluation of R&D, specifically related to land and farmer assessment.

The Division operates from ARC-Central Office in Pretoria, but works strategically across the organisation, with all Campuses spread across the country.

OUTCOME 4: A SKILLED AND CAPABLE AGRICULTURE SECTOR.

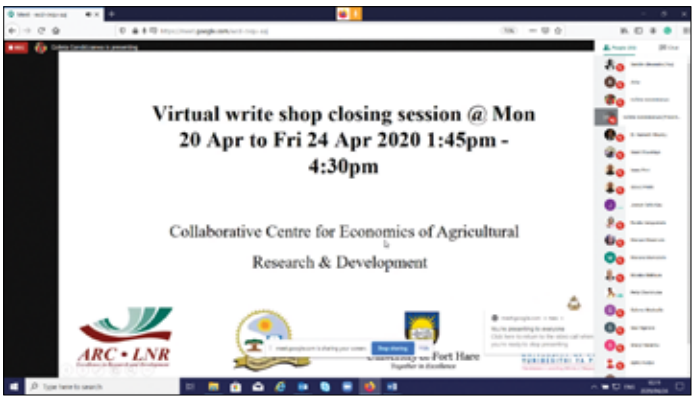
AGRICULTURAL ECONOMICS "ADAPTING TO THE ONLINE CULTURE TO RAISE THE ARC FLAG"

Within the space of a few weeks during March-May 2020, the concept of virtual meetings took over our lives. The ARC Collaborative Centre for Economics of Agricultural Research & Development (CoC) embraced this, and took it a step further by organising not just meetings, but rather a workshop at a time when companies were still trying to figure out what to do about planned conferences!

An online write shop was hosted on the Google Meet Platform from 20-24 April 2020, from 08h30-16h00. Each day started with a 30 minute plenary session to outline the day's individual goals and report progress from the previous day. The final session on Friday afternoon included presentations by all participants. Breaking new ground is not easy, as the write shop was held just about a month after the implementation of the hard lockdown, but participants welcomed the challenge.

Online write shops showed benefit, as there was higher attendance of especially experts (Professors), than in normal write shops as they were able to connect inbetween their meetings and the logistical challenges were minimal, especially in terms of travel. Participants were also able to work until late and in their quiet spaces. A total of 20 papers were conceptualised and first drafts developed during the week.

Challenges faced were mainly around poor connectivity, particularly for students. The experience was remarkable as it helped us connect and motivate each other to work during a very difficult time.



Virtual write shop held during the COVID-19 hard lockdown by the ARC's Collaborative Centre on Economics of Agricultural R&D.

BIOMETRY

The Biometry unit provides statistical services to ARC and scientists from industry, government and universities. The unit generates external income from these engagements and market the ARC and its services. The biometricians aimed to review 44 scientific articles during the year, but due to limited mobility during the pandemic, scientists were able to review 79.

The unit also exceeded its target of 11 publications and co-authored 18, reviewed 21 proposals instead of the targeted eight and furtermore exceeded the targets for consultations and external income by recorded 2988 consultations with ARC and external scientists collectively, earning R521 411 in external income.

INTELLECTUAL PROPERTY MANAGEMENT AND COMMERCIALISATION

The Intellectual Property Management and Commercialisation Unit concludes on, and appoints potential licensees for the commercialisation of the ARC IP. It uses different interventions to expose new IP, including open demonstration days, information sessions, etc. When the Minister of Agriculture, Land Reform and Rural Development, declared food security an essential service, it gave the Unit an opportunity to showcase new IP and engage potential licensees.

The IP and Commercialisation as well as Marketing and Communication units, held information sessions for the ARC breed cultivars. The information sessions held were to market the ARC winter grain cultivars for commercialisation purposes. These sessions were held at Tygerhoek, Western Cape; Bethlehem, Free State and Northern Cape. Different companies attended the sessions at different locations and, as per their interest, in particular cultivars for specific areas.

Information Session for oats and wheat cultivars at Tygerhoek, Western Cape.

INTERNATIONAL RELATIONS

The ARC continues to pursue and maintain International Partnerships with agricultural R&D stakeholders to ensure collaboration in thematic areas of common interest. In this period, the ARC strengthened the French partnership with the Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD) and French *Institut National de Recherche Pour l'agriculture, l'alimentation et l'environnement* (INRAE).

This tripartite cooperation framework ensures collaboration between the three institutions recognising the MoU between ARC and INRA in March 2014, and ongoing collaboration between the ARC and *Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement* (CIRAD). The MoU was virtually signed on 24 July 2020. Areas of mutual interests for collaboration include agricultural innovation systems, impact analysis, smallholder farming systems, biosecurity, food security, climate change adaptation, natural resource management, job creation and others regarding agricultural development.

Virtual signing ceremony for the Memorandum of Understanding between the ARC, CIRAD and INRAE on 24 July 2020.

STRATEGIC INFORMATION MANAGEMENT (SIM)

The SIM unit drives a work package in the DIVAGRI (Revenue Diversification in Africa through bio-based and circular Agricultural Innovations) project; an international incentive sponsored by the European Commission. DIVAGRI tests seven bio-based innovations targeting farming inputs, practices and market access that are integrated in existing smallholder systems and assessed in terms of agronomic, environmental, social and economic sustainability.

The ARC team engages farmers in five African countries, describing production systems and livelihoods, informing the solutions tested. The project addresses transition to a circular bio-economy towards socio-economic and environmental sustainability. An assessment toolkit used for farm evaluation has been digitised, in order to allow for online expert panel appraisal.

This functional application can be used on a mobile or desk top device, addressing a key limitation in agricultural transformation, namely a lack of data on land and farmer potential and performance. It can add value to the South African agricultural support system and should influence support strategy and policy, eventually stimulating agricultural development.

TRAINING AND EXTENSION

Keeping up with digital technology trends to assist farmers across South Africa. In the ARC's efforts towards a sustainable sector through sound advisory services; the unit developed a mobile application. The App provides an advisory services platform that supports on-farm decision-making through accurate and timely information at every stage of production.

Different mobile platforms to access the ARC Hub app.

The ARC Hub mobile application delivers information and access to ARC experts at a click of a button. It hosts 158 manuals related to plant and animal production, agro-processing, plant and animal health, developed by scientists across the ARC. It also provides information on ARC training services; up-to-date weather forecasts and an early warning system that allows information sharing between farmers and researchers.

Furthermore, it provides information on ARC training services; up-to-date weather forecasts and an early warning system that allows information sharing between farmers and researchers. It also includes up-to-date marketing data obtained from the national Department of Agriculture Land Reform and Rural Development. The App currently has 3759 users and continually receives positive feedback. It is available free of charge on android play store, apple app store and (www.archub.agric.za).

ARC Facilitating Skills Development among Youth.

In fulfilment of the ARC's mandate of facilitating sector skills development through technical support, training and enterprise mentoring, 185 youth were trained on Social Facilitation Skills in KwaZulu-Natal. The training was part of a project for the Department of Agriculture Land Reform and Rural Development (DALRRD), under the National Rural Youth Service Corps (NARYSEC), a youth development programme. The programme, which has been running for over six years was repackaged to facilitate gainful employment and sustainable enterprise development to support income generation.

Training in soil classification and fertility management, vegetable production, organic farming, agribusiness (marketing and entrepreneurship), poultry production, agro-processing and social facilitation was provided.

The Social Facilitation Skills course focused mainly on transfer of skills and knowledge in order to capacitate the youth for collective project work and create social cohesion.

Youth trained at KwaMkhizwana, Shangase, eThekwini, KZN.

KNOWLEDGE DISSEMINATION

Some of the knowledge dissemination interventions for 2020/21 include the following:

JOURNAL ARTICLES

Human, C., De Beer, D., Aucamp, M., Marx, I.S., **Malherbe, C.J.**, Viljoen-Bloom, M., **Van der Rijst, M.**, & **Joubert, E.** 2019. Preparation of rooibos extract-chitosan microparticles: Physicochemical characterisation and stability of aspalathin during accelerated storage. *LWT - Food Science and Technology*, volume 117, 108653. https://doi.org/10.1016/j.lwt.2019.108653.

Kau, J.S., Mmbengwa, V.M., & Swanepoel, J. 2020. Small-scale citrus farming among selected countries: Determinants for exports and production. *Journal of Human Ecol*, 72(1-3): 199-210.

Loki, O., Mudhara, M., & **Pakela-Jezile, Y.** 2020. Factors Influencing Farmers' use of different extension services in the Eastern Cape and KwaZulu-Natal Provinces of South Africa, *South African Journal of Agricultural Extension*, Vol. 48 (1): 84-98.

Mahlangu, S.A., Belete, A., Hlongwane, J.J., Luvhengo, U., & Mazibuko, N. 2020. Identifying Potential Markets for African Leafy Vegetables: Case Study of Farming Households in Limpopo Province, South Africa. *International Journal of Agronomy,* https://doi.org/10.1155/2020/8819295, 8 pp.

Mahlangu, S.A., Masemola M., Matsaunyane, L.B.T., Letsaolo, S., & Luvhengo U. 2020. Reviewing the current state of extensionin Gauteng Province: Case of food security subdirectorate. *Journal or Critical Review,* Volume7 (13), 241-244. doi:10.31838/jcr.07.13.41.

Mahlangu, S.A., Masemola, M., Matsaunyane, L.B.T., Luvhengo U., Letsaolo, S., & Molebo T. 2020. Reviewing the role of extension officers in sustaining household food gardens: Evidence from Gauteng Province, South Africa. Journal of Critical Reviews, Volume 7 (13), 236-240. doi:10.31838/jcr.07.13.40

Mamabolo, M., Chaminuka, P., & Machethe, C. 2021. Temporal and spatial variation of income diversification strategies among rural households in South Africa. *Development Southern Africa,* https://doi.org/10.1080/0376835X.2020.187093, 17pp.

Marais, A., Labuschagne, J., & **Booyse, M.** 2020. Influence of oats cover crop preceding dryland lucerne establishment on some aspects of soil microbial ecology. *South African Journal of Plant and Soil* 37 (1): 87-89.

Masemola, M., Owusu-Sekyere, E., Ogundeji, A.A., Van Niekerk, H.N., & **Chaminuka, P.** 2021. Farmers' preference and willingness to pay for a multivalent Lumpy Skin Disease and Rift Valley Fever novel vaccine: A discrete choice experiment in the Free State province, South Africa. *Preventative Veterinary Medicine,* https://www.sciencedirect.com/science/article/pii/S0167587721000374?via%3Dihub.

Mdlulwa, Z., Mathebula, E., & Ngwane, C. 2021. Determinants of livestock keepers' primary animal health care practices, *Agrekon,* 60 (1): 57-79.

Mokhaukhau, J. P., Hlongwane, J. J., **Chaminuka, P.**, Mayekiso, A., & Cholo, M. S. 2020. Risk management strategies adopted by small-scale vegetable farmers in Thaba Chweu Local Municipality, Mpumalanga Province in South Africa. *J. Agribus. Rural Dev.*, 1(55), 45–51. http://dx.doi.org/10.17306/J.JARD.2020.01227.

Ngarava, S., Mushunje, A., & **Chaminuka, P.** 2020. Determinants of participation in livestock development programmes: Evidence from South Africa's Kaonafatso ya Dikgomo (KyD) Scheme. *African Journal of Science, Technology, Innovation and Development*. 1-13. 10.1080/20421338.2020.1791387.

Nhundu, K., Gandidzanwa, C., **Chaminuka, P., Mamabolo, M., Mahlangu, S.**, & Makhura, M.N. 2021. Agricultural supply response for sunflower in South Africa (1947–2016): The partial Nerlovian framework approach. *African Journal of Science, Technology, Innovation and Development* ,https://doi.org/10.1080/20421338.2020.1844944, 11pp.

Nongcula, V.V., Jaja, I.F., **Nhundu, K.,** & Zhou, L. 2020. Prevalence, perception and implication of solid waste in cattle slaughtered in Eastern Cape Province, South Africa. *Adv. Anim. Vet. Sci.* 8(7): 692-700.DOI: http://dx.doi.org/10.17582/journal.aavs/2020/8.7.692.700.

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Shew, A., Tack, J., Nalley, L., & **Chaminuka, P.** 2020. Yield reduction under climate warming varies among wheat cultivars in South Africa. *Nature Communications.* 11. 1234567890. 10.1038/s41467-020-18317-8.

Thovhogi, F., Gwata, E.T, Mchau, G.R.A., & **Ntutshelo, N**. 2020. Perceptions of end-users in Limpopo Province (South Africa) about the Spider plant (*Cleome gynandra* L.). *Genetic Resources and Crop Evolution.* 1-10. 10.1007/s10722-020-01009-z.

THESES AND DISSERTATIONS

Masters

Mampe, M. 2020. Smallholder farmers' preference and willingness to pay for veterinary vaccines: A Case study of cattle farmers in the Free State Province. Master of Science (Agricultural Economics), University of Free State.

Doctoral

Loki, O. 2020. Privatisation of Agricultural Extension Services: Smallholder Farmers' Perceptions and Willingness to Pay for Extension Services in Eastern Cape and KwaZulu-Natal Provinces of South Africa. Doctor of Philosophy (Agricultural Extension & Rural Resource Management), University of KwaZulu-Natal.

CHAPTERS IN BOOKS

Marais, A., **Booyse, M.**, & Botha, A. 2021. A Decade Plus of Monoculture Wheat Compared to Wheat/Legume Pastures - Long-term Effects of Management Practices on Some Soil Physicochemical And Microbial Properties in the Winter Rainfall Region of South Africa. In: *International Research in Environment, Geography and Earth Science.* ISBN 978-81-949988-6-0. Volume 8, Chapter 10, pp. 144-161.

Ouma-Mugabe, J., & **Chaminuka, P.** 2020. Africa-Europe science, technology and innovation cooperation. In: *The Routledge Handbook of EU-Africa Relations*. ISBN 9781138047303. 1st Edition, Chapter 16, pp. 224-232.

CONFERENCE PROCEEDINGS

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Identity and access management

INFORMATION AND COMMUNICATION TECHNOLOGY & INFRASTRUCTURE

With the advent of the Fourth Industrial Revolution (4IR), South Africa (SA) formed a Presidential Commission on the Fourth Industrial Revolution (PC4IR). The Commission was designed to help government make the most of the opportunities revealed in the current upheaval. The goal of the Commission is to develop relevant policies, systems and action plans to enable South Africa to respond appropriately to the opportunities and challenges presented by the 4IR.

In its report, the Commission argues that the combination of biotechnology with agri-informatics enabled by precision data has the power to improve seed and plant resilience, particularly given climate variability. This can enhance food security and, in the case of bio-diversity management and protection, aid in the preservation of existing biodiversity for future generations, such as the use of drones for mapping and data gathering and automated, energy-efficient water-monitoring sensors that support precise water-use for irrigation.

In 2020, the ARC completed a comprehensive process towards the development of a Five-Year Strategic Plan for a period 2020/21-2024/25. To align with the Corporate Strategic Plan, the Information and Communication Technology (ICT) division developed the ICT Strategic Plan for a period 2020/21-2024/25, followed by the operational plans outlining key initiatives for the financial year 2020/21 (FY2020/21).

In 2020, the world experienced a global public health crisis, unlike any we have faced before. If there is one thing that this public health crisis has brought to light, it is the essential role of the ICT division in the ARC. This crisis reaffirms the importance of taking very seriously the opportunities and challenges brought to light by 4IR.

OUTCOME 6: A HIGH PERFORMING AND SUSTAINABLE ORGANISATION.

DIGITAL TRANSFORMATION

With the increase in remote work, employees were increasingly located outside the premises, which forced the organisation to rethink its approach and security controls.

Collaboration and Business Insight

With the COVID-19 pandemic, ARC employees needed to stay at home for a considerable amount of time while continuing with their normal responsibilities. The ARC-ICT team implemented Microsoft Teams to provide effective communication, collaboration, and meetings solution to enable employees to continue performing their duties from home.

As a Cloud-based platform, Microsoft Teams is accessed and used from anywhere, anytime and on any device. Microsoft Teams empowers ARC employees to collaborate inside and outside the ARC by protecting sensitive information such as emails and documents. In addition, the ARC also implemented the Microsoft Power Bi, a business intelligence product, to provide ARC employees with a set of tools for collecting, sorting, and presenting business intelligence data.

Digital and Electronic Signature

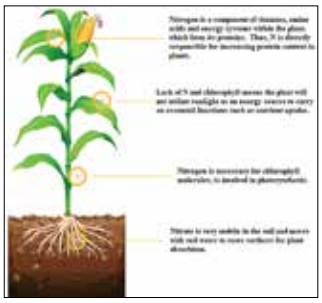
To increase efficiency, the ARC introduced the SigningHub solution for electronic and digital processing and signing of documents. SigningHub is unique in combining strong, long-term digital signatures and advanced Public Key Infrastructure (PKI) e-trust services with the latest cloud-based technologies to deliver an easy to use and cost-effective solution.

The SigningHub application has since enabled ARC employees and management to work flexibly while allowing them to manage document approvals more efficiently. The solution allowed employees to sign or approve documents securely from anywhere and anytime. The introduction of SigningHub reduced the approval process by approximately 80%.

Research and Development Applications for Farmers

In line with the ARC mandate, the ICT team developed various applications to support farmers. These applications includes, Dairy Dash Board Mobile App, ARCHER mobile application, PLAS Toolkit, Maize Information Guide, and Cactus Pear Application (CactiGrow), to name but a few.

The use of these applications is essential to the sustainability of farmers. For instance, Cacti Pear application assists farmers with the information needed to manage the entire life cycle of the Cactus Pear. These includes information on planting, establishment, sanitation, irrigation, pruning, and selection of a good quality cultivar that is suitable for fruit or feed production.



Maize Information Guide.

Cactus Pear Application (CactiGrow).

Equally, to prevent hampered maize plant growth, the ARC developed an application to assists farmers to identify and diagnose nutrient deficiencies in maize and gives information on how to control or correct the deficiency.

CYBER SECURITY

As 2020 has shown us, disruption and trends in the economic, business, and technology environment can have a profound impact on the security risks facing the organisation. Any changes in these environments need to be assessed and if appropriate, it need to be dealt with in the security strategy. The ARC-ICT division responded appropriately with the development of the cyber security strategy. The development of the strategy used the combination of different assessment types to paint an overall picture. This includes conducting the following assessments:

1. Vulnerability assessment of the technical infrastructure;
2. Risk assessment to balance the investment in controls appropriate to the actual risks;
3. Internal and external audit results to assess the effectiveness of policy and controls compliance; and
4. Maturity assessment to assess the maturity programme and the associated processes.

The above-mentioned assessment activities led to the development of the three-year roadmap Cyber Security interventions.

INFRASTRUCTURE

The ARC had three major cost saving projects during the Financial Year 2020/21, namely:

1. Bien Donne Farm;
2. Nietvoorbij; and
3. Installation of Solar at ARC-TSC.

Bien Donne and Nietvoorbij Farm

Bien Donne: Two boreholes were recommissioned at the Farm. The recommissioning was done during the drought period that the Western Cape experienced, particularly the Winelands region in Boland.

The rationale behind this initiative was two-fold:

a) The first was to use the borehole water for irrigation purposes, by pumping water back through the main line, into cement reservoirs situated in the farmyard; and

b) The second was to incorporate the one borehole's water with that of the drinking water obtained from the Wemmershoek drinking water scheme that supplies the farm with drinking water in order to reduce dependency on the scheme's water.

One borehole enclosed in the metal cage. This is also the combined pumping facility where the two boreholes' electrical controls are and where their delivery is combined. Each borehole can be operated separately.

Second borehole that has been enclosed with concrete rings in order to protect it.

Cement holding tank which is the main holding tank for water from the Wemmershoek scheme. Water from the borehole can be pumped from the tank.

Nietvoorbij: The existing drink water borehole was opened up again to minimise the use of municipality water. The water was tested before cleaning of the borehole was done, to ensure that the water is clean and suitable for human consumption. This has enabled the Campus to reduce the water supply for the Nietvoorbij farm to the minimum and to reduce the cost of the municipal account.

Borehole safely secured and tamper free.

Installation of a Hybrid Solar System at ARC-TSC

The installation of a solar system project in the administration building was completed. The completion of the project has resulted in a marginal reduction on the electricity bill and provision of continuous power supply during load shedding. The main building continues to operate during load shedding, as it no longer relies on a constrained national grid, due to Eskom's inability to generate enough power and the unreliability of its generation plants.

Solar system project.

SECURITY SERVICES

The ARC Security Services division is primarily responsible for the safety and security of the ARC. The ARC has suffered significant financial losses as a result of numerous security incidents. During the financial year 2020/21, the division's top priority was to implement and improve security initiatives that would supplement existing security installations and reduce crime and its impact on business operations.

ARC-OVR and ARC-TAD declared as National Key Points.

In accordance with National Key Points Act 102 of 1980, the ARC-Onderstepoort Veterinary Research (ARC-OVR) Campus and the Transboundary Animal Diseases (ARC-TAD) facility were designated as National Key Points (NKPs). The Act establishes and protects sites of national strategic importance from sabotage, terrorism, or subversion. The campuses are primarily responsible for the development and production of vaccines and diagnostic services, and as such, they store biological material that must be kept secure and under suitable conditions for the protection of employees and the general public.

The NKP applications were based on the nature of the research activities that take place at both sites, as well as crime incidents that pose a threat to the safe storage of these biological materials and research activities. The applications to the South African Police Service were based on these merits and to consider declaring the campuses a national key point in order to safeguard the biological material and mitigate any potential national disaster. The declaration means that these campuses are now subject to the National Key Points Act.

Technology-Electronic Visitor Management System.

Security Services implemented an Electronic Visitor Management System (EVMS) at Central Office to improve access control at the gates in accordance with the Control of Access to Public Premises and Vehicles Act 53 of 1985.

The system ensures accuracy and efficiency when processing visitors. The electronic visitor management solution replaces the paper-based system of recording visitors and thus eliminates inaccuracies while also providing additional functionalities such as creating visitor profiles that include the visitor's photo, name, SAID, SAVL, and the pictures of the visitor, authenticating the ID or credentials submitted, audit trail and an early notification about unwanted visitors.

Another important feature of the system is that it is POPI compliant, which means that other visitors will not be able to view the logbook and obtain confidential information about ARC clients.

PART C: HUMAN RESOURCES MANAGEMENT

1. INTRODUCTION

- **Overview of HR matters at the public entity**

The Human Resources (HR) Division aims to place an impactful long-term emphasis on service offerings centred on enhancing our processes, people, and organisation to meet the evolving needs of the ARC community. Supporting a population of over 2 305 scientists, researchers, specialists and core support staff, represented by two trade unions and one non-unionised employee group, brings increasing complexity and a requirement for HR to continually evolve its service offerings to meet new and changing client needs. The HR Division supports the ARC's commitment to excellence through the provision of innovative and evidence-based HR programmes and resources. Guided by a shared Vision and Mission, as identified in the ARC's Strategic Plan, our HR team is highly capable and dedicated to serve the ARC community with excellence. Working collaboratively and cohesively together, the broader HR portfolio is organised into five main areas of specialisation namely:

1. Employee Relations;
2. Employee Wellness;
3. Human Resources and Organisational Development;
4. Talent & Performance Management; and
5. Human Resources Information Systems.

The Human Resources Division is committed to partnering with all ARC Business Divisions to maximise the potential of our greatest assets, ARC Human Capital. It focuses on delivering quality customer service and is committed to recruiting, developing and rewarding and retaining our workforce.

- **Set HR priorities for the year under review and the impact of these priorities**

Our goal is to provide an integrated professional service aligned to the Business Strategy of the ARC. The following were priorities for the year under review:

1. Addressing the current working capital gap and financial position through the implementation of a targeted and robust Sustainability and Turnaround Plan;
2. Getting the best performance from employees, anticipating and building skills and lead transformation and growth at ARC;
3. Ensuring excellence in scientific research and development through enhanced capacity, capabilities and appropriate organisational technology and infrastructure;
4. Improve the foundations for human development (implementation of Recognition of Prior Learning (RPL)) programme;
5. Empower and develop the workforce that would generate sufficient high quality research to make an impact globally;
6. Develop the Competency Development Framework (Core and support competencies); and
7. Increased efficiency and effectiveness of HR systems and processes.

- **Workforce planning framework and key strategies to attract and recruit a skilled and capable workforce**

The HR strategy drivers included, among others, human resources development initiatives to build the pipeline and strengthen the skills set considering the ARC's response to the 2050 Vision and the 4IR, and implementing the turnaround strategy. The new HR strategy included a revision of existing and, the development of new HR policies, guidelines and procedures, and approval of key policies, guidelines and frameworks such as succession planning, Employment Equity (EE), skills development and others as frameworks to support the realisation of the strategy.

- **Employee performance management framework**

The ARC has a performance management system that evaluates individual and team performance in the achievement of organisational goals. The ARC has not implemented performance bonuses in the year under review. The current system is being upgraded to a full electronic system.

- **Employee Wellness Programmes**

In response to an increasing spread of COVID-19 infections across the globe and the impact it has in the workplace, ARC presented digital workplace risk management in line with best practice guidlines. These guidelines were used by employees for daily self-screening, employer preparation for staff return to work and the management of the ongoing employee disease surveillance system.

The risk tool offered the following:

1. Daily employee symptom checker, coupled with digital support and self-care resources;
2. Daily risk tracker, to monitor and track the healthcare journey of at-risk and exposed employees;
3. Aggregated risk surveillance dashboard and reporting tool, for consolidated view of at-risk and exposed employees; and
4. Telephonic technical system support.

- **COVID-19 Pandemic**

The ARC developed the following COVID-19 safety protocols to guide all employees on how to limit the spread of COVID-19 in the workplace, while also being aligned to broader government regulations and protocols:

1. Interim HR Procedures - COVID-19.
2. COVID-19 Working from Home Procedures; and
3. ARC COVID-19 Contingency

The following table below provides a summary of the COVID-19 incidents in the ARC, since the inception of the COVID-19 pandemic in March 2020 the ARC until 31 March 2021.

ARC COVID-19 Statistics

	STATUS	IMPACT
TOTAL	Number of employees tested positive	103
	Number of Employees Recovered	98
	Number of Employees Deceased	4

- **Policy development**

As the world of work is changing, ARC continues to ensure that its policies, procedures and systems are streamlined to responding to the changing world of work. During the year under review, ARC renegotiated a number of policies and procedures.

- **Achievements**

We are talent-seekers, advocates, coaches, resource experts, mediators, negotiators, out-of-the-box thinkers, strategists, risk managers, and thought leaders. Our Division's comprehensive programmes and services support the professional growth and well-being of each employee. The following are the highlights for the year under review:

1. The ARC partnered with the AgriSETA to increase the levels of investment in education and training in the labour market. The AgriSETA contributed R11 766 000 towards Human Capacity Development which were mainly used to provide workplace integrated learning (internship) opportunities to unemployed graduates;
2. Continuous investment in the ARC's flagship programme - the Professional Development Programme, in which 51 employees/students graduated from the programme in the year under review;
3. The ARC maintained a staff turnover rate below 5% for the year under review. It shows a slight decrease. There is currently no concern regarding the turnover rate in the ARC; and
4. The EE ratio target in the designated groups in respect of women at Senior Management level was achieved.

Professional Development Programme (PDP):

ARC launched the Professional Development Programme (PDP) in 1996 with the purpose of attracting interest from young graduates from previously disadvantaged communities in South Africa into the agricultural sector. The ARC prides itself on creating an environment in which young researchers are exposed to projects that add value to their studies and allow them to gain insight from world-class supervisors. The programme has successfully enticed, nurtured and developed scientific knowledge and skills exposing students and participants to various modalities of agricultural research and development thereby contributing to the overall mandate of the ARC and South Africa as a whole.

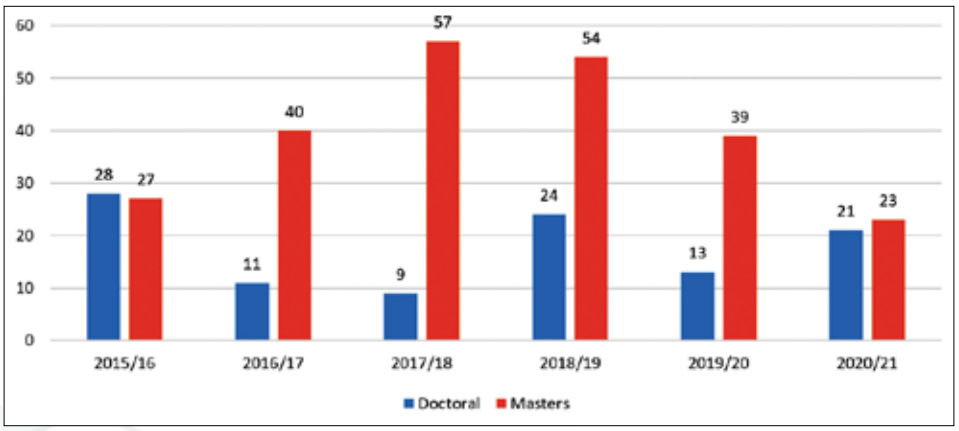
Below is a summary of the ten year review of the PDP programme.

Ten Year Review of PDP Students (Masters, Doctoral and Post-Doc)

CATEGORY	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Post-Doc	3	5	15	16	21	19	14	16	15	11
Doctoral	21	33	54	70	84	117	121	117	97	82
Masters	27	56	130	191	149	170	102	63	38	24
Total	**51**	**94**	**199**	**277**	**254**	**306**	**237**	**196**	**150**	**117**

The table above outlines the number of students enrolled in the programme in the past ten years in the three categories of the programme. The programme reached the highest peak of enrolment in 2016/17, however the enrolment declined due to funding reductions and recently the COVID-19 outbreak.

The chart below depicts students that graduated in the past five years. These are classes of 2015 to 2021. The chart provides an overview of students graduating from the programme at an average of 33% per year over the past five year period. 2017/18 had higher Masters students graduating in the programme whilst 2020/21 experienced a low number of students graduating in the programme due to COVID-19 outbreak challenges.



Review of students graduated in the past five years.

- **Challenges faced by the public entity**

1. Managing high labour costs in a difficult financial situation;
2. Employee motivation and retention within the current economic conditions;
3. A high proportion of experienced researchers are approaching retirement;
4. Scientific skills are in global demand, need for long-term development and require resources, including funding, infrastructure, and conducive environment;
5. The need for a higher ratio of research employees to total staff compliment, particularly at post graduate level;
6. The urgent need to improve ratios of women, black and young researchers;
7. The need to improve the qualifications profile of ARC and to expand its Sector Education Training (SET) base;
8. The need to train and deploy young graduates into ARC Researcher positions;
9. Managing relationship with Organised Labour (OL); and
10. Managing the changing world of work imposed by the COVID-19 outbreak.

- **Future HR plans /goals**

The ARC-HR will begin a massive transformation drive to implement an entirely new service delivery model to provide a better employment experience across the organisation. A summary of key HR strategic objectives and the operating model is included below:

Talent Management

- Expand individual and organisational development programmes to develop and retain ARC workforce.
- Develop the next generation talent pipeline.

Effecting Transformational Change

- Intensify employee development and developing future leaders.
- Improve engagement with the workforce.
- Create enabling people management frameworks (policies, procedures, systems and outcomes).
- Develop and support innovative workforce interventions.
- Encourage a high performance culture.

Continuous Business Process Improvements

- Finding new ways to conduct Business Processes.
- Streamlining administrative processes.

Employment Relations

- Collaborating on employee/employer needs.
- Maintain positive working relationship with Organised Labour.

2. HUMAN RESOURCES OVERSIGHT STATISTICS

The tables below highlight key information on human resources.

Personnel Cost (Total Cost to Company) by Business Division

(All payrolls that include active employees and students, as at 31/03/2021)

BUSINESS DIVISION	PERSONNEL EXPENDITURE (R'000)	NUMBER OF EMPLOYEES	AVERAGE PERSONNEL COST PER EMPLOYEE (R'000)
Crop Sciences	273 686	1193	229
Animal Sciences - including BTP	167 732	520	323
Natural Resources and Agricultural Engineering	49 027	207	237
Impact and Partnerships	16 201	22	736
Support (HR, FINANCE AND ICT)	178 235	438	407
Professional Development Programme (PG Funded)	7 730	64	121
TOTAL	**692 611 ***	**2 444 #**	**283**

** The Total Cost to Company (TCTC) includes actual remuneration packages (salaries and wages), pension and provident fund employer contributions, medical aid employer contributions, car allowance and deferred compensation of all active employees and students as at 31 March 2021. Other additional employee related costs, as outlined in the Annual Financial Statements (AFS) on page 211, which include: transfer costs (as part of basic salary), employee benefit expenses (both current service and interest cost), unemployment insurance fund (UIF), workmen's compensation assistance (WCA), skills development levies (SDL), leave pay provision charge, personnel training (formal and informal), membership fees, overtime payments, long-service awards and allowances are excluded from the above personnel expenditure calculation. In addition, these employee related costs incorporate all personnel expenditure incurred for all (active and terminated) employees and students for the reporting period.*

 # Permanent employees: 2108; Temporary employees: 272; and Students: 64.

***Core Business Divisions:** Include core staff namely Researchers, Specialist Researchers, Research Team Managers, Research Technicians and Research Support staff being Research Assistants, Labourers, Artisans, Farm Personnel, Truck & Tractor Drivers.*

***Support Staff:** Include all corporate support being HR, Finance, ICT, Facilities, Risk, Admin Support, Secretaries, Librarians, Public Relations, Messengers, Drivers and Office of the CEO.*

Personnel Cost (Total Cost to Company) by Occupational Level

(All payrolls that include active employees and students, as at 31/03/2021)

LEVEL	PERSONNEL EXPENDITURE (R'000)	% OF PERSONNEL EXP. TO TOTAL PERSONNEL COST	NUMBER OF EMPLOYEES	AVERAGE PERSONNEL COST PER EMPLOYEE (R'000)
Top Management (GG17 to GG19)	14 183	2,05%	6	2 364
Senior Management (GG14 to GG16)	28 987	4,19%	24	1 208
Professional qualified (GG11 to GG13)	277 858	40,12%	439	633
Skilled (GG8 to GG10)	194 168	28,03%	568	342
Semi-skilled (GG5 to GG7)	81 125	11,71%	389	209
Unskilled (GG3 to GG4)	88 559	12,78%	954	93
Professional Develoment Programme (PG Funded)	7 730	1,12%	64	121
TOTAL	**692 611 ***	**100%**	**2 444 #**	**283**

** The Total Cost to Company (TCTC) includes actual remuneration packages (salaries and wages), pension and provident fund employer contributions, medical aid employer contributions, car allowance and deferred compensation of all active employees and students as at 31 March 2021. Other additional employee related costs, as outlined in the Annual Financial Statements (AFS) on page 211, which include: transfer costs (as part of basic salary), employee benefit expenses (both current service and interest cost), unemployment insurance fund (UIF), workmen's compensation assistance (WCA), skills development levies (SDL), leave pay provision charge, personnel training (formal and informal), membership fees, overtime payments, long-service awards and allowances are excluded from the above personnel expenditure calculation. In addition, these employee related costs incorporate all personnel expenditure incurred for all (active and terminated) employees and students for the reporting period.*

 # Permanent employees: 2108; Temporary employees: 272; and Students: 64.

Performance Bonuses

The ARC strives to be a high-performance scientific organisation that yields on-going, long-term value to all its stakeholders. It therefore needs to maintain total commitment to high standards of performance, collaboration and teamwork, openness to new ideas and on-going research and learning. This needs to be done in line with the AR Act (Agricultural Research Act 86 0f 1990), the ARC strategic objectives, Vision 2050 and underpinned by ARC Values. It is within this context that the ARC Performance Management System (PMS) and its requirements are positioned, driven and implemented.

The Agricultural Research Council did not pay out any bonuses during the reporting period. However the ARC recognises long service in the organisation. Employees are awarded a long service award after a number of continuous years' of service in the ARC. Employees are recognised by means of a monetary reward or a number of leave days and a certificate of excellence. During the 2020/21 financial year a total of 180 employees qualified for long service awards to the value of R3.9m.

ARC Long Service Awards

YEARS OF SERVICE	NUMBER OF AWARDS
10	49
15	45
20	20
30	42
40	24
TOTAL	**180**

Training Costs

The ARC mandate commits the organisation to conduct research with partners, develop human capital and foster innovation to support and develop the agricultural sector including fostering scientific and industrial development. In this section, we share a few highlights from our investment in human capital.

Human resources development continue to be key enabler to business excellence through number of training interventions offered to employees in the organisation and non-employees aspiring to be employed in ARC or within the industry. The COVID-19 outbreak affected our training spend for the year under review, ARC spent 0.4% of its annual personnel cost in training and development. This led to ARC failing to reach its target of 2% spend against the total personnel cost. This has led to the organisation exploring other alternatives (e-Learning) to offering training which are still in concept phase.

In harnessing and embedding the research skills within the organisation and the sector, the ARC continued to invest in its flagship project, The Professional Development Programme (PDP). During the year under review, 48 students were enrolled on the programme at a cost of R7.7 million per annum. There was a significant decline in the number of enrolled students due to reduced activity during the year under review caused by the COVID-19 disruption.

Employment and Vacancies

FOCUS	2019/2020 NO. OF EMPLOYEES (31/03/2020 - PERMANENT EMPLOYEES)	2020/21 APPROVED POSTS	2020/21 NO. OF EMPLOYEES (31/03/2021 - PERMANENT EMPLOYEES)	2020/21 VACANCIES - 31 MARCH 2021	% OF VACANCIES
Crop Sciences	1 037	1 135	1 041	94	8,28%
Animal Sciences – including BTP	527	586	510	76	12,97%
Natural Resources and Agricultural Engineering	109	119	105	14	11,76%
Impact and Partnerships	27	27	22	5	18,52%
Corporate Support (HR, Finance, ICT)	497	468	430	38	8,12%
TOTAL	**2 197**	**2 335**	**2 108**	**227**	**9,72%**

Core Business Divisions: *Include core staff namely Researchers, Specialist Researchers, Research Team Managers, Research Technicians and Research Support staff being Research Assistants, Labourers, Artisans, Farm Personnel, Truck & Tractor Drivers.*

Support Staff: *Include all corporate support being HR, Finance, ICT, Facilities, Risk, Admin Support, Secretaries, Librarians, Public Relations, Messengers, Drivers and Office of the CEO.*

ARC Vacancies

LEVEL	2019/2020 NO. OF EMPLOYEES (31/03/2020 - PERMANENT EMPLOYEES)	2020/21 APPROVED POSTS	2020/21 NO. OF EMPLOYEES (31/03/2021 - PERMANENT EMPLOYEES)	2020/21 VACANCIES - 31 MARCH 2021	% OF VACANCIES
Top Management (GG17 to GG19)	7	6	6	0	0%
Senior Management (GG14 to GG16)	23	26	23	3	11,54%
Professional qualified (GG11 to GG13)	441	523	432	91	17,40%
Skilled (GG8 to GG10)	571	607	547	60	9,88%
Semi-skilled (GG5 to GG7)	397	404	381	23	5,69%
Unskilled (GG3 to GG4)	758	760	719	50	6,50%
TOTAL	**2 197**	**2 335**	**2 108 ***	**227**	**9,72%**

** Permanent employees, excluding Corporate, Executive, Contractors, Students and Wages.*

On 31 March 2021 the ARC had 227 vacancies. These vacancies are PG funded and were budgeted for in respect of the 2020/21 financial year. ARC Management reprioritised these positions and identified 100 positions as priority with a cost of R47 million. At year end, 23 of these prioritised positions were filled. The recruitment to identify successful candidates is also linked to externally funded projects. The vacancy rate is 9.72%.

Employment changes

The staff turnover rate of 2020/21 is 3,32%. For the 2019/20 financial year, the turnover rate was 3,7%. It shows a slight decrease in the turnover rate and is not of any concern to the ARC as it is below marker norms. The turnover rate for Researchers is 4,97% and 4,22% for Research Technicians.

SALARY BAND	EMPLOYMENT AT BEGINNING OF PERIOD	APPOINTMENTS (PERMANENT STAFF)	TERMINATIONS (PERMANENT STAFF)	EMPLOYMENT AT END OF THE PERIOD (31 MARCH 2021)
Top Management (GG17 to GG19)	7	0	1	6
Senior Management (GG14 to GG16)	23	1	1	23
Professional qualified (GG11 to GG13)	441	20	29	432
Skilled (GG8 to GG10)	574	10	37	547
Semi-skilled (GG5 to GG7)	393	3	15	381
Unskilled (GG3 to GG4)	752	4	37	719
TOTAL (Permanent staff)	**2 190**	**47**	**120**	**2 108**

Reasons for Staff Leaving (Permanent staff)

REASON	NUMBER	% OF TOTAL NUMBER OF STAFF LEAVING
Death	14	11,67%
Resignation	53	44,17%
Dismissal	4	3,33%
Retirement (Normal & Early Retirement)	41	34,17%
Ill health	3	2,5%
Expiry of contract	4	3,33%
Other	1	0,83%
Total	**120**	**100%**

Labour Relations: Misconduct and Disciplinary Action

NATURE OF DISCIPLINARY ACTION	NUMBER
Verbal Warning	2
Written Warning	2
Final Written warning	5
Dismissal	4

Equity Target and Employment Equity Status

Levels	FEMALE								
	African		Coloured		Indian		White		FOREIGN NATIONALS
	Current	Target	Current	Target	Current	Target	Current	Target	
Top Management	2	3	0	0	0	0	0	0	0
Senior Management	4	4	0	0	0	0	4	4	2
Professional qualified	84	96	4	8	5	7	105	125	6
Skilled	221	151	13	14	2	5	71	86	1
Semi-skilled	106	118	24	26	0	0	49	58	0
Unskilled	206	227	30	34	0	0	2	3	0
TOTAL PERMANENT	**623**	**599**	**71**	**82**	**7**	**12**	**231**	**276**	**9**

Levels	MALE								
	African		Coloured		Indian		White		FOREIGN NATIONALS
	Current	Target	Current	Target	Current	Target	Current	Target	
Top Management	4	4	0	0	0	0	0	0	0
Senior Management	8	11	1	1	0	0	2	4	2
Professional qualified	94	108	9	12	4	5	94	127	27
Skilled	172	203	17	23	0	0	49	68	1
Semi-skilled	165	188	30	32	0	0	7	8	0
Unskilled	410	501	65	76	0	0	6	7	0
TOTAL PERMANENT	**853**	**1 015**	**122**	**144**	**4**	**5**	**158**	**214**	**30**

Levels	EMPLOYEES WITH DISABILITIES			
	MALE		FEMALE	
	Current	Target	Current	Target
Top Management	0	0	0	0
Senior Management	0	0	0	0
Professional qualified	4	4	4	4
Skilled	1	1	0	1
Semi-skilled	1	1	0	0
Unskilled	2	4	0	1
TOTAL PERMANENT	**8**	**10**	**4**	**6**

The Employment Equity Plan is currently under review. There has been lot of movement in terms of appointments and resignations and priority when filling positions is given to races that are least represented in ARC in order to address the inequality challenge.

The ARC has over the years improved its facilities to be friendlier to employees with disabilities, the next steps are:

1. To conduct awareness sessions across the organisation to encourage employees with undeclared status to declare if they have any disability; and
2. To have increased emphasis on the recruitment of people with disabilities within our recruitment processes.

PART D: GOVERNANCE

1. INTRODUCTION

Corporate governance embodies processes and systems by which public entities are directed, controlled and held to account. In addition to legislative requirements based on a public entity's enabling legislation, and the Companies Act, corporate governance with regard to public entities is applied through the precepts of the Public Finance Management Act (PFMA) and run in tandem with the principles contained in the King Report on Corporate Governance.

Parliament, the Executive and the Accounting Authority of the public entity are responsible for corporate governance.

2. PORTFOLIO COMMITTEE

These were the dates where the ARC attended meetings:

Portfolio Committee Meetings

ITEM	DESCRIPTION	DATE	ATTENDED
1	Briefing on 2020/21 APP	5 May 2021	Virtual
2	Briefing on the Annual Report	13 November 2020	Virtual
3	Briefing on Budget Vote 2020/21	11 May 2020	Virtual

There were no areas of risk identified except what has been presented and updated on the quarterly report.

3. EXECUTIVE AUTHORITY

The following reports were presented to the Executive Authority:

1. Briefing on 2020/21 APP - 2020
2. Budget Vote 2020/21 - 2020
3. Briefing on the Annual Report - 2020

4. THE ACCOUNTING AUTHORITY/COUNCIL

INTRODUCTION

- **The importance and purpose of the Council**

The main role of the Council is management, oversight and planning of the affairs of the ARC, which shall, subject to the provisions of Agricultural Research Act 86 of 1990, determine the policy and objectives of the ARC and exercise control generally over the performance of its functions, the exercise of its powers and the execution of its duties.

- **Council's responsibilities and accountability for the public entity's performance and strategic direction**

The statutory functions of the ARC Council are determined in terms of the provisions of the Agricultural Research Act, 1990 (Act No 86 of 1990, and the Public Finance Management Act, 1999 (Act No. 1 of 1999) (the PFMA).

These include the following: to be the Accounting Authority; approval of the corporate Business Plan, strategic plan and the policies of the ARC; and setting of performance targets for the organisation.

The Council is responsible *inter alia* for approval of the prepared Annual Financial Statements that accurately reflect the ARC financial position and results at the end of the financial year, which is set at 31 March each year. The Office of the Auditor General is responsible for auditing the Annual Financial Statements of the ARC.

THE ROLE OF THE COUNCIL

In the governance of the ARC, the Council is responsible for policymaking and control while the ARC President has been delegated the responsibility for the day-to-day execution of the policies and objectives as directed by the Council.

The members of the Council are appointed by the Minister of Agriculture, Land Reform and Rural Development on the basis of their expertise in the fields of agriculture, business, financial management, law, research, technology development and technology transfer in the field of agriculture, as prescribed by the Agricultural Research Council Act, 1990 (Act No. 86 of 1990). Council members are appointed for a maximum period of three years and eligible for re-appointment. With the exception of the President and CEO of the ARC none of the members of the Council hold an executive position in the ARC.

The Council exercises full and effective control over the ARC and monitors its Executive Management Committee. The Council may obtain independent professional advise if deemed necessary.

COUNCIL CHARTER

In compliance with best practice of corporate governance principles, and in accordance with the powers and authority delegated to them by the Minister of Agriculture, Land Reform and Rural Development (the Minister), the Council Members (Council) of the ARC have agreed to define their responsibilities and duties, and record them in a statement of powers reserved to the ARC Council within the constraints of their authority as defined in the Agriculture Research Act (Act No 86 of 1990), Public Finance Management Act (Act No 1 of 1999) (the PFMA), the Treasury Regulations, the Charter and any other relevant legislation.

Council Members recognise their accountability in achieving the objectives defined in the Act.

In accordance with its stated intent, Council seeks to identify and record its responsibilities and reserved powers and to clarify the authority delegated to the Management of the ARC, defining the organisation monitoring measures required to ensure the proper execution of the delegated authority and the integrity of risk management and internal controls.

Furthermore, in recognition of the importance of the leadership role of the Chairperson, her functions and duties are stipulated in the Charter.

All information relating to the ARC Council and associated committees are reported from 01 July 2020, due to the extended reporting period during the 2019/20 financial year, as per the Department of Planning, Monitoring and Evaluations (Circular number 01 of 2020) and National Treasury communications.

COMPOSITION OF THE COUNCIL (*From 1 July 2020)*

NAME	DESIGNATION IN TERMS OF BOARD	DATE APPOINTED	DATE RESIGNED/ TERM ENDED	QUALIFICATIONS	AREA OF EXPERTISE	BOARD OF DIRECTORS	OTHER COMMITTEES (E.G. TASK TEAMS)	NO. OF MEETINGS ATTENDED
Ms Joyene Isaacs	Chairperson	1 July 2020	-	Bachelor of Science in Pathology and Plant Protection Honours, Bachelor of Science	Research and management	Yes	-	4
Dr Monodowafa Mashaba	Deputy Chairperson	1 July 2020	-	PhD in Public Affairs, Masters of Management (P&DM), Post-Graduate Diploma (P&DM), Bachelor of Art Degree	Research	Yes	Finance & Investment	4

NAME	DESIGNATION IN TERMS OF BOARD	DATE APPOINTED	DATE RESIGNED/ TERM ENDED	QUALIFICATIONS	AREA OF EXPERTISE	BOARD OF DIRECTORS	OTHER COMMITTEES (E.G. TASK TEAMS)	NO. OF MEETINGS ATTENDED
Prof Raymond Auerbach	Member	1 July 2020	-	Masters of Science, Doctorate	Research	Yes	R&D	4
Prof Nic Olivier	Member	1 July 2020	-	BA Law, LLB, B.Phil, BA Honours, MA Linguistics, Dr of Law (private and comparative law), Dr of Law (recognition of Legal pluralism	Legal	Yes	HR; Audit Committee	4
Dr Konanani Liphadzi	Member	1 July 2020	-	MBL, MAD, PhD-Agronomy, M.Inst Agrar, B. Inst Agrar, B. Agriculture	Legal and research	Yes	R&D; HR	4
Ms Nalini Maharaj	Member	1 July 2020	-	B Proc, Bachelor of Laws, Financial Accounting for Public Entities, Corporate Governance	Legal	Yes	HR; Finance & Investment	4
Dr Naude Malan	Member	1 July 2020	-	Doctor of Philosophy, Master of Arts, B.A Hons, Bachelor of Arts	Research	Yes	R&D; HR	4
Dr Poncho Mokaila	Member	1 July 2020	-	MBA, BVMCH, Certificate in HACCP	Research	Yes	HR; Finance & Investment	4
Mr Goodman Gcaba	Member	1 July 2020	-	Master of Science in Forest Management, Bachelor in Agriculture and Commercial Forestry	Research	Yes	Finance & Investment; R&D	4
Dr Steven Cornelius	Member	1 July 2020	-	BSc, BSc Hons, BVMCh, BVSc H	Research	Yes	HR; R&D	4
Prof Phatu Mashela	Member	01/04/2017 Reappointed 1 July 2020	30 June 2020 Reappointed 1 July 2020	MSc (Nematology), PhD (Nematology and Horticulture), MBA	Research	Yes	HR & Social Ethics	4
Dr Saskia Van Oosterhout	Member	01/04/2017 Reappointed 1 July 2020	30 June 2020 Reappointed 1 July 2020	PhD (Agricultural Ecology)	Research	Yes	Finance & Research	4

COMMITTEES

Summary of Committee Meetings

COMMITTEE	NO. OF MEETINGS HELD	NO. OF MEMBERS	NAME OF MEMBERS
Human Resources & Remuneration, Social & Ethics Committee (From 1 July 2020)			
HUMAN RESOURCES, REMUNERATION AND SOCIAL ETHICS COMMITTEE	4 MEETINGS	7 MEMBERS	Dr Steven Cornelius Dr Naude Malan Prof Nic Olivier Konanani Liphadzi Ms Nalini Maharaja Prof Phatu Mashela Dr Poncho Mokaila
Research, Development & Evaluation Committee (From 1 July 2020)			
RESEARCH, DEVELOPMENT & EVALUATION COMMITEE	4 MEETINGS	7 MEMBERS	Dr Saskia Van Oosterhout Prof Raymond Auerbach Mr Goodman Gcaba Prof Phatu Mashela Dr Steven Cornelius Dr Naude Malan Dr Konanani Liphadzi
Finance, Investment & ICT Governance Committee (From 1 July 2020)			
FINANCE, INVESTMENT AND ICT GOVERNANCE COMMITTEE	4 MEETINGS	6 MEMBERS	Dr Monodowafa Mashaba Prof Raymond Auerbach Mr Goodman Gcaba Dr Poncho Mokaila Ms Nalini Maharaj Dr Saskia Van Oosterhout

Executive Committee

During the year under review, three (3) Executive Committee meeting were held.

Summary of Executive Committee Meetings

COUNCIL MEMBER	NO. OF MEETINGS ATTENDED
Dr Shadrack Moephuli (CEO)	3
Ms Joyene Isaacs	5
Dr Monodowafa Mashaba	5
Dr Steven Cornelius	5
Dr Saskia Van Oosterhout	5

REMUNERATION OF COUNCIL MEMBERS

Council members, who are not Government officials, receive fees for the services they render to the ARC in accordance with the relevant tariffs as determined by National Treasury and approved by the DALRRD.

Members of the Audit & Risk Committee are remunerated in accordance with an agreed tariff set by the National Treasury. "Refer to Note disclosure 37 of the Detailed information on remuneration of Council members can be found in the Annual Financial Statements on pages 170 to 245 for the Retention of Surplus Funds detailed calculation."

5. RISK MANAGEMENT

The ARC has an established risk management process, which is captured and outlined within the organisation's formulated and approved Risk Management Strategy. Contained within this strategy, the ARC outlines its commitment to the undertaking of formal annual strategic risk assessments for purposes of identifying new and emerging risks, which may impede the achievement of the ARC strategic goals. From a governance perspective, the ARC has an established Corporate Enterprise Risk Management Committee (CERMC), comprising of both Senior and Executive Management and representatives from the respective divisions/ operations of the organisation. The Committee's key role is to advise management on the overall system of risk management within the organisation, which is inclusive of the mitigations of strategic risk exposures.

The organisation's Audit and Risk (A&R) Committee also plays a key role in advising on risk management processes and practices, which is further supported through the Internal Audit function whom independently monitors and reports to the A&R Committee on the effectiveness of the entire risk management system. The ARC have, over the reporting period, realised varied levels of success, being ascribed to the minimisation of key strategic risk exposures, translating into an improvement in the ARC performance. The focus for the next financial year and beyond would be on devising and implementing risk minimisation strategies, aimed at reducing the resultant impacts posed by key strategic risk exposures for the benefit of enhancing the organisation's performance.

6. INTERNAL CONTROL UNIT

Not applicable to the ARC.

7. INTERNAL AUDIT AND AUDIT RISK COMMITTEE

Internal auditing is an independent and objective assurance and consulting activity that is guided by a policy of adding value to improve the operations of the ARC. It assists the ARC in accomplishing its objectives by bringing a systematic and disciplined approach (an annual and three-year rolling risk-based internal audit plan) to evaluate and improve the effectiveness of the entity's governance, risk management and internal control. The Internal Audit (IA) function implemented its annual risk-based audit plan for 2020/21 as part of the three-year rolling plan after consultation with management and approval by the Audit and Risk Committee. Nineteen (19) audits were planned and completed for the year.

All the changes to planned audits were approved by the Audit and Risk Committee. For the year, 19 planned audits with an additional four *ad-hoc* audits culminating in 23 audits, were conducted in the predetermined timeframe. This resulted in a 100% completion of the approved 2020/21 IA Annual Plan. All audits and other work of the IA function were conducted in accordance with the International Standards for the Professional Practice of Internal Audit, as issued by the Institute of Internal Auditors (IIA).

The Audit and Risk Committee is established as a statutory committee in terms of section 77 of the PFMA and Treasury Regulations 3.1.13. The committee performs an oversight and advisory role to the ARC and is accountable to the ARC Council and the public and must therefore properly consider and evaluate all matters as per its terms of reference.

The purpose of the committee is to assist the Council in fulfilling its oversight responsibilities and the CEO in fulfilling executive duties regarding the financial reporting process, the management of risk, the system of internal control, the audit process, and the entity's process for monitoring compliance all within laws, regulations and code of conduct. The Committee also has a primary responsibility to the public to form an opinion on the effectiveness of those issues within its ambit, and communicates this in the Annual Report in terms of the Treasury Regulations:

- To review, with the external auditor(s) before the audit commences, the auditor(s) engagement letter, the terms, nature and scope of the audit, procedures and engagement and the audit fee;
- Consider any problems identified in the going concern statement or relating to internal control and consider any accounting treatments, significant unusual transactions, or accounting judgments, that could be contentious;

- Examine and review the Annual Financial Statements, prior to submission and approval by Council, making such comments as it may deem necessary. Particular attention should be paid to:
  - ◊ Evaluating judgments and reporting decisions made by management;
  - ◊ Critical accounting policies and practices, and any changes;
  - ◊ Decisions requiring a significant element of judgement;
  - ◊ The extent to which the financial statements are affected by any significant and unusual transactions in the year and how they are disclosed;
  - ◊ The clarity and completeness of proposed disclosures;
  - ◊ Significant adjustments resulting from the audit;
  - ◊ The going concern assumption; and
  - ◊ Compliance with accounting standards.

- Key activities and objectives of the Audit Committee: The Audit & Risk Committee (Committee) is constituted to assist Council in discharging its duties relating to the safeguarding of assets, the operation of adequate systems, control processes and the preparation of accurate financial reporting and statements in compliance with all applicable legal requirements and accounting standards as prescribed in the Public Finance Management Act, 1999 (Act 1/1999) and the prevailing Treasury Regulations; and

- Attendance of Audit Committee meetings by Audit Committee members.

AUDIT AND RISK COMMITTEE (From 1 July 2020)

Summary of Audit and Risk Committee

NAME	QUALIFICATIONS	INTERNAL OR EXTERNAL	IF INTERNAL, POSITION IN THE PUBLIC ENTITY	DATE APPOINTED	DATE RESIGNED	NO. OF MEETINGS ATTENDED
Mr Vishnu Naicker	- B.Com. - Higher Diploma in taxation - Business Management Diploma - Systems Administration Diploma - Short Course	External	N/A	1 Dec 2013 Re-appointed 1 July 2020	31 June 2020 Reappointed 1 July 2020	3
Ms Patricia Stock	- Masters in International Accounting - Post Graduate Diploma in Auditing - Charted Accountant and CTA - Bcom Honours Accounting Science - Bcom Accounting Science	External	N/A	1 July 2020	N/A	4
Ms Nthabiseng Mokone	- MDP – B-BBEE - Charted Accountant - Bcom Honours + CTA - Bcom CTA - Bcom	External	N/A	1 July 2020	N/A	4
Dr Kobus Laubscher	- PHD Agriculture Economics - Master of Science - Bachelor of Commerce Honours - Bachelor of Commerce Bcom	External	N/A	1 July 2020	N/A	3

NAME	QUALIFICATIONS	INTERNAL OR EXTERNAL	IF INTERNAL, POSITION IN THE PUBLIC ENTITY	DATE APPOINTED	DATE RESIGNED	NO. OF MEETINGS ATTENDED
Dr Monowasha Mashaba	- PhD in Public Affairs - Masters of Management (P& DM) - Post-Graduate Diploma (P&DM) - Bachelor of Art Degree	External		1 July 2020	Resigned August 2020	1
Ms Hazel Masedi	- B Rationis - B. Computer Science - H. Diploma in Computer Auditing - M.Com Computer Auditing - Post Graduate Diploma in Management	External		1 July 2020		1
Prof Nic Olivier	- BA Law - LLB - B.Phil - BA Honours - MA Linguistics - Dr of Law (private and comparative law) - Dr of Law (recognition of Legal pluralism	Council member	N/A	1 July 2020	N/A	4

8. COMPLIANCE WITH LAWS AND REGULATIONS

The ARC is fully committed to comply with the provisions of the Public Finance Management Act (PFMA), 1999 (Act No. 1 of 1999). The internal and external auditors continue to provide the Council with assurance on the degree of compliance with the PFMA.

9. FRAUD AND CORRUPTION

The ARC stance on fraud and corruption remains that of zero tolerance. The ARC focuses on preventative procedures in its fight against fraud and corruption. To this end all ARC employees undergo a two-step process to ascertain their suitability for employment and reduce the risk of fraud. All new employees undergo an initial pre-employment suitability check, which is followed by a comprehensive vetting process once the employee has been appointed. This process has already yielded results in identifying and dealing with employees who could have potentially defrauded the entity.

The Internal Audit function of the ARC runs a comprehensive annual anti-corruption awareness campaign in all ARC campuses which ensures that all employees of the entity are made aware of the internal and external impact of fraud and corruption. ARC has an anonymous tip-off service independently managed by Deloitte and this Tip-offs Anonymous service provides an anonymous reporting channel for unethical behaviour in the ARC workspace. All allegations received are investigated either by an independent forensic firm and/or internal audit; depending on the complexity of the allegations. Depending on the outcome of the investigation, disciplinary measures, civil and/or criminal action will be taken against implicated employees and third parties if found guilty.

10. MINIMISING CONFLICT OF INTEREST

The Code of Ethics and Business Conduct ("Code") of the ARC stipulates that employees should avoid conflict of interest as this may occur when personal interest of an employee or the interest of the third party competes with that of the ARC. ARC supports the prohibition of employees doing business with any organs of state (including the ARC), or of being a director of a public or private company conducting business with an organ of state. The code stipulates that all new employees and students in the ARC are required to disclose their interests within 30 days after assumption of duty; and all employees and students will be required to disclose their interest on an annual basis, but not later than 30 April of each year.

These new measures assist the ARC in raising awareness of possible conflicts of interest for employees, and to avoid them. The ARC continues to raise awareness and to coach and guide employees on how to avoid conflicts of interest. Where such interests are identified, employees are engaged and, where appropriate, standard disciplinary steps are taken in terms of the code.

11. CODE OF CONDUCT

The Code of Ethics and Business Conduct ("Code") of the ARC outlines expectations regarding employees' behaviour towards their colleagues, stakeholders, and when conducting any business of the ARC. ARC is committed to being exemplary at all times and in all respects, and for its work and conduct to be guided by the values outlined in the Code. The ARC expects employees to be ethical, responsible and professional, and to fulfil their duties with integrity. The ARC builds a culture that encourages employees to think and behave ethically by providing training and awareness through induction, security and fraud prevention and training sessions. These sessions are conducted continuously throughout all ARC campuses to remind and reinforce the ethical conduct of employees at all times. The ARC will take disciplinary action in terms of its disciplinary code and procedure against employees who repeatedly or intentionally fail to follow its Code.

12. HEALTH SAFETY AND ENVIRONMENTAL ISSUES

OVERVIEW

The ARC operations encompass both the world of services, which is the corporate (offices) and the biosafety environmental facilities (laboratories, general environmental applications). This has resulted in a scenario that requires a comprehensive Safety, Health and Environment (SHE) performance. The environment includes the different types of farms and land that the ARC uses for experimental purposes and other land leased for commercial purposes.

PERFORMANCE REVIEWS

The individual campuses or sites have developed different committees to effectively monitor, evaluate and ensure compliance requirements. This is through the monthly SHE coordination meetings, review and comments on monthly reports necessary for the operational monitoring and evaluation of SHE matters with regard to ARC obligations in terms of legislative compliance and best practice.

The Campuses' SHE performance reviews are categorised into the following, namely Compliance Requirements, Building Services, Infrastructure and Technical Compliance.

Summary of SHE Performance Reviews

SERVICE LINE	PERFORMANCE REVIEW ISSUES	REMARKS
Compliance Requirements	• Challenge with the appointment of health services contractors; • DAFF biosafety report not issued as yet; and • Risk register not updated.	• SCM to review strategies; • Stakeholder engagement protocol; and • OHSA capacity reconfiguration.
Building Services Infrastructure	• Structural durability compromised; and • Aging infrastructure and obsolete installation.	• Inadequate maintenance budget; and • Ineffective service and maintenance.
Technical compliance	• Emergency preparedness and evacuation exercises.	• Not effective because of some work activities impeding compliance.

RELEVANT IMPACT ON ENVIRONMENT

Throughout the year, the ARC has considered environmental sustainability projects for two critical resources, water and electricity. The objective is to reduce reliance on the grid supply by the local municipalities with the view to manage and reduce consumption. Energy savings have already been implemented at ARC-INF-NVB, located in the Western Cape. Data at these two installation sites will be reviewed to inform the extension to other campuses. Water and waste management processes still to be considered. The ARC, to ensure continuous relevance to its obligations and compliance to Occupational Health and Safety Act

(OHSA) and the National Environment Management Act (NEMA), has appointed a contractor to review various environmental activities on campuses.

COVID-19 PANDEMIC

The global outbreak of the COVID-19 pandemic has affected the livelihoods in all spheres of life. The South African Government introduced the Disaster Management Act that provided protocols for the new way of conduct that included the changes in the workplace design and operations. The ARC has satisfied the requirements as set out in the Act. Below are some of the key initiative implemented:

1. Disinfection of buildings: sanitisation protocols are in place;
2. Hand sanitisers are available at ARC premise entrances;
3. Restroom sanitisation is scheduled and recorded;
4. Communal areas: social gatherings are not allowed;
5. Monitoring of personnel: Contactless temperature checks at security entry points are recorded;
6. Masks: there are notices at entrances regarding compulsory mask regulation. In addition, all employees are issued with at least two masks;
7. Social distancing: a social distance of at least 1.5m is followed at all times;
8. Work from Home – the work from home policy was approved and implemented;
9. COVID-19 Committee: each campus has a COVID-19 committee comprising of Management and Organised Labour; and
10. The COVID-19 response plan was developed and implemented. Below are some of the key items included in the response plan.
    - Procedures around testing - positive cases/close contacts;
    - Record keeping of all identified cases by Human Resources;
    - Employees notified via e-mail and intranet of cases/closure of building;
    - COVID-19 posters are placed at various parts of the building to improve awareness; and
    - The ongoing communication of National and Provincial Government statements.

13. COMPANY/BOARD SECRETARY

Provides guidance and advise to the board regarding their duties, responsibilities, powers and matters of procedure in terms of the Board Charter, terms of reference, principles of good ethics, good governance, and best practices.

Assists the Board and its subcommittees with interpretation of applicable legislation relevant to or affecting the organisation and implications for non-compliance with such applicable statutory requirements.

Monitors compliance to execution of duties in line with the delegation of authorities.

Key role in preparing the reports for the Annual Report and ensuring that relevant deadlines and appropriate statutory disclosures are met.

14. SOCIAL RESPONSIBILITY

ARC COVID-19 relief fund based on voluntary contributions by ARC employees was set up to encourage those who can afford to assist our most vulnerable colleagues. In order to participate in the relief fund employees could contribute their 3% *ex gracia*, either, in full or 50% as a once-off payment. Colleagues from across all ARC campuses collected used clothes for Mandela Day. Colleagues also ran the annual "King of the Mountain" challenge in support of the World Food Day Food Mountain campaign, and collected non-perishable food items. ARC-SCW Campus won the 2020/21 "King of the Mountain" challenge and donated all the clothes and non-perishable food stuffs to two charities of their choice namely the Jacaranda Children's Home and Mamelodi Sundown. The ARC Council is considering the establishment of a Social & Ethics Committee in the new financial year.

15. AUDIT AND RISK COMMITTEE REPORT

We are pleased to present our Audit and Risk Committee report for the financial year ended 31 March 2021.

The Audit and Risk Committee Responsibility and Attendance

The Audit and Risk Committee (the Committee) reports that it has complied with its responsibilities arising from Sections 49 - 55 of the Public Finance Management Act and Treasury Regulation 3.1.13. The Audit and Risk Committee also reports that it has adopted appropriate formal terms of reference as its Audit and Risk Committee Charter, has regulated its affairs in compliance with this charter and has discharged all its fiduciary duties and responsibilities as contained therein. The charter is updated regularly and complies with the principles of good governance as per King IVTM and the requirements of the PFMA. The Committee is accountable to the Council and performs an oversight function over:

- Financial management;
- Financial and performance reporting practices;
- Risk management and internal audit;
- Compliance with laws, regulations, and ethical conduct;
- ICT governance;
- External Audit; and
- Internal Audit.

The Audit Committee consists of the four (4) external members and two (2) members of Council listed hereunder and is required to meet a minimum of at least four times per annum as per the provisions of the Public Finance Management Act, 1999 (Act Number 1 of 1999) (PFMA). In terms of the approved Audit and Risk Committee Charter, four (4) meetings were held during the current year to consider the Quarterly Performance Reporting (financial and non-financial) and to review and discuss the Annual Financial Statements, internal audit reports the Auditor-General of South Africa's (AGSA) Audit and Management Reports.

The Chief Executive Officer, Chief Financial Officer and the relevant senior management attended all meetings that were held during the course of the financial year. Please refer to section D.7 Internal Audit and Audit and Risk Committee, for member's meeting attendance. The Committee conducted an internal self-assessment. The results concluded that the Committee is effective in executing its duties. Areas of improvement identified will be addressed to ensure continuous improvement.

The Effectiveness of Internal Controls and Internal Audit

Our review of the findings of the Internal Audit work, which was based on the risk assessments conducted in the public entity revealed certain weaknesses, which were then raised with the public entity.

The following internal audit work was completed during the year under review:

- Review of the organisation's Audit Improvement Plan;
- Performance Information;
- Review of Critical Financial Reporting Controls (CFRC's);
- Application and Network Security Control Review - ICT systems;
- Supply Chain Management;
- Irregular expenditure review;
- Assets management process;
- Revenue completeness;
- FMD (Foot and mouth disease) Project review;
- Follow-up of Internal Audit Findings/Issue Tracker;
- Quarterly PFMA compliance review; and
- Corporate Governance review.

The internal audit function of Agricultural Research Council was co-sourced during the reporting period, and they operated objectively and independently. Based on the annual assessment of the internal audit by the Committee , the Internal Audit function was found to be partially effective during the financial year. An independent external review of the internal audit function will be conducted during 2021/22 financial year. The Committee is satisfied that the Internal Audit Plan represents a clear alignment with the key risks, has adequate information systems coverage, and a good balance across the different categories of audits, i.e., risk based, standard/transversal, performance, and computer audits.

Risk Management

The Committee is satisfied that the risk management function remains at an appropriate level within the organisation and continues to receive attention and refinements in line with its business model. Embedding of risk and mitigation around the critical risks is now a continuous process which is monitored by the General Manager: Risk and Planning and reported to the Committee on a quarterly basis.

Forensic Investigations

A total number of five forensic investigations were undertaken during the financial year and the committee received feedback each investigation on a quarterly basis. Appropriate consequence management has been vigorously implemented to ensure continued ethical behaviour at the ARC.

Information and Communication Technology (ICT) Governance

The Committee also continued with its review of the progress with respect to the ICT Governance in line with the ICT Framework approved by the ARC and notes the Auditor-Generals opinion around the improvement identified relating to the adequate design and/or implementation of controls in the focus areas of security management, user access management, program change management and ICT service continuity which contributes to the business operations of the entity.

In-Year Management and Monthly/Quarterly Report

The Agricultural Research Council has submitted monthly and quarterly reports to the Executive Authority and National Treasury, as is required by the PFMA.

Evaluation of Financial Statements and Annual Performance Report

The Committee has:

- Reviewed and approved changes to the accounting policies in line with the Standards of Generally Recognized Accounting Practice (GRAP) including any interpretations, guidelines and directives issued by the Accounting Standards Board. In addition to the Committee's review, the compliance with GRAP was also based on the conclusions reached based on the internal audit review of the draft financial statements;
- We reviewed changes in accounting policies and practices as applicable to the year ended 31 March 2021. However, the Committee did not obtain clarity on matters that still needs to be addressed to resolve the difference of opinion with the conclusion reached by AGSA as forming the basis of qualification on Property, Plant and Equipment (PPE);
- Reviewed and discussed the audited Annual Financial Statements to be included in the Annual Report, with the AGSA and the Accounting Authority;
- Reviewed the Audit Report of the AGSA;
- Reviewed the AGSA's Management Report and Management's response thereto;
- Reviewed the ARC's compliance with legal and regulatory provisions; and
- Reviewed significant adjustments resulting from the audit.

The Committee has once again taken note of the concerns of the AGSA, more notably the emphasis on matters reported in the management report relating to financial record keeping and accepts that there is further room for improvement in the finance function and elements of the internal control environment. However, the Committee noted that some of the information provided for the audit was not considered by the AGSA due to the auditors stating that there was a time constraint to meet the legislated deadlines. As such, despite the attempts to resolve this matter, the Committee is unable to express a view on the qualification relating to Property, Plant and Equipment. The Committee noted with disappointment the qualified audit outcome for the financial year under review and as a result, will intensify its efforts to ensure improved validation of financial reporting and more thorough measures in addressing of areas identified as requiring improvement by the AGSA.

During the financial year under review the Committee placed substantial effort towards the implementation of the Audit Improvement Plan, including follow up by the entity's internal audit services. Such audit plan placed particular focus on addressing root causes that resulted in the prior year's misstatements and other findings. It is noted that as at the submission of the unaudited annual financial statements all matters within the Audit Improvement Plan that resulted in the material findings that had an impact on the prior year's audit report, had been duly resolved by management. This has been confirmed by the AGSA; hence, there are no repeat findings from prior year, considering the nature of the basis of the qualification.

Management should also engage more effectively with the relevant National Departments for support in the collection of long outstanding debts. It is deemed appropriate to mention that the Committee has on numerous occasions highlighted its serious concerns over the following matters:

- The extent of debtor's balance exceeding 150 days. Most of this money is owed to the ARC by government departments and efforts to recover these long outstanding amounts have been met with limited success, placing severe strain on the ARC cash flows;
- The decline in the level of non-government external revenue;
- Funding constraints and the decline in cash resources; and
- Inadequate maintenance and the failure to dispose of facilities that are no longer required to prevent them continuing to impose a cost burden on the ARC.

The Committee has expressed its concern to management and the Council of the ARC over the limited funding of the ARC, which is highly dependent on the extent of support from Government and the extent of the Parliamentary Grant. However, the Committee considers that the statement relating to the going concern status of the organisation contained in the Annual Financial Statements is appropriate.

The Committee assessed the finance function and found that the leadership of the finance function have the appropriate skills and expertise. However, the skills review needs to be conducted to ensure that there is an appropriate balance of skills to enable the organisation to successfully implement the Audit Improvement Plan and strengthen the control environment of the entity. The Committee took note of the challenges faced by the decentralised structure of financial management systems at the ARC and is dedicated to continue monitoring of the efficiencies and improvements being implemented by the management.

The Committee has once again noted the constraints to achieve certain targets as identified by management. These constraints continue to adversely impact upon the ARC achieving certain objectives. The most important factor impacting past and future performance is the limited funding available to the organization to meet its full mandate. Efforts by management to secure additional research funding from both government and third-party sources have so far failed to resolve this pressing matter. The inadequacy of funding places a considerable strain on the financial resources of the ARC, which in turn places at risk the ARC ability to fulfil its mandates. The effective implementation of the financial turn-around strategy is required with continuous monitoring by Council.

The monitoring of the organization's performance is a key function of management, executive management, and the Council. However, the Committee obtained assurance through the internal audit function, that the systems of performance measurement and reporting, as well as the systems of internal control that underpin the performance management framework of the Council are addressed routinely in the audit plans. The Committee also obtained assurance from management and internal audit that the Council's performance management system adequately and effectively reports appropriate and relevant information.

Auditor-General of South Africa and Auditor's Report

The AGSA has a standing invite and attends the Committee's quarterly meetings. The Committee met with the AGSA to ensure that there are no unresolved issues. However, a follow up engagement will be held with the AGSA to ensure that clarity is provided on acceptable policy position and root causes to ensure that the measure to be taken as per the Audit Improvement Plan, to address the material audit finding are appropriate. The Committee assessed the role of all assurance providers including the AGSA and the outcome of this assessment will be discussed in the upcoming quarterly meeting.

The Committee is of the opinion that the audited annual financial statements and annual performance report be read together with this report and the report of the AGSA noting matters raised in this report.

In Conclusion

The Committee appreciates the effort made by Management to ensure that the entity does not regress further even though it has received a qualified opinion. We also wish to highlight the increasing pressure on the Council, Acting Chief Executive Officer, Chief Financial Officer and staff of the ARC to improve the control environment, manage the heightened risk around the going concern and its accountability towards service delivery during these unprecedented times of the COVID-19 pandemic.

We would like to thank the Council, members of management and members of the Committee for their professional contributions made during the reporting year, FY2020/21.

Ms Patricia Stock
Chairperson of the Audit and Risk Committee
Agricultural Research Council
31 August 2021

16. B-BBEE COMPLIANCE PERFORMANCE INFORMATION

The following table has been completed in accordance with the compliance to the B-BBEE requirements of the B-BBEE Act of 2013 and as determined by the Department of Trade and Industry.

B-BBEE Compliance Performance Information

HAS THE DEPARTMENT/PUBLIC ENTITY APPLIED ANY RELEVANT CODE OF GOOD PRACTICE (B-BBEE CERTIFICATE LEVELS 1-8) WITH REGARDS TO THE FOLLOWING:		
CRITERIA	**RESPONSE YES/NO**	**DISCUSSION (include a discussion on your response and indicate what measures have been taken to comply)**
Determining qualification criteria for the issuing of licences, concessions or other authorisations in respect of economic activity in terms of any law?	N/A	N/A
Developing and implementing a preferential procurement policy?	Yes	The Preferential Procurement Policy Framework Act 5 of 200 and 2017 Regulations are applied to evaluate and appoint suppliers/service providers for all transactions from R30 000 and above
Determining qualification criteria for the sale of state-owned enterprises?	N/A	N/A
Developing criteria for entering into partnerships with the private sector?	Yes	ARC is guided by Chapter 16 of Treasury Regulations in entering into partnerships with private sector
Determining criteria for the awarding of incentives, grants and investment schemes in support of Broad-Based Black Economic Empowerment?	N/A	N/A

PART E: FINANCIAL STATEMENTS

1. REVENUE COLLECTION

Sources of Revenue

SOURCES OF REVENUE	2020/2021			2019/2020		
	Estimate	Actual Amount Collected	(Over)/ Under Collection	Estimate	Actual Amount Collected	(Over)/ Under Collection
Government grants	1 016 488 956	985 817 006	30 671 950	1 089 902 609	978 339 783	111 562 826
Sale of goods in agricultural services	26 651 782	13 661 784	12 989 998	30 793 944	17 517 257	13 276 687
Rendering of services	361 937 994	244 056 120	117 881 874	328 711 128	259 396 855	69 314 273
Royalty income	36 850 767	39 307 747	(2 456 980)	28 700 928	27 321 406	1 379 522
Rental of facilities and equipment	40 326 058	39 918 716	407 342	46 847 937	27 651 794	19 196 143
Recoveries	-	26 173 900	(26 173 900)	-	1 124 782	(1 124 782)
Other income	7 006 084	8 541 428	(1 535 344)	7 916 163	21 470 209	(13 554 046)
Interest received	23 453 952	21 666 258	1 787 694	13 280 000	19 441 866	(6 161 866)
Dividends received	21 232	25 814	(4 582)	-	136 972	(136 972)
Total	**1 512 736 825**	**1 379 168 773**	**133 568 052**	**1 546 152 709**	**1 352 400 924**	**193 751 785**

1.1. CAPITAL INVESTMENT

The outbreak of COVID-19 has put severe strain on our already constrained maintenance budget. In response to this outbreak, frequent maintenance of buildings and equipment had to be carried out in compliance with the Disaster Management Act and amendments to the OHS Act regulations issued under the lockdown regulations. Accordingly, in our efforts to mitigate the spread of the COVID-19 virus, the ARC paid for COVID-19 testing for employees (314) and during the 2020/21 FY a total of 122 workspaces were sanitised across the ARC. Furthermore, a COVID-19 Contingency Plan was developed, and approved by the ARC President and CEO as a 16.1 appointee in terms of the Occupational Health and Safety Act 85 of 1993 as amended.

Ageing infrastructure and equipment remains one of the key risks in our risk register and this in some aspects; becomes an impediment to seamless research work being carried out thus compromising our competitive edge in the research and development sector. In response to this, several projects were implemented to upgrade some dilapidated buildings and infrastructure supporting research.

Accordingly, some of the key capex funded Infrastructure projects completed during the 2020/21 FY and their associated expenditure are listed below:

Summary of Key Infrastructure Projects (CAPEX funded)

Project Description	FY2020/2021			
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Comment
Renovations of Poultry Production Chicken houses.	2 500	1 940	560	CAPEX
Renovation of Milk Recording building in Cedara.	200	180	20	CAPEX
Refurbishment of water purification plant.	500	410	90	CAPEX

Project Description	FY2020/2021			
	Budget (R'000)	Actual Expenditure (R'000)	(Over)/Under Expenditure (R'000)	Comment
Installation of hybrid rooftop solar system.	1 000	741	259	CAPEX
Replacement of old and dysfunctional air-conditioning units.	500	338	162	CAPEX
Procurement of two orchard-spraying tractors.	1 000	1 063	63	CAPEX
Total	**5 700**	**4 672**	**1 028**	

Furthermore, there are some capex funded projects, which were budgeted for during 2020/21 FY but could not be implemented, but are scheduled for implementation in the current financial year. Some of these are:

- Renovation of external PVVD main building including Molecular Laboratory building at OVR Campus;
- Renovation of blood vaccine quarantine stable at OVR Campus;
- Roof renovation of the TAD building at OVR Campus; and
- Installation of palisade fence at Kaalplaas at OVR Campus.

The ARC has signed a four-year soil analytical contract with the Soils4Africa project (funded by the EU) worth R>25 million. Accordingly, R2m has been approved for the renovation of the SCW Campus' Analytical Services Laboratory roof and other ancillaries, in an effort to attain SANAS accreditation. To date, a professional engineering service provider has been appointed for the project management and construction supervision of the construction project. Below are the project costs and benefits:

PROJECT COSTS AND BENEFITS (QUANTITATIVE)

Summary of Project Costs and Benefits

REVENUE/BENEFITS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Increased Analytical Income	R500 000	R500 000	R750 000	R750 000	R1 000 000
Cumulative Net benefits / (costs)	R500 000	R1 000 000	R1 750 000	R2 500 000	R3 500 000

Maintenance

The implementation of planned maintenance continues to be a challenge due to limited opex funding. This reduces the useful life of infrastructure, plant and equipment as maintenance cannot be carried out according to the original equipment manufacturers' requirements, thus resulting in plant and equipment breakdowns. Furthermore, this reduces the reliability and availability of infrastructure, plant and equipment thus resulting in frequent downtime. This has a negative impact on research and productivity.

Some of the projects undertaken to support research activities and create a safe and habitable work environment are:

- Service boiler as per specifications and legislative requirements, boiler PB 450 lagging and cladding and boiler water treatment at OVR Campus;
- Maintenance of standby generators across the ARC;
- Installation of electrical cables to connect the library building and Irrigation laboratory at AE Campus;
- Electrical supply to the Agrimat processing unit at AE Campus;

- Installation of industrial ovens at AE Campus;
- Maintenance of chillers at OVR Campus;
- Maintenance of Heating, Ventilation and Air Conditioning systems across the ARC;
- Maintenance of compressors and vacuum pump at SCW Campus; and
- At SCW, employees working in laboratories were taken for medical screening.

One of the key projects conducted during the 2020/21 FY, is the appointment of a service provider to conduct the valuation of ARC properties. As part of the ARC's cost reduction strategies, the service provider was also requested to conduct a feasibility study for the consolidation of Pretoria based campuses as part of the ARC's efforts of reducing operating expenses like utilities (water, electricity and property rates).

FOOT AND MOUTH DISEASE FACTORY PROJECT

Background

Foot-and-Mouth disease (FMD), which is listed as a controlled disease in South Africa in terms of the Animal Disease Act 35 of 1984, is a highly contagious and acute viral affliction of domestic and wild cloven-hoofed animals. The cost of FMD is based on the stringent control measures needed to contain this highly infectious disease and the impact on production the disease has. The direct losses incurred due to an outbreak of the disease include the capital value of herds should culling processes be implemented as part of the control programme, loss of production and associated income and an increase in production costs as a results of additional on-farm quarantine restrictions. However, by far the greatest costs associated with FMD are the trade restrictions placed on an area with a confirmed outbreak, where the impact can go far beyond the livestock industry traditionally linked with FMD.

South Africa and other SADC countries made good progress in managing FMD between the late 1970s and the turn of the 21st Century, probably largely because of the use of improved FMD vaccines manufactured locally from the late 1970s onwards. Other contributing factors were the separation of animal populations - wild and domestic - by fencing systems to create FMD-free zones, control of movement of animals and their products, routine vaccination and surveillance. However, since 2001 the situation has deteriorated, with intervals between FMD outbreaks becoming shorter while individual outbreaks lasted longer and were more difficult to control. In the early part of 2021 up to nine out of the 16 SADC countries were dealing with or had recently reported FMD outbreaks.

The impact of the disease would reach far beyond livestock production. Even though mortality rates are low (typically less than 5%) the direct losses are mainly due to reduced production of meat, milk and other animal products during an outbreak, and the reduced production base thereafter. This has a ripple effect on upstream and downstream industries dependant on livestock production. Most recent estimates of the total loss in export revenue, including losses incurred by upstream and downstream sectors linked to livestock production, exceed R 6.4 billion measured against the 2016 red meat export value.

Currently there is only one vaccine producer for SAT strains of the virus in the world. There have been reports of concerns expressed on the efficacy of vaccine. Given that the successes of late 1970s-2000 were attributed mainly to the use of improved vaccines from Onderstepoort and Botswana Vaccine Institute (BVI), calls for the resuscitation of vaccine production at Onderstepoort have been growing. In response the ARC developed a Business Plan outlining its intensions to construct a new state-of-the-art FMD vaccine production facility at Onderstepoort. The Business Plan was presented to National Treasury on 01 March 2010, outlining the ARC's economic and business cases in terms of the National Treasury guidelines titled: "2010 MTEF: Budgeting for Infrastructure and Capital Expenditure Guidelines". The document was endorsed by the Minister of Agriculture and funded by the National Treasury in the 2011/2012 financial year. Initially R214 million were allocated by the National Treasury. Despite many attempts made since the initial allocation in 2011/12, it was only in 2019 that the National Treasury promised to allocate an additional R400 million over the 2019-2022 MTEF in support of the project.

The process development for the production of the vaccine at pilot scale level has been completed and adaptation of the process to industrial scale production processes and construction of the factory expected to commence shortly after the ARC's SCM processes have been completed.

2. REPORT OF THE AUDITOR-GENERAL

Report of the auditor-general to Parliament on Agricultural Research Council

Report on the audit of the financial statements

Qualified Opinion

1. I have audited the financial statements of the ARC set out on pages 170 to 245, which comprise the statement of financial position as at 31 March 2021, statement of financial performance, statement of changes in net assets, cash flow statement and statement of comparison of budget and actual amounts for the year then ended, as well as the notes to the financial statements, including a summary of significant accounting policies.
2. In my opinion, except for the effects of the matters described in the basis for qualified opinion section of this report, the financial statements present fairly, in all material respects, the financial position of ARC as at 31 March 2021 and its financial performance and cash flows for the year then ended, in accordance with the Standards of Generally Recognised Accounting Practice (GRAP) and the requirements of the Public Finance Management Act 1 of 1999 (PFMA).

Basis for qualified opinion

Property, plant and equipment

3. I was unable to obtain sufficient appropriate audit evidence that management had properly accounted for property, plant and equipment, as the public entity did not have adequate systems to record and maintain proper accounting records for all classes of property, plant and equipment. There were material differences between the financial statements and the fixed assets register and underlying schedules. I was unable to confirm property, plant and equipment by alternative means as the public entity's systems did not permit this. Consequently, I was unable to determine whether any adjustment was necessary to property, plant and equipment stated at R2 005 808 585 (2020: R2 025 564 815) as disclosed in note 21 to the financial statements.
4. Furthermore, the public entity did not correctly apply the requirements of GRAP 17, Property, Plant and Equipment as they did not correctly calculate the revaluation reserve of R915 991 422 (2020: R899 405 480), as disclosed in note 30 to the annual financial statements, which arose when the entity changed its accounting policy for buildings from the cost model to the revaluation model. I was unable to determine the full extent of the misstatement on the revaluation reserve as it was impracticable to do so. The misstatement indicated above also has an impact on the following amounts in the financial statements:
    - Note 39: prior-year adjustments depreciation and amortisation change in accounting policy of R15 880 452
    - Note 39: prior-year adjustments property, plant and equipment change in accounting policy of R317 491 805
    - Note 39: prior-year adjustments revaluation reserve change in accounting policy of R364 238 266
    - Note 3: change in accounting policy revaluation reserve of R915 991 421 (2020: R899 405 480)
    - Note 8: depreciation and amortisation of R78 418 757 (2020: R97 990 862)

Context for the opinion

5. I conducted my audit in accordance with the Intemational Standards on Auditing (ISAs). My responsibilities under those standards are further described in the Auditor-General's responsibilities for the audit of the financial statements section of my report.
6. I am independent of the public entity in accordance with the International Ethics Standards Board for Accountants' *International code of ethics for professional accountants (including International Independence Standards*) (IESBA code) as well as other ethical requirements that are relevant to my audit in South Africa. I have fulfilled my other ethical responsibilities in accordance with these requirements and the IESBA code.
7. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my qualified opinion.

Responsibilities of the accounting authority for the financial statements

8. The accounting authority is responsible for the preparation and fair presentation of the financial statements in accordance with GRAP and the requirements of the PFMA, and for such internal control as the accounting authority determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

9. In preparing the financial statements, the accounting authority is responsible for assessing the public entity's ability to continue as a going concern, disclosing, as applicable, matters relating to going concern and using the going concern basis of accounting unless the appropriate governance structure either intends to liquidate the public entity or to cease operations, or has no realistic alternative but to do so.

Auditor-general's responsibilities for the audit of the financial statements

10. My objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatements, whether due to fraud or error, and to issue an auditor's report that includes my opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with the ISAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.
11. A further description of my responsibilities for the audit of the financial statements is included in the annexure to this auditor's report.

Report on the audit of the annual performance report

Introduction and scope

12. In accordance with the Public Audit Act 25 of 2004 (PAA) and the general notice issued in terms thereof, I have a responsibility to report on the usefulness and reliability of the reported performance information against predetermined objectives for selected outcome presented in the annual performance report. I performed procedures to identify material findings but not to gather evidence to express assurance.
13. My procedures address the usefulness and reliability of the reported performance information, which must be based on the public entity's approved performance planning documents. I have not evaluated the completeness and appropriateness of the performance indicators included in the planning documents. My procedures do not examine whether the actions taken by the public entity enabled service delivery. My procedures do not extend to any disclosures or assertions relating to the extent of achievements in the current year or planned performance strategies and information in respect of future periods that may be included as part of the reported performance information. Accordingly, my findings do not extend to these matters.
14. I evaluated the usefulness and reliability of the reported performance information in accordance with the criteria developed from the performance management and reporting framework, as defined in the general notice, for the following selected outcome presented in the public entity's annual performance report for the year ended 31 March 2021:

Outcome	Pages in the annual performance report
Outcome 5 - enhanced resilience of agriculture	44 - 46

15. I performed procedures to determine whether the reported performance information was properly presented and whether performance was consistent with the approved performance planning documents. I performed further procedures to determine whether the indicators and related targets were measurable and relevant, and assessed the reliability of the reported performance information to determine whether it was valid, accurate and complete.
16. I did not identify findings on the usefulness and reliability of the performance information of the selected outcome.

Other matter

17. I draw attention to the matter below.

Achievement of planned targets

18. Refer to the annual performance report on pages 34 to 51 for information on the achievement of planned targets for the year and management's explanations provided for the under-/over achievement of targets.

Report on the audit of compliance with legislation

Introduction and scope

19. In accordance with the PAA and the general notice issued in terms thereof, I have a responsibility to report material findings on the public entity's compliance with specific matters in key legislation. I performed procedures to identify findings but not to gather evidence to express assurance.

20. The material findings on compliance with specific matters in key legislation are as follows:

Annual financial statements

21. The financial statements submitted for auditing were not prepared in accordance with the prescribed financial reporting framework and/or supported by full and proper records, as required by section 55(1)(a) and (b) of the PFMA.

22. Material misstatements of contingencies and financial instruments identified by the auditors in the submitted financial statements were corrected, but the uncorrected material misstatements and/or supporting records that could not be provided resulted in the financial statements receiving a qualified opinion.

Expenditure management

23. Effective and appropriate steps were not taken to prevent irregular expenditure amounting to R2 488 097 as disclosed in note 44 to the annual financial statements, as required by section 51(1) (b) (ii) of the PFMA. The majority of the irregular expenditure was caused by non-compliance with Treasury Regulations.

Other information

24. The accounting authority is responsible for the other information. The other information comprises the information included in the annual report. The other information does not include the financial statements, the auditor's report and the selected outcome presented in the annual performance report that have been specifically reported in this auditor's report.

25. My opinion on the financial statements and findings on the reported performance information and compliance with legislation do not cover the other information and I do not express an audit opinion or any form of assurance conclusion on it.

26. In connection with my audit, my responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements and the selected outcome presented in the annual performance report, or my knowledge obtained in the audit, or otherwise appears to be materially misstated.

27. I did not receive the other information prior to the date of this auditor's report. When I do receive and read this information, if I conclude that there is a material misstatement therein, I am required to communicate the matter to those charged with govemance and request that the other information be corrected. If the other information is not corrected, I may have to retract this auditor's report and re-issue an amended report as appropriate. However, if it is corrected this will not be necessary.

Internal control deficiencies

28. I considered internal control relevant to my audit of the financial statements, reported performance information and compliance with applicable legislation; however, my objective was not to express any form of assurance on it. The matters reported below are limited to the significant internal control deficiencies that resulted in the basis for the qualified opinion and the findings on compliance with legislation included in this report.

43. Monitoring over financial reporting was inadequate. As a result, there were still findings in areas of financial reporting and compliance with laws and regulations.

44. Action plans implemented by management did not adequately address root causes of previously raised audit findings. This resulted in inadequate remedies for internal control shortcomings previously reported and repeat matters being reported.

45. The misstatements that were identified in the financial statements were mainly due to daily and monthly controls not being adequate and effective, specifically in respect of disclosure notes.

Auditor - General

Pretoria
31 August 2021

AUDITOR-GENERAL
SOUTH AFRICA

Auditing to build public confidence

Annexure – Auditor-general's responsibility for the audit

1. As part of an audit in accordance with the ISAs, I exercise professional judgement and maintain professional scepticism throughout my audit of the financial statements and the procedures performed on reported performance information for selected outcome and on the public entity's compliance with respect to the selected subject matters.

Financial statements

2. In addition to my responsibility for the audit of the financial statements as described in this auditor's report, I also:
   - identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error; design and perform audit procedures responsive to those risks; and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations or the override of internal control;
   - obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the public entity's internal control;
   - evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the accounting authority;
   - conclude on the appropriateness of the accounting authority's use of the going concern basis of accounting in the preparation of the financial statements. I also conclude, based on the audit evidence obtained, whether a material uncertainty exists relating to events or conditions that may cast significant doubt on the ability of the Agricultural Research Council to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the financial statements about the material uncertainty or, if such disclosures are inadequate, to modify my opinion on the financial statements. My conclusions are based on the information available to me at the date of this auditor's report. However, future events or conditions may cause a public entity to cease operating as a going concern; and
   - evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and determine whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

Communication with those charged with governance

3. I communicate with the accounting authority regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that I identify during my audit.
4. I also provide the accounting authority with a statement that I have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on my independence and, where applicable, actions taken to eliminate threats or safeguards applied.

3. ANNUAL FINANCIAL STATEMENTS

1. ACCOUNTING AUTHORITY'S RESPONSIBILITIES AND APPROVAL

The council members are required by the Public Finance Management Act (Act 1 of 1999), to maintain adequate accounting records and are responsible for the content and integrity of the annual financial statements and related financial information included in this report. It is the responsibility of the members to ensure that the annual financial statements fairly present the state of affairs of the entity as at the end of the financial year and the results of its operations and cash flows for the period then ended. The external auditors are engaged to express an independent opinion on the annual financial statements and was given unrestricted access to all financial records and related data. The narrative to be updated and enhanced based on the audited annual financial statements.

The annual financial statements have been prepared in accordance with Standards of Generally Recognised Accounting Practice (GRAP) including any interpretations, guidelines and directives issued by the Accounting Standards Board.

The annual financial statements are based upon appropriate accounting policies consistently applied and supported by reasonable and prudent judgements and estimates.

The council members acknowledge that they are ultimately responsible for the system of internal financial control established by the entity and place considerable importance on maintaining a strong control environment. To enable the council members to meet these responsibilities, the accounting authority sets standards for internal control aimed at reducing the risk of error or (deficit) in a cost-effective manner. The standards include the proper delegation of responsibilities within a clearly defined framework, effective accounting procedures and adequate segregation of duties to ensure an acceptable level of risk. These controls are monitored throughout the entity and all employees are required to maintain the highest ethical standards in ensuring the entity's business is conducted in a manner that in all reasonable circumstances is above reproach. The focus of risk management in the entity is on identifying, assessing, managing and monitoring all known forms of risk across the entity. While operating risk cannot be fully eliminated, the entity endeavours to minimise it by ensuring that appropriate infrastructure, controls, systems and ethical behaviour are applied and managed within predetermined procedures and constraints.

The council members are of the opinion, based on the information and explanations given by management, that the system of internal control provides reasonable assurance that the financial records may be relied on for the preparation of the annual financial statements. However, any system of internal financial control can provide only reasonable, and not absolute, assurance against material misstatement or (deficit).

The council members have reviewed the entity's cash flow forecast for the year to 31 March 2022 and, in the light of this review and the current financial position, they are satisfied that the entity has or has access to adequate resources to continue in operational existence for the foreseeable future.

- Cash carried forward 01 April 2021 is based on the closing balance as at 31 March 2021.
- It's assumed that only 60% of the planned sale of goods and services will be realized respectively for the FY2022.
- It's assumed that the full Grant payments (current, capital and FMD) will be received as per the Allocation letter.
- Interest income is projected to realize based on the ARC's continued investments of excess funding into CPD and short-term investments with the banks which provides better yields. Once FMD work commences, less interest
- Employee costs cash flows is estimated to remain constant for the period with the implementation of the ARC Sustainability and Financial Turnaround Plan.
- Supplier payments of the planned operating expenditure are expected to be honored.
- It is assumed that all capital grant will be spent in the year in which it is received. FMD spending is estimated at R50 million (FY2022), R119 million (FY2023) and R179 million (FY2024).

The ARC's financial statements are prepared based on the going concern assumption. This assumption presumes that funds will be available to finance future operations and that the realisation of assets and settlement of liabilities, contingent obligations and commitments will occur in the ordinary course of business. Management has considered a number of inputs in the annual going concern assessment for the year-ended 31 March 2021 and the following factors/considerations were made:

- Financial plans for the three years;
- Solvency and liquidity test;
- Contingent liabilities; and
- Key ratios (if applicable).

Solvency and liquidity tests are performed in order to assess whether the company's assets exceed its liabilities as well as assessing its ability to pay its debts as they become due in the ordinary course of business for a period of twelve months.

The solvency test entails that the assets of the company, as fairly valued equal or exceeds the liabilities of the company. As at 31 March 2021, the ARC was considered solvent as the assets exceeded the liabilities by R2.05 billion. Therefore, based on this assessment, it can be concluded that the ARC is solvent.

The liquidity test determines if the company will appear to be able to pay its debts as they become due in the ordinary course of the business, for a projected period of twelve months. The ARC's Cash position is positive with a favourable cash balance for both current and prior year. The ARC managed to reduce the creditor payment period to 21 days (2020: 39 days) showing a positive move to ensure that creditors are paid as they become due and ability to collect money owed at an improved rate. However, the debtor collection period (after impairment) deteriorated from 72 days (2020) to 121 days (2021).

The financial plan that has been initially submitted as part of the Business Plan for the MTEF period FY2020/21 to FY2022/23 was based on the business as usual (i.e. not taking into account the benefits from the Financial Sustainability plan). The COVID 19 lockdown was declared on 26 March 2020, there has been varying levels of restrictions which has had an impact on the Annual Financial Statements for the year ended 31 March 2021.

COVID 19 is an unprecedented challenge for humanity, businesses and the economy at large. At the date of the report, its effects are subject to significant levels of uncertainty. To further address the inherent uncertainty embedded in the current situation that the ARC and country find themselves in, management has considered the potential impacts on the organisation by taking a variety of risk elements into account and, impact on forward looking business prospects as articulated in the MTEF FY2021 - FY2023:

- Future revenue pipeline, as thus it is assumed that the external income targeted on the Annual Performance Plan FY2021/22 will be achieved accordingly;
- Impacts on the cost structures. The additional costs arising from COVID – 19 pandemic will be prioritised and catered for, within the approved budget. The Operating Costs for FY2022 is estimated to be incurred as planned and outlined in the APP for FY2021/22;
- The employee related costs will be incurred as per the APP for FY2021/22, which entails no salary increases budgeted and only critical and prioritised vacancies has been budgeted; and
- Impact of the non-payment from private customers has been considered not significant.

Some of our clients may also face credit related issues but, the company's assessment of credit risk is that that the ARC's customer base is unrelated and concentration of credit risk with respect to trade receivables is limited.

Despite the potentially considerable impact of this pandemic on the 2021 results and financial position, the equity of the ARC is strong enough for the foreseeable future to absorb the economic shock caused by Covid19. The ARC will be able to continue in operation and meet its liabilities as they fall due for at least the next twelve months. Therefore, 2021 annual financial statements have been established on a going concern basis.

The entity is mainly dependent on the government for continued funding of operations. In the event that the going concern assumption was not used, the annual financial statements would have to be prepared on a liquidation basis. This assumes cessation of operations, which would lead to a fire sale of assets, nor the need to liquidate or curtail materially the scale of the entity.

The entity is wholly dependent on the entity for continued funding of operations. The annual financial statements are prepared on the basis that the entity is a going concern, and that the entity has neither the intention nor the need to liquidate or curtail materially the scale of the entity.

Although the accounting authority are primarily responsible for the financial affairs of the entity, they are supported by the entity's external auditors.

The external auditors are responsible for independently reviewing and reporting on the entity's fair presentation of its Annual Financial Statements. The Annual Financial Statements have been examined by the entity's external auditors and their report is presented on pages 165 to 169. The Annual Financial Statements set out on pages 170 to 245, which have been prepared on the going concern basis, were approved by the accounting authority on 31 August 2021 and were signed on its behalf by:

Ms J Isaacs
Chairperson of the ARC Council

Dr HW Vergotine
Acting President and CEO

2. STATEMENT OF FINANCIAL PERFORMANCE

Figures in Rand	Note(s)	2021	2020 Restated*
Revenue			
Revenue from exchange transactions			
Sale of goods in agricultural activities		13 661 784	17 517 257
Rendering of services		244 056 120	259 396 855
Royalty income		39 307 747	27 321 406
Rental of facilities and equipment		39 918 716	27 651 794
Recoveries		26 173 900	1 124 782
Other income		8 541 428	21 470 209
Interest received	4	21 666 258	19 441 866
Dividends received	4	25 814	136 972
Total revenue from exchange transactions		**393 351 767**	**374 061 141**
Revenue from non-exchange transactions			
Transfer revenue	5	985 817 006	978 339 783
Government grants			
Total revenue	6	**1 379 168 773**	**1 352 400 924**
Expenditure			
Employee-related costs	7	(785 839 917)	(795 275 004)
Depreciation and amortisation	8	(78 418 757)	(97 990 862)
Finance costs	9	(97 276)	(220 425)
Lease rentals on operating lease	10	(4 388 295)	(10 357 852)
Operating and administrative expenses	11	(319 733 387)	(353 044 787)
Repairs and maintenance		(28 223 605)	(30 419 189)
Total expenditure		**(1 216 701 237)**	**(1 287 308 119)**
Operating surplus		**162 467 536**	**65 092 805**
(Loss) gain on disposal of assets and liabilities		(5 394 334)	(6 847 627)
Gains on foreign exchange		(458 518)	782 334
Fair value adjustment on other financial assets at fair value	12	1 329 557	(1 762 441)
Actuarial gains/losses	27	(1 815 831)	2 249 638
Gain on biological assets and agricultural produce	13	6 132 639	9 199 407
Reversal of impairments (Impairment loss)	14	1 479 359	(1 984 608)
Inventories losses/write downs		(2 176 568)	(618 175)
		(903 696)	**1 018 528**
Surplus for the year		**161 563 840**	**66 111 333**

**See Note 3 & 39*

3. STATEMENT OF FINANCIAL POSITION AS AT 31 MARCH 2021

Figures in Rand	Notes	2021	2020 Restated*
Assets			
Current Assets			
Inventories	15	21 033 414	24 641 503
Operating lease asset	16	3 019 573	3 258 942
Receivables from exchange transactions	17	135 943 741	129 205 930
Cash and cash equivalents	18	502 162 930	245 935 648
		662 159 658	**403 042 023**
Non Current Assets			
Biological assets	19	824 425	1 176 201
Investment property	20	3 068 873	3 155 498
Property, plant and equipment	21	2 005 808 585	2 025 564 815
Intangible assets	22	15 508 653	16 577 552
Heritage assets	23	223 167	223 167
Living resources	24	1 826 001	-
Other financial assets	25	4 454 539	3 215 862
		2 031 714 243	**2 049 913 095**
Total Assets		**2 693 873 901**	**2 452 955 118**
Liabilities			
Current Liabilities			
Operating lease liability	16	20 356	20 242
Payables from exchange transactions	26	259 517 989	318 434 851
VAT payable		2 474 077	2 482 142
		262 012 422	**320 937 235**
Non Current Liabilities			
Employee benefit obligation	27	11 228 000	10 570 000
Unspent conditional grants	28	372 532 347	250 924 785
		383 760 347	**261 494 785**
Total Liabilities		**645 772 769**	**582 432 020**
Net Assets		**2 048 101 132**	**1 870 523 098**
Capital funds	29	111 986 013	111 986 013
Reserves			
Revaluation reserve	30	915 991 422	899 405 480
Self-insurance reserve		5 732 604	6 304 348
Accumulated surplus		1 014 391 093	852 827 257
Total Net Assets		**2 048 101 132**	**1 870 523 098**

**See Note 3 & 39*

4. STATEMENT OF CHANGES IN NET ASSETS

Figures in Rand | Notes | 2021 | 2020 Restated*

Figures in Rand	Capital funds	Revaluation reserve	Insurance reserve	Total reserves	Accumulated surplus	Total net assets
Balance at 01 April 2019	**111 986 013**	**809 271 803**	**3 043 478**	**812 315 281**	**789 449 963**	**1 713 751 257**
Changes in net assets						
Revaluation of land	-	90 133 677	-	90 133 677	-	90 133 677
Net income (losses) recognised directly in net assets	-	90 133 677	-	90 133 677	-	90 133 677
Surplus for the year	-	-	-	-	66 111 333	66 111 333
Total recognised income and expenses for the year	-	90 133 677	-	90 133 677	66 111 333	156 245 010
Transfer from retained earnings	-	-	4 298 728	4 298 728	(4 298 728)	-
Decrease in reserves	-	-	(1 037 858)	(1 037 858)	-	(1 037 858)
Gains (losses) from mergers or transfer of functions between entities under common control	-	-	-	-	1 564 689	1 564 689
Total changes	-	90 133 677	3 260 870	93 394 547	63 377 294	156 771 841
Opening balance as previously reported	111 986 013	899 405 480	6 304 348	905 709 828	948 515 432	1 966 211 273
Adjustments						
Change in accounting policy (Note 3)	-	-	-	-	(15 880 452)	(15 880 452)
Prior year adjustments (Note 39)	-	-			(79 807 727)	(79 807 727)
Restated* Balance at 01 April 2020 as restated*	**111 986 013**	**899 405 480**	**6 304 348**	**905 709 828**	**852 827 253**	**1 870 523 094**
Changes in net assets						16 585 942
Revaluation of buildings	-	16 585 942	-	16 585 942	-	
Net income (losses) recognised directly in net assets	-	16 585 942	-	16 585 942	-	16 585 942
Surplus for the year	-	-	-	-	161 563 840	161 563 840
Total recognised income and expenses for the year	-	16 585 942	-	16 585 942	161 563 840	178 149 782
Decrease in reserves	-	-	(571 744)	(571 744)	-	(571 744)
Total changes	-	16 585 942	(571 744)	16 014 198	161 563 840	177 578 038
Balance at 31 March 2021	**111 986 013**	**915 991 422**	**5 732 604**	**921 724 026**	**1 014 391 093**	**2 048 101 132**
Note(s)	29	30				

See Note 3 & 39

5. CASH FLOW STATEMENT

Figures in Rand	Notes	2021	2020 Restated*
Cash flows from operating activities			
Receipts			
Sale of goods and services		363 635 646	395 441 488
Grants		1 086 886 957	1 090 178 418
Interest income		21 666 258	19 441 866
Dividends received		25 814	136 972
		1 472 214 675	**1 505 198 744**
Payments			
Employee costs		(779 453 621)	(790 081 255)
Suppliers		(393 134 892)	(454 235 715)
Finance costs		(97 276)	(220 425)
		(1 172 685 789)	(1 244 537 395)
Net cash flows from operating activities	33	**299 528 886**	**260 661 349**
Cash flows from investing activities			
Purchase of property, plant and equipment	21	(36 366 980)	(90 055 491)
Purchase of other intangible assets	22	(6 934 624)	(1 020 336)
Proceeds from sale of financial assets		-	1 947
Net cash flows used in investing activities		**(43 301 604)**	**(91 073 880)**
Net increase/(decrease) in cash and cash equivalents		**256 227 282**	**169 587 469**
Cash and cash equivalents at the beginning of the year		245 935 648	76 348 179
Cash and cash equivalents at the end of the year	18	**502 162 930**	**245 935 648**

**See Note 3 & 39*

6. STATEMENT OF COMPARISON OF BUDGET AND ACTUAL AMOUNTS

Budget on Accrual Basis

Figures in Rand	Approved budget	Adjustments	Final Budget	Actual amounts on comparable basis	Difference between final budget and actual	Refer-ence
Statement of Financial Performance						
Revenue						
Revenue from exchange transactions						
Sale of goods in agricultural activities	26 651 782	-	**26 651 782**	13 661 784	**(12 989 998)**	#1
Rendering of services	361 937 994	-	**361 937 994**	244 056 120	**(117 881 874)**	#2
Royalty income	36 850 767	-	**36 850 767**	39 307 747	**2 456 980**	#3
Rental of facilities and equipment	40 326 058	-	**40 326 058**	39 918 716	**(407 342)**	#4
Recoveries	-	-	**-**	26 173 900	**26 173 900**	#5
Other income	7 006 084	-	**7 006 084**	8 541 428	**1 535 344**	#6
Interest received	23 453 952	-	**23 453 952**	21 666 258	**(1 787 694)**	#7
Dividends received	21 232	-	**21 232**	25 814	**4 582**	#8
Total revenue from exchange transactions	**496 247 869**	**-**	**496 247 869**	**393 351 767**	**(102 896 102)**	
Revenue from non-exchange transactions						
Transfer revenue						
Government grants	1 016 488 956	-	**1 016 488 956**	985 817 006	**(30 671 950)**	#9
Total revenue	**1 512 736 825**	**-**	**1 512 736 825**	**1 379 168 773**	**(133 568 052)**	
Expenditure						
Personnel	(837 150 901)	-	**(837 150 901)**	(785 839 917)	**51 310 984**	#10
Depreciation and amortisation	(49 958 274)	-	**(49 958 274)**	(78 418 757)	**(28 460 483)**	#11
Impairment loss/Reversal of impairments	-	-	**-**	1 479 359	**1 479 359**	#12
Finance costs	-	-	**-**	(97 276)	**(97 276)**	#13
Lease rentals on operating lease	(9 233 362)	-	**(9 233 362)**	(4 388 295)	**4 845 067**	#14
Operating and administrative expenses	(513 167 271)	-	**(513 167 271)**	(347 956 992)	**165 210 279**	#15
Total expenditure	**(1 409 509 808)**	**-**	**(1 409 509 808)**	**(1 215 221 878)**	**194 287 930**	
Operating surplus	**103 227 017**	**-**	**103 227 017**	**163 946 895**	**60 719 878**	
(Loss)/gain on disposal of assets and liabilities	-	-	**-**	(5 394 334)	**(5 394 334)**	#16
(Loss)/gain on foreign exchange	-	-	**-**	(458 518)	**(458 518)**	#17
Fair value adjustments	-	-	**-**	1 329 557	**1 329 557**	#18
Actuarial gains/losses	-	-	**-**	(1 815 831)	**(1 815 831)**	#19
Gain on biological assets and agricultural produce	(50 000)	-	**(50 000)**	6 132 639	**6 182 639**	#20
Inventories losses/write downs	-	-	**-**	(2 176 568)	**(2 176 568)**	#21
	(50 000)	**-**	**(50 000)**	**(2 383 055)**	**(2 333 055)**	
Surplus before taxation	**103 177 017**	**-**	**103 177 017**	**161 563 840**	**58 386 823**	
Net Surplus/(Deficit)	**103 177 017**	-	**103 177 017**	**161 563 840**	**58 386 823**	
Capital expenditure	(104 466 997)	-	**(104 466 997)**	(43 301 604)	**61 165 393**	#22
Net Operational Surplus/(Deficit)	**(1 289 980)**	**-**	**(1 289 980)**	**118 262 236**	**119 552 216**	

Narration area

The budget was approved by the ARC Council and submitted to the Executive Authority in terms of section 53(1) of the PFMA. (Both the annual budget and annual financial statements adopt an Accrual Basis). The budget amounts reflected excludes VAT.

#1 Less uptake of ARC products and services due to COVID-19 restrictions

#2 Less uptake of ARC products and services due to COVID-19 restrictions

#3 The royalties received were higher than anticipated

#4 Usage rate of ARC rental facilities was less than anticipated due to COVID-19 restrictions

#5 Recoveries from staff S&Ts from prior years

#6 Less uptake of ARC products and services due to COVID-19 restrictions

#7 The budget cuts and slow paying by government departments affected the level of cash available for short-term investments

#8 More dividends received than anticipated

#9 Budget cuts of R18,7m from DALRRD during the course of the year as well as R26,1m retracted from DSI

#10 Unfilled vacancies in response to the employee budget cut from DALRRD

#11 There has been an increase in computer equipment due to the equipment that is no longer leased but has been bought as well as increased depreciation on infrastructure.

#12 The decrease in bad debts was not anticipated.

#13 Interest paid which was not anticipated

#14 Some equipment has been bought and is no longer rented, the related contracts have come to an end and will not be renewed.

#15 Less expenses incurred in line with the reduction in revenue which was impacted by COVID-19 restrictions

#16 The sale of assets was not anticipated

#17 Loss on foreign exchange was not anticipated

#18 The variance is due to the improved share price of the JSE listed investments.

#19 The actuarial gains and losses cannot be anticipated as it is based on changes in economic variables.

#20 The variance is due to harvest of fruit and increase in biological assets.

#21 Losses and write-downs were not anticipated

#22 There were delays in SCM processes, especially on items that could not be procured due to the COVID-19 restrictions.

7. ACCOUNTING POLICIES

1. PRESENTATION OF ANNUAL FINANCIAL STATEMENTS

The annual financial statements have been prepared in accordance with the Standards of Generally Recognised Accounting Practice (GRAP), issued by the Accounting Standards Board in accordance with Section 91(1) of the Public Finance Management Act (Act 1 of 1999).

These annual financial statements have been prepared on an accrual basis of accounting and are in accordance with historical cost convention as the basis of measurement, unless specified otherwise. They are presented in South African Rand.

Assets, liabilities, revenues and expenses were not offset, except where offsetting is either required or permitted by a Standard of GRAP.

A summary of the significant accounting policies, which have been consistently applied in the preparation of these annual financial statements, are disclosed below.
These accounting policies are consistent with the previous period, except for the changes set out in note 3 Changes in accounting policy.

1.1 Entity information

The ARC is a national government business enterprise (enacted by the Agricultural Research Act,1990 (Act 86 of 1990) domiciled in the Republic of South Africa.

1.2 Presentation currency

These annual financial statements are presented in South African Rand, which is the functional currency of the entity.

1.3 Going concern assumption

These annual financial statements have been prepared on a going concern basis, and that the Agricultural Research Council (ARC) will continue in operation and meet its obligations for at least the next 12 months.

1.4 Significant judgements and sources of estimation uncertainty

In preparing the annual financial statements, management is required to make estimates and assumptions that affect the amounts represented in the annual financial statements and related disclosures. Use of available information and the application of judgement is inherent in the formation of estimates. Actual results in the future could differ from these estimates which may be material to the annual financial statements. Significant judgements include:

Other significant judgements, sources of estimation uncertainty and/or relating information, have been disclosed in the relating notes.

Impairment testing
The entity reviews and tests the carrying value of current and non-current assets when events or changes in circumstances suggest that the carrying amount may not be recoverable. Assets are grouped at the lowest level for which identifiable cash flows are largely independent of cash flows of other assets and liabilities. If there are indications that impairment may have occurred, estimates are prepared of expected future cash flows for each group of assets. Expected future cash flows used to determine the value in use of tangible assets are inherently uncertain and could materially change over time. They are significantly affected by a number of factors including supply demand, and other economic factors.

Provisions
Provisions were raised and management determined an estimate based on the information available. Additional disclosure of these estimates of provisions are included in note - Provisions.

Property, plant and equipment and intangible assets
Property, plant and equipment and intangible assets are depreciated over their useful lives, taking into account residual values, where appropriate. The entity's management determines useful lives, residual values and related depreciation charges for its property, plant and equipment (Including biological assets held for research) and intangible assets with reference to the estimated periods that the entity intends to derive future economic benefits from the use of these assets. The useful lives of the assets and residual values are assessed annually and may vary depending on a number of factors. In re-assessing asset useful lives, factors such as technological innovation and maintenance programs are considered. Residual value assessments consider issues such as future market conditions, the remaining life of the asset and projected disposal values.

Post-retirement benefits
The present value of the post-retirement obligation depends on several factors that are determined on an actuarial basis using a number of assumptions. The assumptions used in determining the net cost (income) include the discount rate. Any changes in these assumptions will impact on the carrying amount of post-retirement obligations.

The entity determines the appropriate discount rate at the end of each year. This is the interest rate that should be used to determine the present value of estimated future cash outflows expected to be required to settle the pension obligations. In determining the appropriate discount rate, the entity considers the interest rates of high-quality corporate bonds that are denominated in the currency in which the benefits will be paid, and that have terms to maturity approximating the terms of the related pension liability.

Other key assumptions for pension obligations are based on current market conditions. Additional information is disclosed in Note 27.

Biological Assets
In measuring fair value of biological assets, management estimates and judgements are required for determination of fair value. The determination of the fair value of a biological asset or agricultural produce may be facilitated by grouping biological assets or agricultural produce according to the significant attributes of the asset, e.g. sorted by age or quality. The Company selects the attributes corresponding to the attributes used in the market as a basis for pricing.

If an active market exists for a biological asset or agricultural produce, the quoted market price is appropriate for determining the fair value.

Stage of completion
In determining the stage of completion of a research project, management estimates the stage of completion based on work completed for as assessed by project leaders. This is then compared to costs incurred to date with appropriate revenue recognition processed in the statement of financial performance. Consideration is given to any arrangements with funders to offset any costs incurred in excess of budgeted amounts.

Capitalisation of intellectual property
ARC generates royalty revenue from Intellectual Property (IP) including Plant Breeders Rights, Patents and a Design arising from research conducted (either by ARC employees or funded by ARC or research collaboration or industry funding). These are internally generated intangible assets; however, they arise as a result of research activities and not development activities as envisioned by paragraph 52 of GRAP 31.

ARC protects the IP in terms of the Act by registering the results of the research (either an improved variant or cultivars or other products) with the relevant authorities. ARC protects the IP in terms of the Intellectual Property Rights from Publicly Financed Research and Development Act of 2008. It is a requirement to protect IP as a publicly funded institution.

ARC does not intend to sell the IP nor to use the IP for its own use but rather holds the IP for use by third parties and earns royalties from the IP. The object from the results of the research conducted by ARC (either through employees or funded research by ARC) is generally to improve farming quality, either through more cost-effective techniques, better yield and/or better quality of product for all levels of farming including Small and Medium Enterprises.

Consequently, ARC does not recognise any internally generated intangible assets in the statement of financial position but expenses all research costs when incurred.

1.5 Transfer of functions between entities under common control

Definitions
An acquirer is the entity that obtains control of the acquiree or transferor.

Carrying amount of an asset or liability is the amount at which an asset or liability is recognised in the statement of financial position.

Control is the power to govern the financial and operating policies of another entity so as to benefit from its activities.

A function is an integrated set of activities that is capable of being conducted and managed for purposes of achieving an entity's objectives, either by providing economic benefits or service potential.

A merger is the establishment of a new combined entity in which none of the former entities obtains control over any other and no acquirer can be identified.

Transfer date is the date on which the acquirer obtains control of the function and the transferor loses control of that function.

A transfer of functions is the reorganisation and/or the re-allocation of functions between entities by transferring functions between entities or into another entity.

A transferor is the entity that relinquishes control of a function.

Common control - For a transaction or event to occur between entities under common control, the transaction or event needs to be undertaken between entities within the same sphere of government or between entities that are part of the same economic entity. Entities that are ultimately controlled by the same entity before and after the transfer of functions are within the same economic entity.

A function is an integrated set of activities that is capable of being conducted and managed for purposes of achieving an entity's objectives, either by providing economic benefits or service potential. A function consists of inputs and processes applied to those inputs that have the ability to create outputs. A function can either be a part or a portion of an entity or can consist of the whole entity. Although functions may have outputs, outputs are not required to qualify as a function. The three elements of a function are defined as follows:

- Input: Any resource that creates, or has the ability to create, outputs when one or more processes are applied to it.
- Process: Any system, standard, protocol, convention or rule that when applied to an input or inputs, creates or has the ability to create outputs.
- Output: The result of inputs and processes applied to achieve and improve efficiency. This may be in the form of achieving service delivery objectives, or the delivery of goods and/or services.

Identifying the acquirer and transferor
For each transfer of functions between entities under common control an acquirer and transferor are identified. All relevant facts and circumstances are considered in identifying the acquirer and transferor.

The terms and conditions of a transfer of functions undertaken between entities under common control are set out in a binding arrangement. The binding arrangement governing the terms and conditions of a transfer of functions may identify which entity to the transaction or event is the transferor(s) and which entity is the acquirer. Where the binding arrangement does not clearly identify the acquirer or the transferor, the behaviour or actions of the entities may indicate which entity is the acquirer and which entity is the transferor.

Determining the acquirer includes a consideration of, amongst other things, which of the entities involved in the transfer of functions initiated the transaction or event, the relative size of the entities, as well as whether the assets or revenue of one of the entities involved in the transaction or event significantly exceed those of the other entities. If no acquirer can be identified, the transaction or event is accounted for in terms of the Standard of GRAP on Mergers.

Determining the transfer date
The acquirer and the transferor identify the transfer date, which is the date on which the acquirer obtains control and the transferor loses control of that function.

All relevant facts and circumstances are considered in identifying the transfer date.

Assets acquired [transferred] and liabilities assumed [relinquished]
The recognition of assets and liabilities, is subject to the following conditions:

The assets acquired and the liabilities assumed are part of what had been agreed in terms of the binding arrangement (if applicable), rather than the result of separate transactions.

Determining what is part of the transfer of functions transaction
Where the entity and the transferor have a pre-existing relationship before or when negotiations for a transfer of functions began, or where a binding arrangement is entered into during the negotiations that are separate from a transfer of functions, any amounts that are not part of what were transferred in a transfer of functions are identified. This policy only applies to the consideration transferred and the assets acquired and liabilities assumed in a transfer of functions as governed by the terms and conditions of the binding arrangement.

The following factors are considered, which are neither mutually exclusive nor individually conclusive, to determine whether a transaction is part of a transfer or function or whether the transaction is separate:

- the reasons for the transaction; and
- the timing of the transaction.

Accounting by the entity as acquirer

Initial recognition and measurement
As of the transfer date, the entity recognises the purchase consideration paid to the transferor and all the assets acquired and liabilities assumed in a transfer of functions. The assets acquired and liabilities assumed are measured at their carrying amounts. If, prior to the transfer of functions, the transferor was not applying the accrual basis of accounting, the transferor changes its basis of accounting to the accrual basis of accounting prior to the transfer.

The consideration paid by the entity can be in the form of cash, cash equivalents or other assets. If the consideration paid is in the form of other assets, the entity de-recognises such assets on the transfer date at their carrying amounts.

The difference between the carrying amounts of the assets acquired, the liabilities assumed and the consideration paid to the transferor, is recognised in accumulated surplus or (deficit).

Measurement period
If the initial accounting for a transfer of functions is incomplete by the end of the reporting period in which the transfer occurs, the entity reports in its annual financial statements provisional amounts for the items for which the accounting is incomplete. During the measurement period, the entity retrospectively adjusts the provisional amounts recognised at the transfer date to reflect new information obtained about facts and circumstances that existed as of the transfer date and, if known, would have affected the measurement of the amounts recognised as of that date. The measurement period ends as soon as the entity receives the information it was seeking about facts and circumstances that existed as of the transfer date or learns that more information is not obtainable. However, the measurement period does not exceed two years from the transfer date.

The entity considers all relevant factors in determining whether information obtained after the transfer date should result in an adjustment to the provisional amounts recognised or whether that information results from events that occurred after the transfer date.

The entity recognises an increase (decrease) in the provisional amount recognised for an asset (liability) by means of decreasing (increasing) the excess of the purchase consideration paid over the carrying amount of the assets acquired and liabilities assumed previously recognised in accumulated surplus or deficit. However, new information obtained during the measurement period may sometimes result in an adjustment to the provisional amount of more than one asset or liability.

During the measurement period, the entity recognises adjustments to the provisional amounts as if the accounting for the transfer of functions had been completed at the transfer date. Thus, the entity revises comparative information for prior periods presented in annual financial statements as needed, including making any change in depreciation, amortisation or other income effects recognised in completing the initial accounting.

After the measurement period ends, the entity revises the accounting for a transfer of functions only to correct an error in accordance with the Standard of GRAP on Accounting Policies, Changes in Accounting Estimates and Errors.

Subsequent measurement
The entity subsequently measures any assets acquired and any liabilities assumed in a transfer of functions in accordance with the applicable Standards of GRAP.

At the transfer date, the entity classifies or designates the assets acquired and liabilities assumed as necessary to apply other Standards of GRAP subsequently. The entity makes those classifications or designations on the basis of the terms of the binding arrangement, economic conditions, its operating or accounting policies and other relevant conditions that exist at the transfer date. An exception is that the entity classifies the following contracts on the basis of the contractual terms and other factors at the inception of the contract (or, if the terms of the contract have been modified in a manner that would change its classification, at the date of that modification, which might be the transfer date):

- classification of a lease contract as either an operating lease or a finance lease in accordance with the Standard of GRAP on Leases; and
- classification of a contract as an insurance contract in accordance with the International Financial Reporting Standard on Insurance Contracts.

1.6 Biological assets

The entity recognises biological assets or agricultural produce when, and only when:

- the entity controls the asset as a result of past events;
- it is probable that future economic benefits or service potential associated with the asset will flow to the entity; and
- the fair value or cost of the asset can be measured reliably..

Biological assets are measured at their fair value less costs to sell.

The fair value of livestock is determined based on market prices of livestock of similar age, breed, and genetic merit.

The fair value of milk is determined based on market prices in the local area.

The fair value of the vine/pine plantations is based on the combined fair value of the land and the vines/pine trees. The fair value of the raw land and land improvements is then deducted from the combined fair value to determine the fair value of the vines/pine trees.

A gain or loss arising on initial recognition of biological assets or agricultural produce at fair value less costs to sell and from a change in fair value less costs to sell of biological assets is included in surplus or (deficit) for the period in which it arises.

Where market determined prices or values are not available, the present value of the expected net cash inflows from the asset, discounted at a current market-determined pre-tax rate where applicable is used to determine fair value.

1.7 Investment property

Investment property is property (land or a building - or part of a building - or both) held to earn rentals or for capital appreciation or both, rather than for:

- use in the production or supply of goods or services;
- administrative purposes; or
- sale in the ordinary course of operations.

Owner-occupied property is property held for use in the production or supply of goods or services or for administrative purposes.

Investment property is recognised as an asset when, it is probable that the future economic benefits or service potential that are associated with the investment property will flow to the entity, and the cost or fair value of the investment property can be measured reliably.

Investment property is initially recognised at cost. Transaction costs are included in the initial measurement.

Where investment property is acquired through a non-exchange transaction, its cost is its fair value as at the date of acquisition. Costs include costs incurred initially and costs incurred subsequently to add to, or to replace a part of, or service a property. If a replacement part is recognised in the carrying amount of the investment property, the carrying amount of the replaced part is derecognised.

Cost model
Investment property is carried at cost less accumulated depreciation and any accumulated impairment losses.

Depreciation is provided to write down the cost, less estimated residual value by equal instalments over the useful life of the property, which is as follows:

Item	Useful life
Property - buildings	40 - 70 years

Investment property is derecognised on disposal or when the investment property is permanently withdrawn from use and no future economic benefits or service potential are expected from its disposal.

The entity separately discloses expenditure to repair and maintenance investment property in the notes to the annual financial statements (see note 20).

1.8 Property, plant and equipment

Property, plant and equipment are tangible non-current assets (including infrastructure assets) that are held for use in the production or supply of goods or services, rental to others, or for administrative purposes, and are expected to be used during more than one period.

Property, plant and equipment comprises of land, buildings, machinery and farming equipment, office furniture and equipment, motor vehicles and aircraft, computer equipment, infrastructure, laboratory equipment, bearer plants, buffalo and horse.

The cost of an item of property, plant and equipment is recognised as an asset when:

- it is probable that future economic benefits or service potential associated with the item will flow to the entity; and
- the cost of the item can be measured reliably.

Property, plant and equipment is initially measured at cost.
The cost of an item of property, plant and equipment is the purchase price and other costs attributable to bring the asset to the location and condition necessary for it to be capable of operating in the manner intended by management. Trade discounts and rebates are deducted in arriving at the cost.

Where an asset is acquired through a non-exchange transaction, its cost is its fair value as at date of acquisition.

Where an item of property, plant and equipment is acquired in exchange for a non-monetary asset or monetary assets, or a combination of monetary and non-monetary assets, the asset acquired is initially measured at fair value (the cost). If the acquired item's fair value was not determinable, it's deemed cost is the carrying amount of the asset(s) given up.

When significant components of an item of property, plant and equipment have different useful lives, they are accounted for as separate items (major components) of property, plant and equipment.

Costs include costs incurred initially to acquire or construct an item of property, plant and equipment and costs incurred subsequently to add to, replace part of, or service it. If a replacement cost is recognised in the carrying amount of an item of property, plant and equipment, the carrying amount of the replaced part is derecognised.

The fruit trees are bearer plants under the definition in Standard of GRAP 27 Agriculture and therefore presented and accounted for as property, plant and equipment. Costs capitalised to bearer assets (Fruit trees: i.e banana palms, deciduous and macadamia trees) include all direct costs of land preparation and planting.

Items such as spare parts, standby equipment and servicing equipment are recognised when they meet the definition of property, plant and equipment.

Property, plant and equipment is carried at cost less accumulated depreciation and any impairment losses.

Land and buildings is carried at revalued amount, being the fair value at the date of revaluation less any subsequent accumulated depreciation and subsequent accumulated impairment losses.

When an item of property, plant and equipment is revalued, any accumulated depreciation at the date of the revaluation is eliminated against the gross carrying amount of the asset and the net amount restated to the revalued amount of the asset.

Any increase in an asset's carrying amount, as a result of a revaluation, is credited directly to a revaluation surplus. The increase is recognised in surplus or (deficit) to the extent that it reverses a revaluation decrease of the same asset previously recognised in surplus or (deficit).

The revaluation surplus in equity related to a specific item of property, plant and equipment is transferred directly to retained earnings when the asset is derecognised.

Property, plant and equipment are depreciated on the straight-line basis over their expected useful lives to their estimated residual value.

The useful lives of items of property, plant and equipment have been assessed as follows:

Item	Depreciation method	Average useful life
Buildings	Straight line	3 to 70 years
Machinery and farming equipment	Straight line	3 to 60 years
Office furniture and equipment	Straight line	5 to 30 years
Motor vehicles and aircraft	Straight line	4 to 20 years
Computer equipment	Straight line	3 to 15 years
Infrastructure	Straight line	10 to 60 years
Laboratory equipment	Straight line	5 to 60 years
Bearer plants	Straight line	4 to 50 years
Buffalo	Straight line	23 years
Horse	Straight line	30 years

The depreciable amount of an asset is allocated on a systematic basis over its useful life.

Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item is depreciated separately.

The entity assesses at each reporting date whether there is any indication that the entity expectations about the residual value and the useful life of an asset have changed since the preceding reporting date. If any such indication exists, the entity revises the expected useful life and/or residual value accordingly. The change is accounted for as a change in an accounting estimate.

The depreciation charge for each period is recognised in surplus or (deficit) unless it is included in the carrying amount of another asset.

Items of property, plant and equipment are derecognised when the asset is disposed of or when there are no further economic benefits or service potential expected from the use of the asset.

The gain or loss arising from the derecognition of an item of property, plant and equipment is included in surplus or (deficit) when the item is derecognised. The gain or loss arising from the derecognition of an item of property, plant and equipment is determined as the difference between the net disposal proceeds, if any, and the carrying amount of the item.

The entity separately discloses expenditure to repair and maintain property, plant and equipment in the notes to the financial statements (see note 21).

The entity discloses relevant information relating to assets under construction or development, in the notes to the financial statements (see note 21).

1.9 Intangible assets

An intangible asset is recognised when:

- it is probable that the expected future economic benefits or service potential that are attributable to the asset will flow to the entity; and
- the cost or fair value of the asset can be measured reliably.

The entity assesses the probability of expected future economic benefits or service potential using reasonable and supportable assumptions that represent management's best estimate of the set of economic conditions that will exist over the useful life of the asset.

Where an intangible asset is acquired through a non-exchange transaction, its initial cost at the date of acquisition is measured at its fair value as at that date.

The entity has registered a number of patents, Plant Breeders' Rights and designs emanating from the research conducted or funded by ARC in terms of Agricultural Research Act as amended in order to protect the Intellectual Property derived from the research. ARC does not capitalize the research costs incurred but expenses these costs in terms of GRAP 31: Intangible Assets, as the criteria to capitalize these assets as development costs has not been met.

Expenditure on research (or on the research phase of an internal project) is recognised as an expense when it is incurred.

An intangible asset arising from development (or from the development phase of an internal project) is recognised when:

- it is technically feasible to complete the asset so that it will be available for use or sale;
- there is an intention to complete and use or sell it;
- there is an ability to use or sell it;
- it will generate probable future economic benefits or service potential;
- there are available technical, financial and other resources to complete the development and to use or sell the asset; and
- the expenditure attributable to the asset during its development can be measured reliably.

Intangible assets are carried at cost less any accumulated amortisation and any impairment losses.

An intangible asset is regarded as having an indefinite useful life when, based on all relevant factors, there is no foreseeable limit to the period over which the asset is expected to generate net cash inflows or service potential. Amortisation is not provided for these intangible assets, but they are tested for impairment annually and whenever there is an indication that the asset may be impaired. For all other intangible assets amortisation is provided on a straight-line basis over their useful life.

The amortisation period and the amortisation method for intangible assets are reviewed at each reporting date.

Reassessing the useful life of an intangible asset with a finite useful life after it was classified as indefinite is an indicator that the asset may be impaired. As a result, the asset is tested for impairment and the remaining carrying amount is amortised over its useful life.

Amortisation is provided to write down the intangible assets, on a straight-line basis, to their residual values as follows:

Item	Depreciation method	Average useful life
Computer software	Straight line	3 to 10 years

The entity discloses relevant information relating to assets under construction or development, in the notes to the financial statements (see note 22).

Intangible assets are derecognised:

- on disposal; or
- when no future economic benefits or service potential are expected from its use or disposal.

The gain or loss arising from the derecognition of intangible assets is included in surplus or (deficit) when the asset is derecognised (unless the Standard of GRAP on leases requires otherwise on a sale and leaseback).

1.10 Heritage assets

Carrying amount is the amount at which an asset is recognised after deducting accumulated impairment losses.

Class of heritage assets means a grouping of heritage assets of a similar nature or function in an entity's operations that is shown as a single item for the purpose of disclosure in the annual financial statements.

Cost is the amount of cash or cash equivalents paid or the fair value of the other consideration given to acquire an asset at the time of its acquisition or construction or, where applicable, the amount attributed to that asset when initially recognised in accordance with the specific requirements of other Standards of GRAP.

Fair value is the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's length transaction.

Heritage assets are assets that have a cultural, environmental, historical, natural, scientific, technological or artistic significance and are held indefinitely for the benefit of present and future generations.

An impairment loss of a non-cash-generating asset is the amount by which the carrying amount of an asset exceeds its recoverable service amount.

Recognition
The entity recognises a heritage asset as an asset if it is probable that future economic benefits or service potential associated with the asset will flow to the entity, and the cost or fair value of the asset can be measured reliably.

Initial measurement
Heritage assets are measured at cost.

Where a heritage asset is acquired through a non-exchange transaction, its cost is measured at its fair value as at the date of acquisition.

Subsequent measurement
After recognition as an asset, a class of heritage assets is carried at its cost less any accumulated impairment losses.

Impairment
The entity assesses at each reporting date whether there is an indication that it may be impaired. If any such indication exists, the entity estimates the recoverable amount or the recoverable service amount of the heritage asset.

Derecognition
The entity derecognises heritage asset on disposal, or when no future economic benefits or service potential are expected from its use or disposal.

The gain or loss arising from the derecognition of a heritage asset is included in surplus or (deficit) when the item is derecognised (unless the Standard of GRAP on leases requires otherwise on a sale and leaseback).

1.11 Financial instruments

A financial instrument is any contract that gives rise to a financial asset of one entity and a financial liability or a residual interest of another entity.

The amortised cost of a financial asset or financial liability is the amount at which the financial asset or financial liability is measured at initial recognition minus principal repayments, plus or minus the cumulative amortisation using the effective interest method of any difference between that initial amount and the maturity amount, and minus any reduction (directly or using an allowance account) for impairment or uncollectability.

Credit risk is the risk that one party to a financial instrument will cause a financial loss for the other party by failing to discharge an obligation.

Currency risk is the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in foreign exchange rates.

Derecognition is the removal of a previously recognised financial asset or financial liability from an entity's statement of financial position.

The effective interest method is a method of calculating the amortised cost of a financial asset or a financial liability (or group of financial assets or financial liabilities) and of allocating the interest income or interest expense over the relevant period. The effective interest rate is the rate that exactly discounts estimated future cash payments or receipts through the expected life of the financial instrument or, when appropriate, a shorter period to the net carrying amount of the financial asset or financial liability. When calculating the effective interest rate, an entity shall estimate cash flows considering all contractual terms of the financial instrument (for example, prepayment, call and similar options) but shall not consider future credit losses. The calculation includes all fees and points paid or received between parties to the contract that are an integral part of the effective interest rate (see the Standard of GRAP on Revenue from Exchange Transactions), transaction costs, and all other premiums or discounts. There is a presumption that the cash flows and the expected life of a group of similar financial instruments can be estimated reliably. However, in those rare cases when it is not possible to reliably estimate the cash flows or the expected life of a financial instrument (or group of financial instruments), the entity shall use the contractual cash flows over the full contractual term of the financial instrument (or group of financial instruments).

Fair value is the amount for which an asset could be exchanged, or a liability settled, between knowledgeable willing parties in an arm's length transaction.

A financial asset is:

- cash;
- a residual interest of another entity; or
- a contractual right to:
  - ◊ receive cash or another financial asset from another entity; or
  - ◊ exchange financial assets or financial liabilities with another entity under conditions that are potentially favourable to the entity.

A financial liability is any liability that is a contractual obligation to:

- deliver cash or another financial asset to another entity; or
- exchange financial assets or financial liabilities under conditions that are potentially unfavourable to the entity.

Interest rate risk is the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market interest rates.

Liquidity risk is the risk encountered by an entity in the event of difficulty in meeting obligations associated with financial liabilities that are settled by delivering cash or another financial asset.

Market risk is the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market prices. Market risk comprises three types of risk: currency risk, interest rate risk and other price risk.

Other price risk is the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market prices (other than those arising from interest rate risk or currency risk), whether those changes are caused by factors specific to the individual financial instrument or its issuer, or factors affecting all similar financial instruments traded in the market.

Transaction costs are incremental costs that are directly attributable to the acquisition, issue or disposal of a financial asset or financial liability. An incremental cost is one that would not have been incurred if the entity had not acquired, issued or disposed of the financial instrument.

Financial instruments at amortised cost are non-derivative financial assets or non-derivative financial liabilities that have fixed or determinable payments, excluding those instruments that:

- the entity designates at fair value at initial recognition; or
- are held for trading.

Financial instruments at cost are investments in residual interests that do not have a quoted market price in an active market, and whose fair value cannot be reliably measured.

Classification

The entity has the following types of financial assets (classes and category) as reflected on the face of the statement of financial position or in the notes thereto:

Class	Category
Cash and cash equivalents	Financial asset measured at amortised cost
Trade and other receivables	Financial asset measured at amortised cost
Other financial asset	Financial asset measured at fair value
Other financial asset	Financial asset measured at cost

The entity has the following types of financial liabilities (classes and category) as reflected on the face of the statement of financial position or in the notes thereto:

Class	Category
Trade and other payables	Financial liability measured at amortised cost

1.12 Statutory receivables

Identification
Statutory receivables are receivables that arise from legislation, supporting regulations, or similar means, and require settlement by another entity in cash or another financial asset.

Carrying amount is the amount at which an asset is recognised in the statement of financial position.

The cost method is the method used to account for statutory receivables that requires such receivables to be measured at their transaction amount, plus any accrued interest or other charges (where applicable) and, less any accumulated impairment losses and any amounts derecognised.

The transaction amount for a statutory receivable means the amount specified in, or calculated, levied or charged in accordance with, legislation, supporting regulations, or similar means.

Recognition
The entity recognises statutory receivables as follows:

- if the transaction is an exchange transaction, using the policy on Revenue from exchange transactions;
- if the transaction is a non-exchange transaction, using the policy on Revenue from non-exchange transactions (Taxes and transfers); or
- if the transaction is not within the scope of the policies listed in the above or another Standard of GRAP, the receivable is recognised when the definition of an asset is met and, when it is probable that the future economic benefits or service potential associated with the asset will flow to the entity and the transaction amount can be measured reliably.

Initial measurement
The entity initially measures statutory receivables at their transaction amount.

Subsequent measurement
The entity measures statutory receivables after initial recognition using the cost method. Under the cost method, the initial measurement of the receivable is changed subsequent to initial recognition to reflect any:

- interest or other charges that may have accrued on the receivable (where applicable);
- impairment losses; and
- amounts derecognised.

Derecognition
The entity derecognises a statutory receivable, or a part thereof, when:

- the rights to the cash flows from the receivable are settled, expire or are waived;
- the entity transfers to another party substantially all of the risks and rewards of ownership of the receivable; or
- the entity, despite having retained some significant risks and rewards of ownership of the receivable, has transferred control of the receivable to another party and the other party has the practical ability to sell the receivable in its entirety to an unrelated third party, and is able to exercise that ability unilaterally and without needing to impose additional restrictions on the transfer. In this case, the entity:
  - ◊ derecognises the receivable; and
  - ◊ recognises separately any rights and obligations created or retained in the transfer.

The carrying amounts of any statutory receivables transferred are allocated between the rights or obligations retained and those transferred on the basis of their relative fair values at the transfer date. The entity considers whether any newly-created rights and obligations are within the scope of the Standard of GRAP on Financial Instruments or another Standard of GRAP. Any difference between the consideration received and the amounts derecognised and, those amounts recognised, are recognised in surplus or deficit in the period of the transfer.

1.13 Tax

Value added tax
The entity is subject to a value added tax ("VAT") of 15% for the sale of goods and services. The amount of VAT liability is determined by applying the applicable tax rate to the invoiced amount of the sale of goods and services (output VAT) less VAT paid on purchases made with the relevant supporting invoices (input VAT). The entity reports revenue net value added tax for all the periods presented in the statement of financial performance.

1.14 Leases

A lease is classified as a finance lease if it transfers substantially all the risks and rewards incidental to ownership. A lease is classified as an operating lease if it does not transfer substantially all the risks and rewards incidental to ownership.

The ARC has entered into commercial property leases on land and buildings and it retains all the significant risks and rewards of ownership of the properties. The ARC accounts for these contracts as operating lease, with the ARC being a lessor. On the other hand, the ARC leases premises occupied by staff in regional offices, where it does not retain all the significant risks and rewards of ownership of these properties and so accounts for these contracts as operating leases, with the ARC being a lessee.

Operating leases - lessor
Operating lease revenue is recognised as revenue on a straight-line basis over the lease term.

Income for leases is disclosed under revenue in statement of financial performance.

Operating leases - lessee
Operating lease payments are recognised as an expense on a straight-line basis over the lease term. The difference between the amounts recognised as an expense and the contractual payments are recognised as an operating lease asset or liability.

1.15 Inventories

Inventories are initially measured at cost except where inventories are acquired through a non-exchange transaction, then their costs are their fair value as at the date of acquisition.
Subsequently, inventories are measured at the lower of cost and net realisable value.

Inventories are measured at the lower of cost and current replacement cost where they are held for;
- distribution at no charge or for a nominal charge; or
- consumption in the production process of goods to be distributed at no charge or for a nominal charge.

Net realisable value is the estimated selling price in the ordinary course of operations less the estimated costs of completion and the estimated costs necessary to make the sale, exchange or distribution.

Current replacement cost is the cost the entity incurs to acquire the asset on the reporting date.

The cost of inventories comprises of all costs of purchase, costs of conversion and other costs incurred in bringing the inventories to their present location and condition.

The cost of inventories is assigned using the weighted average cost formula. The same cost formula is used for all inventories having a similar nature and use to the entity.

Consumable stores are valued at the lower of cost and current replacement cost. Research Livestock is valued at the lower of cost or net realisable value. Cost of work in progress and finished goods includes direct costs and an appropriate allocation of overheads based on normal production levels.

The agricultural produce is initially recognised at fair value at the point of harvest less estimated costs to sell and subsequently in inventories up until the point when it is sold to a third party or used internally for other purposes. Such measurement is the cost at that date when transferring the harvested produce to Inventory. Agricultural produce resulting from research, is not accounted for as inventories and the income resulting from the sale of these products is brought to account in the year in which it is sold.

When inventories are sold, the carrying amounts of those inventories are recognised as an expense in the period in which the related revenue is recognised. If there is no related revenue, the expenses are recognised when the goods are distributed, or related services are rendered. The amount of any write-down of inventories to net realisable value or current replacement cost and all losses of inventories are recognised as an expense in the period the write-down or loss occurs. The amount of any reversal of any write-down of inventories, arising from an increase in net realisable value or current replacement cost, are recognised as a reduction in the amount of inventories recognised as an expense in the period in which the reversal occurs.

1.16 Impairment of cash-generating assets

Cash-generating assets are assets used with the objective of generating a commercial return. Commercial return means that positive cash flows are expected to be significantly higher than the cost of the asset.

Impairment is a loss in the future economic benefits or service potential of an asset, over and above the systematic recognition of the loss of the asset's future economic benefits or service potential through depreciation (amortisation).

Carrying amount is the amount at which an asset is recognised in the statement of financial position after deducting any accumulated depreciation and accumulated impairment losses thereon.

A cash-generating unit is the smallest identifiable group of assets used with the objective of generating a commercial return that generates cash inflows from continuing use that are largely independent of the cash inflows from other assets or groups of assets.

Costs of disposal are incremental costs directly attributable to the disposal of an asset, excluding finance costs and income tax expense.

Identification
When the carrying amount of a cash-generating asset exceeds its recoverable amount, it is impaired.

The entity assesses at each reporting date whether there is any indication that a cash-generating asset may be impaired. If any such indication exists, the entity estimates the recoverable amount of the asset.

Irrespective of whether there is any indication of impairment, the entity also tests a cash-generating intangible asset with an indefinite useful life or a cash-generating intangible asset not yet available for use for impairment annually by comparing its carrying amount with its recoverable amount. This impairment test is performed at the same time every year. If an intangible asset was initially recognised during the current reporting period, that intangible asset was tested for impairment before the end of the current reporting period.

Value in use
Value in use of a cash-generating asset is the present value of the estimated future cash flows expected to be derived from the continuing use of an asset and from its disposal at the end of its useful life.

When estimating the value in use of an asset, the entity estimates the future cash inflows and outflows to be derived from continuing use of the asset and from its ultimate disposal and the entity applies the appropriate discount rate to those future cash flows.

Recognition and measurement (individual asset)
If the recoverable amount of a cash-generating asset is less than its carrying amount, the carrying amount of the asset is reduced to its recoverable amount. This reduction is an impairment loss.

An impairment loss is recognised immediately in surplus or (deficit).

Any impairment loss of a revalued cash-generating asset is treated as a revaluation decrease.

When the amount estimated for an impairment loss is greater than the carrying amount of the cash-generating asset to which it relates, the entity recognises a liability only to the extent that is a requirement in the Standard of GRAP.

After the recognition of an impairment loss, the depreciation (amortisation) charge for the cash-generating asset is adjusted in future periods to allocate the cash-generating asset's revised carrying amount, less its residual value (if any), on a systematic basis over its remaining useful life.

Reversal of impairment loss
The entity assesses at each reporting date whether there is any indication that an impairment loss recognised in prior periods for a cash-generating asset may no longer exist or may have decreased. If any such indication exists, the entity estimates the recoverable amount of that asset.

An impairment loss recognised in prior periods for a cash-generating asset is reversed if there has been a change in the estimates used to determine the asset's recoverable amount since the last impairment loss was recognised. The carrying amount of the asset is increased to its recoverable amount. The increase is a reversal of an impairment loss. The increased carrying amount of an asset attributable to a reversal of an impairment loss does not exceed the carrying amount that would have been determined (net of depreciation or amortisation) had no impairment loss been recognised for the asset in prior periods.

A reversal of an impairment loss for a cash-generating asset is recognised immediately in surplus or (deficit).

Any reversal of an impairment loss of a revalued cash-generating asset is treated as a revaluation increase.

After a reversal of an impairment loss is recognised, the depreciation (amortisation) charge for the cash-generating asset is adjusted in future periods to allocate the cash-generating asset's revised carrying amount, less its residual value (if any), on a systematic basis over its remaining useful life.

A reversal of an impairment loss for a cash-generating unit is allocated to the cash-generating assets of the unit pro rata with the carrying amounts of those assets. These increases in carrying amounts are treated as reversals of impairment losses for individual assets. No part of the amount of such a reversal is allocated to a non-cash-generating asset contributing service potential to a cash-generating unit.

In allocating a reversal of an impairment loss for a cash-generating unit, the carrying amount of an asset is not increased above the lower of:

- its recoverable amount (if determinable); and
- the carrying amount that would have been determined (net of amortisation or depreciation) had no impairment loss been recognised for the asset in prior periods.

The amount of the reversal of the impairment loss that would otherwise have been allocated to the asset is allocated pro rata to the other assets of the unit.

1.17 Capital funds

The capital fund represents the amount of net assets at the date of transfer from the government to the ARC.

1.18 Employee benefits

Employee benefits are all forms of consideration given by an entity in exchange for service rendered by employees.

Termination benefits are employee benefits payable as a result of either:

- an entity's decision to terminate an employee's employment before the normal retirement date; or
- an employee's decision to accept voluntary redundancy in exchange for those benefits.

Other long-term employee benefits are employee benefits (other than post-employment benefits and termination benefits) that are not due to be settled within twelve months after the end of the period in which the employees render the related service.

Vested employee benefits are employee benefits that are not conditional on future employment.

A constructive obligation is an obligation that derives from an entity's actions whereby an established pattern of past practice, published policies or a sufficiently specific current statement, the entity has indicated to other parties that it will accept certain responsibilities and as a result, the entity has created a valid expectation on the part of those other parties that it will discharge those responsibilities.

Short-term employee benefits

The cost of short-term employee benefits, (those payable within 12 months after the service is rendered, such as paid vacation leave and sick leave, bonuses, and non-monetary benefits such as medical care), are recognised in the period in which the service is rendered and are not discounted.

Short-term employee benefits include items such as:

- wages, salaries and social security contributions;
- short-term compensated absences (such as paid annual leave and paid sick leave) where the compensation for the absences is due to be settled within twelve months after the end of the reporting period in which the employees render the related employee service;
- bonus, incentive and performance related payments payable within twelve months after the end of the reporting period in which the employees render the related service; and
- non-monetary benefits (for example, medical care, and free or subsidised goods or services such as housing, cars and cellphones) for current employees.

When an employee has rendered service to the entity during a reporting period, the entity recognises the undiscounted amount of short-term employee benefits expected to be paid in exchange for that service:

- as a liability (accrued expense), after deducting any amount already paid. If the amount already paid exceeds the undiscounted amount of the benefits, the entity recognises that excess as an asset (prepaid expense) to the extent that the pre-payment will lead to, for example, a reduction in future payments or a cash refund; and

- as an expense unless another standard requires or permits the inclusion of the benefits in the cost of an asset.

The expected cost of compensated absences is recognised as an expense as the employees render services that increase their entitlement or, in the case of non-accumulating absences, when the absence occurs. The entity measures the expected cost of accumulating compensated absences as the additional amount that the entity expects to pay as a result of the unused entitlement that has accumulated at the reporting date.

The entity recognises the expected cost of bonus, incentive and performance related payments when the entity has a present legal or constructive obligation to make such payments as a result of past events and a reliable estimate of the obligation can be made. A present obligation exists when the entity has no realistic alternative but to make the payments.

Post-employment benefits
Post-employment benefits are employee benefits (other than termination benefits) which are payable after the completion of employment.

Post-employment benefit plans are formal or informal arrangements under which an entity provides post-employment benefits for one or more employees.

Post-employment benefits: Defined contribution plans
Payments to defined contribution retirement benefit plans are charged as an expense as they fall due.

Payments made to industry-managed (or state plans) retirement benefit schemes are dealt with as defined contribution plans where the entity's obligation under the schemes is equivalent to those arising in a defined contribution retirement benefit plan.

Post-employment benefits: Defined benefit plans
Defined benefit plans are post-employment benefit plans other than defined contribution plans.

Actuarial gains and losses comprise experience adjustments (the effects of differences between the previous actuarial assumptions and what has actually occurred) and the effects of changes in actuarial assumptions. In measuring its defined benefit liability the entity recognises actuarial gains and losses in surplus or deficit in the reporting period in which they occur.

Current service cost is the increase in the present value of the defined benefit obligation resulting from employee service in the current period.

Interest cost is the increase during a period in the present value of a defined benefit obligation which arises because the benefits are one period closer to settlement.

Past service cost is the change in the present value of the defined benefit obligation for employee service in prior periods, resulting in the current period from the introduction of, or changes to, post-employment benefits or other long-term employee benefits. Past service cost may be either positive (when benefits are introduced or changed so that the present value of the defined benefit obligation increases) or negative (when existing benefits are changed so that the present value of the defined benefit obligation decreases). In measuring its defined benefit liability the entity recognises past service cost as an expense in the reporting period in which the plan is amended.

The present value of a defined benefit obligation is the present value, without deducting any plan assets, of expected future payments required to settle the obligation resulting from employee service in the current and prior periods.

The amount recognised as a defined benefit liability is the net total of the following amounts:
- the present value of the defined benefit obligation at the reporting date;
- minus the fair value at the reporting date of plan assets (if any) out of which the obligations are to be settled directly;
- plus any liability that may arise as a result of a minimum funding requirement.

Any adjustments arising from the limit above is recognised in surplus or deficit.

The entity recognises the net total of the following amounts in surplus or deficit, except to the extent that another Standard requires or permits their inclusion in the cost of an asset:

- current service cost;
- interest cost;
- actuarial gains and losses;
- past service cost;
- the effect of any curtailments or settlements; and
- the effect of applying the limit on a defined benefit asset (negative defined benefit liability).

The entity uses the Projected Unit Credit Method to determine the present value of its defined benefit obligations and the related current service cost and, where applicable, past service cost. The Projected Unit Credit Method (sometimes known as the accrued benefit method pro-rated on service or as the benefit/years of service method) sees each period of service as giving rise to an additional unit of benefit entitlement and measures each unit separately to build up the final obligation.

In determining the present value of its defined benefit obligations and the related current service cost and, where applicable, past service cost, an entity shall attribute benefit to periods of service under the plan's benefit formula. However, if an employee's service in later years will lead to a materially higher level of benefit than in earlier years, an entity shall attribute benefit on a straight line basis from:

- the date when service by the employee first leads to benefits under the plan (whether or not the benefits are conditional on further service); until
- the date when further service by the employee will lead to no material amount of further benefits under the plan, other than from further salary increases.

Actuarial valuations are conducted on an annual basis by independent actuaries separately for each plan. The results of the valuation are updated for any material transactions and other material changes in circumstances (including changes in market prices and interest rates) up to the reporting date.

Before determining the effect of a curtailment or settlement, the entity re-measure the obligation (and the related plan assets, if any) using current actuarial assumptions (including current market interest rates and other current market prices).

Other post retirement obligations

The entity provides post-retirement health care benefits and gratuities upon retirement to some retirees.

The ARC provides post-retirement medical benefits to qualifying employees. The expected costs of these benefits are determined using an accounting methodology similar to that of defined benefit pension plans, with actuarial valuations carried out every year. Contributions are made to the relevant funds over the expected service lives of the employees entitled to those funds. The estimated cost of providing such benefits is charged to the statement of financial performance on a systematic basis over the employees' working lives within the ARC.

The entitlement to post-retirement health care benefits is based on the employee remaining in service up to retirement age and the completion of a minimum service period. The expected costs of these benefits are accrued over the period of employment. Independent qualified actuaries carry out valuations of these obligations. The municipality also provides a gratuity and housing subsidy on retirement to certain employees. An annual charge to income is made to cover both these liabilities.

The amount recognised as a liability for other long-term employee benefits is the net total of the following amounts:

- the present value of the defined benefit obligation at the reporting date;
- minus the fair value at the reporting date of plan assets (if any) out of which the obligations are to be settled directly.

The entity shall recognise the net total of the following amounts as expense or revenue, except to the extent that another Standard requires or permits their inclusion in the cost of an asset:

- current service cost;
- interest cost;
- the expected return on any plan assets and on any reimbursement recognised as an asset;
- actuarial gains and losses, which shall all be recognised immediately;
- past service cost, which shall all be recognised immediately; and
- the effect of any curtailments or settlements.

Independent qualified actuaries carry out valuations of these obligations.

Long-term employee benefits
The liability for employees' entitlements to long service leave represents the present value of the estimated future cash outflows resulting from employees' services provided to the reporting date.

In determining the liability for employee benefits, consideration has been given to future increases in wage and salary rates, and ARC's experience with staff turnover.

1.19 Provisions and contingencies

Provisions are recognised when:

- the entity has a present obligation as a result of a past event;
- it is probable that an outflow of resources embodying economic benefits or service potential will be required to settle the obligation; and
- a reliable estimate can be made of the obligation.

The amount of a provision is the best estimate of the expenditure expected to be required to settle the present obligation at the reporting date.

Provisions are reviewed at each reporting date and adjusted to reflect the current best estimate. Provisions are reversed if it is no longer probable that an outflow of resources embodying economic benefits or service potential will be required, to settle the obligation.

Provisions are not recognised for future operating surplus (deficit).

A restructuring provision includes only the direct expenditures arising from the restructuring, which are those that are both:

- necessarily entailed by the restructuring; and
- not associated with the ongoing activities of the entity.

No obligation arises as a consequence of the sale or transfer of an operation until the entity is committed to the sale or transfer, that is, there is a binding arrangement.

After their initial recognition contingent liabilities recognised in entity combinations that are recognised separately are subsequently measured at the higher of:

- the amount that would be recognised as a provision; and
- the amount initially recognised less cumulative amortisation.

Contingent assets and contingent liabilities are not recognised. Contingencies are disclosed in note 37.

1.20 Commitments

Items are classified as commitments when an entity has committed itself to future transactions that will normally result in the outflow of cash.

Disclosures are required in respect of unrecognised contractual commitments.

Commitments for which disclosure is necessary to achieve a fair presentation should be disclosed in a note to the financial statements, if both the following criteria are met:

- Contracts should be non-cancellable or only cancellable at significant cost (for example, contracts for computer or building maintenance services); and
- Contracts should relate to something other than the routine, steady, state business of the entity - therefore salary commitments relating to employment contracts or social security benefit commitments are excluded.

1.21 Revenue from exchange transactions

Revenue is the gross inflow of economic benefits or service potential during the reporting period when those inflows result in an increase in net assets, other than increases relating to contributions from owners.

An exchange transaction is one in which the entity receives assets or services, or has liabilities extinguished, and directly gives approximately equal value (primarily in the form of goods, services or use of assets) to the other party in exchange.

Fair value is the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's length transaction.

Measurement

Revenue is measured at the fair value of the consideration received or receivable, net of trade discounts and volume rebates. The amount of revenue arising on a transaction which is statutory (non-contractual) in nature is usually measured by reference to the relevant legislation, regulation or similar means. The fee structure, tariffs or calculation basis specified in legislation, regulation or similar means is used to determine the amount of revenue that should be recognised. This amount represents the fair value, on initial measurement, of the consideration received or receivable for revenue that arises from a statutory (non-contractual) arrangement (see the accounting policy on Statutory Receivables).

Sale of goods

Revenue from the sale of goods is recognised when all the following conditions have been satisfied:

- the entity has transferred to the purchaser the significant risks and rewards of ownership of the goods;
- the entity retains neither continuing managerial involvement to the degree usually associated with ownership nor effective control over the goods sold;
- the amount of revenue can be measured reliably;
- it is probable that the economic benefits or service potential associated with the transaction will flow to the entity; and
- the costs incurred or to be incurred in respect of the transaction can be measured reliably.

Rendering of services

When the outcome of a transaction involving the rendering of services can be estimated reliably, revenue associated with the transaction is recognised by reference to the stage of completion of the transaction at the reporting date. The outcome of a transaction can be estimated reliably when all the following conditions are satisfied:

- the amount of revenue can be measured reliably;
- it is probable that the economic benefits or service potential associated with the transaction will flow to the entity;
- the stage of completion of the transaction at the reporting date can be measured reliably; and
- the costs incurred for the transaction and the costs to complete the transaction can be measured reliably.

When services are performed by an indeterminate number of acts over a specified time frame, revenue is recognised on a straight-line basis over the specified time frame unless there is evidence that some other method better represents the stage of completion. When a specific act is much more significant than any other acts, the recognition of revenue is postponed until the significant act is executed.

When the outcome of the transaction involving the rendering of services cannot be estimated reliably, revenue is recognised only to the extent of the expenses recognised that are recoverable.

Service revenue is recognised by reference to the stage of completion of the transaction at the reporting date. Stage of completion is determined by the proportion that costs incurred to date bear to the total estimated costs of the transaction.

Diagnostic service revenue is recognised by reference to the stage of completion of the tests at the reporting date. Stage of completion is determined by the proportion that costs incurred to date bear to the total estimated costs of the transaction.

Diagnostic services
Due to the short lead time and the nature of the diagnostic tests, the diagnostic revenue is recognised at the completion of the diagnostic tests.

Research revenue
When the outcome of a research can be estimated reliably, research revenue and research costs associated with the research are recognised with reference to the stage of completion of the research at the reporting date. The stage of completion is determined using costs or scientific estimate and or milestone achieved as set in the project.

An expected loss on research is recognised in the statement of financial performance immediately.

When the outcome of research cannot be estimated reliably, revenue is recognised only to the extent of research costs incurred for which it is probable that the costs will be recovered. Research costs are recognised as expenses in the period they are incurred.

The ARC has several funders that normally process payments for research related activities prior to the actual research commencing. Upon receipt, a liability is raised (income received in advance) and reduced as and when costs are incurred on the respective project.

Advisory services
Revenue from consulting and training services is recognised when services have been rendered however revenue from the PDP programme is recognised on a cost recovery basis.

Bad debts recovered
Revenue from bad debts recovered is recognised when payment is received for debts that were written off and considered uncollectible.

Other income
Revenue that is not in the ordinary course of business is recognised as other income. Revenue from the sale of blood vaccines is recognised when significant risks and rewards of ownership of the goods are transferred to the buyer. Revenue from lost cards, tender sales and other adhoc sales are recognised when goods or services are received or rendered.
Interest, royalties and dividends

Interest, royalties and dividends
Revenue arising from the use by others of entity assets yielding interest, royalties and dividends or similar distributions is recognised when:

- It is probable that the economic benefits or service potential associated with the transaction will flow to the entity; and
- The amount of the revenue can be measured reliably.

Interest is predominantly earned from funds received in advance prior to the commencement or execution of projects and invested in fixed deposits and call accounts.

Royalties are recognised as they are earned in accordance with the substance of the relevant agreements.

Dividends or similar distributions are recognised, in surplus or (deficit), when the entity's right to receive payment has been established.

1.22 Revenue from non-exchange transactions

Revenue comprises gross inflows of economic benefits or service potential received and receivable by an entity, which represents an increase in net assets, other than increases relating to contributions from owners.

Conditions on transferred assets are stipulations that specify that the future economic benefits or service potential embodied in the asset is required to be consumed by the recipient as specified or future economic benefits or service potential must be returned to the transferor.

Control of an asset arise when the entity can use or otherwise benefit from the asset in pursuit of its objectives and can exclude or otherwise regulate the access of others to that benefit.

Non-exchange transactions are transactions that are not exchange transactions. In a non-exchange transaction, an entity either receives value from another entity without directly giving approximately equal value in exchange or gives value to another entity without directly receiving approximately equal value in exchange.

Government grants are recognised when it is probable that future economic benefits will flow to the public entity and these benefits can be measured reliably. The grants are recognised as income to the extent that there are no further obligations arising from the receipt of the grants.

Recognition
An inflow of resources from a non-exchange transaction recognised as an asset is recognised as revenue, except to the extent that a liability is also recognised in respect of the same inflow.

Government grants received for the purpose of giving immediate financial support with no future related costs are recognised as revenue in the period in which they become receivable. Government grants relating to specific expenditure are recognised in the year during which the expenses are incurred

Measurement
Revenue from a non-exchange transaction is measured at the amount of the increase in net assets recognised by the entity.

1.23 Accounting by principals and agents

Identification
An agent is an entity that has been directed by another entity (a principal), through a binding arrangement, to undertake transactions with third parties on behalf of the principal and for the benefit of the principal.

A principal is an entity that directs another entity (an agent), through a binding arrangement, to undertake transactions with third parties on its behalf and for its own benefit.

A principal-agent arrangement results from a binding arrangement in which one entity (an agent), undertakes transactions with third parties on behalf, and for the benefit of, another entity (the principal).

Identifying whether an entity is a principal or an agent
When the entity is party to a principal-agent arrangement, it assesses whether it is the principal or the agent in accounting for revenue, expenses, assets and/or liabilities that result from transactions with third parties undertaken in terms of the arrangement.

The assessment of whether an entity is a principal or an agent requires the entity to assess whether the transactions it undertakes with third parties are for the benefit of another entity or for its own benefit.

Binding arrangement
The entity assesses whether it is an agent or a principal by assessing the rights and obligations of the various parties established in the binding arrangement.

Where the terms of a binding arrangement are modified, the parties to the arrangement re-assess whether they act as a principal or an agent.

Assessing which entity benefits from the transactions with third parties
When the entity in a principal-agent arrangement concludes that it undertakes transactions with third parties for the benefit of another entity, then it is the agent. If the entity concludes that it is not the agent, then it is the principal in the transactions.

The entity is an agent when, in relation to transactions with third parties, all three of the following criteria are present:
- It does not have the power to determine the significant terms and conditions of the transaction;
- It does not have the ability to use all, or substantially all, of the resources that result from the transaction for its own benefit; and
- It is not exposed to variability in the results of the transaction.

Where the entity has been granted specific powers in terms of legislation to direct the terms and conditions of particular transactions, it is not required to consider the criteria of whether it does not have the power to determine the significant terms and conditions of the transaction, to conclude that is an agent. The entity applies judgement in determining whether such powers exist and whether they are relevant in assessing whether the entity is an agent.

Recognition
The entity, as a principal, recognises revenue and expenses that arise from transactions with third parties in a principal-agent arrangement in accordance with the requirements of the relevant Standards of GRAP.

The entity recognises assets and liabilities arising from principal-agent arrangements in accordance with the requirements of the relevant Standards of GRAP.

1.24 Translation of foreign currencies

Foreign currency transactions
A foreign currency transaction is recorded, on initial recognition in Rands, by applying to the foreign currency amount the spot exchange rate between the functional currency and the foreign currency at the date of the transaction.

At each reporting date:
- foreign currency monetary items are translated using the closing rate;
- non-monetary items that are measured in terms of historical cost in a foreign currency are translated using the exchange rate at the date of the transaction; and
- non-monetary items that are measured at fair value in a foreign currency are translated using the exchange rates at the date when the fair value was determined.

Exchange differences arising on the settlement of monetary items or on translating monetary items at rates different from those at which they were translated on initial recognition during the period or in previous annual financial statements are recognised in surplus or (deficit) in the period in which they arise.

When a gain or loss on a non-monetary item is recognised directly in net assets, any exchange component of that gain or loss is recognised directly in net assets. When a gain or loss on a non-monetary item is recognised in surplus or (deficit), any exchange component of that gain or loss is recognised in surplus or (deficit).

Cash flows arising from transactions in a foreign currency are recorded in Rands by applying to the foreign currency amount the exchange rate between the Rand and the foreign currency at the date of the cash flow.

1.25 Insurance fund

In terms of the ARC policy to cover a portion of vehicle, non-vehicle, stated benefits and fire and allied perils insurance claims, a risk assessment is made annually in conjunction with the insurance brokers in order to determine the extent of the self-insured amount to be credited to the reserve.

In determining the amount to be credited, the principle of maximum insurance cover at the lowest possible cost is applied.

The portion of claims borne by the ARC is accounted for against the reserve. Any shortfalls on the reserve are written off against accumulated surplus in the year in which it originated and any surplus is carried over to the following year.

1.26 Comparative figures

Where necessary, comparative figures have been reclassified to conform to changes in presentation in the current year.

1.27 Fruitless and wasteful expenditure

Fruitless expenditure means expenditure which was made in vain and would have been avoided had reasonable care been exercised.

All expenditure relating to fruitless and wasteful expenditure is recognised as an expense in the statement of financial performance in the period that the expenditure was incurred. The expenditure is classified in accordance with the nature of the expense, and where recovered, it is subsequently accounted for as revenue in the statement of financial performance.

Fruitless and wasteful expenditure is accounted for in line with all relating requirements, including, but not limited to, ruling Legislation, Regulations, Frameworks, Circulars, Instruction Notes, Practice Notes, Guidelines etc (as applicable).

1.28 Irregular expenditure

Irregular expenditure as defined in section 1 of the PFMA is expenditure other than unauthorised expenditure, incurred in contravention of or that is not in accordance with a requirement of any applicable legislation, including -

(a) this Act;
(b) the State Tender Board Act, 1968 (Act No. 86 of 1968), or any regulations made in terms of the Act; or
(c) any provincial legislation providing for procurement procedures in that provincial government.

Irregular expenditure that was incurred and identified during the current financial and which was condoned before year end and/or before finalisation of the financial statements must also be recorded appropriately in the irregular expenditure register. In such an instance, no further action is also required with the exception of updating the note to the financial statements.

Irregular expenditure that was incurred and identified during the current financial year and for which condonement is being awaited at year end must be recorded in the irregular expenditure register. No further action is required with the exception of updating the note to the financial statements.

Where irregular expenditure was incurred in the previous financial year and is only condoned in the following financial year, the register and the disclosure note to the financial statements must be updated with the amount condoned.

Irregular expenditure that was incurred and identified during the current financial year and which was not condoned by the National Treasury, or the relevant authority must be recorded appropriately in the irregular expenditure register. If liability for the irregular expenditure can be attributed to a person, a debt account must be created if such a person is liable in law. Immediate steps must thereafter be taken to recover the amount from the person concerned. If recovery is not possible, the accounting officer or accounting authority may write off the amount as debt impairment and disclose such in the relevant note to the financial statements. The irregular expenditure register must also be updated accordingly. If the irregular expenditure has not been condoned and no person is liable in law, the expenditure related thereto must remain against the relevant programme/expenditure item, be disclosed as such in the note to the financial statements and updated accordingly in the irregular expenditure register.

1.29 Segment information

A segment is an activity of an entity:

- that generates economic benefits or service potential (including economic benefits or service potential relating to transactions between activities of the same entity);
- whose results are regularly reviewed by management to make decisions about resources to be allocated to that activity and in assessing its performance; and
- for which separate financial information is available.

Reportable segments are the actual segments which are reported on in the segment report. They are the segments identified above or alternatively an aggregation of two or more of those segments where the aggregation criteria are met.

Measurement

The amount of each segment item reported is the measure reported to management for the purposes of making decisions about allocating resources to the segment and assessing its performance. Adjustments and eliminations made in preparing the entity's financial statements and allocations of revenues and expenses are included in determining reported segment surplus or deficit only if they are included in the measure of the segment's surplus or deficit that is used by management. Similarly, only those assets and liabilities that are included in the measures of the segment's assets and segment's liabilities that are used by management are reported for that segment. If amounts are allocated to reported segment surplus or deficit, assets or liabilities, those amounts are allocated on a reasonable basis.

If management uses only one measure of a segment's surplus or deficit, the segment's assets or the segment's liabilities in assessing segment performance and deciding how to allocate resources, segment surplus or deficit, assets and liabilities are reported in terms of that measure. If management uses more than one measure of a segment's surplus or deficit, the segment's assets or the segment's liabilities, the reported measures are those that management believes are determined in accordance with the measurement principles most consistent with those used in measuring the corresponding amounts in the entity's financial statements.

1.30 Research and development expenditure

Expenditure on research is recognised as an expense when it is incurred.

An asset arising from development is recognised when:

- it is technically feasible to complete the asset so that it will be available for use or sale;
- there is an intention to complete and use or sell it;

- there is an ability to use or sell it;
- it will generate probable future economic benefits or service potential;
- there are available technical, financial and other resources to complete the development and to use or sell the asset; and
- the expenditure attributable to the asset during its development can be measured reliably.

1.31 Budget information

Entity are typically subject to budgetary limits in the form of appropriations or budget authorisations (or equivalent), which is given effect through authorising legislation, appropriation or similar.

General purpose financial reporting by entity shall provide information on whether resources were obtained and used in accordance with the legally adopted budget.

The approved budget is prepared on a accrual basis and presented by programmes linked to performance outcome objectives. The approved budget covers the fiscal period from 2020-04-01 to 2021-03-31.

The budget for the economic entity includes all the entities approved budgets under its control.

The annual financial statements and the budget are on the same basis of accounting therefore a comparison with the budgeted amounts for the reporting period have been included in the Statement of comparison of budget and actual amounts.

1.32 Related parties

A related party is a person or an entity with the ability to control or jointly control the other party, or exercise significant influence over the other party, or vice versa, or an entity that is subject to common control, or joint control.

Control is the power to govern the financial and operating policies of an entity to obtain benefits from its activities.

Joint control is the agreed sharing of control over an activity by a binding arrangement and exists only when the strategic financial and operating decisions relating to the activity require the unanimous consent of the parties sharing control (the venturers). Related party transaction is a transfer of resources, services or obligations between the reporting entity and a related party, regardless of whether a price is charged.

Significant influence is the power to participate in the financial and operating policy decisions of an entity but is not control over those policies.

The entity operates in an economic sector currently dominated by entities directly or indirectly owned by the South African Government. As a consequence of the constitutional independence of the three spheres of government in South Africa, only entities within the national sphere of government are considered to be related parties.

Management are those persons responsible for planning, directing and controlling the activities of the entity, including those charged with the governance of the entity in accordance with legislation, in instances where they are required to perform such functions.

Close members of the family of a person are those family members who may be expected to influence or be influenced by that person in their dealings with the entity.

The entity is exempt from disclosure requirements in relation to related party transactions if that transaction occurs within normal supplier and/or client/recipient relationships on terms and conditions no more or less favourable than those which it is reasonable to expect the entity to have adopted if dealing with that individual entity or person in the same circumstances and terms and conditions are within the normal operating parameters established by that reporting entity's legal mandate.

Where the entity is exempt from the disclosures in accordance with the above, the entity discloses narrative information about the nature of the transactions and the related outstanding balances, to enable users of the entity's financial statements to understand the effect of related party transactions on its annual financial statements.

1.33 Events after reporting date

Events after reporting date are those events, both favourable and unfavourable, that occur between the reporting date and the date when the financial statements are authorised for issue. Two types of events can be identified:

- those that provide evidence of conditions that existed at the reporting date (adjusting events after the reporting date); and
- those that are indicative of conditions that arose after the reporting date (non-adjusting events after the reporting date).

The entity will adjust the amount recognised in the financial statements to reflect adjusting events after the reporting date once the event occurred.

The entity will disclose the nature of the event and an estimate of its financial effect or a statement that such estimate cannot be made in respect of all material non-adjusting events, where non-disclosure could influence the economic decisions of users taken on the basis of the financial statements.

1.34 Living and non-living resources

Living resources are those resources that undergo biological transformation.

Non-living resources are those resources, other than living resources, that occur naturally and have not been extracted. Agricultural activity is the management by an entity of the biological transformation and harvest of biological assets for:

(a) sale;
(b) distribution at no charge or for a nominal charge; or
(c) conversion into agriculture produce or into additional biological assets for sale or distribution at no charge or for a nominal charge.

A bearer plant is a living plant that:

(a) is used in the production or supply of agricultural produce;
(b) is expected to bear produce for more than one period; and
(c) has a remote likelihood of being sold as agricultural produce, except for incidental scrap sales.

Biological transformation (for purposes of this Standard) comprises the processes of growth, degeneration, production, and procreation that cause qualitative or quantitative changes in a living resource.

Carrying amount is the amount at which an asset is recognised after deducting any accumulated depreciation and accumulated impairment losses.

Cost is the amount of cash or cash equivalents paid or the fair value of the other consideration given to acquire an asset at the time of its acquisition or development and, where applicable, the amount attributed to the asset when initially recognised in accordance with the specific requirements of other Standards of GRAP.

Depreciation is the systematic allocation of the depreciable amount of an asset over its useful life.

Depreciable amount is the cost of an asset, or other amount substituted for cost, less its residual value.

Group of resources means a grouping of living or non-living resources of a similar nature or function in an entity's operations that is shown as a single item for the purpose of disclosure in the annual financial statements.

The residual value of an asset is the estimated amount that an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset was already of the age and in the condition expected at the end of its useful life.

Useful life is the period over which an asset is expected to be available for use by an entity, or the number of production or similar units expected to be obtained from the asset by an entity.

Recognition
Non-living resources, other than land, are not recognised as assets. Required information are disclosed in the notes to the annual financial statements.

A living resource is recognised as an asset if it is probable that future economic benefits or service potential associated with the asset will flow to the entity, and the cost or fair value of the asset can be measured reliably.

Where the entity is required in terms of legislation or similar means to manage a living resource, but it does not meet the definition of an asset because control of the resource cannot be demonstrated, relevant information are disclosed in the notes to the annual financial statements.

Where the entity holds a living resource that meets the definition of an asset, but which does not meet the recognition criteria, relevant information is disclosed in the notes to the annual financial statements. When the information about the cost or fair value of the living resource becomes available, the entity recognises from that date, the living resource and apply the measurement principles.

Measurement at recognition
A living resource that qualifies for recognition as an asset is measured at its cost.

Where a living resource is acquired through a non-exchange transaction, its cost is measured at its fair value as at the date of acquisition.

The cost of a living resource comprises its purchase price, including import duties and non-refundable purchase taxes, and any costs directly attributable to bringing the living resource to the location and condition necessary for it to be capable of operating in the manner intended by management.

Measurement after recognition

Cost model
After recognition as an asset, a group of living resources are carried at its cost less any accumulated depreciation and any accumulated impairment losses.

Depreciation
Living resources are depreciated and the depreciation charge for each period is recognised in surplus or deficit unless it is included in the carrying amount of another asset, where appropriate.

The depreciable amount of a living resource is allocated on a systematic basis over its useful life.
The entity assesses at each reporting date whether there is any indication that the entity's expectations about the residual value and the useful life of a living resource have changed since the preceding reporting date. If any such indication exists, the entity revises the expected useful life and/or residual value accordingly. The change(s) are accounted for as a change in an accounting estimate.

In assessing whether there is any indication that the expected useful life of the living resource has changed, the entity considers the following indications:

(a) The use of the living resource has changed, because of the following:

- The entity has changed the manner in which the living resource is used.
- The entity decided to dispose of the living resource in a future reporting period(s) such that this decision changes the expected period over which the living resource will be used.
- Legislation, government policy or similar means have been amended or implemented during the reporting period that have, or will, change the use of the living resource.
- The living resource was idle or retired from use during the reporting period.

(b) The living resource is approaching the end of its previously expected useful life.
(c) There is evidence that the condition of the living resource improved or declined based on assessments undertaken during the reporting period.
(d) The living resource is assessed as being impaired.

In assessing whether there is any indication that the expected residual value of the living resource has changed, the entity considers whether there has been any change in the expected timing of disposal of the living resource, as well as any relevant indicators as noted above.

The depreciation method used reflects the pattern in which the future economic benefits or service potential of the living resource is expected to be consumed by the entity.

The depreciation method applied to a living resource is reviewed at least at each reporting date and, if there has been a significant change in the expected pattern of consumption of the future economic benefits or service potential embodied in the living resource, the method is changed to reflect the changed pattern. Such a change is accounted for as a change in an accounting estimate.

The useful lives of items of property, plant and equipment have been assessed as follows:

Item	Depreciation method	Average useful life
Cattle	Straight-line	22 years

Impairment
The entity assesses at each reporting date whether there is an indication that the living resource may be impaired. If any such indication exists, the entity estimates the recoverable amount or the recoverable service amount of the living resource.

Compensation from third parties for living resources that have been impaired, lost or given up, is included in surplus or deficit when the compensation becomes receivable.

Transfers
Transfers from living resources are made when the particular asset no longer meets the definition of a living resource and/or is no longer within the scope of this accounting policy.

Transfers to living resources are made when the asset meets the definition of a living resource.

Derecognition
The carrying amount of a living resource is derecognised on disposal, or when no future economic benefits or service potential are expected from its use or disposal.
The gain or loss arising from the derecognition of a living resource is included in surplus or deficit when the item is derecognised.

1.35 Borrowing costs

Borrowing costs are interest and other expenses incurred by an entity in connection with the borrowing of funds.

Borrowing costs are recognised as an expense in the period in which they are incurred.

8. NOTES TO THE ANNUAL FINANCIAL STATEMENTS

2. NEW STANDARDS AND INTERPRETATIONS

2.1 Standards and interpretations effective and adopted in the current year

In the current year, the entity has adopted the following standards and interpretations that are effective for the current financial year and that are relevant to its operations:

Standard/ Interpretation	Effective date: Years beginning on or after	Expected impact:
• GRAP 110 (as amended 2016): Living and Non-living Resources	01 April 2020	The impact of the standard is set out in note 3 Changes in accounting policy.

2.2 Standards and interpretations issued, but not yet effective

The entity has not applied the following standards and interpretations, which have been published and are mandatory for the entity's accounting periods beginning on or after 01 April 2021 or later periods:

Standard/Interpretation	Effective date: Years beginning on or after	Expected impact:
• GRAP 104 (amended): Financial Instruments	To be determined	Unlikely there will be a material impact
• Directive 14: The application of Standards of GRAP by Public Entities that apply IFRSÂ® Standards	01 April 2020	Unlikely there will be a material impact
• Guideline: Guideline on Accounting for Landfill Sites	To be determined	Unlikely there will be a material impact
• Directive 7 (revised): The Application of Deemed Cost	01 April 2020	Unlikely there will be a material impact
• IGRAP 17: Service Concession Arrangements where a Grantor Controls a Significant Residual Interest in an Asset	01 April 2020	Unlikely there will be a material impact

3. CHANGES IN ACCOUNTING POLICY

The annual financial statements have been prepared in accordance with Standards of Generally Recognised Accounting Practice on a basis consistent with the prior year except for the adoption of the following new or revised standards.

- GRAP 17 - Changes in accounting policy of buildings; and
- GRAP 110 - Living and non-living resources.

Figures in Rand	2021	2020

Property, plant and equipment

During the year, the entity changed its accounting policy regarding the valuation of buildings from cost model to revaluation model to achieve a fairer presentation and conform with GRAP 17. A fairer presentation will be achieved since the carrying amount will be shown at more recent and relevant value. The change was accounted for retrospectively and comparative amounts have been appropriately restated. The effect of the changes is as follows:

Living resources

During the year, the entity has elected to apply GRAP 110 Living and non-living resources. The standard has been adopted prospectively from 1 April 2020. Comparatives for the 2020 financial year have not been restated.

Living resources held for research were previously accounted for as inventories. The impact of the standard is that living resources held for research were reclassified from inventories to living resources.

The standard prescribes the accounting treatment, recognition measurement and disclosure requirements for living resources and disclosure requirements for non-living resources.

Statement of financial position

Buildings		
Previously stated	329 760 167	327 078 571
Adjustment	293 135 547	293 359 617
	622 895 714	**620 438 188**
Revaluation reserve		
Previously stated	535 167 214	535 167 214
Adjustment	380 824 207	364 238 266
	915 991 421	**899 405 480**
Inventories		
Previously stated	23 435 904	-
Adjustment	(1 992 000)	-
	21 443 904	**-**
Living resources		
Adjustment	1 992 000	-
Adjustment against retained earnings		
Previously stated	-	948 515 432
Adjustment	-	(15 880 452)
	-	**932 634 980**
Depreciation on buildings		
Previously stated	2 038 695	2 964 859
Adjustment	16 718 659	15 880 452
	18 757 354	**18 845 311**
Reversal of impairment		
Previously stated	-	-
Adjustment	2 979 878	-
	2 979 878	**-**
Depreciation on living resources		
Adjustment	165 999	-

Figures in Rand	2021	2020

4. INVESTMENT REVENUE

Dividend revenue		
Listed financial assets - Local	25 814	136 972
Interest revenue		
Bank	21 666 258	19 441 866
	21 692 072	**19 578 838**

5. GOVERNMENT GRANTS

Operating grants		
Government grant (operating)	881 350 009	863 774 417
Capital grants		
Government grant (capital)	104 466 997	114 565 366
	985 817 006	**978 339 783**
Conditional and Unconditional		
Included in above are the following grants and subsidies received:		
Conditional grants received	131 438	1 205 366
Unconditional grants received	985 685 568	977 134 417
	985 817 006	**978 339 783**
Foot and Mouth Disease (FMD) Vaccine Facility		
Balance unspent at beginning of year	246 047 334	134 208 700
Current-year receipts	121 739 000	113 044 000
Conditions met - transferred to revenue	(131 438)	(1 205 366)
	367 654 896	**246 047 334**
Conditions still to be met - remain liabilities (see note 28)		
Exotic Disease and Wild Suide Facility		
Balance unspent at beginning of year	4 877 451	4 877 451
Conditions still to be met - remain liabilities (see note 28)		

Figures in Rand	2021	2020

6. REVENUE

Sale of goods	13 661 784	17 517 257
Rendering of services	244 056 120	259 396 855
Royalty income	39 307 747	27 321 406
Rental of facilities and equipment	39 918 716	27 651 794
Recoveries	26 173 900	1 124 782
Other income	8 541 428	21 470 209
Interest received - investment	21 666 258	19 441 866
Dividends received	25 814	136 972
Government grants	985 817 006	978 339 783
	1 379 168 773	**1 352 400 924**
The amount included in revenue arising from exchanges of goods or services are as follows:		
Sale of goods	13 661 784	17 517 257
Rendering of services	244 056 120	259 396 855
Royalty income	39 307 747	27 321 406
Rental of facilities and equipment	39 918 716	27 651 794
Recoveries	26 173 900	1 124 782
Other income	8 541 428	21 470 209
Interest received - investment	21 666 258	19 441 866
Dividends received	25 814	136 972
	393 351 767	**374 061 141**
The amount included in revenue arising from non-exchange transactions is as follows:		
Transfer revenue		
Government grants	985 817 006	978 339 783

7. EMPLOYEE RELATED COSTS

Salaries and wages	643 902 031	666 917 603
Medical aid - company contributions	17 132 264	17 931 657
UIF	3 634 454	3 774 704
WCA	1 304 326	1 552 067
SDL	4 484 291	6 681 852
Leave pay provision charge	7 544 127	5 865 111
Personal training	4 921 032	5 450 520
Membership fees	2 498 335	3 338 191
Defined contribution plans	59 066 130	60 796 096
Overtime payments	2 476 720	3 325 893
Long-service awards	3 973 111	3 819 085
Deferred compensation	28 905 860	9 598 570
Allowance	5 997 236	6 223 655
	785 839 917	**795 275 004**

Figures in Rand	2021	2020

8. DEPRECIATION AND AMORTISATION

Property, plant and equipment	70 796 805	90 716 759
Investment property	86 625	48 673
Intangible assets	7 369 328	7 225 430
Living resources	165 999	-
	78 418 757	**97 990 862**

9. FINANCE COSTS

Trade and other payables	97 276	220 425

10. LEASE RENTALS ON OPERATING LEASE

Premises		
Contractual amounts	781 776	602 268
Motor vehicles		
Contingent amounts	299	-
Equipment		
Contractual amounts	3 606 220	9 755 584
	4 388 295	**10 357 852**

Figures in Rand	2021	2020

11. OPERATING AND ADMINISTRATIVE EXPENSES

Advertising	564 337	1 649 987
Auditors' remuneration	5 453 872	7 256 059
Bank charges	814 671	698 608
Cleaning	8 162 328	6 974 519
Commission paid	329 852	348 759
Computer expenses	23 192 745	25 115 861
Consulting and professional fees	33 672 142	40 844 844
Fines and penalties	1 350	-
Animal Costs	9 753 606	10 832 575
Insurance	6 033 077	4 633 200
Conferences and seminars	239 827	1 081 898
Fleet	14 379 587	19 500 628
Marketing	717 326	2 139 098
Horticulture	4 230 222	4 003 981
Magazines, books and periodicals	9 825 495	12 574 574
Pest control	3 183 993	3 006 551
Fuel and oil	4 258 856	5 604 029
Postage and courier	733 482	997 486
Printing and stationery	3 090 060	3 458 259
Protective clothing	6 645 835	1 963 505
Research and development costs	48 484 370	51 509 977
Security (Guarding of municipal property)	24 606 473	19 357 955
Staff welfare	3 043 508	3 293 701
Telephone and fax	3 877 155	5 643 617
Travel - local	7 950 964	17 377 476
Travel - overseas	2 422 693	9 013 804
Utilities	80 499 305	82 967 855
General expenses*	13 566 256	11 195 981
	319 733 387	**353 044 787**

General expenses comprise of library database subscriptions, institute costs - lab, special investigations, tools and inter-institutes transactions.

12. FAIR VALUE ADJUSTMENTS

Other financial assets		
Other financial assets (Designated as at FV through P&L)	1 329 557	(1 762 441)

13. GAINS/(LOSSES) ON BIOLOGICAL ASSETS

Gains/(losses) arising from a change in fair value less point of sale costs	2 292 383	640 160
Gain/(loss) on initial recognition of biological asset	3 840 256	8 559 247
	6 132 639	**9 199 407**

Figures in Rand	2021	2020

14. IMPAIRMENT OF ASSETS

Impairments		
Property, plant and equipment	(2 765 597)	10 000
A revaluation on land and buildings was performed which resulted in the impairment being recognised. The recoverable amount or [recoverable service amount] of the asset was based on its fair value less costs to sell or [its value in use.]		1 974 608
Trade and other receivables	1 286 238	
	(1 479 359)	**1 984 608**
The main classes of assets affected by impairment losses are:		
Property, plant and equipment		
Receivables from exchange transactions		

15. INVENTORIES

Biological Assets - Bearer	7 415 004	6 389 878
Biological Assets - Consumable (Fair Value)	3 254 602	6 438 887
Consumable stores	6 720 328	7 172 667
Finished goods	959 694	191 404
Forage	1 265 622	1 805 359
Livestock held for research	1 418 164	2 643 308
	21 033 414	**24 641 503**

16. OPERATING LEASE ASSET (ACCRUAL)

Current assets	3 019 573	3 258 942
Current liabilities	(20 356)	(20 242)
	2 999 217	**3 238 700**

17. RECEIVABLES FROM EXCHANGE TRANSACTIONS

Trade debtors	97 971 919	111 353 911
Staff debtors	1 817 150	274 581
Deposits	2 737 030	2 697 115
Prepaid expenses	7 228 985	3 174 318
Recoverable fruitless and wasteful expenditure	10 861	-
Other debtors*	26 177 796	11 706 005
	135 943 741	**129 205 930**
Trade receivables are shown net of impairment losses.		
**Included other debtors is revenue accruals.*		

Of the receivables balance as at 31 March 2021, R22 million is due from the largest customer the Department of Rural Development and Land Reform and R16m is due from the second largest customer the Department of Agriculture, Land Reform and Rural Development (DALRRD) [formerly (DAFF) Department of Agriculture Forestry & Fisheries] and R11m is due from the third largest customer Culdevco, the fourth largest customer South African Breweries (SAB) owes 7% and fifth largest customer UNDP Comoros owe 6% of the total balance respectively. There are no other debtors who represent more than 5% of total balance of the trade receivables.

Figures in Rand	2021	2020

Of the R28 million in 150 days R15 million is due from the two major customers who are government department. In line with our credit policy, amounts due from government for more than a year will be assessed annually for impairment.

Of the R31 millions of provision for bad debts R11 million relates to government while R20 million relates to private clients.

Trade and other receivables past due but not impaired.

The ageing of amounts past due but not impaired is as follows:

60 days past due	13 131 421	3 835 431
61 - 90 days past due	2 626 331	1 093 446
120 days past due	769 406	1 190 503
More than 150 days past due	28 481 493	58 310 391
Reconciliation of provision for impairment of trade and other receivables		
Opening balance	54 030 855	63 605 881
Provision for impairment	1 286 238	1 974 608
Amounts written off as uncollectible	-	(11 549 634)
Amounts recovered	(24 214 225)	-
	31 102 868	**54 030 855**

The creation and release of provision for impaired receivables have been included in operating expenses in surplus or (deficit) (note 14). Amounts charged to the allowance account are generally written off when there is no expectation of recovering additional cash.

18. CASH AND CASH EQUIVALENTS

Cash and cash equivalents consist of:

Bank balances	49 430 347	12 483 699
Short-term deposits*	452 732 583	233 451 949
	502 162 930	**245 935 648**

**Included in short-term deposits are funds received from ARC funders for various research projects. These funds had not been utilised as at 31 March 2021.*

The total unsecured credit facilities granted to ARC relate to fleet management cards. At year end the facility amounted to R1.2 million (2020: R1.2 million).

Figures in Rand 2021 2020

19. BIOLOGICAL ASSETS

	2021			2020		
	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value
Dairy cattle - Bearer	683 905	-	683 905	931 321	-	931 321
Biological assets 1 - Bearer	140 520	-	140 520	244 880	-	244 880
Total	**824 425**	**-**	**824 425**	**1 176 201**	**-**	**1 176 201**

Reconciliation of biological assets 2021

	Opening balance	Decreases due to harvest / sales	Increase/ Decrease due to assets acquired through a non-ex-change transaction	Gains or losses arising from changes in fair value	Decrease due to theft	Decrease due to deaths	Total
Dairy cattle - Bearer	931 321	(268 381)	103 106	(82 141)	-	-	683 905
Chickens - Bearer	244 880	(172 920)	38 120	136 100	(6 720)	(98 940)	140 520
	1 176 201	**(441 301)**	**141 226**	**53 959**	**(6 720)**	**(98 940)**	**824 425**

Reconciliation of biological assets 2020

Dairy cattle - Bearer	716 537	-	275 947	(61 163)	-	-	931 321
Chickens - Bearer	30 009	-	201 510	13 361	-	-	244 880
	746 546	**-**	**477 457**	**(47 802)**	**-**	**-**	**1 176 201**

Non-financial information

Quantities of each biological asset		
Dairy cattle - Bearer	30	162
Chicken - Bearer	1 906	4 534
	1 936	**4 696**

Figures in Rand	2021	2020

20. INVESTMENT PROPERTY

	2021			2020		
	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value
Investment property	4 361 259	(1 292 386)	3 068 873	4 361 259	(1 205 761)	3 155 498

Reconciliation of investment property - 2021

	Opening balance	Depreciation	Total
Investment property	3 155 498	(86 625)	3 068 873

Reconciliation of investment property - 2020

Investment property	3 204 171	(48 673)	3 155 498

A register containing the information required by the Public Finance Management Act is available for inspection at the registered office of the entity

Amounts recognised in surplus or deficit

Rental revenue from Investment property	3 403 872	3 178 613

21. PROPERTY, PLANT AND EQUIPMENT

	2021			2020		
	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value	Cost/ Valuation	Accumulated depreciation and accumulated impairment	Carrying value
Land	652 180 000	-	652 180 000	652 180 000	-	652 180 000
Buildings	624 873 177	(1 977 463)	622 895 714	642 195 130	(21 756 942)	620 438 188
Machinery and farming equipment	179 009 539	(71 314 571)	107 694 968	174 752 003	(66 321 409)	108 430 594
Office furniture and equipment	79 890 041	(71 035 891)	8 854 150	81 518 094	(71 804 202)	9 713 892
Motor vehicles and aircraft	91 036 935	(62 563 468)	28 473 467	93 509 730	(61 138 842)	32 370 888
Computer equipment	121 570 149	(68 198 751)	53 371 398	116 012 695	(57 645 515)	58 367 180
Infrastructure	230 098 903	(81 944 490)	148 154 413	222 585 813	(73 248 533)	149 337 280
Buffalo	500 000	(187 500)	312 500	500 000	(125 000)	375 000
Assets under construction	40 211 329	-	40 211 329	40 496 342	-	40 496 342
Laboratory equipment	517 276 827	(206 371 416)	310 905 411	508 695 274	(191 212 424)	317 482 850
Bearer plants	45 531 725	(12 799 691)	32 732 034	46 009 222	(9 665 421)	36 343 801
Horse	29 000	(5 799)	23 201	32 000	(3 200)	28 800
Total	**2 582 207 625**	**(576 399 040)**	**2 005 808 585**	**2 578 486 303**	**(552 921 488)**	**2 025 564 815**

Figures in Rand 2021 2020

Reconciliation of property, plant and equipment - 2021

	Opening balance	Additions	Disposals	Transfers	Gain or loss on initial recognition of biological asset	Revaluations	Reclassifications	Depreciation	Impairment loss	Impairment reversal	Total
Land	652 180 000	-	-	-	-	-	-	-	-	-	652 180 000
Buildings	620 438 188	3 025 761	(1 654 239)	517 038	-	16 585 941	(239 499)	(18 283 104)	(1 273 873)	4 253 751	622 895 714
Machinery and farming equipment	108 430 594	6 565 730	(778 125)	-	-	-	-	(6 523 231)	-	-	107 694 968
Office furniture and equipment	9 713 892	352 095	(44 595)	-	-	-	-	(1 167 242)	-	-	8 854 150
Motor vehicles and aircraft	32 370 888	15 413	(411 853)	-	-	-	-	(3 500 981)	-	-	28 473 467
Computer equipment	58 367 180	6 238 813	(76 647)	-	-	-	-	(11 157 948)	-	-	53 371 398
Infrastructure	149 337 280	5 752 663	(151 511)	1 623 800	-	-	239 499	(8 433 037)	(214 281)	-	148 154 413
Buffalo	375 000	-	-	-	-	-	-	(62 500)	-	-	312 500
Laboratory equipment	317 482 850	12 560 680	(1 094 127)	-	-	-	-	(18 043 992)	-	-	310 905 411
Bearer plants	36 343 801	-	(455 162)	-	(8 684)	-	-	(3 147 921)	-	-	32 732 034
Horse	28 800	-	(3 000)	-	-	-	-	(2 599)	-	-	23 201
Assets under construction	40 496 342	1 855 825	-	(2 140 838)	-	-	-	-	-	-	40 211 329
	2 025 564 815	**36 366 980**	**(4 669 259)**	**-**	**(8 684)**	**16 585 941**	**-**	**(70 796 805)**	**(1 488 154)**	**4 253 751**	**2 005 808 585**

Reconciliation of property, plant and equipment - 2020

	Opening balance	Additions	Additions through transfer of functions/ mergers	Disposals	Increase/Decrease due to assets acquired through a nonexchange transaction	Transfers from assets under construction	Revaluations	Reclassifications	Depreciation	Impairment loss	Total
Land	562 056 324	-	-	(1)	-	-	90 133 677	-	-	(10 000)	652 180 00
Buildings	707 808 934	4 226 289	-	(308 201)	-	11 162 805	-	(83 606 328)	(18 845 311)	-	620 438 188
Machinery and farming equipment	109 154 729	6 556 726	7 814	(2 341 238)	-	53 371	-	3 471 614	(8 472 422)	-	108 430 594
Office furniture and equipment	14 246 708	726 643	6 564	(239 369)	-	-	-	384 318	(5 410 972)	-	9 713 892
Motor vehicles and aircraft	37 725 883	940 404	-	(562 646)	-	-	-	-	(5 732 751)	-	32 370 888
Computer equipment	34 963 089	36 602 042	41 471	(339 754)	-	579 342	-	115 437	(13 594 447)	-	58 367 180
Infrastructure	64 052 663	12 126 383	14 641	(533 052)	-	1 458 883	-	83 090 096	(10 872 336)	-	149 337 280
Buffalo	437 500	-	-	-	-	-	-	-	(62 500)	-	375 000
Laboratory equipment	317 102 261	25 220 771	1 494 197	(2 510 874)	-	-	-	37 288	(23 860 793)	-	317 482 850
Bearer plants	39 962 639	-	-	-	243 189	-	-	-	(3 862 027)	-	36 343 801
Horse	34 000	-	-	-	-	-	-	(2 000)	(3 200)	-	28 800
Assets under construction	50 094 510	3 656 233	-	-	-	(13 254 401)	-	-	-	-	40 496 342
	1 937 639 240	**90 055 491**	**1 564 687**	**(6 835 135)**	**243 189**	**-**	**90 133 677**	**3 490 425**	**(90 716 759)**	**(10 000)**	**2 025 564 815**

Pledged as security

There are no assets that are pledged as security.

Figures in Rand	2021	2020

Compensation received for losses on property, plant and equipment - included in operating profit.

Motor vehicles	252 400	-

Revaluations

The effective date of the revaluations was Wednesday, 31 March 2021. Revaluations were performed by independent valuer, Mr Deon Van Onselen [Nat Diploma RE (Valuations), MIV], of Spectrum Valuations and Asset Solutions subcontracted through Enterprises University of Pretoria. Mr Van Onselen is not connected to the entity.

Land and buildings are re-valued independently every 5 years.

The valuation was performed using the depreciated replacement cost valuation method, taking into account the physical condition, functional and economical depreciation of the buildings, and the following assumptions were used:

Discount rate based on the physical condition, functional and economical depreciation.

These assumptions were based on current market conditions.

Reconciliation of Work-in-Progress 2021

	Included within Infrastructure	Included within Buildings	Total
Opening balance	-	40 496 342	40 496 342
Additions/capital expenditure	1 855 825	-	1 855 825
Transferred to completed items	(1 623 800)	(517 038)	(2 140 838)
	232 025	**39 979 304**	**40 211 329**

Reconciliation of Work-in-Progress 2020

	Included within Infrastructure	Included within Buildings	Included within *Other PPE	Total
Opening balance	1 458 880	47 805 018	830 610	50 094 508
Additions/capital expenditure	-	3 656 233	-	3 656 233
Other movements (reclassifications)	-	197 897	(197 897)	-
Transferred to completed items	(1 458 880)	(11 162 806)	(632 713)	(13 254 399)
	-	**40 496 342**	**-**	**40 496 342**

*Included in other PPE is computer equipment and machinery and farming equipment.

Expenditure incurred to repair and maintain property, plant and equipment

Expenditure incurred to repair and maintain property, plant and equipment included in Statement of Financial Performance

General expenses - repairs and maintenance	28 223 605	30 419 189

A register containing the information is available for inspection at the registered office of the entity.

Figures in Rand	2021	2020

22. INTANGIBLE ASSETS

	2021			2020		
	Cost/ Valuation	Accumulated amortisation and accumulated impairment	Carrying value	Cost/ Valuation	Accumulated amortisation and accumulated impairment	Carrying value
Computer software, other	52 014 369	(41 545 516)	10 468 853	50 562 213	(35 004 997)	15 557 216
Intangible assets under development	5 039 800	-	5 039 800	1 020 336	-	1 020 336
Total	**57 054 169**	**(41 545 516)**	**15 508 653**	**51 582 549**	**(35 004 997)**	**16 577 552**

Reconciliation of intagible assets - 2021

	Opening balance	Additions	Disposals	Transfers	Amortisation	Total
Computer software, other	15 557 216	1 894 824	(634 195)	1 020 336	(7 369 328)	10 468 853
Intangible assets under development	1 020 336	5 039 800	-	(1 020 336)	-	5 039 800
Total	**16 577 552**	**6 934 624**	**(634 195)**	**-**	**(7 369 328)**	**15 508 653**

Reconciliation of intangible assets - 2020

	Opening balance	Additions	Disposals	Amortisation	Total
Computer software	22 795 138	-	(12 492)	(7 225 430)	15 557 21
Intangible assets under development	-	1 020 336	-	-	1 020 336
Total	**22 795 138**	**1 020 336**	**(12 492)**	**(7 225 430)**	**16 577 552**

Intangible assets in the process of being constructed or developed

Cumulative expenditure recognised in the carrying value of Intangible assets

Intangible assets under development	5 039 800	1 020 336

23. HERITAGE ASSETS

	2021			2020		
	Cost/Valuation	Accumulated impairment losses	Carrying value	Cost/Valuation	Accumulated impairment losses	Carrying value
Historical buildings	223 167	-	223 167	223 167	-	223 167

Reconciliation of heritage assets - 2021

	Opening balance		Total
Historical buildings	223 167		223 167

Reconciliation of heritage assets - 2020

	Opening balance		Total
Historical buildings	223 167		223 167

Figures in Rand	2021	2020

Heritage assets which fair values cannot be reliably measured

Genebanks

Fair value cannot be determined reliably due to the size and magnitude of the ARC Genebanks. The ARC is not aware of any market to buy and sell Genebanks or any other valuation method or technique that is available to measure Genebanks. Due to the uniqueness of the Genebanks, mandate and nature of the ARC's Genebanks, neither the fair value, deemed cost or replacement cost could be determined for these Genebanks. For those reasons, the ARC's Genebanks could not be recognised in the Annual Financial Statements.

Insect collections

Fair value cannot be determined reliably due to the size and magnitude of the ARC insect collections. The ARC is not aware of any market to buy and sell insect collections or any other valuation method or technique that is available to measure insect collections. Due to the uniqueness of the insect collections, mandate and nature of the ARC's insect collections, neither the fair value, deemed cost or replacement cost could be determined for these insect collections. For those reasons, the ARC's insect collections could not be recognised in the Annual Financial Statements.

24. LIVING RESOURCES

	2021			2020		
	Cost/Valuation	**Accumulated depreciation and accumulated impairment**	**Carrying value**	**Cost/Valuation**	**Accumulated depreciation and accumulated impairment**	**Carrying value**
Cattle	1 992 000	(165 999)	1 826 001	-	-	-

Reconciliation of heritage assets - 2021

	Opening balance	**Increase through non-exchange functions**	**Depreciation**	**Total**
Cattle	-	1 992 000	(165 999)	1 826 001

25. OTHER FINANCIAL ASSETS

Designated at fair value		
Distell Group Holdings (Capevin unbundling	3 970 948	2 660 228
34 027 shares at R116.70 (2020: 34 027 shares at R78.18)		
La Concorde Holdings Limited (formerly KWV Holdings LTD)	163 355	163 355
50 263 shares at R3.25 (2020: 51 041 shares at R3.25)		
Hosken Passenger Logistics and Rail Limited	226 693	207 856
64 955 shares at R3.49 (2020: 64 955 shares at R3.20)		
	4 360 996	**3 031 439**

Figures in Rand	2021	2020
Residual interest at cost*		
De Doorns Winery	5 434	5 434
9 880 shares at R0.55 (2020: 9 880 shares at R0.55)		
Hex Valley Coolrooms	8 049	1 070
16 092 shares at R0.50 (2020: 16 092 shares at R0.50)		
Lutzville 2009 Co operative Limited	1 070	1 948
107 000 shares at R0.01 (2020: 107 000 shares at R0.01)		
Lanko Co operative Limited	21 063	44 867
21 063 shares at R1.00 (2020: 21 063 shares at R1.00)		
Lutzville Vineyard Co operative	44 867	10 700
44 867 shares at R1.00 (2020: 44 867 shares at R1.00		
Lutzville Vineyard Co operative	10 700	8 049
1 070 000 shares at R0.01 (2020: 1 070 000 shares at R0.01)		
Mcgregor Co operative Limited	-	93 240
93 240 shares at R1.00 (2020: 110 320 shares at R1.00)		
Roodezandt (Pty) Ltd	2 360	21 063
5 900 shares at R0.40		
	93 543	**184 423**
Total other financial assets	**4 454 539**	**3 215 862**
Non current assets		
Designated at fair value	4 360 996	3 031 439
Residual interest at cost	93 543	184 423
	4 454 539	**3 215 862**

*These interests represent the ARC's shareholding in wine cooperatives that the ARC was a founding member of. There is no active market for the shares which are unlisted. Management considers the carrying value of the shares to be an approximation of their fair values.

Roodezandt Winery and McGregor Cellar established Roodezandt (Pty) Ltd after member producers of both wineries agreed to an amalgamation, this resulted in reduction of shareholding by the ARC.

Financial assets at fair value

Fair values of financial assets measured or disclosed at fair value		
Financial assets designated at fair value - JSE listed shares	4 360 996	3 031 439

Fair value hierarchy of financial assets at fair value

For financial assets recognised at fair value, disclosure is required of a fair value hierarchy which reflects the significance of the inputs used to make the measurements. The fair value hierarchy have the following levels:

Level 1 represents those assets which are measured using unadjusted quoted prices in active markets for identical assets.

Level 2 applies inputs other than quoted prices that are observable for the assets either directly (i.e. as prices) or indirectly (i.e. derived from prices).

Level 3 applies inputs which are not based on observable market data.

Figures in Rand	2021	2020
Level 1		
Financial assets designated at fair value JSE listed shares	4 360 996	3 031 439
Financial assets at cost		
Nominal value of financial assets at cost		
Financial asset: Shareholding in wine co operations	93 543	184 423

26. PAYABLES FROM EXCHANGE TRANSACTIONS

Trade payables	19 408 999	42 054 068
Payments received in advanced - contract in process	117 536 292	137 361 939
*Other payables	52 432 031	72 108 793
Accrued leave pay	63 859 325	61 303 438
Accrued audit fees	6 281 341	5 606 613
	259 517 988	**318 434 851**

* Included in other payables is accruals, deposits from customers and salary control accounts. The movement is mainly due to the increase in goods received not invoiced and income received in advance.

Fair value of trade and other payables

Current	13 253 018	439 680
Up to 60 days	6 065 263	13 529 157
90 days	2 375	(17 399)
91 - 120 days	7 662	1 610
+120 days	80 681	197 961
	19 408 999	**14 151 009**

27. EMPLOYEE BENEFIT OBLIGATIONS

Defined benefit plan

The Post-Retirement Medical Benefits (PRMB) is governed by the Pension Fund Act of 1956.

The actuarial valuation determined that the post-employment medical benefit plan was in a sound financial position.

The plan is a post-employment medical benefit plan.

Post-retirement medical aid plan

This includes current and past employees of ARC who are currently members of the medical aid fund. Membership to the fund is voluntary.

The Council attempted to restructure the defined medical aid scheme, in terms of which the ARC had obligations to provide certain post-retirement medical aid benefits to ARC pensioners in terms of ARC service conditions, by renegotiating the benefit structuring from a medical subsidy to a guaranteed income (pension). ARC currently has no continuation members with effect from 1 April 2004.

The scheme is actuarially valued on an annual basis. The effective date of the most recent actuarial valuation was 30 September 2020. At that date, in the opinion of the actuary, the defined benefit plan was found to be in a sound financial position. The projected unit credit method has been used for purposes of determining the actuarial valuation. Change in currency or interest rate result is an insignificant change in the plan obligation.

Figures in Rand	2021	2020

The following table summarises the components of the net benefit expense recognised in the statement of financial performance and amounts recognised in the statement of financial position as at 30 September 2020. The obligation is fulfilled as the employees exit this fund.

The amount included in the statement of financial position arising from the ARC's obligation in respect of post-retirement medical benefits is as follows:

The amounts recognised in the statement of financial position are as follows:

Carrying value		
Present value of the defined benefit obligation wholly unfunded	(11 228 000)	(10 570 000)
Changes in the present value of the defined benefit obligation are as follows:		
Opening balance	10 570 000	13 491 000
Benefits paid	(2 100 831)	(2 094 362)
Net expense recognised in the statement of financial performance	(2 758 831)	(826 638)
	11 228 000	**10 570 000**
Net expense recognised in the statement of financial performance:		
Current service cost	321 000	420 000
Interest cost	622 000	1 003 000
Actuarial (gains) losses	1 815 831	(2 249 638)
	2 758 831	**(826 638)**
Calculation of actuarial gains and losses		
Actuarial (gains) losses - Obligation	1 815 831	(2 249 638)
Key assumptions used		
Assumptions used at the reporting date:		
Actual return on plan assets	5.88%	7.43%

The basis on which the discount rate has been determined is as follow

The nominal and zero curves as of 31 March 2021 supplied by the JSE were used to determine the discount rates and CPI assumptions.

Defined contribution plan

It is the policy of the entity to provide retirement benefits to all its employees. Several defined contribution provident funds, all of which are subject to the Pensions Fund Act No. 24 of 1956 exist for this purpose.

The entity is under no obligation to cover any unfunded benefits.

The total economic entity contribution to ARC Pension Fund (Option D)	42 954 379	44 770 542
The total economic entity contribution to ARC Provident Fund	16 111 750	16 025 554

Figures in Rand	2021	2020

Included in defined contribution plan information above, is the following plan(s) which is the ARC Pension Fund (option D) and the ARC Provident Fund.

ARC Pension Fund (option D)
Under the ARC Act, the Agricultural Research Council has established its own pension fund, the ARC Pension Fund on 1 April 1992, to provide retirement benefits for employees who were transferred from the Department of Agriculture to the then newly formed Agricultural Research Council. All employees who are appointed on an indefinite basis, is required to become a member of either the ARC-Pension Fund or the NEHAWU National Provident Fund.

The ARCPF is administered by Alexander Forbes. The Fund is a defined contribution fund and members is receiving the benefits provided for the rules of the ARCPF on resignation, dismissal, retrenchment, retirement or death.

ARC Provident Fund
The ARC became a participating employer of the NEHAWU National Provident Fund on 1 November 1997. All employees who are appointed on an indefinite basis will be required to become a member of either the ARC-Pension fund or the NEHAWU National Provident fund.

The NNPF is administered by SANLAM. The Fund is a defined contribution fund and members is receiving the benefits provided for the rules of the ARCPF on resignation, dismissal, retrenchment, retirement or death.

28. UNSPENT CONDITIONAL GRANTS

Unspent conditional grants and receipts comprises of:

Unspent conditional grants and receipts		
Foot-and-mouth Disease ("FMD") vaccines facility	367 654 896	246 047 334
Exotic Disease and the Wild Suide facilities	4 877 451	4 877 451
	372 532 347	**250 924 785**
Movement during the year		
Balance at the beginning of the year	250 924 785	139 086 150
Additions during the year	121 739 000	113 044 001
Income recognition during the year	(131 438)	(1 205 366)
	372 532 347	**250 924 785**

Of the R422.5m allocated by National Treasury for the FMD project, R368m has yet to be spent. The ARC has started ring-fencing the funds during the FY2020 and will continue to ensure that the adequate cash reserves are reserved for funding of the future work on the FMD. At year end, the ARC had cash and cash equivalents of R502m which is adequate to fund the work on this project.

These amounts are invested in a ring-fenced investment until utilised.

29. CAPITAL FUNDS

Issued		
Capital fund	111 986 013	111 986 013

The capital fund represents the cost of land when the ARC was transferred out of the Department of Agriculture, Forestry and Fisheries.

Figures in Rand	2021	2020

30. REVALUATION RESERVE

Opening balance	899 405 480	809 271 803
Change during the year	16 585 942	90 133 677
	915 991 422	**899 405 480**

Revaluation surplus relating to property, plant and equipment

Revaluation surplus beginning of period	899 405 480	809 271 803
Movements in the reserve for the year	16 585 942	90 133 677
	915 991 422	**899 405 480**

31. ACCOUNTING BY PRINCIPALS AND AGENTS

The entity is a party to a principal-agent arrangement(s).

Details of the arrangement(s) is|are as follows: Details of the arrangement(s) is|are as follows:

The entity is the principal. Refer to note for significant judgements applied in making this assessment.
ARC is the proprietor of certain plant varieties wherein SANSOR is appointed to collect royalties on behalf of the ARC. The entity is the principal. SANSOR is the designated authority to manage and execute all functions pertaining to seed certification on behalf of government.

Entity as principal

Resources (including assets and liabilities) of the entity under the custodianship of the agent
The resources have not been recognised by the agent in its financial statements.

There are no cost implications for the entity if the principal-agent arrangement is terminated. The arrangement may be terminated by either party subject to three months' notice.

Fee paid		
Fee paid as compensation to the agent	329 852	348 759

32. TAXATION

Reconciliation of the tax expense
Reconciliation between applicable tax rate and average effective tax rate.

The ARC is exempt from Income Tax in terms of section 10(1) (a) of the Income Tax Act no. 58 of 1962.

Figures in Rand	2021	2020

33. CASH GENERATED FROM OPERATIONS

Surplus (deficit)	161 563 840	66 111 333
Adjustments for:		
Depreciation and amortisation	78 418 757	97 990 862
Loss on sale of assets and liabilities	(738 305)	(2 351 780)
(Loss) gain on foreign exchange	458 518	(782 334)
Fair value adjustments	(1 329 557)	1 762 441
Impairment (deficit)	(1 479 359)	1 984 608
Movements in operating lease assets and accruals	239 483	13 130
Movements in retirement benefit assets and liabilities	(1 157 831)	(671 362)
Movements in provisions	-	(90 469)
Actuarial (gains)/or losses	1 815 831	(2 249 638)
Sale of other financial assets	-	2 529
Stock write-off	2 176 568	618 175
Transfer of entities under common control	-	(1 564 687)
Movement in reserves	(571 744)	(1 037 859)
Non-cash items	-	161 937
Changes in working capital:		(2 723 887)
Inventories	5 932 620	41 897 296
Receivables from exchange transactions	(8 701 752)	-
Construction contracts and receivables	-	
Payables from exchange transactions	(58 697 680)	(44 559 557)
VAT	(8 065)	(5 688 023)
Unspent conditional grants	121 607 562	111 838 634
	299 528 886	**260 661 349**

34. FINANCIAL INSTRUMENTS DISCLOSURE

Categories of financial instruments

2021

Financial assets

	At fair value	At amortised cost	At cost	Total
Other financial assets	4 360 996	128 714 756	93 543	4 454 539
Trade and other receivables from exchange transactions	-	-	-	128 714 756
Cash and cash equivalents	-	502 162 930	-	502 162 930
	4 360 996	**630 877 686**	**93 543**	**635 332 225**

Financial liabilities

	At amortised cost		Total
Trade and other receivables from exchange transactions	70 366 119		70 366 119

Figures in Rand	2021	2020

2020

Financial assets

	At fair value	At amortised cost	At cost	Total
Other financial assets	3 031 439	126 031 612	184 423	3 215 862
Trade and other receivables from exchange transactions	-	-	-	126 031 612
Cash and cash equivalents	-	245 935 648	-	245 935 648
	3 031 439	**371 967 260**	**184 423**	**375 183 122**

Financial liabilities

	At amortised cost		Total
Trade and other receivables from exchange transactions	114 661 982		114 661 982

35. TRANSFER OF FUNCTIONS BETWEEN ENTITIES UNDER COMMON CONTROL

Transfer of functions between entities under common control occurring during the current reporting period

Entities involved in the transfer of functions were:

Agricultural Research Council (ARC)

Department of Agriculture, Forestry and Fisheries

The following functions were transferred:

Assets transferred to the ARC on inception of the entity which were not on the asset register of the ARC.

The transfer was due to the creation/inception of the ARC.

The transfer of function took place during the 1992 financial year.

The transfer was finalised on Wednesday, 01 April 1992.

Value of the assets acquired and liabilities assumed

Assets acquired		
Property, plant and equipment	-	1 564 687
Difference between the carrying amounts of the assets acquired, the liabilities assumed and adjustments required to the basis of accounting	**-**	**1 564 687**
Difference between net assets and the consideration paid	**-**	**1 564 687**
Amounts recognised [for each transaction] and line item affected:		
Property, plant and equipment	**-**	1 564 687

Figures in Rand	2021	2020

36. COMMITMENTS

Authorised capital expenditure

Already contracted for but not provided for		
• Buildings	726 063	215 843
• Computer equipment	335 809	160 663
• Computer software	-	13 773
• Infrastructure	3 656 286	3 680 495
• Laboratory equipment	13 475 807	7 218 888
• Machinery and farming equipment	1 585 527	784 845
• Office furniture and equipment	460 120	187 813
• WIP Buildings	120 800	-
	20 360 412	**12 262 320**
Total capital commitments		
Already contracted for but not provided for	20 360 412	12 262 320
Total commitments		
Authorised capital expenditure	20 360 412	12 262 320
Operating leases as lessee (expense)		
Minimum lease payments due		
- within one year	1 755 177	1 930 086
- in second to fifth year inclusive	1 831 197	1 303 230
	3 586 374	**3 233 316**

ARC leases certain of its equipment in terms of operating leases. The ARC does not have the option to acquire the assets at the termination on the lease. There are no escalation or renewal terms clauses or restrictions imposed by the leases. The ARC is not charged any contingent rentals.

37. CONTINGENCIES

The guarantees on municipal and electrical accounts relate to the City of Tshwane municipality to ensure a continued service to the ARC Onderstepoort Veterinary Institute.

Legal costs and litigations relate to in the nature of the ARC's business, agreements with complex deliverables may be entered into. All necessary steps are taken to manage the risks inherent to these transactions. If and when it is evident that there is a reasonable probability that a dispute on a transaction could lead to costs against the ARC, such costs will be disclosed.

Guarantees on municipal and electricity accounts	1 075 360	1 075 360
Legal costs and litigations	50 368 662	52 568 662
Pending labour dispute	1 300 000	8 207 095
	52 744 022	**61 851 117**

Figures in Rand 2021 2020

Retention of surplus funds

In terms of section 53 (3) of PFMA, constitutional institutions and public entities listed in schedule 3A and 3C to the Public Management Act (PFMA), 1999 may not accumulate surpluses that were realised in the previous financial year without obtaining prior written approval of the relevant Treasury.

In terms of paragraph 3.2 of the National Treasury instruction no. 12 of 2020/21, surplus is based on the net assets. A request for surplus retention will be submitted to National Treasury based on the audited financial statements.

Figures in Rand	Controlling entity	
	2021	2020
Cash and Cash Equivalents at end of the year (#)	502 162 930	245 935 648
Add: Receivables	135 943 741	129 205 930
less: Current Liabilities	(262 012 422)	320 937 235
Uncommitted surplus	**376 094 249**	**54 204 343**
less: Deferrend Income Grant (Ringfenced)	372 532 347	250 924 785
Net Surplus / (Deficit) after taking into account conditional grants	**3 561 902**	**(196 720 442)**

(#) the Cash and cash equivalents includes the funds relating to the Conditional Grant for Foot and Mouth Disease (FMD) vaccine facility and the Exotic Disease and the Wild Suide facilities. The FMD and Exotic Disease & Wild Suide facility liability (disclosed under non-current Liabilities) had a balance of R372 532 347 as of 31 March 2021 (2020: R250 924 785).

The commitments for the ARC of R20,360,412 are to also be funded from the cash surpluses retained.

Contingent assets

Mr Pretorius' lease agreement fell into arrears in respect of his rental obligation, civil proceedings have commenced against the tenant concerned to recover an amount of R502 708. According to entity's legal advisors, it is probable that the proceedings will result in the recovery of the full amount, but this recovery is virtually certain.

Maenetja Attorneys took over the matter from Madlhopa Attorneys on expiry of their contract. Summons were issued to recover R1 200 000 and the defendant raised prescription of the claim.

38. RELATED PARTIES

The ARC is a Schedule 3A national public entity in terms of the Public Finance Management Act (Act No. 1 of 1999 as amended) and therefore falls within the national sphere of government. As a consequence, the ARC has a significant number of related parties being entities that fall within the national sphere of government.

Such transactions are for the research that the ARC performs from time to time. All such transactions are concluded on an arm's length basis.

The ARC reports Department of Agriculture, Land Reform and Rural Development (DALRRD). Amounts disclosed below as related parties relates to the parent department, Department of Agriculture, Land Reform and Rural Development (DALRRD) and entities within DALRRD.

Figures in Rand	2021	2020

Relationships	
Ultimate controlling entity	
Controlling entity	
Public entity (Under common control with the ARC)	Department of Agriculture, Land Reform and Rural Development
Public entity (Under common control with the ARC)	Department of Agriculture, Land Reform and Rural Development
Public entity (Under common control with the ARC)	Agricultural Land Holding Account
Public entity (Under common control with the ARC)	KwaZulu-Natal Ingonyama Trust Board (ITB)
	National Agricultural Marketing Council
Public entity (Under common control with the ARC)	Office of the Valuer-General
Public entity (Under common control with the ARC)	Onderstepoort Biological Products
Public entity (Under common control with the ARC)	Perishables Products Export Control Board
	Registration of Deeds Trading Account
Public entity (Under common control with the ARC)	South African Veterinary Council

Related party balances

Amounts included in Trade receivable (Trade Payable) regarding related parties		
AgriSETA	5 323 235	589 208
Department of Agriculture, Forestry and Fisheries - ECSP	-	(20 537 611)
Department of Agriculture, Forestry and Fisheries - Other grants	16 173 625	69 524 304
Department of Agriculture, Land Reform and Rural Development	3 890	-
Department of Education	57 109	174 782
Department Military Veterans	1 439 916	1 442 705
Department of Public Works	130 454	156 086
Department of Rural Development and Land Reform	21 741 511	26 511 484
Department of Rural, Environment and Agricultural Development	414 586	1 022 081
Department of Science and Innovation	406 400	412 900
Department of Water Affairs	-	(5 821)
Director of Veterinary Service	103 569	289 280
The National Commissioner	453 130	454 724
Government Printing Works	(4 290)	(53 313)
National Research Foundation	-	1 356 400
Onderstepoort Biological Products - receivables	2 739 647	1 179 342
Onderstepoort Biological Products - payables	(848)	-
South African Veterinary Council	(4 404)	-
Unconditional grants from related parties		
Department of Agriculture, Forestry and Fisheries - Wild Suide	(4 877 451)	(4 877 451)
Department of Agriculture, Forestry and Fisheries - FMD	(367 654 896)	(233 115 514)

These are government grants received that will be recognised in future accounting periods. Recognition in future periods will be in line with reporting standards and determined by construction work on the facilities concerned.

Figures in Rand	2021	2020
Expenses recognised in respect of bad or doubtful debts		
Department of Agriculture, Land Reform and Rural Development	-	1 680 567

Related party transactions

Purchases from (sales to) related parties		
AgriSETA	(4 833 995)	(1 242 041)
Department of Agriculture, Forestry and Fisheries	-	4 568
Department of Agriculture, Forestry and Fisheries - PBR registration	45 968	32 045
Department of Agriculture, Forestry and Fisheries - PIA registration	167 157	361 212
Department of Agriculture, Forestry and Fisheries - Services	(19 349 673)	(13 322 558)
DAFF Dep. Forestry & Fisheries	-	604
Department Of Education	-	(379 617)
Department Of Public Works	(349 439)	(276 534)
Department of Rural, Environment and Agricultural Development	(3 483 377)	(511 547)
DAFF Registration Account	-	11 041
Department of Police, Roads and Transport Administration and Licensing	86 244	95 997
Department of Science and Innovation - Other Revenue Grants	(13 070 495)	(19 273 611)
Department of Water Affairs	81 512	39 660
Director of Veterinary Service	(138 077)	(216 266)
Government Printing Works	36 361	390 830
National Agricultural Market Council	-	111 000
National Research Foundation	(11 087 394)	(11 463 272)
National Treasury	-	59 964
Onderstepoort Biological Products - Services	33 244	61 241
Onderstepoort Biological Products - Utilities Recovery	(13 923 088)	(13 750 088)
Perishables Products Export Control Board	-	29 948
South African Veterinary Council	135 875	111 645
Parliamentary grants		
Department of Agriculture, Land Reform and Rural Development	(965 147 957)	(951 048 652)
Department of Agriculture, Land Reform and Rural Development	(131 438)	(1 205 366)
Department of Science and Innovation	-	(26 086 957)

Figures in Rand	2021	2020

Remuneration of management

Management class: Council

2021

Name	Fees for services as a member of management	Total
Prof S Vil Nkomo (Former Chairperson)	41 840	41 840
Ms JS Isaacs (Chairperson)	149 712	149 712
Dr JM Mashaba	205 768	205 768
Ms J Mashiteng	38 880	38 880
Dr JM Chitja	40 005	40 005
Miss B Kali	38 880	38 880
Mr SG Mthombeni	46 656	46 656
Dr M Ngoepe Ntsoane	31 104	31 104
Dr MN Makhura	15 552	15 552
Adv ME Mphahlele	34 992	34 992
Mr A Bishop	38 880	38 880
Mr LA Makenete	31 104	31 104
Mr A Stroebel	38 880	38 880
Dr ME Ngidi	7 776	7 776
Mr M Brinkhuis	31 104	31 104
Mr M Mahanjana	34 992	34 992
Dr ST Cornelius	167 670	167 670
Dr KB Liphadzi	160 623	160 623
Dr CPN Malan	143 856	143 856
Dr PJ Mokaila	132 192	132 192
Dr SAM van Oorsterhout	229 878	229 878
Miss N Maharaj	157 950	157 950
Mr GS Gcaba	147 744	147 744
Prof. RMB Auerbach	151 632	151 632
Prof PW Mashela	147 744	147 744
Prof NJJ Olivier	187 110	187 110
	2 452 524	**2 452 524**

2020

Name	Fees for services as a member of management	Total
Prof S Vil Nkomo (Chairperson)	94 245	94 245
Ms J Mashiteng	101 244	101 244
Dr JM Chitja	84 633	84 633
Miss B Kali	97 356	97 356
Mr SG Mthombeni	144 167	144 167
Dr M Ngoepe Ntsoane	81 726	81 726
Dr SAM van Oorsterhout	62 208	62 208
Dr MN Makhura	69 734	69 734
Adv ME Mphahlele	175 349	175 349
Mr A Bishop	109 253	109 253
Mr LA Makenete	77 838	77 838
Mr A Stroebel	65 764	65 764
Dr ME Ngidi	77 916	77 916
Prof PW Mashela	70 140	70 140
Mr M Brinkhuis	38 958	38 958
Mr M Mahanjana	66 174	66 174
	1 416 705	**1 416 705**

Figures in Rand	2021	2020

Management class: Executive management

2021

Name	Basic salary	Other short-term employee benefits	Post-employment benefits	Termination benefits	Other benefits received	Total
Dr SR Moephuli	2 742 392	83 784	411 800	-	840	3 238 816
Ms MM Manyama	2 550 534	35 568	325 458	-	840	2 911 900
Dr MA Magadlela	1 828 845	19 744	260 417	-	-	2 109 006
Dr N Motete	1 821 093	27 656	260 417	-	-	2 109 166
Ms MH Umlaw (note 1)	1 057 330	32 791	113 932	139 992	-	1 344 045
Dr T Sethibe	1 829 702	47 736	191 559	-	-	2 068 997
Dr TS Mkhabela	2 070 952	-	-	-	-	2 070 952
Dr HW Vergotine (note 2)	107 821	-	-	-	-	107 821
	14 008 669	**247 279**	**1 563 583**	**139 992**	**1 180**	**15 960 703**

2020

Name	Basic salary	Other Short-term employee benefits	Post-employment benefits	Termination benefits	Other long-term benefits	Other benefits received	Total
Dr SR Moephuli	2 758 091	77 586	411 800	-	-	40 861	3 288 338
Ms MM Manyama	2 574 388	33 372	325 458	-	-	-	2 933 218
Dr MA Magadlela	1 805 061	20 933	227 865	-	78 238	11 818	2 143 915
Dr N Motete	1 766 767	25 952	260 417	-	-	-	2 053 136
Ms MH Umlaw	1 810 737	52 767	195 313	-	-	396	2 059 213
Dr T Sethibe	1 778 454	44 196	191 559	-	-	6 167	2 020 376
Dr TS Mkhabela	2 017 143	-	-	-	-	15 158	2 032 301
Dr MS Jeenah	461 093	-	-	247 451	52 279	-	760 823
	14 971 734	**254 806**	**1 612 412**	**247 451**	**130 517**	**74 400**	**17 291 320**

*Refer to note "Employee related costs"

Note 1: Ms Umlaw resigned effective from 31 October 2020.
Note 2: Dr Vergotine acted for the period is from 01 November 2020 to 30 April 2021.

Management class: Audit committee

2021

Name	Fees for services as a member of management	Total
Mrs P Stock (Chairperson)	73 533	73 533
Mr VN Naicker	88 743	88 743
Miss HN Masedi	21 585	21 585
Dr JM Laubcscher	36 666	36 666
Ms ND Maidi	36 666	36 666
Mr LM Mangquku	31 875	31 875
Mr JH Mcbain	30 000	30 000
Ms K Mokoena	30 000	30 000
	349 068	**349 068**

Figures in Rand	2021	2020

2020

Name	Committee Fees	Total
Mr VN Naicker	116 016	116 016
Mr LM Mangquku	114 475	114 475
Mr JH Mcbain	110 300	110 300
Ms K Mokoena	90 300	90 300
	431 091	**431 091**

39. PRIOR-YEAR ADJUSTMENTS

Presented below are those items contained in the statement of financial position, statement of financial performance and cash flow statement that have been affected by prior-year adjustments:

Statement of financial position

2019

	Note	As previously reported	Correction of error	Change in accounting policy	Re-classification	Restated
Operating lease asset	16	-	3 260 710	-	-	3 260 710
Receivables from exchange transactions	17	174 656 732	(2 517 009)	-	-	172 139 723
Investment property		3 139 481	-	-	64 690	3 204 171
Property, plant and equipment	21	1 373 655 458	246 556 667	317 491 805	(64 690)	1 937 639 240
Operating lease liability		-	(8 880)	-	-	(8 880)
Payables from exchange transactions	26	(363 869 647)	1 031 015	-	-	(362 838 632)
Unspent conditional grants and receipts	28	(126 154 331)	(12 931 819)	-	-	(139 086 150)
Revaluation reserve		(215 020 431)	(230 013 106)	(364 238 266)	-	(809 271 803)
Accumulated surplus		(830 818 848)	41 368 883	-	-	(789 449 965)
		15 588 414	**46 746 461**	**(46 746 461)**	**-**	**15 588 414**

2020

	Note	As previously reported	Correction of error	Change in accounting policy	Re-classification	Restated
Inventories	15	24 375 747	265 756	-	-	24 641 503
Operating lease asset	16	-	3 258 942	-	-	3 258 942
Receivables from exchange transactions	17	132 014 635	(2 808 705)	-	-	129 205 930
Investment property	20	3 092 6611	-	-	62 837	3 155 498
Property, plant and equipment	21	1 738 347 026	(30 211 179)	317 491 805	(62 837)	2 025 564 815
Operating lease liability		7 699	(12 543)	-	-	(20 242)
Payables from exchange transactions	26	(311 932 685)	(6 502 168)	-	-	(318 434 853)
Unspent conditional grants and receipts	28	(237 992 966)	(12 931 819)	-	-	(250 924 785)
Revaluation reserve	30	(535 167 214)	-	(364 238 266)	-	(899 405 480)
Accumulated surplus		(948 515 432)	95 688 174	-	-	(852 827 258)
		(135 785 927)	**46 746 461**	**(46 746 461)**	**-**	**(135 785 927)**

Figures in Rand	2021	2020

Statement of financial performance

2020

	Note	As previously reported	Correction of error	Change in accounting policy	Re-classification	Restated
Sale of goods in agricultural activities	6	17 516 561	696	-	-	17 517 257
Rendering of services	6	266 227 207	1 125 166	-	(7 955 518)	259 396 855
Royalty income	6	27 290 905	30 501	-	-	27 321 406
Rental of facilities and equipment	6	19 556 146	(416 426)	-	8 512 074	27 651 794
Other income	6	27 746 233	2 236 050	-	(8 512 074)	21 470 209
Employee related costs	7	(795 041 357)	(233 647)	-	-	(795 275 004)
Depreciation and amortisation	8	(81 914 130)	(196 280)	(15 880 452)	-	(97 990 862)
Finance costs	9	(219 869)	(556)	-	-	(220 425)
Lease rentals on operating lease	10	(9 865 553)	(492 299)	-	-	(10 357 852)
Operating and administrative expenses	11	(360 094 021)	23 779 079	-	(16 729 845)	(353 044 787)
Repairs and maintenance		(30 293 028)	(126 161)	-	-	(30 419 189)
(Loss) gain on disposal of assets and liabilities		1 926 700	-	-	(8 774 327)	(6 847 627)
Reversal of impairments (Impairment loss)	14	30 265 350	(32 249 958)	-	-	(1 984 608)
Deficit for the year		**(886 898 856)**	**(6 543 835)**	**(15 880 452)**	**(33 459 690)**	**(942 782 833)**

Cash flow statement

2020

	As previously reported	Correction of error	Restated
Cash flow from operating activities			
Sale of goods and services	400 133 834	(4 692 346)	395 441 488
Employee costs	(787 753 246)	(2 328 009)	(790 081 255)
Suppliers	(463 569 988)	9 334 273	(454 235 715)
Finance costs	(219 869)	(556)	(220 425)
	(851 409 269)	**2 313 362**	**(849 095 907)**
Cash flow from investing activities			
Proceeds from equipment land and buildings	2 313 363	(2 313 363)	-

Errors

The following prior period errors adjustments occurred:

Inventories

During the year, management discovered that an inventory delivery was erroneously expensed. As consequence, the cash flow statement, the prior year expenses, accumulated surplus were overstated and inventory was understated. The error was corrected by restating the affected financial statement line items for prior periods.

Operating lease asset

During the year, management decided to update the lease register as thus it was discovered that the lease smoothing was understated. As consequence, the cash flow statement, the prior year operating lease asset, accumulated surplus and lease income were understated. The error was corrected by restating the affected financial statement line items for prior periods.

Figures in Rand	2021	2020

Receivables from exchange transactions

During the year, management discovered that projects, sale of goods revenue and rendering of services were accounted for in the incorrect period. As consequence, the cash flow statement, trade receivables & other receivables, income received in advance, accumulated surplus, and revenue were misstated. The error was corrected by restating the affected financial statement line items for prior periods.

Further it was discovered that provision for bad debts was incorrectly accounted for. Consequently, the provision for bad debts was understated. The error was corrected by restating the affected financial statement line items for prior periods.

Property, plant and equipment

During the year, management noted that the prior year land revaluation was misstated thus management decided to correct the error. Consequently, land, accumulated surplus and revaluation surplus were understated. The error was corrected by restating the affected financial statement line items for prior periods.

Operating lease liability

During the year, management discovered that there were leases that were omitted. As consequence, the cash flow statement, the prior year operating lease liability, accumulated surplus and lease expenses were understated. The error was corrected by restating the affected financial statement line items for prior periods.

Payables from exchange transactions

During the year, management discovered that some payments made after year end related to prior year invoices which were not accrued. Consequently, the cash flow statement, accruals, accumulated surplus, employee related costs, finance costs, lease rentals on operating lease, operating & administrative expenses and repairs & maintenance were understated. The error was corrected by restating the affected financial statement line items for prior periods.

Unspent conditional grants and receipts

During the year, management discovered that expenses were erroneously capitalised to the FMD project. An amount of R12m was incorrectly capitalised. Consequently, the cash flow statement, assets under construction, unspent grants, accumulated surplus and expenses were misstated. The error was corrected by restating the affected financial statement line items for prior periods.

Cash flow statement

During the year, management decided to adjust the cash paid on post-retirement medical to employee related cost as opposed to payment to suppliers. As a consequence, cash paid to suppliers and cash paid to employees. The error was corrected by restating the affected financial statement line items for prior periods.

Irregular expenditure

Opening balance	535 745 402	513 193 702
Adjustments made	(21 621)	**(6 080 000)**
Restated opening balance	**535 723 781**	**507 113 702**

An adjustment of R6 208 093 made to the opening balance of irregular expenditure is due to the inclusion of items that were determined not to be irregular. The items were included as part of the opening balance, it was subsequently noted that the items should be removed from the irregular expenditure note.

An adjustment of R21 621 made to the opening balance of irregular expenditure is due to an error in disclosing an irregular expenditure that was not paid. The WIETA amount was included in the 31 March 2020 financial statements as irregular expenditure, it was subsequently noted that the amount was not paid thus should be adjusted.

Figures in Rand	2021	2020

Fruitless and wasteful expenditure

Opening balance	810 847	-
Adjustments made	165 856	-
Restated opening balance	**976 703**	**-**

Change in accounting policy

The following change in accounting policies occurred:

Valuation of buildings

During the year, management decided to change the accounting policy for valuing buildings from cost model to the revaluation model. Management is of the opinion that changing to the revaluation model will provide more reliable information to the users of the financial statements. Consequently, depreciation, cost, impairment, revaluation reserve, accumulated surplus and accumulated depreciation were impacted. The change was affected by restating the affected financial statement line items for prior periods.

Living resources

During the year, the entity has elected to apply GRAP 110 Living and non-living resources. The standard has been adopted prospectively from 1 April 2020. Comparatives for the 2020 financial year have not been restated. Living resources held for research were previously accounted for as inventories. The impact of the standard is that living resources held for research were reclassified from inventories to living resources.

The standard prescribes the accounting treatment, recognition measurement and disclosure requirements for living resources and disclosure requirements for non-living resources.

Reclassifications

The following reclassifications adjustment occurred:

Municipal services

During the year, management discovered that the general ledger account for municipal services was classified as other income while the general ledger account for municipal recoveries was classified as rental of facilities and equipment to achieve consistency the municipal services amounting R8,5 million was reclassified to rental of facilities and equipment.

Investment property

During the year, management discovered that certain buildings were classified as property, plant and equipment instead of investment property. As consequence, the buildings were incorrectly classified. The error was corrected by restating the affected financial statement line items for prior periods.

Inter-institute charges

During the year, management decided to reclassify all the internal charges amounting to R7,9 million to operating and administrative expenses as they did not meet the requirements of revenue.

40. RISK MANAGEMENT

Financial risk management

The entity's activities expose it to a variety of financial risks: market risk (including currency risk, cash flow interest rate risk and price risk), credit risk and liquidity risk.

Figures in Rand	2021	2020

The Council has overall responsibility for the establishment and oversight of the entity's risk management framework.

The entity's risk management policies are established to identify and analyse the risks faced by the entity, to set appropriate risk limits and controls, and to monitor risks and adherence to limits. Risk management policies and systems are review regularly to reflect changes in market conditions and the entities activities.

The audit and risk committee oversees how management monitors compliance with the entity's risk management policies and procedures and reviews the adequacy of the risk management framework in relation to the risks faced by the entity. The entity Audit and Risk Committee is assisted in its oversight role by Internal Audit. Internal Audit undertakes both regular and ad hoc review of risk management controls and procedures, the results of which are reported to the Audit and Risk Committee.

Liquidity risk

Liquidity risk is the risk that the entity will not meet its financial obligations as they become due.

The entity manages liquidity through effective management of working capital, capital expenditure and cash flows. Adequate cash reserves are maintained. The entity manages liquidity risk through forecasting as well as monitoring cash flows daily.

The following are the maturities of financial liabilities. The amounts disclosed in the table are the undiscounted cash flows. Balances due within 12 months equal their carrying balances as the impact of discounting is not significant.

On 31 March 2021	Less than 1 year	Between 1 and 2 years	Between 2 and 5 years	Over 5 years
Trade and other payables	70 366 119	-	-	-
On 31 March 2020	Less than 1 year	Between 1 and 2 years	Between 2 and 5 years	Over 5 years
Trade and other payables	114 661 982	-	-	-

Credit risk

Credit risk is the risk that a counterparty will not meet its obligations under a financial instrument or customer contract, leading to a financial loss. The entity is exposed to credit risk from its operating activities (primarily trade receivables) and deposits with banks and financial institutions, and other financial instruments.

Trade receivables are presented net of an allowance for doubtful receivables. Currently only five of the entity's largest debtors exceed 5% of the total trade receivables balance as disclosed in note 17. The ARC does not have any significant exposure to any other individual customer or counter party.

The entity's bank balances and cash are placed with high credit, quality financial institutions with no significant exposure to any one counter-party.

The carrying amounts of financial assets included in the statement of financial position represent the ARC's maximum exposure to credit risk in relation to these assets. ARC does not hold collateral or any credit enhancements to cover its credit risk.
Financial assets exposed to credit risk at year end were as follows:

Financial instrument	**2021**	**2020**
Cash and cash equivalents	502 162 930	245 935 648
Trade and other receivables	128 714 756	126 031 612

Figures in Rand	2021	2020

Market risk

Interest rate risk

Interest rate risk is the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market interest rates. The entity's exposure to the risk of changes in market interest rates relates primarily to the entity's cash and cash equivalents. Exposure to interest rate risk is monitored on a continuous and proactive basis.

Financial instrument	Current interest rate	Due in less than a year	Due in 1 to 2 years	Due in 2 to 3 years	Due in 3 to 4 years	Due after 5 years
Cash in current banking institutions	1.75%	49 430 347	-	-	-	-
36-month fixed deposits	3.40%	452 732 583	-	-	-	-

Surplus or deficit is sensitive to higher/lower interest income from cash and cash equivalents because of changes in interest rates. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2020.

Figures in Rand	Impact on surplus or deficit	
	2021	2020
Interest rates - increase by 50 basis points	2 510 815	1 229 678
Interest rates - decrease by 50 basis points	(2 510 815)	(1 229 678)

Foreign exchange risk

The entity does not hedge foreign exchange fluctuations.

The exchange rates were obtained from OANDA.com.

The entity is exposed to currency risk on sales and purchases that are denominated in a currency other than the functional currency of the entity. The currencies in which the Council primarily deals are US Dollars, British Pounds and Euros. No forward exchange contracts are taken out for these transactions. The Council consider the foreign currency risk to be insignificant.

Foreign currency exposure at statement of financial position date

Exchange rates used for conversion of foreign items were:

USD	15.0635	16.6668
GBP	20.8537	20.9763
EURO	17.9105	18.4323

Price risk

The entity is exposed to equity securities price risk because of investments held by the entity and classified on the consolidated statement of financial position either as available-for-sale or at fair value through surplus or (deficit). The entity is not exposed to commodity price risk. To manage its price risk arising from investments in equity securities, the entity diversifies its portfolio. Diversification of the portfolio is done in accordance with the limits set by the entity.

The entity's investments in equity of other entities that are publicly traded and are included in the JSE all share index.

Figures in Rand 2021 2020

The table below summarises the impact of increases/decreases of the indexes on the entity's post-tax surplus for the year and on equity. The analysis is based on the assumption that the equity indexes has increased/decreased by 5% with all other variables held constant and all the entity's equity instruments moved according to the historical correlation with the index:

	Impact on post tax surplus in Rand		Impact on other components of equity in Rand	
Financial instrument	2021	2020	2021	2020
JSE/FTSE	218 050	151 572	218 050	151 572

Post-tax surplus for the year would increase/decrease because of gains or losses on equity securities classified as at fair value through surplus or (deficit). Other components of equity would increase/decrease because of gains or losses on equity securities classified as available-for-sale.

41. GOING CONCERN

COVID -19 is an unprecedented challenge for humanity, businesses and the economy at large. At the date of the report, its effects are subject to significant levels of uncertainty. To further address the inherent uncertainty embedded in the current situation that the ARC and the country finds it selves in; management has considered the potential impacts on the organisation by taking a variety of risk elements into account and the impact of COVID-19 has been factored in the going concern assessment.

- The COVID-19 has affected the organisation's ability to generate/earn external income. Future revenue pipeline is still at risk for as long as the world is still in a pandemic mode.
- Impacts on the cost structures. The additional costs arising from COVID-19 pandemic will be prioritised and catered for, within the approved budget.
- Impact on the reduction in employee related costs arising from the implementation of the ARC Sustainability and Financial Turnaround Plan.
- Impact of the non-payment from private customers has been considered not significant.

Some of our clients may also face credit-related issues but the company's assessment of credit risk is that that the ARC's customer base is unrelated and concentration of credit risk with respect to trade receivables is limited.

Despite the potentially considerable impact of this pandemic, the equity of the ARC is strong enough for the foreseeable future to absorb the economic shock caused by Covid-19. On that basis the annual financial statements have been prepared based on accounting policies applicable to a going concern. This basis presumes that funds will be available to finance future operations and that the realisation of assets and settlement of liabilities, contingent obligations and commitments will occur in the ordinary course of business.

42. EVENTS AFTER THE REPORTING DATE

Mr Sandile Tshabalala of Huruma Bantfu (Pty) Ltd was appointed as company secretary effective from Thursday, 01 April 2021. We confirm that he is a South African citizen with no criminal records and that he complies with the requirements of the Companies Act.

At reporting date, 31 March 2021, the ARC raised a contingent liability of R1 590 536 in respect of an outstanding court case. On 26 April 2021, the court dismissed the ARC's application for the arbitrator's award to be reviewed and set aside the application with costs and further made the arbitration award an order of Court as prayed for by NAP Designs in its counter application.

Figures in Rand	2021	2020

Consequently, the ARC if in agreement, it's required to raise the provision, as the court ruling would result in an adjusting event (it provides evidence of a situation that existed at the reporting date). The ARC is appealing the court case and only a contingent liability is sufficient as at 31 March 2021 due to the uncertainty about the outcome of the appeal.

At reporting date, 31 March 2021, the ARC raised a provision for bad debts of R16 967 000 in respect of a long outstanding debt with the Department of Land Reform and Rural development. On 7 April 2021, the ARC received R16 967 000 from the Department of Land Reform and Rural Development, which is towards the settlement of the debt owed to the ARC. Consequently, the ARC is required to downwardly adjust the provision for bad debts by an amount of R16 967 000, as the remittance dated 31 March 2021 provide evidence of a condition that existed at the reporting date.

43. FRUITLESS AND WASTEFUL EXPENDITURE

Opening balance as previously reported	812 607	579 403
Correction of prior period error	165 856	-
Opening balance as restated	**976 703**	**581 163**
Add: Expenditure identified - current	95 098	237 532
Less: Amounts recoverable - current	(21 278)	(1 870)
Less: Amounts recoverable - prior period	(70)	-
Less: Amount written off - prior period	-	(4 218)
Less: Condoned	(960 477)	-
Closing balance	**89 976**	**812 607**

Expenditure identified in the current year include those listed below:

Missed flight	**Disciplinary steps taken/ criminal proceedings**		
	Amount recovered	-	1 870
Interest on late payment of suppliers	Under Internal Audit investigation	95 098	219 750
Incorrect orders received	Under internal audit investigation	-	15 912
		95 098	**237 532**

Amounts recoverable

After the internal audit investigations, council adopted the council committee recommendations to recover an amount of R21 348 from all officials who caused the fruitless and wasteful expenditure.

Missed flight	-	1 870
Interest on late payment of suppliers	21 348	-
	21 348	**1 870**

Amounts written-off

After the internal audit investigations, council adopted the council committee recommendation to write-off an amount of R960 477 from the total fruitless and wasteful expenditure amount as it was proven without reasonable doubt that the amount was not recoverable.

	Condoned by (Condoning authority)		
Payroll related penalties	Council	265 258	-
Interest and procurement related expenditure	Council	695 219	-
Missed flight	Chief Executive Officers of the ARC	-	4 218
		960 477	**4 218**

Figures in Rand	2021	2020

44. IRREGULAR EXPENDITURE

Opening balance as previously reported	529 665 402	513 193 702
Correction of prior period error	(21 621)	(6 080 000)
Opening balance as restated	**529 643 781**	**507 113 702**
Add: Irregular Expenditure - current	2 226 844	22 576 980
Add: Irregular Expenditure - prior	261 253	-
Less: Amounts recoverable - current	-	(25 280)
Closing balance	**532 131 878**	**529 665 402**

Incidents/cases identified in the current year include those listed below:

	Disciplinary steps taken/criminal proceedings:		
Competitive bidding not invited	To be determined	2 447 407	22 240 106
Three written quotations not invited	A written warning was issued by the Campuses	-	44 972
Costs incurred on incorrect delivery	Senior Manager		
Purchasing of office refreshments without prior approval	An internal audit investigation was concluded and it was determined that no one can be held liable as Mr Benjamin Molefe who authorised the payment had already resign	-	266 622
WIETA audit were done without an order number It was determined that the transaction is not irregular	The full amount was recovered	-	25 280
		40 690	-
		2 488 097	**22 576 980**

Amounts recoverable

After the internal audit investigations, management adopted the internal audit recommendations to recover an amount of R25 280 from the official as it was proven without reasonable doubt that the official was liable for the identified non compliance to the SCM processes.

	Condoned by (Condoning authority)		
Purchase of office refreshment without approval	Funds recovered approval	-	25 280

45. SEGMENT INFORMATION

General information

Identification of segments

The entity is organised and reports to management on the basis of five major functional areas: animal sciences, crop sciences, impact & partnerships, research & innovation systems and soil, climate & water. The segments were organised around the type of service delivered and the target market. Management uses these same segments for determining strategic objectives. Segments were aggregated for reporting purposes.

Information reported about these segments is used by management as a basis for evaluating the segments' performances and for making decisions about the allocation of resources. The disclosure of information about these segments is also considered appropriate for external reporting purposes.

Aggregated segments

The entity operates throughout South Africa in eight provinces. Segments were aggregated based on services delivered as management considered that the economic characteristics of the segments throughout Gauteng were sufficiently similar to warrant aggregation.

Figures in Rand	2021	2020

Types of goods and/or services by segment

These reportable segments as well as the goods and/or services for each segment are set out below:

Reportable segment	Goods and/or services
Animal Science	Animal health and production
Crop Science	Improvement and cultivation of various crops
Impact and Partnerships	Translating the ARC's research results into useable outputs in support of agrarian transformation and the efficiency and competitiveness of the sector
Soil, Climate and Water	Carry out research and development on the natural agricultural resources, viz, soil, climate and water
Research and Innovation Systems	Provides collaborative and support functions to a wide range of technologies in areas such as genomics, phenomics, remote sensing, agricultural systems modelling and engineering systems.

Segment surplus or deficit, assets and liabilities

2021

	Animal Sciences	Crop Sciences	Impact and Partnerships	Soil, Climate and Water	Research and Innovation Systems	Total
Revenue						
Revenue from non-exchange transactions	244 490 163	302 145 241	14 838 192	63 960 779	43 287 710	668 722 085
Revenue from exchange transactions	117 952 782	172 460 939	5 543 382	19 124 829	26 855 385	341 937 317
Interest revenue	36 445	62 015	-	-	720	99 180
Total segment revenue	**362 479 390**	**474 668 195**	**20 381 574**	**83 085 608**	**70 143 815**	**1 010 758 582**
Entity's revenue						**1 010 758 582**
Expenditure						
Depreciation and amortisation and impairments	17 107 285	37 122 443	-	6 108 122	5 380 594	65 718 444
Total segment expenditure	**343 704 452**	**503 810 857**	**22 125 621**	**77 841 735**	**77 923 229**	**1 025 405 894**
Total segmental surplus/(deficit)						**(14 647 312)**
Interest expense						(84 797)

Figures in Rand 2021 2020

2020

	Animal Sciences	Crop Sciences	Impact and Partner-ships	Soil, Climate and Water	Research and Innovation Systems	Total
Revenue						
Revenue from non-exchange transactions	195 092 979	308 020 461	22 038 201	37 215 898	66 374 284	628 741 823
Revenue from exchange transactions	124 048 625	166 161 030	1 945 715	23 283 776	26 081 330	341 520 476
Interest revenue	56 062	27 471	-	-	-	83 533
Total segment revenue	**319 197 666**	**474 208 962**	**23 983 916**	**60 499 674**	**92 455 614**	**970 345 832**
Entity's revenue						**970 345 832**
Expenditure						
Salaries and wages	226 147 476	344 068 831	16 238 909	48 772 866	45 003 549	680 231 631
Other expenses	104 035 198	132 138 879	2 173 959	27 728 488	30 586 046	296 662 570
Depreciation	21 713 353	51 521 280	57 469	7 083 721	7 266 742	87 642 565
Total segment expenditure	**351 896 027**	**527 728 990**	**18 470 337**	**83 585 075**	**82 856 337**	**1 064 536 766**
Total segmental surplus/(deficit)						**(94 190 934)**
Interest expense						203 651

46. BBBEE PERFORMANCE

Information on compliance with the B-BBEE Act is included in the annual report under the section titled B-BBEE Compliance Performance Information.

NOTES

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