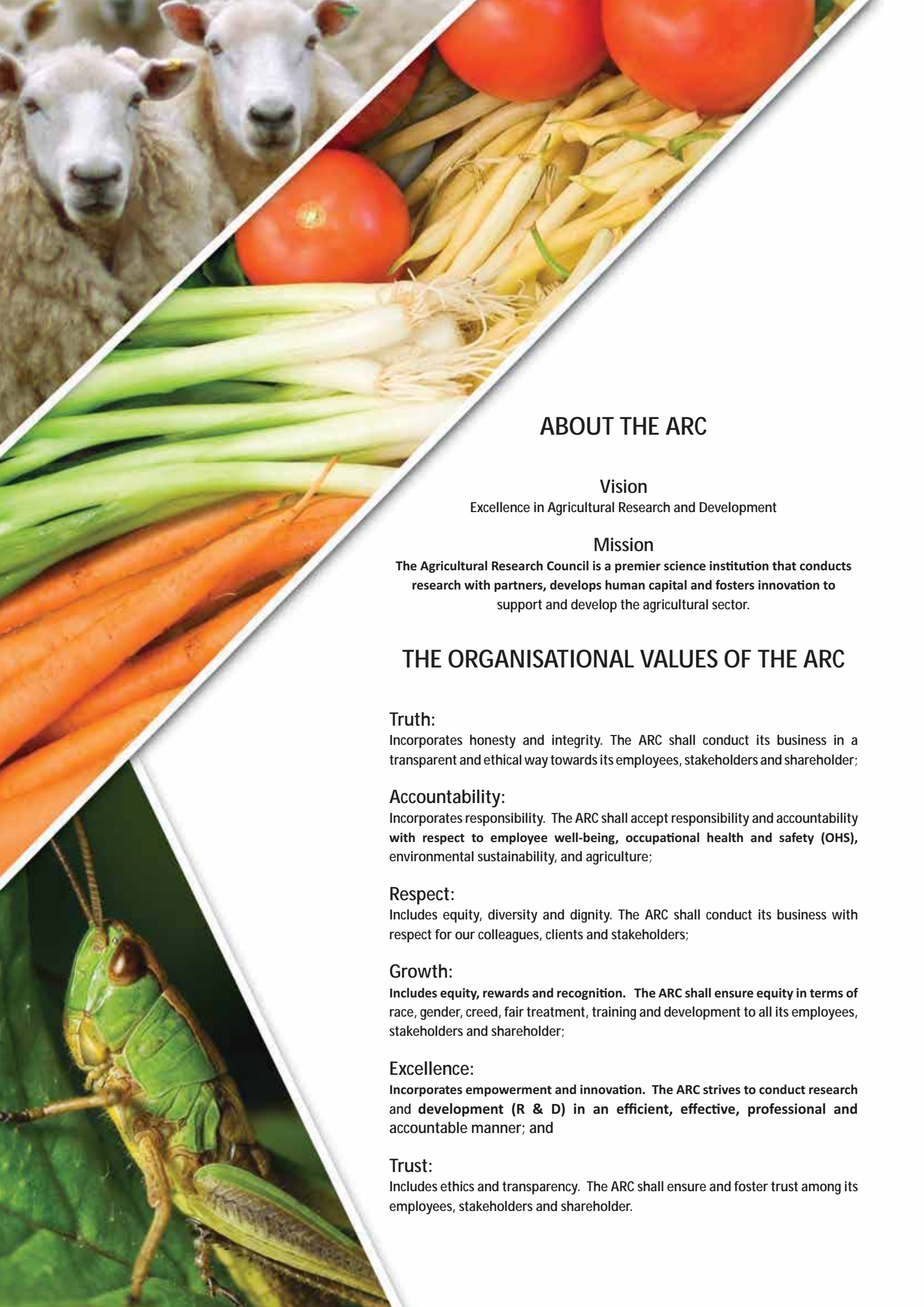


**ARC • LNR**

*Excellence in Agricultural Research and Development*

# **ANNUAL REPORT 2016 / 2017**



## ABOUT THE ARC

### Vision

Excellence in Agricultural Research and Development

### Mission

The Agricultural Research Council is a premier science institution that conducts research with partners, develops human capital and fosters innovation to support and develop the agricultural sector.

## THE ORGANISATIONAL VALUES OF THE ARC

### Truth:

Incorporates honesty and integrity. The ARC shall conduct its business in a transparent and ethical way towards its employees, stakeholders and shareholder;

### Accountability:

Incorporates responsibility. The ARC shall accept responsibility and accountability with respect to employee well-being, occupational health and safety (OHS), environmental sustainability, and agriculture;

### Respect:

Includes equity, diversity and dignity. The ARC shall conduct its business with respect for our colleagues, clients and stakeholders;

### Growth:

Includes equity, rewards and recognition. The ARC shall ensure equity in terms of race, gender, creed, fair treatment, training and development to all its employees, stakeholders and shareholder;

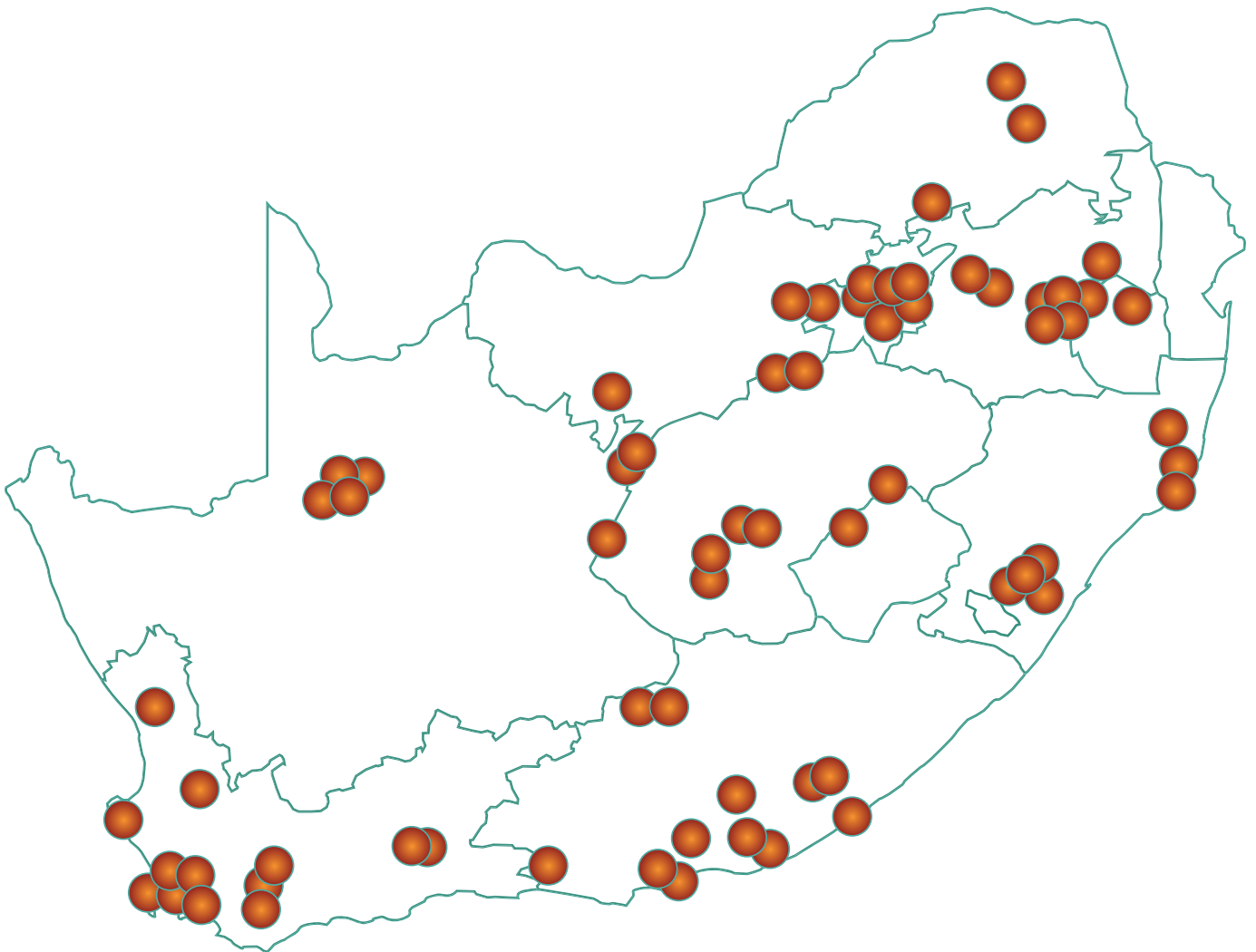
### Excellence:

Incorporates empowerment and innovation. The ARC strives to conduct research and development (R & D) in an efficient, effective, professional and accountable manner; and

### Trust:

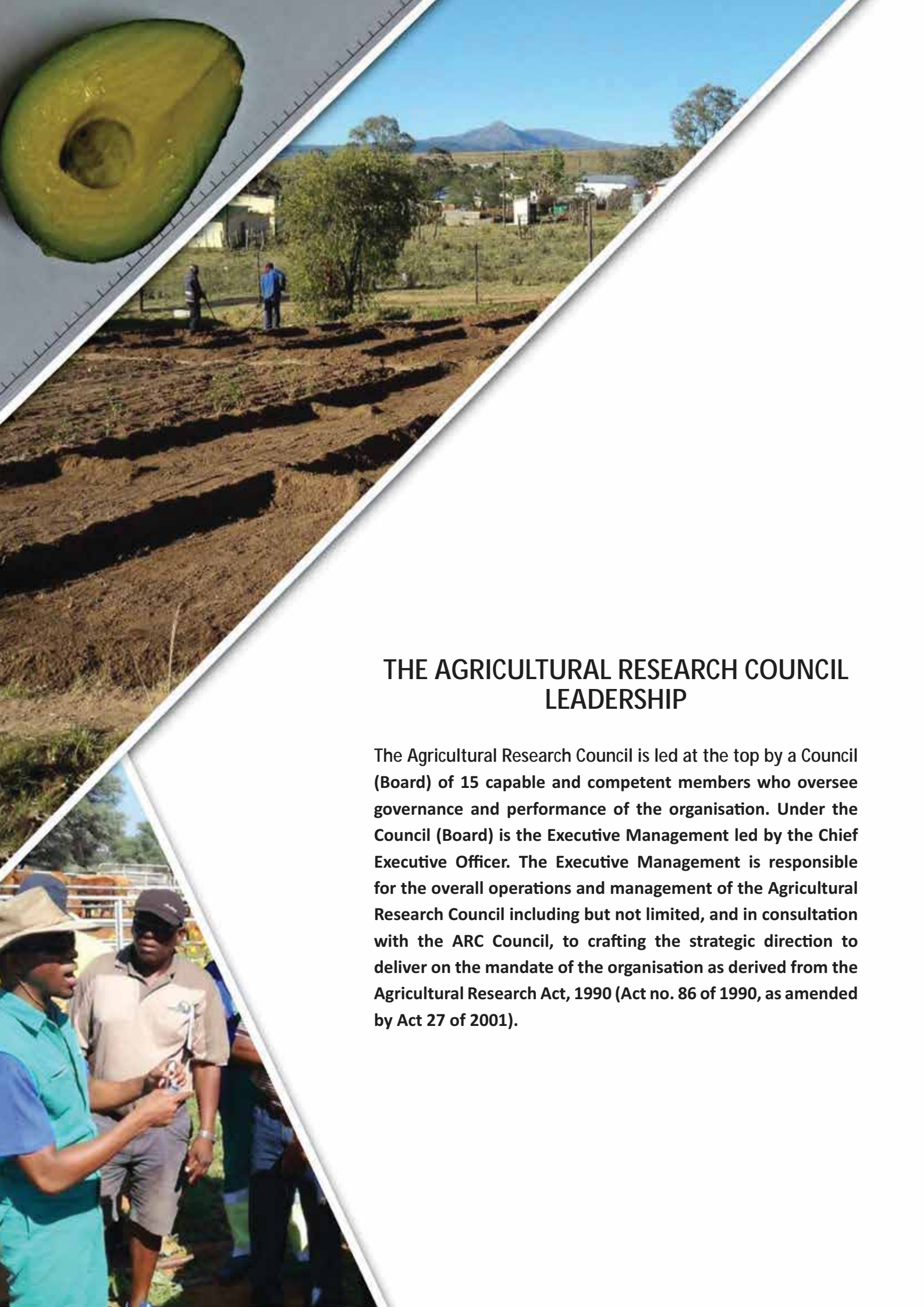
Includes ethics and transparency. The ARC shall ensure and foster trust among its employees, stakeholders and shareholder.

# AGRICULTURAL RESEARCH COUNCIL RESEARCH FACILITIES



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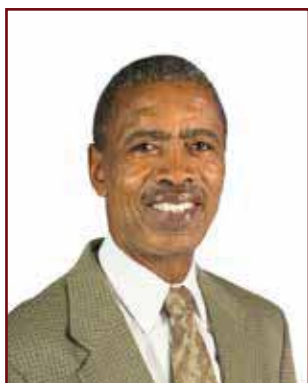


## THE AGRICULTURAL RESEARCH COUNCIL LEADERSHIP

The Agricultural Research Council is led at the top by a Council (Board) of 15 capable and competent members who oversee governance and performance of the organisation. Under the Council (Board) is the Executive Management led by the Chief Executive Officer. The Executive Management is responsible for the overall operations and management of the Agricultural Research Council including but not limited, and in consultation with the ARC Council, to crafting the strategic direction to deliver on the mandate of the organisation as derived from the Agricultural Research Act, 1990 (Act no. 86 of 1990, as amended by Act 27 of 2001).



## ARC 2016/2017 BOARD MEMBERS



**Prof Sibusiso Vil-Nkomo**  
(Gauteng) PhD (Economics and Policy Analysis/Public Sector/ Political Economy); Research Prof - Centre for the Advancement of Scholarships at University of Pretoria; Serves on various Public Sector Boards and Chairperson of Mapungubwe Institute for Strategic Reflection



**Prof Frans Swanepoel**  
(Free State) PhD (Animal Science); Professor: Centre for Sustainable Agriculture; Director: Research development



**Prof Michael Kahn**  
(Western Cape) PhD (Mathematical Physics); MA (Policy); management Consultant; and Professor Extraordinaire, University Stellenbosch



**Dr Joyce Chitja**  
(KwaZulu-Natal) PhD (Food Security); Lecturer: Food Security, University of KwaZulu-Natal



**Mr Clive Kneale**  
(Gauteng) fellow of the Chartered Institute of Secretaries and Administrators (International); Fellow of the Southern African Institute of Chartered Secretaries and Administrators; Company Secretary



**Dr Wilna Jansen Van Rijssen**  
(Gauteng) PhD, Pr. Nat Sci M.Sc (Applied Toxicology, Plant Biochemistry, Masters in Public Administration); Honours in Pharmacology; Consultant to Government



**Distinguished Prof Louw Hoffman**  
(Western Cape) PhD (Meat Science); Professor Meat Science DST/NRF South African Research; Chair in Meat Science Genomics to Nutriomics, Department of Animal Science, Faculty of AgriSciences University Stellenbosch



**Mr Mzolisi Dyasi**  
(Eastern Cape) Diploma in  
Business Administration; Red Meat  
Farmer



**Ms Dora Ndaba**  
(Gauteng) BTech Transport  
Logistics; Business Person



**Mr Allan Bishop**  
(Western Cape) B.Com (Hons),  
B.Compt (Hons) (CTA);  
Independent Business Consultant



**Mr Gerard Martin**  
(Western Cape) B.Sc; Business  
Management (Master); Executive  
Manager, Winetech



**Ms Joyce Mashiteng**  
(Gauteng) B.Sc (Master);  
Environmental Management  
Programme Manager; Nuclear  
Sites, ESKOM



**Mr Ismail Motala**  
(Western Cape) Farmer

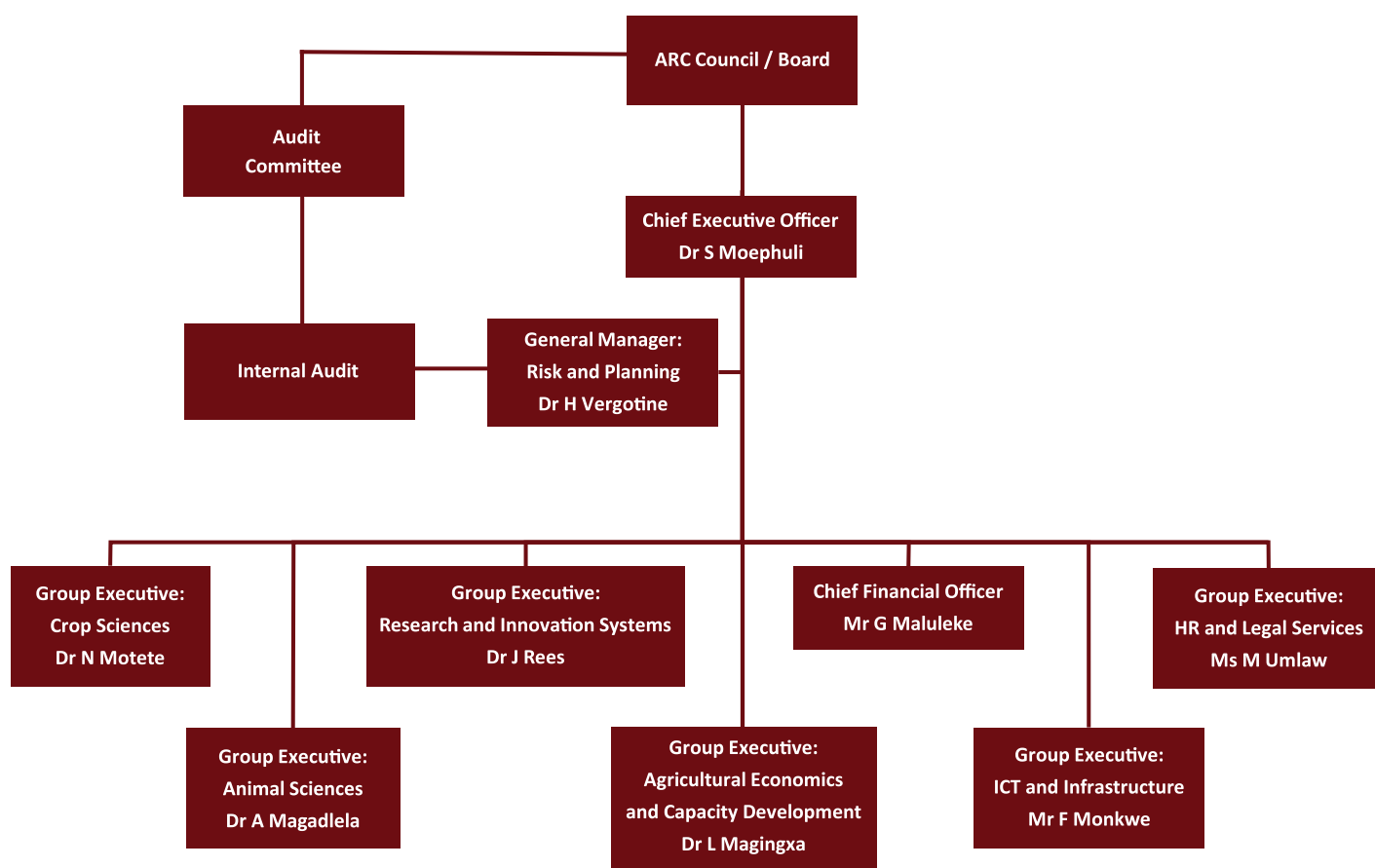


**Mr Rowan Nicholls**  
(Western Cape) B.Com CA (SA);  
Business Person; Registered  
Accountant and Auditor



**Dr Shadrack Moephuli**  
(Gauteng) PhD ARC President and  
CEO

# ORGANOGRAM



## CHAIRPERSON'S OVERVIEW



**Prof Sibusiso Vil-Nkomo**  
Chairperson of the ARC Council

always assume scarcity of financial resources and use their resources wisely.

The year in question has been turbulent for the ARC particularly from a financial sustainability point of view. The financial situation of the organization is under severe strain and points to an urgent need for it to be properly funded, if there is to be hope for it to continue to fulfill its mandate effectively. Research is fundamental for a nation to produce outcomes that lead to competitive food production, its sustainability and having a healthy as well as productive population. When research in agriculture fails, the nation's food security and economic sustainability are threatened.

The Council of the ARC remains very concerned about the insolvency of this critical research institution. The 2016-2017 revenue of the ARC clearly points in a direction that is undesirable. The cash surplus (deficit) of this period is concerning and has been identified by the previous Council as a challenge since 2015. It has become abundantly clear that a financial infusion is the only solution if the organization and its research undertakings are to be pursued effectively beyond 2017. The current continued reduction in funding affects excellent research, and will compromise the health of the nation and its food sustainability. The above concerns were raised in the Chairperson's Annual Report statement of 2015/2016.

A key endeavor of the Agricultural Research Council (ARC) is to improve its research competitiveness. To be a leading knowledge hub requires proper investment by all beneficiaries and interested stakeholders. Science bodies thrive in an environment that allows them to generate new knowledge, creates the opportunity for them to be relevant and allows them to engage in the knowledge of discovery and the knowledge of inventions. This cannot be achieved on a shoestring budget. At the same time, during good economic times institutions like the ARC must

The ARC continued to pursue its research agenda. The development of vaccines to prevent harmful parasites to the food chain and deadly negative effects on human beings as well as domesticated animals remained the focus of the institution. Consistent search for drought resistant seeds was a priority. The ARC will continue to focus on these areas as well as others that are important for the country in fulfillment of its research mandate.

Let me also point out that the ARC did not have a fully constituted Council from November 2016 to April 2017. Dr Shadrack Moephuli, the CEO/President became the sole member of Council during this period. The new Council thanks him for having diligently pursued matters of governance on behalf of the ARC. Going forward, I also want to encourage the Audit and Risk Committee to keep a close watch on the dire financial status of the ARC.

Lessons from the 2016-2017 year must be kept in mind so that the millennials must have hope for the future and desire to be part of a leading research institution the ARC can become. This organization can become employer of first choice because of the quality of its research outputs and technological advancements.

I thank the Honorable Minister Senzeni Zokwana and Deputy Minister General Bheki Cele for all the effort to support the work of the ARC. This was particularly important at a time when there was no Council in place to govern the ARC.

Finally, the 2016-2017 Council made its contribution to ARC to the best of its ability. Thank you for all the diligence and the care demonstrated during your term. Best wishes in your future endeavors.



**Prof Sibusiso Vil-Nkomo**  
Chairperson of the ARC Council

## ARC 2016/2017 EXECUTIVE MANAGEMENT



**Standing: from left to right:**

Dr J Rees, PhD (GE: Research and Innovation Systems); Dr L Magingxa, Phd (GE: Agricultural Economics and Capacity Development); Mr F Monkwe, MBA (GE: ICT & Infrastructure); Dr A Magadlela, Phd (GE: Animal Sciences) and Mr G Maluleke, CA (SA) (Chief Financial Officer)

**Seated: from left to right:**

Ms M Umlaw, MBA (GE: Human Resources and Legal Services); Dr S Moephuli, Phd (ARC President and CEO) and Dr N Motete, Phd (GE: Crop Science)

# MESSAGE FROM THE PRESIDENT AND CEO OF ARC



**Dr Shadrack Moephuli**  
ARC President and CEO

South Africa's agriculture success lies in the effective agriculture research and innovations by scientists and interactive exchanges with farmers (including large commercial producers), with targeted focus on smallholder and resource poor enterprises. Food and nutrition security is an essential element of a peaceful, developmental society that depends on ensuring increased agricultural production. This informs the mandate of the Agricultural Research Council.

In accordance with the requirements of the Agricultural

Research Act, 1990 (Act no. 86 of 1990 as amended by Act no. 27 of 2001) and the Public Finance Management Act, 1999 (Act no. 1 of 1999 as amended by Act 29 of 1999) (PFMA) we hereby present the annual report of the Agricultural Research Council (ARC) containing audited financial statements and performance information for the year ending 31 March 2017. Accordingly, it is with great honour on behalf of all of us, the employees of the ARC together with Council (Board) that we submit this annual report to South Africa's Parliament, through the Executive Authority, the Minister of Agriculture, Forestry and Fisheries: Honourable Mr. Senzeni Zokwana.

The outputs in this annual report were in accordance with the pre-determined objectives that are contained in the Business Plan for financial year 2016/17 as approved by Council, and tabled in parliament by the Honourable Minister of Agriculture, Forestry and Fisheries: Mr. Senzeni Zokwana. Further, this annual report provides a fair representation of organisational performance for the second year of the five (5) year strategic plan for the period 2015/16 to 2019/20.

On behalf of all employees of the ARC we hereby express our gratitude for good governance, oversight and strategic advice provided by Council and the support given to the ARC by the Honourable Minister and Deputy Minister: General Bheki Cele. Further, management and staff hereby express their appreciation for the oversight and stewardship of the Audit and Risk Committee.

As reflected in the performance information report the ARC has successfully delivered on its pre-determined outputs. Analysis of performance indicates that in many instances the ARC has exceeded the set targets for some of the strategic objectives. However, it should be noted that good organizational performance was achieved with limited resources (people, finances, equipment, infrastructure) and through a variety of partnerships, particularly during a difficult economic period.

During the reporting period the ARC prioritized its contributions on the following National Outcomes as outlined in the Medium Term Strategic Framework (MTSF):

- a) Outcome 4: Decent employment through inclusive economic growth;
- b) Outcome 7: Vibrant, equitable, sustainable rural communities contributing towards food security for all; and,

- c) Outcome 10: Protect and enhance our environmental assets and natural resources.

In order to ensure successful delivery and contribution towards the MTSF Outcomes, the ARC organized its deliverables within six strategic goals, programme orientation and performance data articulated within the context of SMART (specific, measurable, achievable, realistic and time-bound) principles. The following strategic goals enabled the ARC to fulfil its mandate and respond to sector needs:

1. To generate knowledge and technologies that will enhance the efficiencies in crop based agriculture;
2. To generate knowledge and technologies that will enhance the efficiencies in livestock based agriculture;
3. To generate knowledge and technologies for conservation and utilization of natural resources;
4. To generate knowledge, solutions and technologies for food safety, quality and improved efficiencies in the agriculture value chain;
5. Translate research outputs in order to generate knowledge, facilitate decision making and contribute to the transformation in the agriculture sector; and,
6. Apply resource management practices towards a high performing and visible organization.

However, it's important to note that most of South Africa is unsuitable for crop production due to low rainfall, poor soil conditions, pests and diseases. Estimates suggest that 12 to 15 percent of the country is arable. These natural constraints present challenges for all farmers, often requiring significant scientific innovation and technology investments; exacerbating prospects for economic profitability of enterprises in agriculture. Resource poor smallholder farmers are particularly constrained because they seldom apply inputs to improve soil health; and their crops are often subjected to moisture stress during periodic droughts. It's against this backdrop that the ARC prioritized focus on research and development for solutions, technologies and information for South African agriculture.

## DISSEMINATING SCIENTIFIC SOLUTIONS FOR AGRICULTURAL DEVELOPMENT

In the year under review, the ARC has disseminated a wide range of scientific solutions, information and technology to the agricultural sector to respond to different challenges.

### *ARC disseminating scientific advice in the war against pests and diseases*

A critical factor to achieve food and nutrition security is through attaining yield potential during agricultural production. However, yield potential can be adversely affected by pests and diseases on both crops and animals; which in turn would result in reduced production with dire consequences for food and nutrition security. The ARC provides diagnostic and analytical services for identification as well as elimination of prevailing pests and diseases. Results are disseminated directly to farmers, regulatory authorities and other stakeholders in agriculture sector.

During this reporting period, the ARC successfully identified and provided necessary solutions to farmers for crop pests and diseases such as tomato leaf miner (*Tuta absoluta*), fall armyworm (*Spodoptera frugiperda*), Mirafiori lettuce big vein disease, nematode root knot (*Meloidogyne*) and false codling moth, to name a few. Rapid identification of these pests and diseases was achieved because of effective utilization of specimen collections in National Public Good Asset repositories and resident expertise. Failure to identify and provide solutions for these pests and diseases could have resulted in national and household food insecurity.

Effective diagnostic and analytical services of the ARC have enabled South Africa's livestock and wildlife sectors to continue to provide the necessary animal products for food and nutrition security. For example, the ARC successfully identified African Swine Fever virus (ASFV) as the causative agent for hemorrhagic disease of pigs in Ipelegeng in Sweizer Reneke, North West Province. The quick diagnosis enabled effective dissemination of information and appropriate solutions to farmers, mainly through media, but also directly through veterinary services.

Similarly, the ARC diagnosed infection of black rhinoceros in the Kruger National Park with bovine tuberculosis (*Mycobacterium bovis*). Even more significant was the diagnosis and isolation of *Mycobacterium tuberculosis*, which is commonly a human pathogen, from an elephant in the Kruger National Park. The information was communicated to the South African National Parks authorities, who in turn, implemented movement control of wildlife to prevent possible zoonotic outbreaks of disease. Periodically, the ARC has provided diagnostic and analytical services to confirm outbreaks of other important diseases such as Foot and Mouth Disease virus and brucellosis among others. In all instances, the ARC has successfully disseminated all the necessary solutions, information and technologies.

#### **ARC providing scientific services to enable income generation in agriculture**

Income generation among small enterprises is an important mechanism towards economic growth, poverty alleviation and sustainable agriculture development.

To ensure food and nutrition security it's important to ensure access to animal protein in people's diet. Accordingly, cattle are an important source of animal protein. A recent census by Statistics SA has revealed that more than 600 000 rural households own cattle as a form of wealth and source of food. To ensure food and nutrition security, as well as provide sustainable income generation opportunities, the ARC has embarked on information and technology dissemination programmes that integrate scientific research into production systems of smallholder livestock producers, popularly known as Kaonafatso ya dikgomo (KyD). Following training by ARC, to date KyD has registered more than 8400 smallholder livestock farmers on Integrated Registration Genetic Information System (INTERGIS), a national animal improvement database. Evidence suggests that participants have experienced market off – take increased by 16%. As a result of participating in the KyD, one of the farmers has established a small – scale abattoir with packaging and processing. Such an initiative could potentially accelerate market access for smallholder farmers in Mpumalanga.

During the reporting period, analysis of ARC's Peach and Nectarine breeding programmes indicated that more than 90 cultivars were released. Further, ARC advised and disseminated information to improve tree planting density from 609 trees per hectare to 956 trees per hectare. Through research and development investment in

the breeding programme resulted in a return of R1.56 for every rand invested. All the peach cultivars used in the canning industry in South Africa are ARC bred cultivars. An industry that provides sustainable income to more than 20 000 direct employees in rural areas of South Africa; while indirectly, the output multiplier for the industry is estimated at 12 persons for every R1 million turnover. The fruit canning industry is estimated to generate more than R2.5 billion.

One of the highlights for the year was for the ARC to co – host, together with the Global Forum for Agriculture Research (GFAR), the Third Global Conference on Agricultural Research for Development (GCARD3). This international event brought together representatives of key sectors active in agricultural research and innovation and connected many others around the world. GCARD3 recognized and emphasized the pivotal role of agri – food research and innovation in achieving the United Nations Sustainable Development Goals (SDGs) and agreed on three key implementation principles:

- National partners to work with rural communities to shape their own futures, taking an integrated, multi – sectoral approach to address capacity needs and constraints in innovation systems;
- Consultative Group of International Agricultural Research (CGIAR), and other international research systems will actively engage with national agricultural systems, strengthen and add value to national partners, and help deliver on national development objectives. Site integration and systems approaches will bring new synergies and avoid duplication; and,
- Public, private and civil partners will find new ways of bringing together finance and capacity development, embedded in wider development investments and operating through community – driven, nationally led and regionally and internationally supported mechanisms.

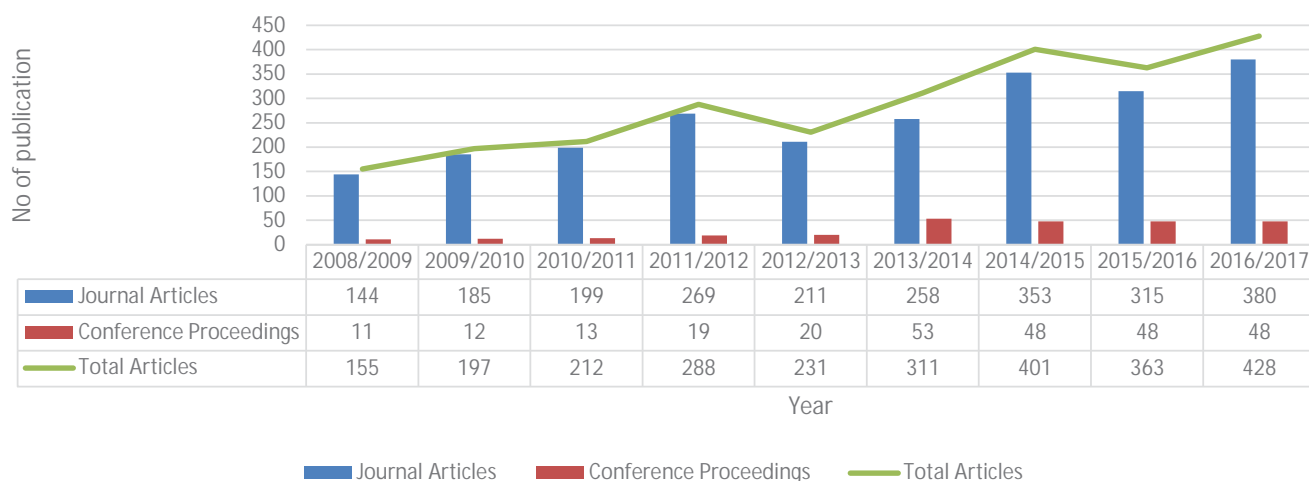
## **TOWARDS SOLUTIONS FOR A DEVELOPING ECONOMY: RESEARCH AND DEVELOPMENT**

Research and development efforts within the ARC continue to contribute towards the scientific excellence within the country's National System of Innovation. Further, the ARC's research and development initiatives continue to contribute towards national priorities as outlined in the Medium Term Strategic Framework.

In the year under review the ARC has continued to increase its contribution to scientific knowledge base of our economy through peer reviewed publications emanating from research and development. The ARC has excelled in scientific output as measured through significant increase in the number of peer reviewed scientific publications. In the period between 2008/09 and 2016/17 the number of peer reviewed scientific publications has increased by 176 percent from 155 to 428. Further, research collaboration across the spectrum of strategic objectives has increased and diversified, as demonstrated by the greater number of peer reviewed scientific journals with external authors that exceeded targets.

When compared to prior year (2015/16), the number of peer reviewed journal articles published in 2016/17 increased by more than 20 percent. This includes the increased number of publications with ISI rating (impact factor) higher than 2.0 suggesting improved quality of science and publications. These outcomes are particularly significant as they form the basis of technology development, information dissemination and possible development of new innovations; which in turn, indicates the ARC's excellence in research and development.

## Scientific Publications



Climate change is a serious threat to South Africa's primary objective of food security, sustainable agricultural production, rural development and economic growth. The adverse impacts of climate change have often been experienced through decreased agricultural production and productivity, with severe consequences on food security and people's livelihoods. To enable the agriculture sector to respond with practical solutions towards climate change, the ARC has been engaged in a range of scientific research and development initiatives, including learning about experiences and solutions from other countries. For example, the ARC has investigated the rainy season characteristics, drought and flooding climatology aimed at assisting farmers in the Luvuvhu River catchment in Limpopo Province to adapt to changes in climate.

South Africa is the third largest producer of pears after grapes and apples; while the country ranks sixth in the world in terms of production, it's fourth largest exporter. The ARC in collaboration with the fruit industry have focused on developing new pear cultivars adapted to producing good blush under warm weather conditions. Scientific climate predictions suggest that South Africa will be severely affected by climate change, resulting in lower winter chill - an important factor for vernalisation, hotter, dryer and windy summers in all typical/traditional pear - growing areas. Should this occur, it will reduce marketability of fruit due to poorer quality, including reduced blushing. As part of an integrated plant breeding strategy, the ARC is also exploring the inheritance of morphological traits and the possible genetic control of the blush trait to ensure that South Africa remains the world's leading producer and exporter of top quality pears.

Recent droughts have highlighted the risks to human beings and livestock, which occur when rains falter or fail. While irrigation may be the most obvious response to drought, it has proved costly and can therefore only benefit a few. Needless, there is now increasing interest in a low - cost alternative, generally referred to as rainwater harvesting. Rainwater harvesting (RWH) is the collection of runoff for productive purposes; wherein both yields and reliability of production could be significantly improved. Application of rainwater harvesting and conservation techniques in homestead gardens, croplands and rangelands in some rural villages in South Africa could empower villagers to produce their own crops and enhance livestock production; thereby contributing to increasing household food security.

As livestock production is an important component of many smallholder farming systems, manure can be used to produce biogas, a simple, cost - effective and renewable energy source. The

ARC has initiated a project on up-scaling of rainwater harvesting and conservation on croplands and rangelands for food and renewable fuel (biogas) production in villages in Eastern Cape.

Sustainable use and conservation of indigenous genetic resources is essential for ensuring food and nutrition security. Indigenous livestock such as goats have demonstrated ability to thrive and be productive in low input, and unfavourable landscapes. This adaptation is important for the survival of goat populations, particularly as a source of protein for human consumption.

The ARC initiated a goat improvement programme that aimed at unravelling the genetic diversity, and population structure; and investigating factors influencing genetic variation and adaptation in South Africa indigenous goat populations. This included breed types such as, the Boer, Savanna, Kalahari Red, Tankwa, and unimproved non - descript village ecotypes from goat procuring provinces of Eastern Cape, KwaZulu - Natal, Limpopo, Northwest and the Nguni. Applications of genomic tools indicated that higher level of inbreeding and lower levels of genetic diversity were observed in commercial and Tankwa breeds when compared to unimproved non - descript ecotypes; suggesting the effects of different production systems on the genetic diversity in these goat populations. Further analysis revealed genes involved in metabolism and responses to heat, water scarcity and diseases that allow indigenous goats to tolerate environmental pressure in their local production systems. This study could potentially contribute to the design and implementation of goat improvement programmes such as community breeding programs.

The ARC continues to provide technical advice, data and information for the National Cultivar Evaluation Programme, a partnership with all stakeholders in the grain industry (farmers, seed producers, millers, agro - processors, researchers, commodity organizations and funding agencies) that involves evaluation of the most suitable crop cultivars for specific agro - ecological zone in grain production. As a public entity with good scientific expertise and other resources (land, laboratories etc), the ARC is central to generating all data and information required for decision making in grain production. During the reporting period, the ARC conducted more than 100 field trials, including more than 70 cultivars of wheat and maize throughout South Africa. The data and associated information was published as production guidelines for maize and wheat. In addition, the guidelines were presented at Cultivar Evaluation workshops, printed and distributed to more than 1000 farmers, as well as made accessible through various media (website, study groups, exhibitions, farmers' days etc).

## OUR PEOPLE, THE MOST IMPORTANT ASSET FOR EFFECTIVE DELIVERY

Human resources capacity (skills and appropriate numbers) are the most critical resources for ARC's success and sustainable impact on the agricultural sector to fulfil its mandate. For this and other reasons, the ARC continuously engages employees and students, including prospective students, for skills development and careers in the sector.

As a result of good relationships between management and employees, the ARC remains a stable organization. This is reflected by low employee turnover averaging below 5 percent for the reporting period. Indeed, the ARC's employee turnover since financial year 2007/08 till 2016/17 has been below 10 percent on average. The organization has experienced 10 years of continuous stability without labour disruptions. In the same period, the number of labour disputes and disciplinary cases have remained low, providing a good working environment for effective and successful delivery on projects.

Although employee turnover remains low within the ARC, the country lacks a critical mass of highly skilled scientists, engineers and technicians. Therefore, any resignation of highly skilled scientists adversely impacts upon continuity of research and development, which sometimes delays the delivery of outputs.

### ***ARC developing skills for sustainable agriculture research and innovation***

To mitigate the lack of critical mass of skills in South Africa, the ARC continued to invest substantially in the training and development of the employees. Such training and development includes formal training at higher education institutions that includes the use of National Research Foundation, Technology for Human Resources Industry Programme (THRIP) and Agri-SETA support.

Brief analysis indicates that interventions implemented in the last ten years for capacity building, particularly the Professional Development Programme (PDP) and employee development have significantly changed. During this period, the PDP has increased from less than 50 postgraduate students in 2007/08 to more than 340 in 2016/17. Similar analysis indicates that employees enrolled for postgraduate degrees beyond bachelor of honours has increased from less than 60 to more than 190 in 2016/17. The effect has been that ARC has contributed to attainment of more than 50 MSc and PhD degrees awarded respectively during the same period. In particular, during financial year 2016/17 at least 40 PDP students obtained masters degrees and at least 10 were awarded PhD degrees. Simultaneously, no less than 20 employees obtained postgraduate degrees (MSc and PhD). These achievements represent significant contribution of the ARC towards skills development, especially as more than 60 percent of the graduates were classified as black and no less than 70 percent were female.

Development of students has largely been achieved through direct supervision and mentorship by ARC research scientists in collaboration with partners at various universities, mostly in South Africa. However, student unrest at South African universities hampered the completion of some studies, thereby delaying completion of some projects and awarding of degrees. This phenomenon places a particular risk to delivering on projects that could have significant impact both on skills development and on effective dissemination of scientific solutions to clients in the agricultural sector.

## MANAGING OUR FINANCES FOR EFFECTIVE AND SUSTAINABLE SUCCESS

Effective, efficient and transparent management of finances is an important indicator for organizational sustainability and success. The ARC continuously strives for ensuring optimal value is derived from utilization of financial and other resources on behalf of customers and the shareholder, the government of South Africa. This includes good governance and zero tolerance for financial misconduct.

In order to provide reasonable assurance against material losses and misstatements of financial results, the ARC reviewed its materiality framework for improvement of internal controls. The ARC's internal financial controls comply with the Public Finance Management Act, 1999 (Act no. 1 of 1999, as amended) (hereafter referred to as PFMA) and the organisation's Enterprise Risk Management Framework. Further, management recognized the importance of a good control environment for effective management of risks, improving performance, enhancing governance and enlisting stakeholder confidence in order to strengthen the organization's reputation. Therefore, in the year under review particular emphasis was placed on managing business risk and its possible impact on continuity.

During the reporting period the ARC continuously improved upon its performance information system that is aligned to the Business Plan for financial year 2016/17. A dashboard system was used throughout the year to enable management to monitor and report on performance information. This has enhanced the ability of management to ensure accurate and timely reporting of performance on all pre – determined objectives and targets as well as monitoring any non – compliance or failures. The results of this performance information system are contained in this annual report.

In the year under review the ARC was saddled with unfunded and insufficiently funded mandates from the Department of Agriculture, Forestry and Fisheries (DAFF); which are mainly the national public good assets that continue to adversely impact on the financial performance of the organization. Further, Parliamentary Grant allocations were not commensurate with associated operational cost requirements. Resource limitations constrained the ARC's potential to grow external income without adversely impacting upon research, technology development and technology transfer. Lack of financial resources adversely impacted upon the ARC's ability to successfully complete some of the research, technology development and technology transfer projects, again compromising the organization's ability to fulfil its mandate.

Conducting business in the reporting period has been very difficult for the ARC. The parliamentary grant was reduced by R228 million over the Medium Term Expenditure Framework period ending 31 March 2017. In addition, grant allocation from the Department of Science and Technology for the maintenance and operation of national gene banks (National Public Goods Assets) was reduced by R39 million in the reporting period. External income (mainly private sector) for research services declined by 5 percent as a result of poor economic conditions in the country. When combined, these factors presented difficult operating conditions for the ARC.

Although the ARC reduced expenditure through various cost containment measures, difficult economic conditions resulted in expenditure beyond amounts approved in the Annual Business Plan for 2016/17; wherein there was no prior approval for incurring excess expenditure. This was largely due to personnel and other fixed costs such as electricity, municipal services and security that could not be

curtailed timeously. The recoverability of long outstanding debtors with significant amounts, mainly government departments, in turn presented difficulty for the ARC as the organization had not made provision for such situation. As a result of these factors the ARC received a qualified audit opinion from the Auditor General of South Africa.

On behalf of management, the ARC concurs with the observations of the Audit and Risk Committee relating to the going concern status of the organization as contained in the Annual Financial Statements. It's imperative that the ARC engages with the Shareholder, through the Minister for Agriculture, Forestry and Fisheries to provide necessary financial resources that will ensure the organization is a going concern.

Management has accepted with disappointment the outcome of the external audit from the Auditor General of South Africa and resolved to immediately implement measures to eliminate adverse audit findings for 2018. This includes, among others the following:

- i) An Audit Improvement Plan targeting at eliminating root causes of adverse findings;
- ii) Review and development of business processes, including associated delegations of authority;
- iii) Review and implementation of improved Information Technology (IT) system support;
- iv) Obtaining necessary approvals for condoning the irregular expenditure; and,
- v) Review of skills (competencies and appropriate placements), including required training among all relevant personnel.

Management and employees of ARC hereby express appreciation for the oversight and leadership of Council and the stewardship of the Audit and Risk Committee supported by internal audit service providers, particularly aimed at improving internal controls.

The ARC hereby thanks the Auditor General for providing an external audit service of good quality in a professional manner. Management undertakes to implement effective and timeous interventions through the audit improvement plan.

## TO OUR CLIENTS AND STAKEHOLDERS

To our most valued customers, partners, beneficiaries, suppliers and stakeholders, we the people at ARC hereby extend our utmost gratitude for your support and assistance during the last financial year. We trust and hope you will continue to partner and work with us in various ways to ensure that we meet the expectations and

developmental needs of the South African communities.

A special message of thanks for support, advice and commitment for the success of the ARC is extended to the government, mainly through the Departments of Science and Technology and Department of Agriculture, Forestry and Fisheries. Further thanks and appreciation are extended to our partners in the private sector, particularly the commodity organizations of commercial agriculture that have continued to place trust in the scientific capability of ARC through funding allocations; and, in some instances joint partnerships in executing projects.

On behalf of the ARC management hereby thanks all members of the previous Council whose term expired during financial year 2016/17 for their dedication to ensure effective oversight of ARC governance. Further, the ARC thanks the Audit and Risk Committee for exercising their fiduciary duties with utmost care and vision for excellence. In particular, management appreciates the support, guidance and effort you have all devoted to the ARC.

Further, on behalf of all at the ARC, Executive management hereby thanks the Executive Authority, the Minister of Agriculture, Forestry and Fisheries: Honourable Minister Mr. Senzeni Zokwana and Deputy Minister: General Bheki Cele, for consideration of this report and the Portfolio Committee for Agriculture, Forestry and Fisheries for the contribution and support towards the success of ARC.

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 Ralekeno Moephuli  
President and CEO

## Statutory Basis

The Agricultural Research Council is a public entity established under the Agricultural Research Act, 1990 (Act No. 86 of 1990, as amended). It is a schedule 3A public entity in terms of the Public Finance Management Act, 1999 (Act No. 1 of 1999, as amended by Act No. 29 of 1999).

## Primary Mandate

In terms of the Agricultural Research Act, the objectives of the Agricultural Research Council are to conduct research, drive research and development, drive technology development and transfer (dissemination), in order to:

- promote sustainability and equitable economic participation in the agricultural sector;
- promote agricultural development and growth in related industries;
- facilitate sector skills development and knowledge management;
- facilitate or ensure natural resource conservation;
- promote national food security; and
- contribute to better quality of life.

## Main Functions

The Agricultural Research Council's main functions, as provided for in the Act, are to:

- Undertake and promote research, technology development and technology transfer;
- 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;
- Publish the results of research;
- Establish and control facilities in the fields of research, technology development and technology transfer that the Council may determine from time to time;
- Cooperate with departments of state, institutions, persons and other authorities for the promotion and conduct of research, technology development and technology transfer;
- Promote the training of research workers by means of bursaries or grants-in-aid for research, technology development and technology transfer, and contribute financially to research, development and technology transfer Programmes;
- Hire or let facilities; and
- Cooperate with persons and authorities in other countries conducting or promoting research, technology development and technology transfer in agriculture.

## Agency Mandates

The Government of South Africa, through the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Science and Technology (DST), has mandated the Agricultural Research Council to manage and maintain National Public Goods Assets. The National Public Goods Assets comprise national collections (gene banks) of animals, bacteria, animal databases, range and forage gene banks, fungi, genetic material, insects, crops, yeasts and viruses, to mention a few.

These provide important sources of genetic material for research and development, scientific reference (especially for pest risk assessment), future use, as well as rehabilitation of planting and breeding stock for national recovery from natural disasters. The collections serve as a basis for the Agricultural Research Council's research, technology development and technology transfer, which contribute to a better life for all and includes the conservation of natural resources. The Agricultural Research Council maintains and manages a combination of the classes in alignment with its mandate as indicated below.

### Animal Production, Improvement and Health

This includes the full value chain of animal production and animal health.

#### **DNA Databank for Stock Identification**

The maintenance and expansion of a national DNA database that is utilised for DNA fingerprinting, biochemical genetic typing and species identification with the purpose of animal identification, the prevention of stock theft, forensic investigations, and species and population characterisation.

#### **Conservation of Adapted Indigenous Livestock Breeds**

The conservation, maintenance and evaluation of indigenous and adapted South African cattle, small stock, poultry and pig breeds. This activity is in line with the Green Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity.

#### **Animal Recording Facility**

The maintenance of a domestic animal genetic resources information system to organise information regarding indigenous breeds so that it is easily accessible.

#### **National Forage Gene Bank**

The National Forage Gene Bank was founded in the early 1980s and incorporates the valuable National Forage Collection from Rietondale, which already incorporated previous collections from Prinsloof, Stellenbosch and Cedara dating back to 1900.

#### **National Culture Collection of Beneficial Gastrointestinal and Food Fermentation Organisms**

The maintenance, conservation, utilisation and development of the bacterial culture collection. This indigenous culture collection is unique in Africa and has existed since 1950.

#### **Transboundary Animal Disease Programme (TADP)**

This division is responsible for the diagnosis of Foot and Mouth Disease (FMD) and African Swine Fever (ASF) and the manufacture of FMD vaccines. It is a P3 high-containment facility that operates under special quarantine restrictions within a specially-designed building. It used to operate as an institute on its own. DAFF and Provincial Departments of Agriculture take full responsibility for the control of FMD and ASF in the country.

#### **Rabies Laboratory, Onderstepoort**

This laboratory is responsible for diagnosing rabies in animal brain tissue submitted for analysis. DAFF and Provincial Departments of Agriculture take full responsibility for the control of rabies in animals in South Africa. It is a zoonosis (an animal disease that can be transferred to humans), and is therefore significant to public health.

#### **Blood Vaccines Production Unit**

This unit produces blood that contains the parasites for use as vaccines against redwater, heartwater and gall sickness. All these diseases severely limit production.

#### **National Tick Collection**

- National Helminth (parasitic worms) collection.
- Serum bank (virology).
- Insect collection (entomology).
- Diagnostic services (reference laboratories for Rift Valley Fever, blue tongue, African horse sickness, lumpy skin disease and African swine fever).

## Natural Resources Management, Mechanisation and Engineering

Activities focus on biosystematics and integrated pest and weed management, soil, climate and water, as well as engineering.

<p><b>Agricultural Engineering</b></p> <ul style="list-style-type: none"> <li>• Agricultural equipment and implementation of test facility.</li> <li>• Renewable energy demonstration centre.</li> </ul>	<p><b>Soil, Climate and Water</b></p> <ul style="list-style-type: none"> <li>• Agro-meteorological network, databanks and information systems.</li> <li>• Land type and other surveys with associated databases and sample collections.</li> <li>• National Oceanic and Atmospheric Administration (NOAA) satellite image database for natural resource and disaster management.</li> </ul>	<p><b>Plant Protection</b></p> <ul style="list-style-type: none"> <li>• National collection of insects.</li> <li>• National collection of arachnid.</li> <li>• National collection of nematodes.</li> <li>• National collection of fungi.</li> <li>• South African plant pathogenic and plant-promoting bacterial collections.</li> <li>• South African plant virus and antisera collection.</li> <li>• Rhizobium culture collection.</li> <li>• Integrated pest and disease management.</li> <li>• Biological control of invasive alien plants.</li> </ul>
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### Plant Voucher Specimen Collection and Vegetation Database

This is an Integrated National Vegetation Resource database. The databases currently being used by the Vegetation Ecology Section are:

- Phytotab, which contains site records of species with estimates of abundance.
- The Rooideplaat herbarium specimen database.
- National weeds list.
- Ecology literature index.
- Autecological database containing miscellaneous information about plant species.
- Agricultural Research Council/INFO database, which contains map coverage and Acocks' sampling site localities. The Acocks maps database has been made available to SA-IGIS and includes information from other floristic data sets.

## Crop Production, Improvement and Protection

This includes work on citrus and subtropical crops, deciduous fruits and grapes, as well as vegetable, medicinal, indigenous and ornamental plants, summer grains and oil and protein crops, small grains, and industrial crops.

### Germplasm Collection

The collection has a large number of inbred lines and cultivars well-adapted to local and sub-Saharan biotic and abiotic stress factors. Some germplasm collections have been maintained for more than 50 years. If this asset is lost or not maintained properly, all breeding projects of mandated crops will suffer and become entirely dependent on foreign, often non-adapted material.

<p><b>Deciduous Fruits, Vines and Wine</b> Grapevine, deciduous fruit, yeast and alternative crops gene bank.</p>	<p><b>Tropical and Subtropical Crops</b> Tropical and subtropical crops gene banks, indigenous plants and vegetable gene banks.</p>	<p><b>Vegetable and Ornamental Plants</b> Indigenous plants and vegetable gene banks.</p>
<p><b>Grain Crops</b> Protein seeds and summer grain crops gene banks.</p>	<p><b>Small Grains</b> Small grain crops gene banks, wheat, barley, oats, rye, triticale, durum and tropical crops gene banks.</p>	<p><b>Industrial Crops</b> Tobacco, cotton and fibre crops gene banks.</p>

## Custodianship of the National Assets

It is important, and in the national public interest, to maintain a national reference collection. The concept of the “public good” is defined as “that good, the benefit (including financial) of which does not entirely accrue to an individual or group, but to the public at large and where the government acts on behalf of the country”. It also relates to ongoing research and the delivery of essential services. They provide a wide range of functions, among which are:

- To support public functions of government and obligations under international agreements.

Regulatory decision support systems include:

- International obligations such as the Convention on Biological Diversity (CBD), and the International Plant Protection Convention (IPPC), which compels it to keep reference collections of all agricultural specimens with respect to the import and export of agricultural produce;
  - Providing critical diagnostic support to the government phyto-sanitary services;
  - Strategic national and international diagnostic and animal disease control capacity; and
  - Strategic national and international diagnostic and plant disease control capacity.
- Research
    - Natural resource inventories such as soil, water, climate and vegetation databanks, as well as weather stations for climate inventories and collection of data;
    - A significant amount of the germplasm contained in the gene banks forms the basis for further research and development (plant breeding, cultivar development, new product development, etc.);
    - Provide a resource for training; and
    - They make an important contribution to scientific studies, biodiversity replenishment, sustainable development and production, food security and pest invader identification.

- Emergency systems - Gene banks serve as the basis for resuscitating agricultural production following natural disasters and are important for biodiversity and food security.
- Organisation and Facilities: the Agricultural Research Council conducts its business at various campuses, including its administrative office, situated at different locations within the country – at Bethlehem, Nelspruit, Potchefstroom, Pretoria, Rustenburg and Stellenbosch – and at a number of laboratories, office buildings and research farms throughout the country. Much of the research facilities of the Agricultural Research Council are distributed in accordance with agro-ecological zones, which enables specific focus on particular commodities. The Agricultural Research Council’s research and development capability is organised as follows:
  - Crop Production, consisting of the following research areas: Citrus and Subtropical Crops, Deciduous Fruits and Grapes; Vegetable, Medicinal and Ornamental Plants, Summer Grains and Oil and Protein Crops, Small Grains and Industrial Crops;
  - Animal Production, consisting of Animal Production, Animal Health and Aquaculture;
  - Natural Resources Management, consisting of Soil, Climate and Water; Biosystematics and Integrated Pest and Weed Management;
  - Mechanisation and Engineering consisting of Engineering;
  - Agro-processing, Food Technology and Safety; and
  - Biotechnology.

Additionally, the Agricultural Research Council has an Agricultural Economics and Capacity Development division that focuses on transferring research output to stakeholders such as farmers, both smallholder and commercial, as well as communities. Supporting core business divisions, the Agricultural Research Council has functional divisions, namely human resources; marketing and communications; finance; information technology and communication; facilities management; risk management; and internal audit, and all of these groups operate from its main office in Pretoria.

# CHIEF FINANCIAL OFFICER'S REVIEW



**Mr Gabriel Maluleke**  
Chief Financial Officer

## OVERVIEW

The year ending 31 March 2017 was the third consecutive year during which the ARC faced decline in revenue as a result of reduced allocations of Parliamentary Grant (PG) for the Medium Term Expenditure Framework (MTEF) period ending 31 March 2017. This was accompanied by the lack of growth in external income derived mainly from research revenue from organisations outside of government due to the tough economic conditions affecting potential investors in agricultural research.

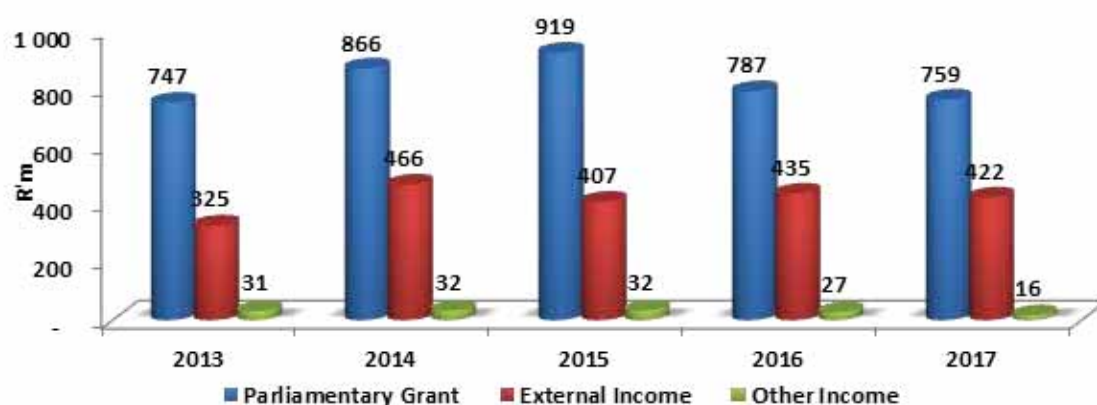
In reaction to the reduced revenue management, reduced costs to an effective 5% over the MTEF ending 31 March 2017, in order to mitigate the effects of the reduced Parliamentary Grant. The year-on-year reduction on costs was 3% compared to a 4% reduction in revenue.

The effect of Parliamentary Grant cuts was two consecutive years of deficits of R86 million and R68 million (restated) for the years ending 31 March 2017 and 2016 respectively.

Financial Performance	2017 R'm	2016 R'm	Variance %
<b>Parliamentary Grant</b>	<b>759</b>	<b>787</b>	<b>(4%)</b>
PG - Operational	652	662	(1%)
PG - Ring-fenced Projects	19	43	(55%)
PG - Capex	87	83	5%
External Income	422	435	(3%)
Other Income	16	27	(39%)
<b>Total Revenue</b>	<b>1,197</b>	<b>1,249</b>	<b>(4%)</b>
<b>Operating Expenditure</b>	<b>1,283</b>	<b>1,317</b>	<b>3%</b>
Personnel Costs	744	768	3%
Other Operating Costs	496	509	3%
Depreciation & Impairment	43	40	(5%)
<b>Surplus/(Deficit) for the year</b>	<b>(86)</b>	<b>(68)</b>	<b>(26%)</b>

## REVENUE

The ARC's revenue is down for the third consecutive year by 4% (R52 million) to R1 197 million (2016: R1 249million). The ARC derives Parliamentary Grant from the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Science and Technology (DST). External Income is derived from contract research and development income from both public and private sector, locally and internationally.

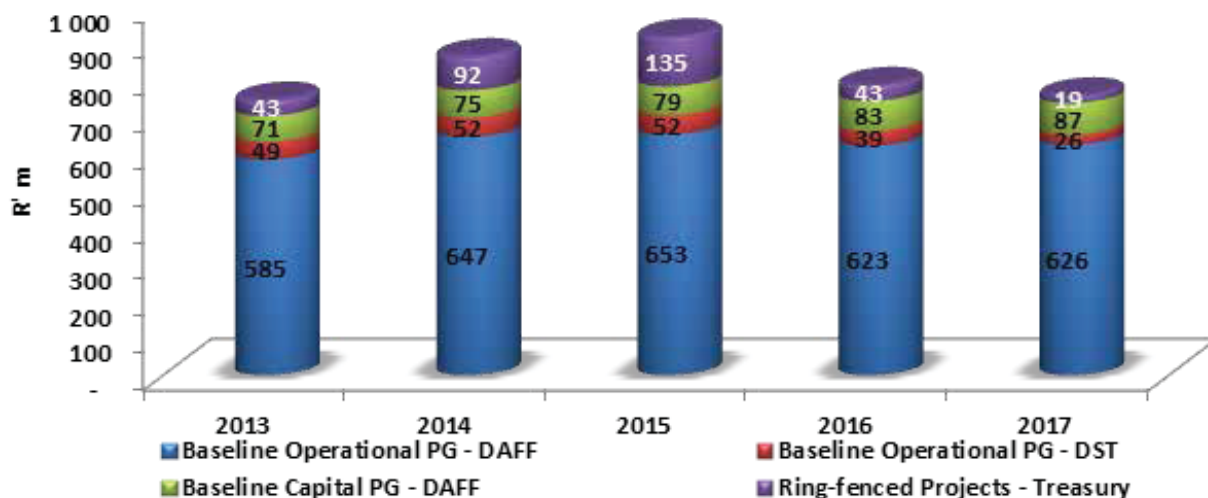


The ARC's revenue funds research and development programmes, technology transfer, infrastructure as well as support services. The ARC

has processes, policies and guidelines to ensure effective utilization of the funding in line with the PFMA, National Treasury guidelines and applicable accounting standards.

### PARLIAMENTARY GRANT

Parliamentary Grant (PG) went down by 4% (R28 million) to R759 million (2016: R787 million). PG consists of Operational PG, Capital PG and Ring-fenced PG (Economic Competitiveness and Support Packages and Foot-and-Mouth disease facility).



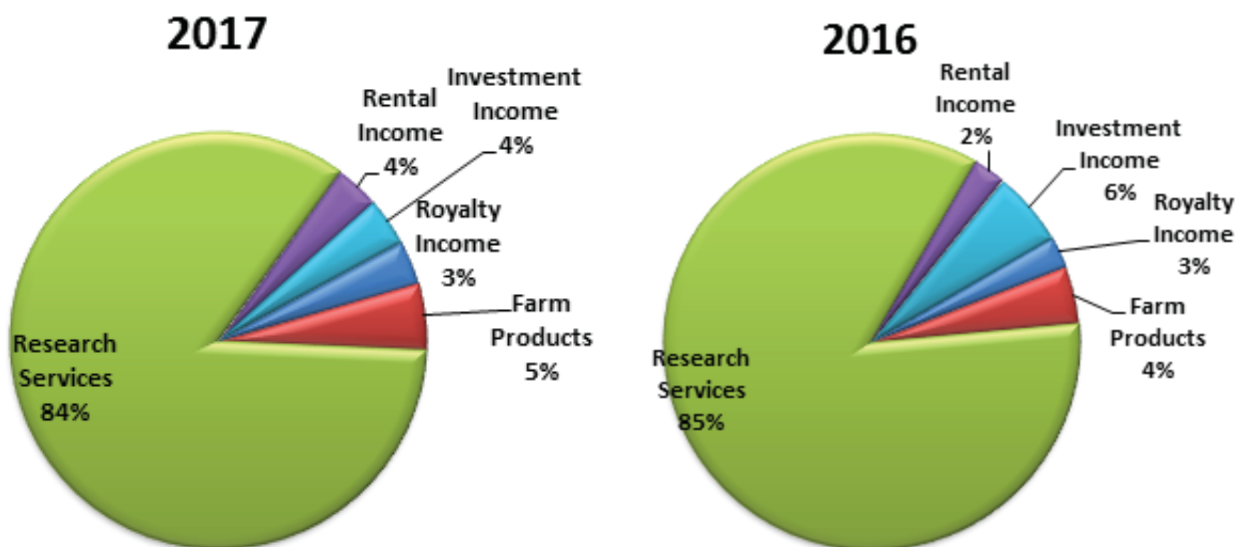
Operational PG from DAFF, which constitutes 83% of the total PG, grew by only 0.6% to R626 million (2016: R623 million). The PG allocation to the ARC was cut by a total of R228 million over the MTEF ending 31 March 2017. This grant is mainly used to cover operational activities such as salaries, research consumables, travelling costs, maintenance, etc.

There was also a 33% cut in Operational PG from DST for the second consecutive year to R26 million (2016: R39 million; 2015: R52 million). This grant is used to maintain the National Assets such as, Indigenous plants and vegetable gene banks.

Baseline Capital PG from DAFF increased by 5% to R87 million (2015: R83 million). The ageing infrastructure within the ARC requires investments at the rate much higher than the current allocations for the maintenance of the infrastructure and replacement of assets. Depreciation of fixed assets is an equivalent of 50% of PG Capex allocation.

### EXTERNAL AND OTHER INCOME

External Income is derived through projects contracts, research and development contracts, royalty from Intellectual property, and sales of farm products.

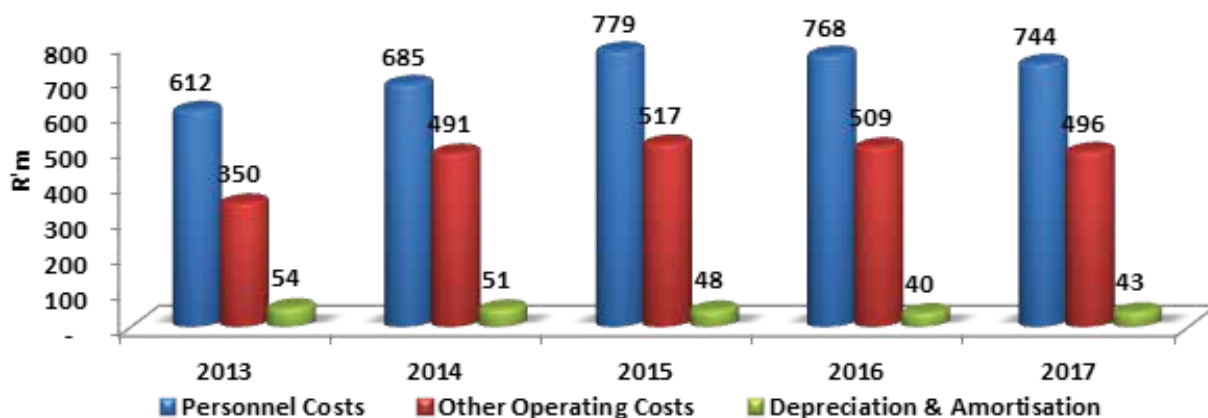


External income is down for the first time since 2011, by 4% (R13 million) to R422 million (2016: R435 million). The decline in external income is driven by a 5% drop in Research Services, as some research contracts with funders were revised due to tough economic conditions. Some projects have been extended by clients in order to deal with their cash flow constraints.

Other revenue streams, which contributes less than 15% of the total external income, outperformed 2016, with sale of farm products up 10% (R2 million) and royalty up by 28% (R3 million).

Other income consists of interest received on short-term investments and rental of our facilities and equipment to third parties. Other income is down 39% (R11 million) to R16 million (2016: R27 million) driven by the 40% (R11 million) drop in interest income, which is a direct result of PG cuts. Rental income grew by 33% to R15 million (2016: R11 million) because of improved management and enforcement of lease contracts.

### OPERATING EXPENDITURE



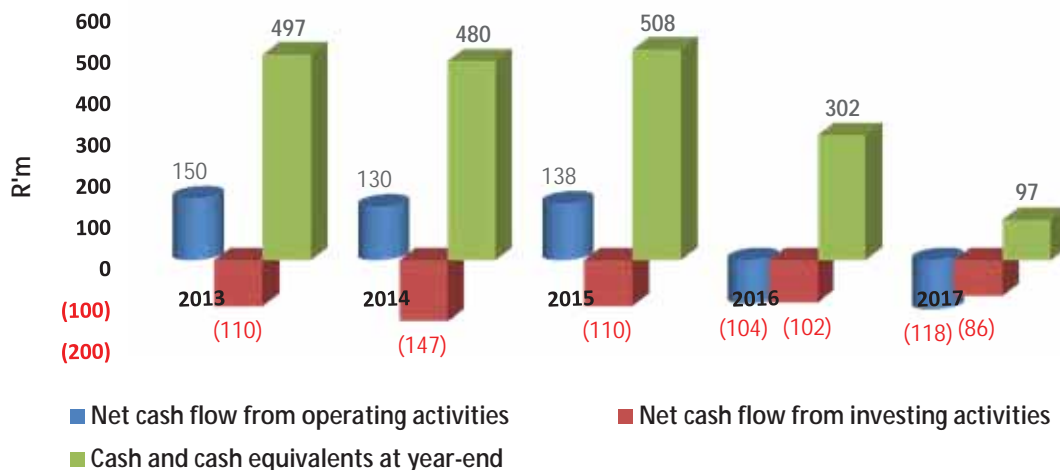
The ARC continuously review the operating costs, especially focusing on its costing model to ensure that projects costs do not spiral out of control over the life-cycle of the projects. Total Operational Expenditure is down by 3% to R1 283 million (2016: R1 317 million). The ARC improved the cost control measures which were implemented in the prior financial year to combat the Parliamentary Grant cuts that we encountered during the current financial year. This is the third consecutive year that the cost base has not grown but reduced by an effective 5% over the MTEF ending 31 March 2017.

- Personnel Costs**  
 Personnel cost are down 3% (R24 million) to R744 million (2016: R768 million). Tight controls were placed on this biggest cost component of the ARC total Operating Expenditure (58% of Operating Expenditure). During the financial year, employees received a 6% increase on salaries. In order to be in a position to afford the salary increase, some of the vacancies were delayed except for those that were considered strategic. The use of temporary workers were also minimized in combination with management deciding not to pay performance bonuses which would have amounted to an estimated R35 million for the period ending 31 March 2017.
- Operating Costs**  
 Other operating costs are mainly research-related costs such as consumables, administration, maintenance and fixed costs such as electricity and security cost. Operating cost are down 3% (R13 million) to R496 million (2016: R509 million). The reduction in operating cost is in line with the decline in external income.

Management had to implement drastic cost containment measures taking into account that cost such as electricity and maintenance of ailing infrastructure increased by more than inflation.

### CASH FLOW

ARC's cash position went down by 68% (R204 million) to R97 million as at 31 March 2017, from an opening balance of R302 million at the beginning of the financial year.



Due to the cut in PG over the last 2 years, the cash flow from operating activities has been negative for the same period. The ARC is dependent on PG in order to fund 60% of its budget.

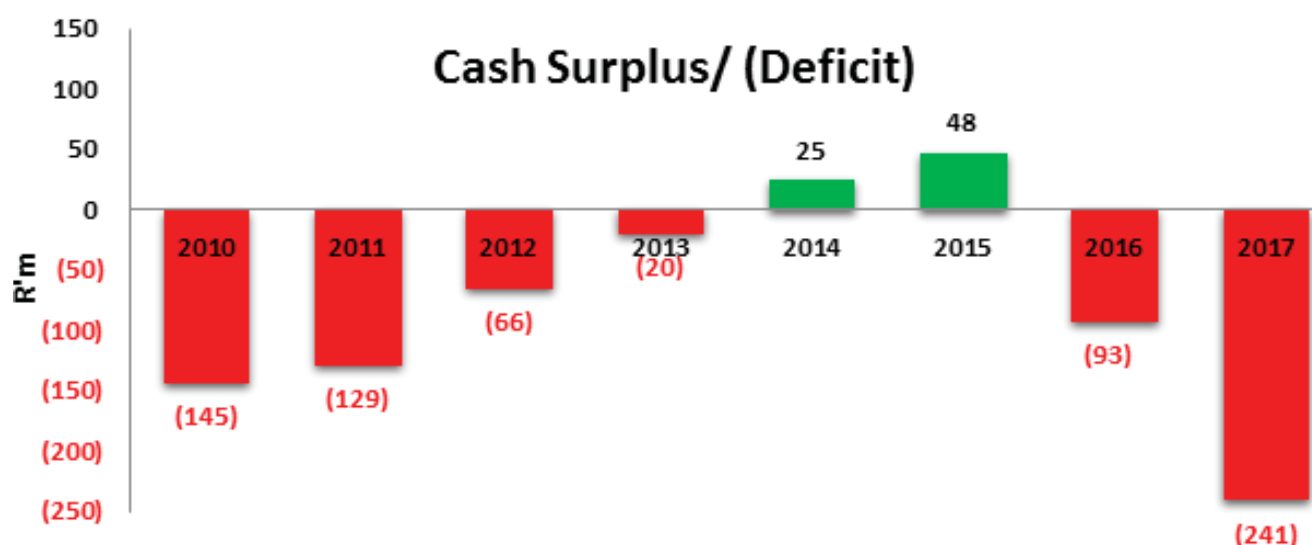
Although the cash balance is at R97 million as at 31 March 2017, the following factors should be taken into account when assessing the cash status:

- Of the R188 million received for the construction of the Foot-and-Mouth disease facility, R133 million (2016: R138 million) was still unspent.
- Acquisition of fixed asset to the value of R51 million (2016: R45 million) were yet to be finalised.
- Trade creditors, representing amounts owed to suppliers of goods and services, amounted to R40 million (2016: R59 million).

The table below indicates cash and cash equivalents vs the cash commitments as at the end of March 2017 compared to March 2016. The net effect indicates the ARC's ability to meet its short term commitments.

Cash Surplus/(Deficit)	2017	2016	Variance	Variance
	R'M	R'M	R'M	%
Cash and cash equivalents	97	302	(204)	(68%)
Add: Net Trade Account Receivable	258	278	(20)	(7%)
	<b>356</b>	<b>580</b>	<b>(224)</b>	<b>(39%)</b>
Less: Cash Commitments	<b>597</b>	<b>673</b>	<b>(76)</b>	<b>(11%)</b>
Employee benefit	15	17	(2)	(10%)
Deferred Grant	133	138	(5)	(4%)
Deferred Capex	51	45	6	13%
Current liabilities	398	473	(75)	(16%)
Cash surplus / (shortage)	<b>(241)</b>	<b>(93)</b>	<b>(148)</b>	<b>(159%)</b>

From 2010 management had embarked on cost containment measures to reverse the cash deficit situation that existed prior to 2010. The result was the improved situation in 2014 and 2015. The impact of the recent budget cuts are visible through the return to a negative cash situation from 2016 to 2017.



It is quite clear from the above that the funding challenges facing the ARC need urgent intervention from the shareholder in order for the ARC to meet its obligations and deliver on its mandate.

## THE CONTROL ENVIRONMENT

The ARC received a qualified audit opinion. This qualification has pointed out some control weaknesses which exist in some of the operational areas including finance. Management has put together a plan to address all the findings from the Auditor General in order to ensure that the organization move towards a clean audit. The focus will be on the repeat findings as well as high risk accounts and material transactions. The control environment will be continuously monitored through exception reporting in order to highlight and address the anomalies on time. Where controls weaknesses point to capacity issues, these will also be addressed taking into account the constraints in budgets.

## IRREGULAR EXPENDITURE

The ARC also reported the irregular expenditure of R199 million and R205 million (restated) for the years ending 31 March 2017 and 2016 respectively. Due to the magnitude of the recent budget cuts in Parliamentary Grant the ARC could not immediately adjust its cost structure

to respond timeously to the cuts. This resulted in the over expenditure for the two consecutive years. Although the deficits are R86 million and R68 million respectively, the amount identified as irregular expenditure by the Auditor General was on the operational costs line. The prior year figures had to be restated as the over expenditure for 2016 was previously not disclosed or identified as irregular expenditure. Management is in discussion with the shareholder, the Department of Agriculture, Forestry and Fisheries, to address the funding issues to prevent the repeat of this situation.

## 10 YEAR REVIEW

AGRICULTURAL RESEARCH COUNCIL-TEN YEAR REVIEW										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	R'm	R'm	R'm	R'm	R'm	R'm	R'm	R'm	R'm	R'm
<b>STATEMENT OF FINANCIAL PERFORMANCE</b>										
<b>Total Income</b>	<b>730</b>	<b>762</b>	<b>831</b>	<b>871</b>	<b>978</b>	<b>1,104</b>	<b>1,364</b>	<b>1,358</b>	<b>1,249</b>	<b>1,197</b>
Parliamentary Grant	452	470	533	590	666	747	866	919	787	759
Baseline Operational - DAFF	371	373	434	439	464	585	647	653	623	626
Baseline Operational - DST	37	37	42	44	47	49	52	52	39	26
Ring-fenced Projects - Treasury	-	-	-	-	-	43	92	135	43	19
Baseline Capital - DAFF	43	60	57	106	155	71	75	79	83	87
External Income	266	256	293	266	294	325	466	407	435	422
Other Income	12	36	6	14	18	31	32	32	27	16
<b>Total Expenditure</b>	<b>718</b>	<b>778</b>	<b>773</b>	<b>811</b>	<b>854</b>	<b>1,015</b>	<b>1,227</b>	<b>1,344</b>	<b>1,317</b>	<b>1,283</b>
Personnel Costs	416	467	490	511	518	612	685	779	768	744
Operating Costs	289	296	265	282	312	350	491	517	509	496
Depreciation & Amortisation	13	14	18	19	23	54	51	48	40	43
<b>Net Surplus\ (Deficit)</b>	<b>12</b>	<b>(16)</b>	<b>58</b>	<b>59</b>	<b>124</b>	<b>89</b>	<b>137</b>	<b>14</b>	<b>(68)</b>	<b>(86)</b>
<b>STATEMENT OF FINANCIAL POSITION</b>										
Property, plant and equipment	608	649	649	666	729	784	880	944	1,006	1,049
Investments	2	2	2	2	2	4	4	5	5	5
Current assets (excluding cash)	95	82	93	76	84	87	141	134	281	274
<b>Cash resources (net of bank overdraft)</b>	<b>59</b>	<b>35</b>	<b>73</b>	<b>163</b>	<b>457</b>	<b>497</b>	<b>480</b>	<b>508</b>	<b>302</b>	<b>97</b>
<b>Total Assets</b>	<b>764</b>	<b>768</b>	<b>818</b>	<b>908</b>	<b>1,273</b>	<b>1,372</b>	<b>1,506</b>	<b>1,592</b>	<b>1,594</b>	<b>1,426</b>
Capital and Reserves	273	502	559	618	742	832	968	985	966	879
Non Current Liabilities	326	87	71	72	115	213	209	213	155	148
Current Liabilities	164	180	188	217	416	327	329	394	473	398
<b>Total Equity and Liabilities</b>	<b>764</b>	<b>768</b>	<b>818</b>	<b>908</b>	<b>1,273</b>	<b>1,372</b>	<b>1,506</b>	<b>1,592</b>	<b>1,594</b>	<b>1,426</b>
<b>CASH FLOWS</b>										
Net cash flow from operating activities	5	36	56	129	384	150	130	138	(104)	(118)
Net cash flow from investing activities	(42)	(60)	(17)	(39)	(91)	(110)	(147)	(110)	(102)	(86)
Cash and cash equivalents at beginning of year	97	59	35	73	163	457	497	480	508	302
<b>Cash and cash equivalents at end of year</b>	<b>59</b>	<b>35</b>	<b>73</b>	<b>163</b>	<b>457</b>	<b>497</b>	<b>480</b>	<b>508</b>	<b>302</b>	<b>97</b>
<b>RATIO ANALYSIS</b>										
Profitability and asset management										
Asset Turnover	1.2	1.2	1.3	1.2	1.1	1.0	1.1	1.1	1.1	1.1
Return on net assets (%)	2.0%	(2.7%)	9.3%	8.6%	31.0%	16.2%	19.7%	2.0%	(8.3%)	(9.3%)
Current Ratio	0.9	0.7	0.9	1.1	1.3	1.8	1.9	1.6	1.2	0.9
Operating margin (%)	1.7%	(2.2%)	7.1%	6.9%	12.9%	8.3%	10.3%	1.1%	(5.6%)	(7.3%)
Performance										
Personnel Costs as a % of Total PG	92%	99%	92%	87%	78%	82%	79%	85%	98%	98%
Personnel Costs as a % of PG (Exc Capex)	102%	114%	103%	106%	101%	90%	87%	93%	109%	111%
Personnel Costs as a percentage of total expenditure %	58%	60%	63%	63%	61%	60%	56%	58%	58%	58%
External revenue as a % of total income	36%	34%	35%	31%	30%	29%	34%	30%	35%	35%
Ratio definitions										
Asset turnover	Revenue divided by net assets including cash resources									
Return on net assets	Net profit as a percentage of net assets excluding cash resources									
Current ratio	Current assets (excluding cash resources) to current liabilities									
Operating margin %	Net surplus\ (deficit) as a percentage of turnover									



## STRATEGIC GOALS AND ORGANISATIONAL ACHIEVEMENTS

With the mandate and statutory basis in mind, six strategic goals were crafted in order to enable the Agricultural Research Council to effectively focus and prioritise its options in delivering on its mandate. The strategic goals are framed as statements that describe the outcome expected in the agricultural sector as a result of the Agricultural Research Council intervention. They align fully with the National Outcomes, but also align to the relevant sectoral policy and strategy frameworks. The six strategic goals have been crafted in order to enable the ARC to effectively focus and prioritise its options in delivering on its mandate and so as to respond to the above strategic frameworks; as follows:

- 1) To generate knowledge and technologies that will enhance the efficiencies in crop based agriculture;
- 2) To generate knowledge and technologies that will enhance the efficiencies in livestock based agriculture;
- 3) To generate knowledge and technologies for the conservation and utilisation of natural resources;
- 4) To generate knowledge, solutions and technologies for food safety, quality and improved efficiencies in the agriculture value chain;
- 5) Translate research outputs in order to generate knowledge, facilitate decision making and contribute to the transformation in the agriculture sector; and
- 6) Apply resource management practices, towards a high performing and visible organisation.

These strategic goals served to inform the Agricultural Research Council's research focus, programme orientation and performance data. The Agricultural Research Council was also structured in a way that would support these strategic goals by clustering its divisions under Crop Science, Animal Science, Research and Innovation Systems, Agricultural Economics and Capacity Development as well as Administration and Corporate Affairs. The Agricultural Research Council also identified nine programmes through which these goals would be achieved. The programmes are Crop Production, Improvement and Protection; Animal Health, Production and Improvement; Natural Resources Management; Mechanisation and Engineering; Agro-processing, Food Technology and Safety; Smallholder Agricultural Development; Agricultural Economics and Commercialisation; Training and Extension; and Administration and Corporate Affairs.

The following sections outlined the overview and highlights of each Division as achieved under the various programmes in the Financial Year 2016/17.

# OVERVIEW AND HIGHLIGHTS OF CROP SCIENCES

The Crop Sciences Division of the Agricultural Research Council primarily supports four of the organisation's strategic goals:

- Strategic Goal 1: To generate knowledge and technologies that will enhance the efficiencies in crop based agriculture;
- Strategic Goal 3: To generate knowledge and technologies for the conservation and utilisation of natural resources;
- Strategic Goal 4: To generate knowledge, solutions and technologies for food safety, quality and improved efficiencies in the agriculture value chain; and
- Strategic Goal 5: To translate research outputs in order to generate knowledge, facilitate decision making and contribute to the transformation in the agriculture sector.

Research is carried out on citrus and subtropical crops, deciduous fruits and grapes, as well as vegetables, medicinal, indigenous and ornamental plants, summer grains, oil and protein crops, small grains and industrial crops.

The Crop Sciences Division has research facilities in Stellenbosch, Rustenburg, Potchefstroom, Bethlehem, Pretoria (Roodeplaat) and Nelspruit. The division also has satellite stations strategically positioned in almost all of the nine provinces of South Africa. Achievements attained by this division under various ARC programmes for the financial year 2016/17 are highlighted below.

The research that supports Strategic Goal 1 can be categorized into three distinct disciplines, namely: breeding, crop production systems and crop protection.

## Research focusing on Breeding (Cultivar Development)

### BREEDING POTATOES TOLERANT TO *ALTERNARIA* BROWN SPOT

Potato brown spot, caused by the fungus *Alternaria alternata*, can result in yield losses of up to 70 to 80%. Management of the disease mainly depends on applications of fungicides, but this fungus can develop resistance to fungicides if they are continuously applied over a prolonged period. The ARC developed a quick screening technique to identify potato breeding lines with tolerance against brown spot. This technique saves time, as screening takes only 4 days rather than the 3 to 5 months previously needed for screening trials, and costs. This technique was used to identify two breeding lines that are moderately tolerant to *Alternaria*, namely 08-0671-056 and 08-0671-127. These will now be used as parents in the ARC potato breeding programme for tolerance against *Alternaria* species. In view of the risk of fungicide resistance and the fact that fungicides are unaffordable to many small-scale potato farmers, an *Alternaria* tolerant cultivar will increase productivity, ensure food security and increase income generation.



Potato plant showing *Alternaria* brown spot symptoms.

### PROMISING NEW SOUTH AFRICAN AVOCADO SELECTION

Avocado in South Africa is produced on an estimated area of 12 000 hectares situated primarily in the Mpumalanga and Limpopo Provinces, with a small amount of production in KwaZulu-Natal. The annual harvest amounts to 90 000 tons with almost all being exported to Europe. The South African avocado industry is based on a limited number of cultivars, each with their own attributes and marketing windows. Irradiation breeding, one of the tools used in plant breeding programmes, was used to develop improved avocado cultivars. 'Hass' avocado (an extremely popular and high-value black-skinned cultivar) budwood was irradiated and a promising green-skinned selection with a very small seed was identified and propagated. High flesh-to-seed fruit are highly sought-after and could command high prices on foreign markets.



The new avocado selection has a very small seed. Fruit with a higher flesh percentage are highly sought-after on the markets.

## USING AN INTEGRATED BREEDING STRATEGY TO DEVELOP AN IMPROVED MACADAMIA CULTIVAR

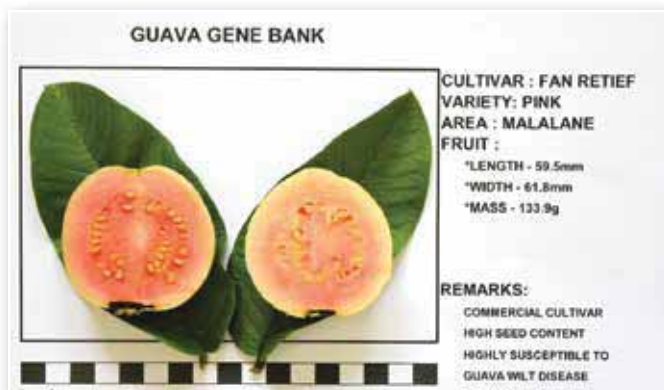
The South African macadamia industry is the largest in the world and is one of the fastest growing tree crop industries in South Africa. The total sales value of macadamia was over R4 billion in 2015 and this is expected to increase even further as the number of plantings increases on a year-on-year basis. The main production areas in South Africa include Levubu and Tzaneen in Limpopo province, Hazyview to Barberton in Mpumalanga and coastal KwaZulu-Natal. One of the highest-yielding cultivars is HAES 814, however the nuts produced are very small and break easily and therefore do not obtain high prices on the markets. As part of the integrated breeding and improvement programme, induced polyploidy, a naturally-occurring phenomenon, was used in efforts to develop a polyploidy HAES 814 selection. Plant breeders have used this tool to breed crops with advantageous traits which may not only be phenotypically distinct (for example higher yield, larger reproductive organs such as fruit and having dwarfing characteristics) from their diploid progenitors, but may express traits which could favour adaptation to suboptimal ecological conditions (heat-, cold- or drought-tolerance) and biotic stressors (pest- and disease-tolerance). Marketable characteristics such as increased nut size and decreased shell thickness for macadamia are highly sought after and could potentially be altered through induced polyploidy. Bud-wood of HAES 814 was treated, grafted onto rootstocks and one pure polyploidy shoot was verified using flow cytometry. A high-yielding, high quality macadamia cultivar could significantly further increase the South African macadamia market share on global markets.



While cultivar HAES 814 is an extremely high-yielding macadamia cultivar, it produces very small nuts which break easily compared with one of the most popular cultivars, HAES 695 which has a far lower yield but larger nuts.

## GUAVA BREEDING PROGRAMME FACILITATES EXPANSION OF THE GUAVA INDUSTRY IN SOUTH AFRICA

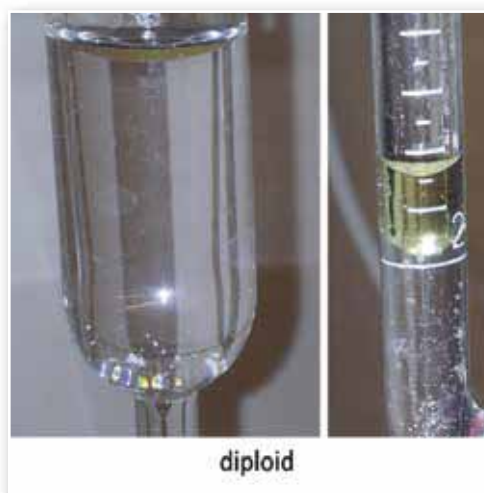
Guava is one of the most important fruit crops cultivated primarily in developing countries and its importance is increasing due to its high nutritional value and yields and affordable price on the market. Although indigenous to tropical America, guava has become naturalised throughout the tropics and sub-tropics where it is cultivated for its fresh fruit as well as processing. The ARC's extensive breeding programme focusses on developing new cultivars with specific fruit attributes designed to meet the needs of the market. Some of these attributes include improved fruit size and shape, increased sweetness and flavour, improved internal and external colour compared with the industry standard, as well as low seediness. The ARC is collaborating with the Western Cape Department of Agriculture and Guava Producers' Association and has established new promising selections in the Western Cape to facilitate industry expansion in the Province.



New guava selections have exceptional internal and external fruit quality attributes that meet the needs of the market.

## CHROMOSOME DOUBLING IN INDIGENOUS WILD GINGER BUSH, *TETRADENIA RIPARIA* INCREASES ITS BIOACTIVITY

*Tetradenia riparia* is a medicinal aromatic shrub with multiple uses which occurs throughout tropical Africa, including South Africa. Polyploids were developed using tissue culture as a development tool and flow cytometry to verify the pure polyploids. Polyploid plants were found to be morphologically distinct from the control plants, the essential oil content of these plants were characterised and bioactivity against *G. candidum*, which causes postharvest rot in fruit and vegetables, was recorded. The polyploid plants produced an essential oil with potential for mitigating postharvest disease and this is the first report on the bioactivity of *T. riparia* essential oil against a plant pathogenic fungal species of postharvest concern.



There are significant differences in essential oil content and bioactivity between diploid and tetraploid *T. riparia* plants.



*Tetradenia riparia* is rich in essential oils.

### BREEDING HIGH QUALITY PEARS FOR A WARMER CLIMATE

Pear is South Africa's third largest fruit crop after grapes and apples and while South Africa ranks sixth in the world in terms of production, it is the fourth largest exporter. Agricultural Research Council scientists work closely with the industry to ensure that industry and market objectives are met, with a major focus on developing new cultivars adapted to producing good blush under warm weather conditions. It is expected that, before long, South Africa will be severely affected by climate change, resulting in lower winter chill and hotter, dryer and windy summers in all traditional pear-growing areas. This will reduce marketability of fruit due to poorer quality, including reduced blushing. As part of an integrated plant breeding strategy, scientists are also exploring the inheritance of morphological traits and the possible genetic control of the blush trait to ensure that South Africa remains one of the world's leading exporters of top quality pears.



Blushed pear selections suitable for warmer climates are highly sought-after on the markets.



Blushed pear suitable for warmer climates are highly sought-after on the markets.

### UNLOCKING SEED GERMINATION CHARACTERISTICS TO ENSURE SUSTAINABLE HONEYBUSH CULTIVATION

*Cyclopia* (i.e. honeybush) is a genus of leguminous shrubs endemic to the fynbos biome of South Africa. Several *Cyclopia* species are used to make honeybush tea for which a high market demand has led to the overharvesting in the wild. Consequently, it has become important to study the cultivation requirements of honeybush in order to support farmers with the cultivation of this crop. Honeybush seeds are known to have either physical or combinational dormancy upon maturity, depending on the species. The plants also produce colour-dimorphic (green and brown), mature seeds in the same pod. A study of honeybush species' seed anatomy was carried out as were dormancy-breaking and germination studies using various seed treatments as alternatives to the traditional sulphuric acid scarification treatment.

The results of the investigations revealed the optimum storage and dormancy-breaking treatments for optimum germination thus providing a practical method for smallholder farmers to produce their own seedlings and at the same time promoting conservation of the *Cyclopia* genus in the wild.



Colour-dimorphic seeds of honeybush.

## NEW DROUGHT TOLERANT AND INSECT-PROTECTED MAIZE HYBRIDS TESTED ON-FARMS

Natural phenomena such as drought and insect pests are making crop production quite difficult in Africa. Climate change is predicted to worsen the situation with more variable rainfall and above average temperatures. The Water Efficient Maize for Africa (WEMA) Project – an international private-public partnership – aims to enhance food security and improve rural livelihoods among smallholder farmers in sub-Saharan Africa through development and deployment of drought-tolerant and insect-protected maize hybrids. The ARC through the WEMA project developed five drought tolerant and insect-protected (Bt-MON89034) TELATM hybrids (WE6206B, WE6207B, WE6208B, WE6209B and WE6210B). Twenty-six TELATM hybrid demos were planted on-farm in Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and North West provinces. These demos were used to host information days to introduce the hybrids to extension officers and farmers as well as to demonstrate the correct way of planting refuge- a strip of maize crop without the Bt gene. In addition 517 x 2kg promotional seed packs of these hybrids were given to smallholder farmers in Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North West provinces for farmers to evaluate them under typical farmers' conditions. An invasion of the fall armyworm was experienced in most provinces and these Bt maize hybrids were found to be resistant.

## Research focusing on Production Systems

### PRODUCTION SYSTEM AFFECTS NUTRITIONAL VALUE OF TOMATOES

Hydroponic production of tomatoes, a major vegetable crop in South Africa, is increasing. Research showed that cultivar performance in terms of the lycopene and beta-carotene content of 17 tomato cultivars was affected by the type of hydroponic production system, namely a non-temperature controlled tunnel or a shade-net structure. While some of the tested cultivars performed better under the shade-net structure, others performed better in the non-temperature controlled tunnel. Research continues to determine the physiological mechanism responsible for these results, because it might become important to select the most suitable production system for a specific cultivar to obtain maximum quality and nutritional value.



Nutritional value of different tomato cultivars being evaluated under different hydroponic cultivation systems.

## UNDERSTANDING EVAPOTRANSPIRATION FACILITATES OPTIMUM YIELD AND QUALITY OF GRAPEVINES

With the ever-decreasing water resources available to bulk water users such as those in agriculture, the accurate estimation of vineyard water use is important for irrigation scheduling in order to optimise yield, growth and quality. Daytime whole-plant transpiration used in combination with a soil evaporation model to estimate vineyard evapotranspiration, was quantified by measuring sap flow in grapevines. Sap flow was measured in grapevine trunks by means of the heat pulse velocity technique. Diurnal sap flow varied widely depending on atmospheric, viticultural and soil conditions making it critical that irrigation is scheduled appropriately for both optimum water use efficiency and crop yield and quality. Furthermore, grapevines with similar leaf area trained onto horizontally orientated trellis systems transpired more than those on vertical trellises under the same atmospheric conditions. These results suggest that it is critical that growers ensure that the irrigation applied to their vineyards is appropriate at both the soil:climate:genotype interface and crop production infrastructure to ensure optimum crop yield and quality.

### RE-USING DILUTED WINERY WASTEWATER AS AN IRRIGATION SOURCE FOR VINEYARDS

Wine production is an important industry in the Western and the Northern Cape regions of South Africa. Wineries produce extremely large volumes of poor quality wastewater, particularly during harvest. Investigations by ARC scientists regarding the possible re-use of this wastewater for vineyard irrigation revealed that since there is marked seasonal variation in water quality characteristics such as EC (Electrical Conductivity) and pH throughout the year, traditional indicators of water quality in the South African wine industry did not provide a suitable indication of suitability for irrigation. Since the cation concentrations were relatively high, it was recommended that EC is a more reliable indicator for suitability of winery wastewater for irrigation purposes. Irrigation of grapevines using diluted winery wastewater did not affect grapevine water status, vegetative growth, production, juice characteristics or wine sensorial characteristics under the trial conditions. Furthermore, a study on the use of cover crops, such as oats and pearl millet, as hyper-accumulators of excess cations as a result of the use of the wastewater, showed that these could be used successfully to remove excess cations from the soil. To prevent the build-up of sodium and therefore salinity problems in the soil which are highly detrimental to grapevines, it was recommended that cellars use alternative KOH-based cleaning detergents rather than NaOH.

### UNDERSTANDING HONEYBUSH PHENOLOGY FOR OPTIMUM PRODUCTION

No information is available on the phenological phases between and within honeybush genotypes. This information is important to understand the timing of plant development and growth, species co-existence, and growth dynamics of the genus. The in-depth study by ARC scientists and students investigated the monthly variation in, the time of the start of a growth phase, and duration of budding, flowering, fruiting, and seed dispersal between different genotypes of *Cyclopia subternata* *C. subternata* and *C. genistoides*, two of the most important honeybush tea species. The results indicated differences in phenology between and within species. By using observational qualitative analysis, the phenology of these honeybush species was categorised into three groups; early, intermediate, and late. The findings serve as a platform for investigating factors affecting the reproductive phases, morphology, and physiology in these and other honeybush species and will assist farmers in the timing of crop requirements and management practices, thus having practical implications for the successful cultivation of the species.



Understanding honeybush phenological cycles will assist farmers in the timing of crop requirements and management practices

## PROGRESS IN GROUNDNUT SEED SUPPLY IN SOUTH AFRICA

Most of the groundnut varieties grown in South Africa were developed by the ARC and the industry depends on ARC for its annual supply of Breeder seed. During 2016/17 season the ARC produced a record 58.6 tons of Breeder seed of eight varieties currently grown by farmers. This provided the industry with adequate amounts of Breeder seed which resulted in increased groundnut production. This led to self-sufficiency, increased exports and savings on foreign exchange. From the sale of the Breeder seed to the Groundnut Industry, the ARC realised an external income of R4,7 million.

## Research focusing on Protection against Pests and Diseases

### MONITORING RUST DISEASES IN SOUTH AFRICA

Rust diseases of small grain crops are caused by fungal pathogens. Three important wheat rusts namely stem rust, stripe rust and leaf rust occur in South Africa. These rust diseases also occur in practically all wheat producing countries in the world and are recognised as some of the most significant threats to international wheat production and food security because these pathogens have the ability to rapidly develop new virulent races and destroy yields.

Internationally, during the past year, two significant new races of stripe rust of wheat have emerged; one in Europe and the other in East Africa. One damaging new wheat stem rust race has emerged in Europe and a noteworthy new stripe rust of triticale has been found in Mexico and Southern USA. Additionally, well-known existing rust races have spread to countries where they were not known to occur before. The speed at which rusts are developing new virulence and spreading appears to be faster than in the past. Several factors may be influencing these changes and the rapid spread: increased travel and trade; increasing pathogen populations; more uniform cropping systems and changing climatic conditions. All this emphasises and highlights the need for information on the distribution and prevalence of damaging rust races.

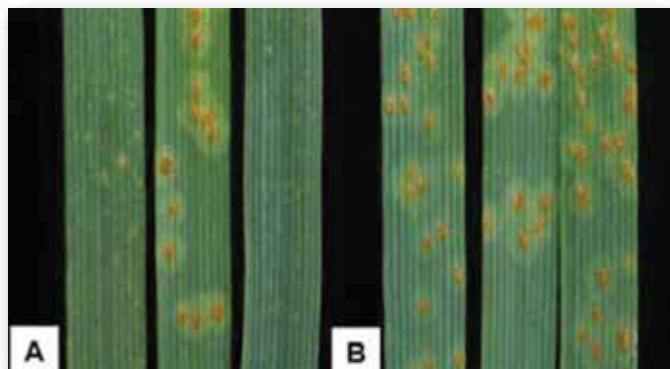
In South Africa, the three rust diseases of wheat are commonly controlled using resistant cultivars. However, the threat posed by new rust races, which develop mostly through mutation of local races, or through introduction from other countries, is a constant concern for scientists. If races with new virulence for South African cultivars are not timeously detected and managed, they may spread and result in epidemics and significant yield losses. Fortunately, South African wheat breeders and producers are supported by ARC scientists who monitor rust occurrence in all the wheat production areas of South Africa on an annual basis. Not only have surveys been conducted annually since the early 1980's, but ARC is one of a select few institutions in the world with the facilities and knowledge to determine the identity of the samples they have collected. This is done on-site at the ARC campus in Bethlehem. Additionally, ARC's rust pathologists work closely with the researchers at University of the Free State (UFS) to use molecular methods to characterise the rust races.

A few isolates collected in 2016 in the Western Cape showed virulence profiles different from races previously reported in South Africa. These isolates were therefore considered as belonging to a new race. Based on tests on standard differential lines, the new race is designated as 3SA10, which codes to CFPS using the North American race nomenclature. In addition, four other isolates collected from the Western Cape were pathotyped to a race not previously recorded in SA. This second new race codes to CDPS (3SA38). Researchers from the University of the Free State also collected isolates with similar virulence as CFPS and CDPS in 2016 in the Western Cape. Except for their virulence on *Lr24*, the new races appeared similar to CCPS, a race that was first detected in the Western Cape in 2009 and eventually dominated the leaf rust population in SA. Race 3SA38 differs from 3SA145 also being virulent on *Lr20*. Screening is underway in ARC-Small Grain to identify effective genes which will be used in breeding new resistant cultivars. In addition, current South African wheat cultivars are being tested at UFS to see if the new races pose a risk to any commercial cultivars. CFPS and CDPS are additions to four leaf rust races identified within the past seven years, indicating a continued variability of rusts in SA and emphasising the need for regular rust monitoring in the early detection of emerging new races.

The severity and importance of wheat rusts in South Africa is largely affected by climatic factors. Stem and leaf rust are favoured by warm temperature of 20°C, but stripe rust infection commonly occurs under cool weather conditions (>15°C). Therefore, stripe rust is more important in the cooler wheat production areas (e.g., Eastern Free State), whereas stem rust and leaf rust are more prevalent in wheat growing regions with mild winter temperatures (e.g., Western Cape). Despite the occurrence of nearly 30 races of leaf and stem rust, and four races of stripe rust since this research was started, few devastating outbreaks of rust have occurred in South Africa. By continually identifying effective resistance genes against the new races, these surveys have made a significant contribution to sustainable breeding of resistant cultivars in SA.

Another initiative which contributes to the success of this ARC project is the collaboration that exists between ARC and international rust research partner, the Global Rust Initiative which has a screening facility in Kenya. ARC's breeding lines are annually tested at the facility and this has allowed us to identify sources of resistance to virulent East African races, which have not yet been detected in South Africa. This collaboration also exposes ARC wheat lines to stem rust races from the Ug99 lineage, an important and troublesome group of 13 related stem rust races. One or more of these variants have been confirmed in 13 countries (Uganda, Kenya, Ethiopia, Eritrea, Sudan, Egypt, Tanzania, Zimbabwe, Mozambique, South Africa, Rwanda, Yemen and Iran). Four of the 13 Ug99 variants have been confirmed in South Africa, however only one race has been detected regularly. The remaining three have rarely been found since 2010.

Because of the indispensable information collected by this research, South African wheat breeding lines can be screened against the four Ug99 variants of stem rust as well as new races of leaf rust and stripe rust. It is therefore expected that South African producers and wheat breeders will continue to benefit from this research.



Virulence of A. race CCPS and B. new race CFPS on lines containing genes (left to right) Lr24, Lr26, and a previously resistant South African commercial wheat cultivar. Note that unlike CCPS, CFPS is virulent on Lr24 and the commercial cultivar.

### NEW TECHNOLOGY TO ENSURE VIRUS-FREE SWEET POTATO PLANTING MATERIAL

Virus diseases threaten sweet potato cultivation in South Africa. A co-infection of the potyvirus SPV2 (sweet potato virus 2) and the crinivirus SPCSV (sweet potato chlorotic stunt virus) causes sweet potato virus disease syndrome. Severe leaf symptoms and stunting of the plants occur, which can lead to yield losses of up to 90%. The traditional method for detection of these viruses takes 8 weeks to obtain a result. Researchers at the ARC developed a rapid nucleic acid screening method for the detection of SPV2, which provides results in a few days. This method can now be used to screen the sweet potato cultivars maintained as mother material (under the sweet potato scheme) for the presence of SPV2 to ensure that virus-free planting material is given to smallholder and commercial farmers. This planting material will produce high yielding sweet potatoes of good quality, which will improve farmers' competitiveness at local and international markets.



Purple ring spots on sweet potato leaves, typical of potyvirus (sweet potato virus 2) infection.

### ARC ON THE FRONTLINE IN THE WAR AGAINST INVASIVE PESTS

The first critical steps in mitigating the damage caused by invasive

pests are early detection and timeous positive identification. Only then can farmers and industry be alerted and control measures devised and implemented. During the past year, two highly invasive moth species, the tomato leafminer and the fall armyworm, were recorded in South Africa for the first time, both with the potential to decimate crops critical to food security of the region.

The tomato leafminer, *Tuta absoluta*, is an extremely invasive moth of South American origin. In 2006, it was recorded for the first time outside its native range in Spain; it is currently spreading eastwards towards India and southwards down into Africa. The larvae make blotch leaf mines and superficial mines on tomato fruit and can cause crop losses of up to 100%. Severe infestations and yield losses have been reported from Tanzania, Zambia, Kenya and Uganda, and in Nigeria, a state of emergency was declared after 90% of the tomato fields outside the northern city of Kano were destroyed by this pest. It also attacks related host plants like potatoes, peppers and eggplant (aubergines).

The first moths were trapped during August 2016 in South Africa from Mpumalanga province and were submitted to the ARC for identification. This moth, which can easily be confused with the potato tuber moth, poses a substantial risk to tomato production in South Africa. Small-scale farmers are particularly vulnerable.

In January 2017, an unknown armyworm damaging maize plants in the Limpopo and Northwest provinces was observed. Specimens of the moth were submitted to the ARC where a resident taxonomist positively identified the specimens as the invasive fall armyworm, *Spodoptera frugiperda*. This pest is classified as an A1 quarantine pest on the list of the European and Mediterranean Plant Protection Organisation (EPPO), and is a quarantine pest in South Africa. By March 2017, it had been reported from Limpopo, North West, Gauteng, Mpumalanga, Free State and KwaZulu-Natal provinces. Extensive damage has been observed on conventional maize planted by smallholder farmers and reports have been received of damage to sorghum and lucerne. At the request of the Department of Agriculture, Forestry and Fisheries (DAFF), the ARC produced factsheets on the fall armyworm in English, Afrikaans and Northern Sotho.

Speedy identification of these invasive pests enabled DAFF to announce the invasion by these pests and to coordinate and implement integrated control programmes, thus avoiding the large-scale devastation suffered in other African countries. This highlights the immeasurable value of the resident expertise at the ARC, as well as the National Asset specimen collections, of which the ARC is the custodian and mandated to maintain and expand.



Fall armyworm damage to maize.



Fall armyworm larva.



Tomato leafminer larva.



Tomato leafminer damage.

## NEW LETTUCE DISEASE IDENTIFIED

The ARC recently identified both Lettuce Big Vein associated Virus (LBVaV) and Mirafiori Lettuce Big Vein Virus (MLBVV) in lettuce samples from the Western Cape and Gauteng provinces that showed typical symptoms of lettuce big vein (LBV) disease. This is the first time that both viruses have been identified in LBV diseased lettuce in South Africa. These viruses are transmitted by the soil-inhabiting fungus, *Olpidium brassicae*. This makes control of the disease a major challenge. LBV causes discoloration and puckering of leaves and enlargement of veins, and affected lettuces are often rejected by consumers. It is now critical to determine if both viruses must be present in a plant or if each of the two viruses alone can cause LBV disease. It is also important to determine whether different strains of the two viruses are present in South Africa, as this could influence disease severity. Future research should include screening of lettuce lines for resistance to LBVaV and MLBVV.



Lettuce leaf showing typical Lettuce Big Vein disease symptoms.

## MANAGING INVASIVE GIANT REED

Giant reed, *Arundo donax*, is a widespread and highly invasive weed in South Africa. Infestations impact negatively on native biodiversity and the country's scarce water resources. Manual and chemical control methods are currently used to manage giant reed populations, with reportedly little long-term success. Biological control is considered the best option for sustainable management of this weed. In 2010, a host-specific, stem-galling wasp, *Tetramesa romana* Walker (Hymenoptera: Eurytomidae) was found to be abundant on giant reed throughout the country. Although the wasp is widespread, it does not appear to contribute significantly to the control of this weed, although it is used as a classical biological control agent for giant reed in the U.S.A. Field research in the U.S.A. demonstrated that 'topping' giant reed stems at a height of 2 meters enhanced wasp populations by increasing host plant suitability. The efficacy of this method and the efficacy of cut stump herbicide applications and ground level cutting (mowing) for reducing giant reed infestations were investigated. Herbicide applications and mowing were not effective in reducing giant reed populations. Topping giant reed stems at 2 m appeared to have a short-term effect in boosting stem-galling wasp populations, but there was limited evidence that this had any real effect on giant reed populations. Topping giant reeds as a pre-treatment to the release of biocontrol agents could increase the efficacy of biological control, but new biocontrol agents are needed for improved management of giant reed in South Africa.



Giant reed (*Arundo donax*).

### FIGHTING INVASIVE HAKEA IN MOUNTAIN FYNBOS

The Australian stem-boring beetle, *Aphanasium australe*, is a natural enemy of *Hakea* species and it is used for biological control of *Hakea sericea* and *H. gibbosa* in South Africa. *Hakea sericea* invades inaccessible mountain fynbos areas and requires integrated management strategies for its control, with biocontrol being integral to successful population restriction. The beetle has a two-year life cycle, so in an effort to speed up its distribution in hakea infestations, new consignments of live beetle larvae were collected in New South Wales in Australia in October/November 2016. A total of 152 infested tree stumps were collected during this time, and the adults that emerged, along with hundreds of eggs that were laid, were released at several new sites across the Western Cape Province. Establishment success will be determined in October or November 2017.



*Hakea* stump infested by the stem-boring beetle.

### POTENTIAL OF MEDICINAL PLANTS FOR COSMETIC AND SUN PROTECTION PRODUCTS

Extracts of 15 medicinal plants from the Eastern Cape Province, traditionally used for beauty and healthcare, were evaluated for

various factors used to calculate their sun protection factor (SPF), namely total phenolic content, flavonoid content, anti-tyrosinase activity and absorption of ultraviolet-visible (UV-Vis) light. Plant extracts of Cape Onionwood or Umemeziobomvu (*Cassipourea flanaganii*), African holly or umDuma (*Ilex mitis*), Botterblom or uBushwa (*Arctotis arctotoides*) and ribwort plantain (*Plantago lanceolata*) showed photo protective effects with SPF values above 15. A number of the plant extracts showed good potential for use in cosmetics and their combined use can enhance their activity. Research to investigate the use of these plant extracts in commercial cosmetic and sun protection products continues as part of the ARC Collaboration Centre on Small Holder Farmer Development, in conjunction with the University of KwaZulu-Natal, University of Limpopo and the University of Fort Hare.

### EFFECTIVE CONTROL OF MACADAMIA PESTS AND ORCHARD MANAGEMENT IS CRITICAL TO ENSURE THAT THE SOUTH AFRICAN INDUSTRY REMAINS GLOBALLY COMPETITIVE

While the South African macadamia industry is arguably the largest in the world, growers are faced with a number of challenges that affect nut production and quality. Macadamia is susceptible to various pests, including the tortricid complex which includes several moth species. These pests cause substantial damage to the nuts, rendering them unmarketable. Although various environmentally-friendly strategies for pest control are available to growers, many farmers still prefer to use contact insecticides. However, it is not only critical that these chemicals are applied appropriately to ensure that effective pest control is obtained, but trees and orchards need to be managed to reduce the incidence of establishment of insect populations. Investigations revealed that the denser the orchard, the higher the incidence of the pests due not only to optimum environmental conditions, but also predator avoidance strategies. The recommendations are that growers need to balance both tree size and shape as well as pest populations to ensure that optimum yields of high quality nuts are obtained.



The macadamia tortricid moth complex causes significant damage to macadamia nuts, rendering them unmarketable.

### LITCHI IS A GOOD HOST PLANT FOR INDIGENOUS PLANT BUGS

A survey of the relative abundance and seasonal distribution of indigenous plant bugs (order Heteroptera) in litchi orchards was carried out in the Mpumalanga Province of South Africa. Twenty-two different species were collected and identified, however only two species, namely *Coenomorpha nervosa* (Dalls) and *Pseudatelus*

*raptorius* (Germer) were dominant. Nearly 80% of the insects collected comprised of these two species. Furthermore, not only were these two species numerically dominant, they were also the only species that were able to breed in litchi and hence were abundant during the fruiting season. None of the other heteropteran species were able to breed in litchis as only adults were recovered. These insects also occurred in low numbers and were abundant during autumn and winter, when no fruit was available on the trees. This implies possible competitive displacement of lesser important plant bugs by *C. nervosa*. Damage to litchi fruit previously ascribed to *P. wayi* may be caused by *C. nervosa* and possibly also *P. raptorius*, the two indigenous species identified in this study. Whilst *P. wayi* overwintered on litchis, it could be controlled on litchi in order to reduce its impact in adjoining alternative subtropical fruit tree hosts where the species is known to cause damage. This is a first report where litchi has been identified as a good host plant for indigenous heteropteran insect species and these pests will need to be monitored in the future in order to prevent losses to the litchi fruit crop.



Typical damage to tomato roots caused by rootknot nematode infestation.



The indigenous plant bugs, *Coenomorpha nervosa* (L) and *Pseudatelus raptorius* (R), were the dominant species found on litchi.



Brassica-nematode trial to determine optimum nematode management strategy.

### USING BRASSICACEAE CROPS AS AN ENVIRONMENTALLY-FRIENDLY METHOD OF MANAGING NEMATODE PESTS

Nematodes parasitise and cause substantial crop yield and quality losses to a wide range of crops worldwide and therefore have a significant negative impact on global food security. The ARC's scientists, in collaboration with their partners, are exploring environmentally-friendly nematode control strategies as alternatives to chemical control as global efforts to conserve the ozone layer as well as soil and water resources. Furthermore, nematode pests are generally managed successfully by the use of synthetically-derived nematicides, however these are progressively being removed from world markets. The inclusion of Brassicaceae (cabbage family) crops in cropping systems is one such alternative and has been demonstrated in most cases to be effective in managing the top-three rated economically important nematode pests, viz. root-knot (*Meloidogyne*), cyst (*Heterodera* and *Globodera*) and lesion (*Pratylenchus*) nematodes as well as others. A critical appraisal of the role of these crops has led to the initiation of Brassicaceae-based management strategies and the biofumigation and cover-crop/rotation characteristics of Brassicaceae in reducing nematode-pest population levels in global cropping systems, including those in South Africa.

### ENTOMOPATHOGENIC NEMATODE RESEARCH REVOLUTIONISES BIOLOGICAL CONTROL OF INSECT PESTS ON SUBTROPICAL FRUIT AND NUT CROPS

A desktop study to determine the potential of a biological product containing a specific entomopathogenic (EPN) nematode for biological control of pests was undertaken. The study investigated potential contamination of endemic EPN species by the active organism, as well as the possibility of it attacking non-target species. The study revealed that this organism as well as other EPNs are safe and effective biological control agents and are certainly more specific and less of a threat to the environment and human health than chemical pesticides. Concomitant with this study, indigenous EPNs are being investigated for the biological control of the nut borer complex on macadamias and false codling moth in avocados in South Africa.

The macadamia and avocado industries are two of the largest horticultural industries in South Africa and earn significant foreign exchange on international markets. These markets require that only top quality product that has passed stringent phytosanitary scrutiny, is sold. There are several economic pests which affect the quality of subtropical fruit and nut crops, including the nut borer complex in macadamia as well as false codling moth in avocado. Already research has shown that several isolates collected appear to be virulent against the pests. ARC scientists, in collaboration with Stellenbosch University, are in the process of describing a completely

new *Steinernema* species which was isolated from a field site. This research could lead to the biological control of the nut borer complex and soil stages of false codling moth (FCM), economic pests causing substantial losses to the macadamia and avocado industries.



Entomopathogenic nematodes (infective juveniles) emerging from pest larvae.

### BACTERIAL ANTAGONISTS CONTROL DEVASTATING FUNGAL DISEASE IN GUAVA

Guava cultivation in South Africa is approximately 1200 hectares in extent. The largest production area is the Western Cape Province comprising 547 ha, followed by the Limpopo Province with 442 ha and the Mpumalanga Province with 140 ha. The total production per annum is approximately 41 000 tons which is used primarily for processing into value-added products. The industry is however under severe threat by guava wilt disease (GWD) caused by the fungus *Nalanthamala psidii*. This devastating disease results in tree decline and ultimately death and can spread rapidly through a production area. GWD control measures other than eradication of diseased trees do not currently exist. Research towards biological control using beneficial microbes showed that a soil drench of a combination of specific rhizobacterial strains of *Bacillus cereus* and *Paenibacillus alvei* species could suppress the disease and that furthermore, these microbes also appeared to enhance plant growth. This is the first report of control of GWD using bacterial antagonists and provides an environmentally-friendly and effective means of disease control for guava producers in South Africa.



Treatment with a combination of specific rhizobacterial strains suppressed guava wilt disease and appeared to enhance plant growth compared with the control.



Guava Wilt Disease caused by *Nalanthamala psidii* causes severe decline, wilt and ultimately death of guava trees.

### FRUIT FLY MONITORING SYSTEMS ARE CRITICAL FOR DETECTING AND MONITORING INVASIONS IN MANGO PRODUCTION AREAS

South Africa's mango production regions are mainly situated in the north eastern part of the country in the subtropical regions of the Limpopo and Mpumalanga Provinces. Fruit is either processed for atchar, is dried or is used for juice, while fresh fruit is marketed both domestically and are exported primarily to Asian and European markets. It is critical that South African fresh produce adheres to phytosanitary requirements and mango products are no exception. Fruit flies are pests of major concern and it is critical that they are detected, monitored and controlled so that export consignments meet market standards. Fruit fly species' responses to lures are critically important, especially when a single lure might be recommended for the purpose of trapping, and therefore detecting multiple fruit fly species in commercial fruit orchards. Several South African subtropical fruit industries are facing threats from the recent invasion of the oriental fruit fly *Bactrocera dorsalis* (Hendel) into production areas in South Africa where the species was not found previously. Research towards testing the relative efficiency of 13 different trapping systems for fruit fly species in mango orchards in Limpopo Province, South Africa showed that there was pronounced variation in species attractiveness across the trapping systems and lures tested. The enriched ginger oil (EGO) Pherolure<sup>TM</sup> captured 33.77% of all the *Ceratitis* spp., while the Invader-lure<sup>TM</sup> captured 36.47% of the total number of *B. dorsalis* trapped. The Torula yeast pellets were not recommended for fruit fly trapping due to the relatively low trap catch numbers and high non-target catches. These results are important and significant for on-farm monitoring strategies, as well as for invasion monitoring systems currently in place to detect the distribution of *B. dorsalis* in South Africa and allows mango producers to implement timely and effective control strategies in their orchards to ensure that quality fruit for which South Africa is known, is exported to international markets.



Fruit fly monitoring systems are critical for detecting and monitoring invasions in mango production areas.



Mango fruit fly (L) and Oriental fruit fly (R) must be detected and monitored for the development of effective control strategies in mango orchards.

## NEMATOLOGY IN SOUTH AFRICA: A VIEW FROM THE 21<sup>ST</sup> CENTURY

Agricultural Research Council scientists were integral to the publication of a book focussing on nematology research in the South African context. A South African perspective on nematology research is unique, since it deals with local nematode problems experienced under the typical environmental conditions experienced. The book provides a comprehensive overview of the plant parasitic nematodes associated with a range of agricultural and horticultural crops in particular, while it also refers to nematodes that infect humans as well as beneficial and marine and estuarine nematodes. While it places most of the emphasis on the nematode species that have the greatest economic impact, it also supplies a list of other nematodes associated with crops as well as beneficial nematodes that contribute towards soil quality and entomopathogenic nematodes that kill insect hosts. International researchers and collaborators will benefit from the information included in this book, since several common grounds in terms of nematology research and training are covered in the various chapters. Furthermore, information that is not available to international students and researchers is included in this book and in this way lead to dissemination of results that can complement and impact on research efforts elsewhere in the world.



Nematodes cause severe crop losses throughout the world.

## Research focusing on Agro-Processing and Reducing Post-Harvest Losses

### DEVELOPING NEW PRODUCTS: MUSHROOM FARMING

The ARC started to promote oyster mushroom farming in 2002. Initially only basic training was provided on site. Since 2015 demand for training in mushroom production increased and a new approach was followed. Training is now presented centrally in Pretoria and to select potentially dedicated learners, they have to pay a minimal

registration fee. The duration of the training course is three to five days. Fifteen learners attended the course in 2016. The course not only deals with technical skills in mushroom production, but also covers some business analysis and skills that are needed to start a small business. As it was a participatory course, ample time was provided for practical activities and open discussions.



Participants learn how to prepare the growth medium for oyster mushroom cultivation.



Oyster mushrooms ready to be packaged.

## OPTIMISING HONEYBUSH PROCESSING PRODUCES NUTRACEUTICAL BY-PRODUCT WITH ANTI-DIABETIC POTENTIAL

Honeybush, prepared from a number of *Cyclopia* species endemic to the Cape fynbos biome, is becoming more and more popular due to its multitude of health benefits. Certain *Cyclopia* spp. have also been identified as a good source for the preparation of nutraceutical extracts, in particular extracts rich in mangiferin. Another bioactive compound of interest, also present in *Cyclopia* spp. is the flavanone, hesperidin, for which various beneficial health effects have also been documented. *Cyclopia maculata*, delivers hot water extracts containing a relatively high hesperidin content, in addition to a moderate mangiferin content. The co-occurrence of mangiferin and hesperidin in an extract is advantageous from a nutraceutical perspective, given the enhanced beneficial effects. Production of "fermented" honeybush tea, the major herbal tea product, includes

a high-temperature oxidation process (“fermentation”), followed by drying and sieving. The by-product generated, i.e. the fraction that does not meet the particle size requirements (very fine “dust” and coarse material containing mainly stem pieces) for high quality herbal tea is currently under-utilised. A similar size fraction is obtained as by-product during production of green (unoxidised) honeybush tea. *C. maculata* plants have thick stems thereby contributing to a larger portion of by-product material than other *Cyclopia* species. Research by ARC scientists showed that extraction of hesperidin could be optimised using response surface methodology, as well as other technologies to obtain a high extraction efficiency, the first of its kind to be used. Use of honeybush tea processing by-product for the production of hesperidin-enriched extract has enormous commercial potential and valorisation of this by-product would increase profitability of the honeybush industry and address governmental priorities, i.e. expansion of the South African bio-economy and agro-processing industries.



Use of honeybush tea processing by-product for the production of hesperidin-enriched extract has enormous commercial potential and valorisation of this by-product would increase profitability of the honeybush industry.

### ESTABLISHING PRODUCTION OF KENAF FIBRE FOR BIOCOMPOSITE MATERIALS IN SOUTH AFRICA

Globally there has been a growing interest in the increasing application of renewable materials such as natural fibre reinforced

composites in applications as diverse as automotive, aerospace, packaging, and the building and construction industry. Key drivers for this trend include an increased environmental awareness on the part of consumers and industries, increasingly stringent legislation relating to product recycling and disposal, as well as economic factors such as increasing oil prices and the consequent need to reduce weight. The development and commercialisation of advanced materials based on natural resources (advanced biocomposites) has been identified as a key industry development cluster in the Industrial Policy Action Plan (IPAP) of the Department of Trade and Industry (the DTI).

Establishing a natural fibre based composite industry in South Africa is not possible without a solid agricultural basis in order to ensure sustainable supply of natural fibres to local manufacturers. Kenaf was identified as the fibre crop with the highest commercial potential under specific climatic and soil conditions prevailing in this country. This fibre crop also has proved to be an excellent source of income for rural communities in many developing countries.

In 2012-13, ARC launched an extensive research programme on optimisation of agronomic practices for the production of high quality Kenaf fibre under South African conditions. This research was conducted in close co-operation with the CSIR Biocomposites Centre of Competence and supported by the IDC, DST and other governmental departments. This research concluded in 2016/17.

More than 29 kenaf cultivars have been evaluated at different localities. Kenaf has proven to be well adapted to different environmental conditions such as at Cedara, Rustenburg and Winterton. The main focus has been on Winterton in KwaZulu-Natal where a processing factory exists. Although bark yield was variable between locality and years, yields between 1 and 8,2 t ha<sup>-1</sup> were obtained under dryland conditions and between 1,2 and 8 t ha<sup>-1</sup> under irrigation. During 2016/17 large plot trials were planted to simulate semi-commercial conditions. Optimal spacing and density requirements and fertilization have also been determined through trials in these areas. The result of all these trials has led to the development of a production manual for farmers.

A highly successful Farmers’ Day was held in Winterton in February 2017 during which progress on kenaf research was reported and the way forward with kenaf production and processing was discussed. The event was attended by 17 producers and industry representatives. A task team was formed consisting of both private and public sector representatives to develop a strategy for commercial uptake of kenaf fibre.

## Research and Services focusing on Sustainable Use, Conservation and Protection of Natural Resources

### CONVERTING ORGANIC HOUSEHOLD WASTE TO FOOD

Safe and environmentally sustainable disposal of organic waste, particularly animal waste, presents many problems and can be costly. The Black Soldier Fly is a beneficial fly used to convert organic waste to food. The commercial company Agroprotein uses this fly on an industrial scale in the Western Cape as a source of protein. The ARC is developing a system for rural and urban households where Black Soldier Flies convert organic waste from households into compost for gardens and food for poultry and wild birds. A culture of the flies has been established at Roodeplaats to evaluate the ability of the flies to overwinter in different environments. This waste management technology will be presented to SANParks for use in rest camps in National Parks, as well as to the rural communities associated with SANPARKS and small agroprocessing industries.



Black Soldier Fly larvae that convert organic waste into compost or poultry food.

### USING COVER CROP MANAGEMENT PRACTICES FOR THE BIOCONTROL OF NEMATODES AND WEEDS

Soil-borne pests have a negative impact on food production in most agricultural crops and the phasing out of effective chemical control options for pests such as nematodes makes their control even more challenging. Alternative methods of control, such as bio-fumigation using selected cover crops are being investigated. Cover crops that are currently used in the vineyards of South Africa have also been studied for their effect on weed suppression since uncontrolled weeds may reduce crop yield by as much as 80%. Furthermore, the increasing number of weed species developing resistance to herbicides makes the use of cover crops as a non-specific biological method of pre-emergence weed control in vineyards essential. Various cover crops are being used to improve soil quality and control nematode and weed populations in grapevine orchards. For the improvement of soil quality, chemical control of the selected cover crops rather than mechanical control maximised organic carbon availability in the soil. Furthermore, these cover crops, depending on the species, were also found to act as natural suppressing agents for both summer- and winter-growing weeds and moreover bioassays revealed that these cover crops could also suppress and therefore control ring nematode populations in the soil. In addition, the cover crops did not affect the pathogen status, biological activity and microbial status in the soil or grapevine performance. Recommendations for growers include the use of various cover crop species which were selected primarily for their biofumigation properties, and can be included in a cover crop rotation system for grapevines without compromising weed-control efficacy.

### MULTI-INSTITUTE COLLABORATION DELIVERS ON KEY STRATEGIES FOR THE CONSERVATION OF *WARBURGIA SALUTARIS*, AN ENDANGERED SPECIES

*Warburgia salutaris*, or pepperbark tree, is one of the most highly prized tree species in South Africa. It is widely used owing to its sought-after medicinal properties. In the Kruger National Park, illegal bark harvesting is being practiced and rangers protect known stands of trees to prevent total destruction of the remaining population due to over-harvesting. The SANParks *Warburgia salutaris* Conservation Programme seeks to address the threat of pressure on local populations that could become locally and eventually regionally extinct in the wild, with negative implications for biodiversity conservation and socio-economic wellbeing. The bark is harvested non-sustainably and trees are effectively ring-barked resulting in death of the trees several months after harvesting. As part of an extensive programme in which the ARC is a collaborator, several interdisciplinary initiatives have been implemented to address these concerns. These include not only monitoring of existing population

sizes and stability, but also the identification of 'new' populations; the use of alternative sustainable sources of material (i.e. leaves) for harvesting; extensive propagation studies including an investigation of reproductive limitations and making use of vegetative and reproductive material for propagation; distribution of propagated trees to traditional healers and associated communities and projects, as well as workshops with traditional healers and development of information dissemination tools for human capacity development in associated communities and projects.



Different cutting types and planting media were tested.



*Warburgia salutaris* trees are grown on for distribution to various communities and projects.

### HEAT TOLERANCE TESTING METHODS IN COTTON

Climate change is necessitating the faster adaptation of crops to adverse growing conditions. It is predicted that temperatures generally will rise in South Africa. High temperatures cause physiological responses in cotton leaves and flowers that effect growth and yield. It is hypothesized that these responses can be used to screen for temperature tolerant cotton genotypes. Research was conducted to determine what physiological changes occur in cotton with rising temperatures. Methods tested included membrane leakage, chlorophyll fluorescence, antioxidant activity (Glutathione Reductase) and sucrose content. These methods were tested on two cotton cultivars known to be heat tolerant and one sensitive to heat. A cultivar of unknown tolerance was included as well. Chlorophyll fluorescence was a rapid and informative screening method, whereas membrane leakage was more time consuming and variable genotypic results were obtained. Antioxidant analysis and sucrose determination are expensive and needed specialized laboratory equipment and personnel, making them impractical as

screening methods. This research was carried out in collaboration with the University of Arkansas, USA, with the research being conducted under both field and controlled growth conditions in both countries and will be contained in a PhD thesis of one ARC researcher. Recommendations can now be made to cotton breeders on which method to use for rapid screening of large cotton populations for heat tolerance.

## Translating Research Results to Support Agrarian Transformation and Efficiency and Competiveness of the Agriculture Sector

### GAUTENG FARMERS INTRODUCED TO NUTRIENT RICH TOMATOES

One out of five children in South Africa is stunted and one out of ten children is underweight, due to malnutrition. Micronutrient deficiencies play an important part in malnutrition and vitamin A deficiency is of particular concern. Tomatoes are the second most important vegetable crop in South Africa, with the average household consuming 5–10 tomatoes per week. Tomatoes contain antioxidants, folate and vitamins, therefore they play an important role in combating micronutrient deficiencies. Beta-carotene in tomatoes is converted into vitamin A in the human body. The ARC in partnership with the Gauteng Department of Agriculture and Rural Development (GDARD) is evaluating high beta-carotene tomato germplasm with Gauteng farmers. ARC and GDARD hosted a farmers' day on 2 March 2017. Fifty-two Gauteng farmers, ARC and GDARD officials attended the farmers' day where farmers received information about tomato production and the importance of the nutritional value of vegetables in the daily diet. The ARC tomato breeding programme focuses on the breeding of nutrient rich tomato cultivars to increase food security and address vitamin A deficiency to combat malnutrition.

### MOBILE PLANT HEALTH CLINIC AT BADPLAAS

More than 60 smallholder farmers attended a Plant Health Clinic on 21 February 2017 in the Badplaas district, off the R541 in Mpumalanga. The clinic was well attended in spite of continuous rain. Although only a few farmers brought diseased plant samples along, the most commonly experienced problems were identified and addressed by means of a group discussion assisted by an interpreter from Grain SA. The ARC and representatives from Grain SA co-operated very well to make the day informative and successful. Common problems included fall armyworm, *Striga* sp. (a parasitic plant on maize), root-knot nematodes (*Meloidogyne* spp.) on potatoes, as well as fungal diseases on tomato and ground nuts. This clinic was particularly successful with many farmers requesting follow-up clinics in that area.



Farmers attending the Mobile Plant Health Clinic in Badplaas.

## ARC IS A PROUD MEMBER OF THE INTERNATIONAL WHEAT YIELD PARTNERSHIP.

The International Wheat Yield Partnership (IWYP) was established late in 2015 as an independent research programme of the International Wheat Initiative with the aim to use science to increase average global wheat yields by 50% by 2030. Various leading research institutions and teams from the United Kingdom, Australia, the United States, Mexico, India, Argentina and Spain make up the IWYP programme. ARC project "Chasing wheat yields in challenging environments" was evaluated by an expert team of researchers and in late 2016, was accepted as a contributing IWYP member through the aligned projects channel. This makes us the first African research institution to become part of the ambitious and prestigious IWYP programme.

To achieve the overall goal of making South Africa not only food secure but food sovereign, this project will make use high-tech research methodologies to identify wheat plants with genetically higher yield potential. Marker-assisted selection of targeted yield component genes and a holistic plant identification approach, using high-resolution phenotyping technologies will be used. After the initial screening of wheat germplasm and in-field yield trials, a dedicated crossing block will be established to stack favourable alleles for yield potential and release high yield-potential germplasm panels.

There are significant advantages for South African wheat breeders and ultimately South African wheat farmers associated with membership of the IWYP. Not only does IWYP facilitate exclusive access to high quality wheat germplasm developed in the programme, the IWYP members' platform allows for the secure sharing of data and new research findings with other IWYP projects leaders. This includes dedicated online storage infrastructure, databases and research tools. As an IWYP member, we now have primary access to germplasm panels from all over the world as they are developed and identified by the research projects from the IWYP hub at CIMMYT. The unique combination of a dedicated information sharing platform, used within and across integrated research projects, is meant to contribute to quicker researcher breakthroughs. This interactive platform allows for all scientists to add value to any project and learn from existing results, ultimately preventing duplication of work.

IWYP focusses on improving the genetic yield potential of wheat through a series of high-risk/high-reward research projects funded/co-funded by multinational and international research and funding agencies and is the ultimate recognition of the international quality of research conducted within the ARC. As an IWYP member, we are recognised as having the ability to contribute to world wheat yield improvement as part of the global food security solution. The Winter Cereal Trust and the South African Society for Crop Science, funded ARC project leader and a research technician attended the second annual scientific program meeting of IWYP in Obregon, Mexico from 20-23 March 2017. Here they took part in discussions on the latest research findings and field-trial visits with 60 other international wheat researchers. They were also part of planning the best collective way forward.

The total value of the first eight IWYP funded research projects is around US \$20 million. The scientific areas of these research projects include:

- Finding and employing traits and genes to increase photosynthesis;
- Testing genes to boost spike development;
- Reducing respiration and thereby enhancing photosynthetic efficiency;
- Optimizing canopy architecture to increase carbon capture and conserve nitrogen;
- Using selected genes from other species to increase biomass and yield; and

- Optimizing plant phenology leading to increased harvest index.

These diverse funded and aligned research projects in the IWYP research portfolio have been tasked to provide the scientific breakthroughs in wheat research that will achieve large, single event, yield jumps. The ARC project is expected to compliment and assist with marker and gene/trait validation of important IWYP funded projects outcomes such as “Molecular Dissection of Spike Yield Components in Wheat” lead by the John Innes Centre, (UK) as well as contributing to the development and identification of novel, high yield- potential germplasm for the larger IWYP programme to be feed into the IWYP CIMMYT pre-breeding hub. This germplasm development outcome is a critical part of the Research Area D: Building elite lines for dispersal to other breeding programs of IWYP’s mandate. The stacking of outstanding traits into elite germplasm and taking care of the relevant trade-offs to create wheat lines with much higher yield potential.

IWYP aligned projects are expected to give smaller but significant yield improvements in the next 5-10 years, compared to longer term funded IWYP projects which are expected to give yield jumps. This closed community of international researchers sharing and collaborating in such a unique manner is previously unheard of in the general science and research community, but is especially significant because of the global importance of wheat.

The ARC furthermore collaborate closely with the Stellenbosch University to guarantee that advantage of IWYP membership reaches all South African wheat pre-breeding programmes and through them, all South African wheat breeders and wheat producers. This project therefore also forms a part of the “*Integrated pre-breeding for wheat yield improvement*” project initiated to address the pressing need of South African wheat producers for higher yielding wheat cultivars. Jointly funded by the Winter Cereal Trust, the ARC and the Department of Science and Technology, ARC and the Plant Breeding Laboratory of Stellenbosch University are working together to provide high yielding wheat for South Africa.



IWYP Mexico.



High yielding wheat.

## MORE AND MORE VILLAGES INVOLVED IN EASTERN CAPE COMMUNITY DEVELOPMENT ASSOCIATIONS TO ENSURE LONG-TERM SUSTAINABILITY OF LIVELIHOOD IN THE REGION

The ARC’s Integrated Village Renewal Programme in the Eastern Cape is going from strength to strength as more and more villages become involved in the programme. This Programme has resulted in the upliftment of communities in villages in the OR Tambo, Alfred Nzo and Amatole District Municipalities. The development of village committees and primary co-operatives in 50 villages continued with the focus on the organization and functioning of the Community Development Associations (CDA). Several training workshops were held at the various villages and topics covered included organization, responsibilities and record keeping. The emphasis of the training was to enable the CDAs to function effectively and understand their roles and responsibilities. Continued support and assistance by the ARC and collaborating NGOs is critical to ensure that village organizations are able to function independently and effectively.

Concomitant with assistance in development of co-operative structures, technical training on subtropical crop production is regularly carried out and covers topics ranging from all aspects of good farming practises to harvesting, packaging and marketing of the product. A large majority of the farmers are also involved in value-added initiatives such as soap making with many of the established groups such as those in Hluleka, Xurana and Ngobozana expanding their activities and supplying their products further afield. A new group of farmers interested in becoming involved in value-added products through soap-making initiatives was identified, and underwent initial training in Dedeni. The agro-processing development in the villages currently allows for niche marketing but the challenge lies in increasing production in the villages to ensure the agro-processing groups produce sufficient products as demand grows.



Several communities in the Eastern Cape are engaged in value-added initiatives such as soap-making. New groups are becoming involved and established groups are expanding their product and market range.

## CREATING AWARENESS OF THE INVADER FRUIT FLY IN COMMUNITIES ACROSS MPUMALANGA AND LIMPOPO PROVINCES

The Oriental fruit fly, *Bactrocera dorsalis* (Hendel), is an extremely

destructive pest of fruit and vegetables in areas where it occurs. It is amongst the world's most important pests of horticultural crops. The Oriental fruit fly was first detected on the African continent in 2003 in Kenya. Since its first discovery in Kenya, the fly was reported in many countries in sub-Saharan Africa and was reported in South Africa for the first time in 2010 in the northern part of the Limpopo Province. By 2012 it was reported in Mpumalanga Province and declared present but subject to official control in the Ehlanzeni district municipality in 2015. Before the arrival of the fly in Kenya, the indigenous Marula fruit fly, *Ceratitis cosyra* (Walker) was the dominant fruit fly pest of mango. Within four years of invasion, the Oriental fruit fly displaced the Marula fruit fly and became the predominant pest of mango. In many African countries the Oriental fruit fly is currently the dominant fruit fly pest species attacking cultivated fruit crops.

The ARC worked closely with the Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) to combat the fruit fly problem in various district municipalities in the Limpopo and Mpumalanga Provinces and a project was initiated with the aim of creating awareness of the fruit fly problem and especially of the new invasive fruit fly species, *Bactrocera dorsalis*. Over 2000 farmers have attended various awareness and training workshops throughout the district municipalities. These workshops focussed on various aspects of the control and management of fruit flies to reduce wastage of fresh fruit as well as to prevent the spread of the pests within the Municipalities.



Over 2000 farmers across several District Municipalities in Mpumalanga and Limpopo Provinces were trained in fruit fly awareness and monitoring as well as the importance of fruit fly control strategies.

### THE BIENNIAL CITRUS RESEARCH SYMPOSIUM SHOWCASES ARC SCIENTISTS' CONTRIBUTIONS TO CITRUS RESEARCH AND THE INDUSTRY

The ARC's scientists regularly attend scientific and industry meetings in order to disseminate their research findings to stakeholders. The biennial Citrus Research Symposium was attended by the GE: Crop Sciences as newly-appointed CRI Board member as well as a number of scientists and PDP students. While the symposium's key focus area was the mitigation of biosecurity risks to the South Africa citrus industry, other thematic areas included horticulture, postharvest technology, cultivars and the potential impact of climate change on the industry. Key challenges to the industry were highlighted and these included phytosanitary constraints on exports and the associated impact on levy income. The importance of the Citrus Improvement Scheme (CIS) as a key mitigating factor to biosecurity risk with regard to diseases was highlighted, as well as issues regarding diseases affecting production and marketing in South Africa, and globally. The major threats to the industry are greening disease, false codling moth and the invader fruit fly, *Bactrocera dorsalis*. The ARC's role in the CIS as a mandate from DAFF was discussed, as was its key role in developing a molecular genotype reference database

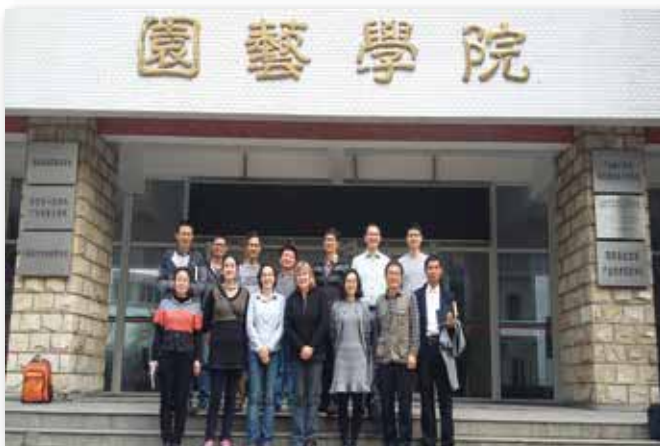
for cultivars in the CIS. The ARC is at the forefront of research for the citrus industry in several spheres and it is imperative that these significant contributions to the industry continue, and continue to be funded.



Several of the Agricultural Research Council's scientists and students attended and presented their research findings at the biennial Citrus Research Symposium.

### INTERNATIONAL COLLABORATION LEADS TO NEW RESEARCH OPPORTUNITIES FOR SUBTROPICAL CROPS

International collaboration with scientists from around the world is critical in terms of knowledge exchange and capacity development. Research results presented on international platforms such as scientific symposia showcase the knowledge and expertise held by the ARC. Collaboration with Chinese, Indian and Mauritian researchers regarding litchi cultivar exchange and expertise on litchi, orchard management practices can add to the SA litchi gene pool and improve current orchard management practices and create new research opportunities not only for litchi but for tropical and subtropical crops in general. One of these opportunities is already being harnessed and has resulted in studies towards addressing adaptive strategies to surviving climate change stress using molecular response to understand adaptation in litchi. The results of this research could have far-reaching applicability to several other subtropical fruit crops.



International collaboration opportunities provide a platform for showcasing the ARC's research as well as provide opportunities for capacity development.

## THE ARC'S EXPERTISE IN TEMPERATE AGRICULTURE RECOGNISED ON THE INTERNATIONAL STAGE

The ARC represented South Africa at the new Collaborative International Research Network on Sustainable Temperate Agriculture, initiated by the Global Science Forum (GSF). The ARC's involvement in the Network provides an opportunity for strengthening South Africa's international research and innovation partnerships in a domain as critical as the agricultural sector. This new network, known as TempAg, will serve as a platform for connecting countries investing in agricultural research in temperate climates. The goal of the network is to identify challenges and find solutions, through international cooperation. Participation in the TempAg initiative provides an opportunity for the ARC and South Africa to be inherently involved in the development of common methods for assessing the sustainability and the efficiency of current, emerging and novel agricultural practices and systems that aim to improve the productivity of temperate agriculture.

## LOCAL HERBAL TEA RESEARCH BY THE ARC PAVES THE WAY TO INTERNATIONAL COLLABORATION AND RECOGNITION

The ARC is currently involved in extensive research towards the potential health properties of rooibos and honeybush teas, both locally-produced beverages. While rooibos is well-known on both the national and international markets, honeybush is becoming more and more popular as a result of the research being carried out by research scientists and postgraduate students involved in a number of international collaborative programmes. The ARC is regularly invited by both National and International groups to discuss research progress towards product development, process optimisation and waste valorisation as well as the development of further collaboration strategies. Not only are new potentially health-promoting compounds (such as those involved in anti-obesity, anti-inflammatory, anti-diabetes, anti-oxidants, chemoprotection etc.) discovered, but methods for their optimised detection and extraction are investigated and are subsequently widely published. The extensive research programmes contribute significantly to the understanding of natural products chemistry and their potential in the development of phytomedicines. The current projects also contribute to human capacity development and smallholder farmer development.



The ARC's Bioactives group involved in rooibos and honeybush tea chemistry works with a number of international collaborators.

## SMALLHOLDER FARMERS TRAINED IN CONSERVATION AGRICULTURE

Smallholder farmers lack adequate knowledge and information on sustainable crop production practices. Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterised by three related principles, namely: i) continuous minimum mechanical soil disturbance, ii) permanent organic soil cover, and iii) diversification of crop species grown in sequences and/or associations. The training provided farmers with information on methodology and awareness on CA principles to revitalise soil as a key natural resource in agriculture. This will enable farmers to use more sustainable production practices, as well as increase their crop production and realise increased household incomes and food security.

## HONEYBUSH RESEARCH AND DEVELOPMENT SUPPORTS THE DEVELOPMENT OF THE HONEYBUSH TEA INDUSTRY BY SMALLHOLDER FARMER COMMUNITIES

Honeybush is an under-utilised endemic crop with a small industry but with the potential to grow internationally into an important herbal tea product. The ARC's honeybush breeding programme supports the growth of the industry through the development of improved selections with not only better yield characteristics but also improved chemical and sensory qualities which are critical in the herbal tea industry. Five communities in the Western and Eastern Cape Provinces established businesses that focus on honeybush seed production, nursery production and plantation establishment. The ARC in collaboration with the Department of Science and Technology facilitated the infrastructure development in these communities and the first seed harvest is expected in November 2017 even with the challenges experienced regarding the extensive drought in the region. In total, 42 community members across the five communities have benefited and their enthusiasm has seen the expansion of the programme despite the drought. Not only have several temporary jobs been created during the development phase, but further jobs are in the pipeline as production expands. Furthermore, human capacity development through skills training has resulted in the development of skills in honeybush propagation, cultivation and harvesting practices as well as business skills which will ensure that the smallholder farmers produce high quality tea for a demanding market. In addition, a number of postgraduate students have been involved and have graduated, or are currently involved in, honeybush research as part of their formal studies and several scientific and popular presentations and papers have been presented and published both nationally and internationally. The continued support of the smallholder farmers by the ARC will ensure that a thriving and successful industry based on South Africa's natural heritage goes from strength to strength.



The ARC in collaboration with DST facilitated infrastructure development including the establishment of honeybush plantations in selected communities.



Community members at the launch of their honeybush businesses in Clarkson.

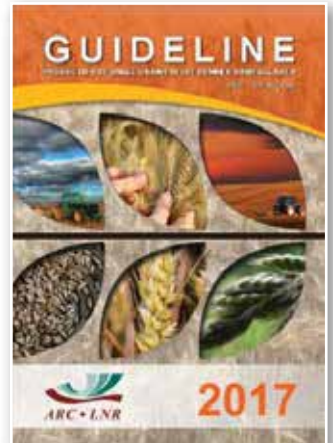
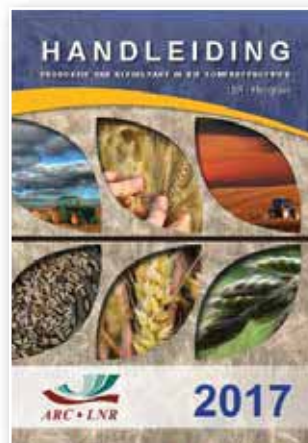
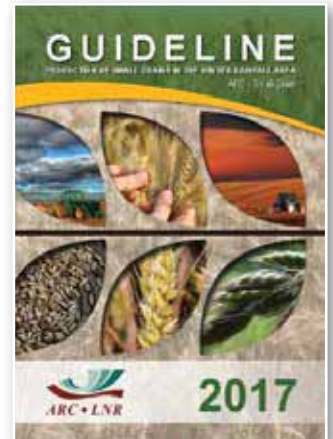
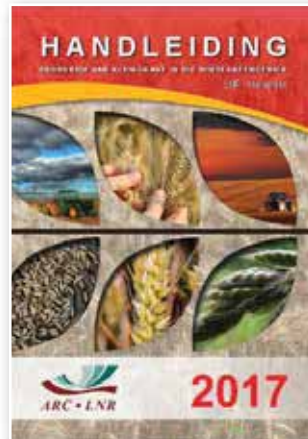
## NATIONAL SMALL GRAIN CULTIVAR EVALUATION PROGRAMME

South Africa has three varied and unique wheat production regions within the country. Irrigated spring wheat is planted near major rivers and reservoirs in the interior; dryland spring wheat in the Mediterranean area of the Western Cape; and dryland winter and intermediate wheat in the Central, summer rainfall region. Each production area makes use of cultivars specially adapted to prevailing conditions and has its own strengths and problems. This means that South Africa has a large number of wheat cultivars in commercial production relative to the area planted. With so many cultivars to choose from, wheat producers need relevant information on which to base their cultivar choice. This is where ARC plays a crucial role; that of managing and co-ordinating the National Wheat Cultivar Evaluation Programme. This programme is guided by a formal Protocol, developed by funders and stakeholders, and overseen by the Cultivar Evaluation Workgroup, where all role players in the Small Grain Industry are represented. Additional institutions that contribute research data to this programme are the Department of Agriculture of the Western Cape, SAB Maltings Pty Ltd (barley production guidelines), Stellenbosch University (triticale production guidelines) and the University of the Free State. In 2016 ARC was responsible for a total of 101 field trials that were planted in the three production regions. This included 72 cultivars for the entire country. ARC scientists harvested, collected data and analysed the results of all trials in time to present the data to the Cultivar Evaluation Workgroup on 8 February 2017. The Committee accepted the project reports and the ARC received the mandate to conduct the National Cultivar Evaluation Programme in all production regions during the 2017 season.



Representatives of the small grain industry that attended the National Cultivar Evaluation Meeting.

The information reported and approved at this annual meeting was published in four Production Guidelines for Small Grain Production, two each (one Afrikaans and one English) for the Winter Rainfall and Summer Rainfall areas. These guidelines were already available on ARC's website ([www.arc.agric.za/arc-sgi](http://www.arc.agric.za/arc-sgi)) during the first week of March 2017, the earliest these guidelines have ever been available to producers. By the third week in March the Winter Region Guideline had been accessed 117 times (Afrikaans) and 249 times (English). The Summer Region Guidelines had been accessed 131 times (Afrikaans) and 323 times (English). Hard copies of all four books were printed and distributed to small grain farmers throughout South Africa.



## TECHNOLOGY SPEEDS UP ONION BREEDING PROGRAMME

ARC male sterile onion lines are sold to seed companies to develop and commercialize F1 onion hybrid cultivars and are a potential source of income via royalties. Research showed that a new method, the TaqMan SNP probe assay, reduces the time to identify the correct genotype of male sterile and maintainer lines from two years to one month. Using this accurate genetic screening technique enables the onion breeding programme to recover the correct genotype and facilitate the production of the correct seed for commercialisation of ARC onion lines, both locally and internationally.

# OVERVIEW AND HIGHLIGHTS OF THE ANIMAL SCIENCES

The Animal Health, Production and Improvement Programme (AHPI) of the Agricultural Research Council largely supports the following organisation's strategic goals:

- Strategic Goal 2: To generate knowledge and technologies that will enhance the efficiencies in livestock based agriculture;
- Strategic Goal 3: To generate knowledge and technologies for the conservation and utilisation of natural resources;
- Strategic Goal 4: To generate knowledge, solutions and technologies for food safety, quality and improved efficiencies in the agriculture value chain; and
- Strategic Goal 5: To translate research outputs in order to generate knowledge, facilitate decision making and contribute to the transformation in the agriculture sector.

The AHPI Programme is directed at the social and economic development of the entire livestock value chain, which is a key factor in South Africa's social and economic development. The specific objective of the AHPI Programme is to advance the productivity, production, competitiveness and sustainability of the livestock industry. This is achieved through scientific research, human capital development and implementing new and improved technologies for animal health production, improvement, veterinary science and animal products. Strategic objectives are defined for each of the focus areas. The ARC Animal Health, Production and Improvement Programme is in dynamic partnerships with the livestock industry from grassroots production to the levels of industrial activity and to product consumption.

In addition, the Programme manages certain national services on behalf of the Department of Agriculture, Forestry and Fisheries (DAFF) and serves as the custodian of some national assets of the Department of Science and Technology (DST). The national services provided by the programme include the National Animal Improvement Schemes which include the Kaonafatso ya Dikgomo (KyD) Scheme, a special purpose vehicle to improve livestock productivity in the smallholder farming sector. The national assets under care of the programme include the national forage genebank, rabies laboratory, blood vaccine production unit, national tick and helminth collection and the collection of beneficial gastrointestinal and food fermentation micro-organisms, to name but a few.

Statutory obligations form a second channel for scientific services and research whose results have a wide application according to the objectives of the various animal improvement and health legislations (e.g. the Animal Improvement Act No. 62 of 1998). Although the main sites of operation for the Programme are at Irene, south of Pretoria and at Onderstepoort, in the north west of Pretoria, it has satellite stations that are strategically positioned in almost all of the nine provinces of South Africa.

Achievements attained by this Programme under various Agricultural Research Council research and development and service delivery programmes for the financial year 2016/17 are highlighted below:

## HEARTWATER VACCINES

Heartwater is an economically important tick-borne disease which affects cattle, sheep and goats in South Africa. It is the result of infection by *E. ruminantium*, an intracellular parasitic bacterium. The only sustainable method for control of heartwater is by vaccination against the disease. Presently, only one vaccine produced by ARC is commercially available on the continent as a live virulent vaccine. This blood vaccine has been in use for over 50 years, but it has numerous well-known inadequacies and requires improvement in

terms of safety, efficacy and cost. It is four times more expensive than conventional livestock vaccines making it inaccessible to resource poor farmers. The need to develop a more safer, efficacious and user friendly vaccine could not be overemphasized.

A new attenuated heartwater vaccine was recently developed at the ARC that meets the above conditions. The technology for producing the vaccine is in the process of being transferred to the Onderstepoort Biological Products (OBP) for commercial mass production. The endothelial cell line and attenuated heartwater organism "working seeds" have been transferred to OBP, with the original "parent seeds" kept at ARC after obtaining mycoplasma free certification. Optimization of growth conditions of the attenuated heartwater pathogen are in progress at OBP. A preliminary work plan for production of a vaccine batch has been developed in line with the project progress.

In addition, another project at ARC is looking at improving an experimental recombinant vaccine for heartwater. Researchers are using global transcriptional analysis to identify differentially transcribed *E. ruminantium* genes in cell culture, as well as tick tissues. From the list of differentially transcribed genes, candidates genes have been selected which are predicted to be expressed on the bacterial cell surface. Their recombinant proteins were expressed in a bacterial expression system. Several chickens were immunised with these recombinant proteins or whole inactivated *E. ruminantium* and chicken IgY isolated. Those shown to bind to proteins located on the surface are being tested for their ability to prevent the organism from entering cells of either the tick or the host. Proteins identified in this way represent potential immune targets which may provide leads for subsequent development of vaccines or transmission blocking therapies.

## COLLABORATION ON ZONOTIC DISEASE RESEARCH

Given the growing importance of zoonotic diseases, it is important for scientists in both the veterinary and medical fields to enhance collaboration in search of viable solutions. The ARC and National Institute of Communicable Diseases (NICD) under the department of Health are the national Co-Chairs of the One Health Forum, in the country. The two entities were involved in an inter-laboratory testing schedule where both laboratories are exchanging standard operating procedures (SOPs) and reagents to test on a standard test panel for Rift Valley Fever (RVF), a zoonotic disease that causes mortality and death in animals and humans.



Members of the South African National One Health Forum.

## NEW GENERATION VACCINES

A research team at ARC are working on a International Development Research Centre (IDRC) funded project that aims to develop multivalent vaccines against a number of economically important viral livestock diseases that impact on the livelihoods of developing farmers throughout Africa. This project resulted in a patent that was registered on 13 October 2016 under the title "Recombinant Lumpy Skin Disease virus knock-out mutant and uses thereof".



Lumpy skin disease (LSD) is an acute or inapparent disease of cattle caused by lumpy skin disease virus (LSDV), a poxvirus, belonging to the genus *Capripoxvirinae*. It is an important, insect-borne infectious disease of cattle; and is endemic in most African countries and has now spread to the Middle East and Turkey.

The invention relates to a live-attenuated recombinant lumpy skin disease virus knock-out mutant, wherein the interleukin-10-like gene has been inactivated in the viral genome. The invention specifically relates to the recombinant lumpy skin disease virus knock-out mutant, pharmaceutical compositions comprising the knock-out mutant, methods of producing the knock out mutant and use of the knock-out mutant.

## DIAGNOSTIC AND ANALYTICAL CAPABILITIES AT THE ARC

The ARC celebrated twenty years of accreditation by SANAS (South African National Accreditation System). The ARC-Irene Analytical Services obtained their official SANAS accreditation on 1 November 1996, a first for the ARC. This analytical laboratory provides an outstanding analytical service to the food and feed industry on a broad technical basis by means of product analysis. The services are rendered from two main locations i.e. Irene and Elsenberg. The Elsenberg Analytical laboratory is equipped with analytical instrumentation that can determine fat, protein, lactose, urea, somatic cell counts, pH, total solids, solids non-fat and freezing point in milk from cows, goats, sheep and buffalos. The unit also tests milk for the purposes of capturing data on the Integrated Registration and Genetic Information System (INTERGIS). This is important to develop technologies to improve the quality of animals; to develop genetic and physiological methods to identify and study superior livestock breeding material in order to improve the efficiency and production of the national herd; and it promotes animal production through improved nutrition. The Irene analytical services includes chemical and microbiological analysis. The laboratory is accredited by SANAS to the international criteria defined in ISO/IEC 17025:2005. The primary role of the laboratory is to deliver accurate results within the shortest turn-around time. The tests include amino acids, fatty acids fat-soluble vitamins, water-soluble vitamins, gross energy, dietary fiber, carbohydrates, crude fiber, proximate analyses, phosphatase activity, *Salmonella spp.*, coli forms, total bacterial count, pathogens, solubility index etc. Clients include municipalities, DAFF, universities, research institutes, food and feed manufacturing companies, commercial and rural farmers.

At the beginning of June 2016 the ARC laboratories received clinical material collected from domestic pigs in Ipelegeng Township in Sweizer Reneke (North West province), where pigs were dying of a hemorrhagic disease. The samples were processed and found to contain the African swine fever virus (ASFV). ASFV is a highly

contagious virus known to infect both wild and domestic suids, resulting in mortality rates of up to 100% in naive domestic pig populations. Based on the laboratory findings the Department of Agriculture Forestry and Fisheries (DAFF) on 10 June 2016 declared an outbreak of African swine fever in the disease-free zone of South Africa. Soon after, another incident of ASF was diagnosed in the Free State province. This causative viruses was found to be similar to the previous identification. The ASF virus that were isolated were classified as belonging to the Genotype I subtype of ASFV. This is the first occurrence of this subtype in domestic pigs in South Africa. The Genotype I subtype is generally associated with the northern parts of southern Africa, West and Central Africa and Europe. These results suggest that the outbreak may have been caused by the introduction of diseased pigs from a neighboring country. The quick diagnosis was appreciated and a report in the Farmers weekly of 18 June 2016 acknowledged the ARC's role in the diagnosis of both outbreaks. In the same year, the OVR received samples from Mauritius where they had been suspicions of an FMD outbreak. The outbreak was confirmed by the laboratory and attributed to SAT2 strain of the virus.



Female technician at work in a diagnostic laboratory at the ARC.

Early in July 2016, and through routine diagnostics, bovine tuberculosis (*Mycobacterium bovis*) was confirmed for the first time in a black rhinoceros from the Kruger National Park (KNP). The pathogen was detected in genetic material (DNA) directly extracted from tissue samples albeit using a test method that is currently under validation, and within 3 days of receipt. The DNA result was confirmed by culture. The identification of bovine tuberculosis in a black rhinoceros has serious repercussions for the South African National Parks (SANParks) rhinoceros trade, as rhinoceros were previously believed to be free of bovine tuberculosis and hence movement control measures did not apply to them. Similarly a *Mycobacterium bovis* (*M. Bovis*) in a white rhinoceros from the Kruger National Park (first case). In this case was identified, *M. bovis* was isolated only from a lung sample, and no further isolation was made in other tissues such as lymph nodes. More interesting is the isolation of *Mycobacterium tuberculosis* (usually a human pathogen) from an elephant originating from Tshokwane (KNP). Laboratory personnel have also also isolated both *M. bovis* and *M. tuberculosis* from a buffalo originating from the Northern Cape Province. Dual infection with *M. bovis* and *M. tuberculosis* was detected in a tonsil sample from 1 in 7 samples submitted for testing.

## DEVELOPING FARMER OUTREACH AND EDUCATION PROGRAMMES

The demand for food, in particular, animal protein, is increasing worldwide and South Africa is no exception. South Africa has approximately 40000 commercial farmers and close to a quarter of

a million smallholder farmers. The resources that farmers make use of, including land, is becoming more and more limiting and there is a general call to “produce more from less” and this is of particular relevance in view of the huge disparities in production figures (based on a number of traits of economic importance) in the different beef producing sectors. One of the key factors that will determine whether farmers will enhance their production and productivity is our ability to ensure that farmers are capacitated and skilled through effectively facilitation of service delivery, technology transfer and information dissemination. Training is regarded as a crucial component of information dissemination and as such central to ensuring the advancement of productivity, production, competitiveness and sustainability.



Farmers being taught the correct method to draw up vaccine dose for their livestock vaccinations.

### NATIONAL BEEF CATTLE IMPROVEMENT SCHEME

The National Beef Cattle Improvement Scheme has embarked upon an aggressive and all-inclusive strategy in this regard. The strategy involved the development of tailor-made packages and numerous training initiatives that involved delegates from countries such as Botswana, Namibia and even the Middle East. The Beef Scheme published more than 27 popular articles, participated 17 radio interviews and made numerous presentations at various platforms. A newly revised Beef Breeding Manual was also published which is used as a training tool for the various courses presented. The Beef Scheme has also been mandated by the Beef Genomics Programme (BGP) to be the accrediting authority for Real Time Ultrasound (RTU) scanning services and has subsequently accredited ARC technicians nationally as well as from Namibia. In addition, new state of the art RTU equipment was also procured in order to satisfy the scanning needs from industry.



Practical training on Real Time Ultrasound scanning at the bull test centre of Animal Production Campus to the farm manager and veterinarian of the Crown Prince of Fujairah.

### KAONAFATSO YA DIKGOMO SCHEME

The Kaonafatso ya Dikgomo (KyD) Scheme is a special purpose vehicle aimed at accelerating the participation of small-holder producers into the mainstream livestock industries. The KyD Scheme strives to catapult small-holder farmers to all levels of the livestock value chain. The Scheme is gradually realising outcomes of this effort illustrated through progress made by individuals and communities. Increased awareness about the importance of income generation from livestock has culminated in escalated demand for localised cattle auction sale activities. The close cooperation between the ARC and provincial departments of agriculture as well as other partners enabled the execution of successful cattle auction sales in rural areas. A total of 8404 smallholder farmers received scientific support from the KyD Scheme and their data has been uploaded onto INTERGIS. Several KyD farmers have made significant progress to upgrade their herds to become stud breeders. Most of these farmers are currently engaging with different breed societies for registration. This highlights the importance of record keeping for tracking of herd performances. These new development within the KyD scheme is important to increase the number of small-holder stud breeders in our county. Other participants of the Scheme are also venturing into intensive production systems such as feedlots. One of the Scheme’s participants has initiated a small-scale feedlot based on weaner supply from local farmers, which is easing the “barriers to market” for smallholder farmers. In another initiative, one of the Scheme’s participants established a small-scale abattoir including packaging and processing. This initiative will also ease the market access for smallholder farmers in the area. These successes highlight the entry of smallholder farmers to the agricultural value chain.



A KyD farmer from Mpumalanga operates a small-scale abattoir.

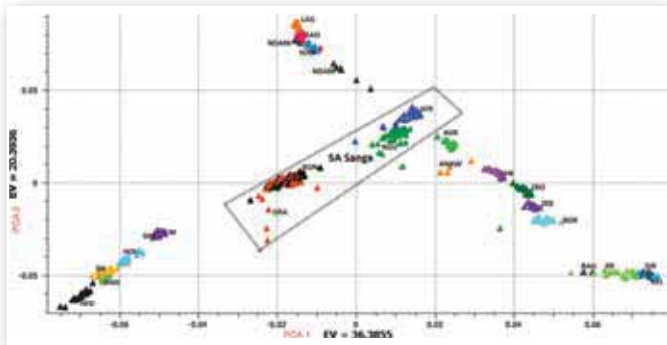
The ARC’s interactions with farmers and other stakeholders through training, field days and workshops increased dramatically in 2016/17. The total number of farmers and animal health technicians trained surpassed 660. Numerous field days were also conducted throughout the country where farmers were advised on best farming practices and disease prevention and treatment management.



Engagement with farmers at Farmer’s Day, Northern Cape.

## GENETIC RESEARCH USING CUTTING-EDGE GENOMIC TECHNOLOGY PROVIDES INSIGHT INTO THE GENETIC COMPOSITION OF SOUTH AFRICAN SANGA CATTLE

The origin of South African cattle remains an interesting research question that continues to attract attention from animal geneticists. The advent of genomics has provided an opportunity to explore this question in a comprehensive manner. A collaborative research project was conducted to gain a better understanding of the origin of South African Sanga cattle by a team of researchers from the ARC University of Pretoria and University of Missouri in the United States. Specifically, the aim of this research was to establish a more precise analysis of patterns of admixture and ancestry in the Afrikaner, Nguni, Drakensberger and Bonsmara cattle of South Africa, in comparison to a comprehensive database of worldwide cattle breeds. Genomic characterisation of South African Sanga cattle is the first step towards the development of appropriate breeding and selection programmes. It was found that Sanga cattle are composites between African taurine and *Bos indicus*. Among these breeds, the Afrikaner significantly diverged from its ancestral forebears, probably due to genetic drift and selection to meet breeding objectives of the breed society. The Nguni, Drakensberger and Bonsmara breeds are admixed, perhaps unintentionally in the case of Nguni and Drakensberger, but certainly by design in the case of Bonsmara, which was developed through crossbreeding between the Afrikaner, Hereford and Shorthorn breeds. This study established patterns of admixture and ancestry for South African Sanga cattle breeds. This information will provide basis for developing appropriate strategies for genetic improvement in these breeds.



Principal component analysis incorporating South African Sanga breeds into a set of 20 worldwide cattle breeds.

## ENDURANCE FODDER RADISH – A BIG BREAKTHROUGH!

Endurance, one of the ARC's new forage variety, was bred at the ARC Cedara Forage Breeding Center in Pietermaritzburg. This variety is a cross between a unique late-flowering fodder radish line obtained from PGG Wrightson Seeds (PGW) of New Zealand, and ARC Cedara's two soft-leaved fodder radish cultivars "Geisha" and "Sterling". Following this initial cross, it took another eight years of annual selection and breeding before Endurance was finally released.

Endurance's IP and Plant Breeders Rights (PBR) are shared between ARC and PGW. ARC has granted a licencing agreement to Pannar to market Endurance in South Africa while PGW will market Endurance in the rest of the world. PGW has already planted Endurance in trials in New Zealand, Uruguay and the USA and Endurance will come onto the market in the USA from 2018, with royalties earned from seed sales being shared between ARC and PGW.

Endurance is proving to be a dual-purpose crop with high-yielding roots and leaves for animal consumption while its soft leaves are

considered very palatable for use as mfino/morogo. In a fodder radish yield trial planted at Cedara on 11 March 2010, Endurance started flowering approximately six weeks later than four other cultivars in the trial, thus giving farmers who plant Endurance extended grazing and the potential of an additional six tons DM yield of roots and leaves. In this trial, following an autumn-planting, the four fodder radish cultivars in this trial flowered early in spring and then the bulbs started rotting, whereas Endurance's late-flowering attribute and its long-lasting roots is particularly noteworthy. Endurance has predominantly white flowers, its leaves and stems are predominantly free of the cell pigment anthocyanin.

In addition, a potential second new late-flowering fodder radish cultivar "Line 2" will require several more years of selection and breeding before it is named and released.



Inspection of pre-basic seed unit of Endurance at Oudtshoorn.

## SAFE SCHOOL MILK AND HEALTHY CALVES ON SMALLHOLDER DAIRY FARMS

Milk is nature's most complete foodstuff, a premium food rich in macro-and micronutrients. Most notable components are calcium and fatty acids. This food is critical for early physical and intellectual development in animals and the most vulnerable groups (children, the sick and elderly). Because milk is an excellent food and income source, schools must ensure that it is available to all learners. It is against these benefits and scholastic advantage that the Dairy Value Chain (DVC) programme modelled a new dairy production system at Bethel College in Butterworth, OR Tambo district in the Eastern Cape province. The dairy unit, and other agriculture enterprises at Bethel College were defunct dairies for over 40 years and pastures retrogressed to bushveld. South Africa has suffered large declines in the number of dairy farms and most smallholder-producers do not meet the criteria for channelling milk through formal markets. The significantly low numbers of young people entering dairy farming businesses is an even more significant factor in the decline. To reverse that trend a creative approach was necessary to make dairy farming more attractive. The Bethel Dairy Value Chain initiative is one such programme that is perfectly aligned to national strategic goals of entrepreneurship and employment creation.

In addition to high feed costs, animal diseases also constitute a major challenge in dairy farming. The high susceptibility as well as the close proximity to humans exposes neonatal dairy animals and milk to a wide range of pathogens. Management strategies such as *ethno-pharmacological remedies* are more suitable for low input systems and have greater appeal to consumers in light of the global concerns with the use of antibiotics in animal production. These are being investigated.

Within the DVC projects, ground pawpaw seed was tested for its potential to improve calf feed intake and growth, and reduce gut pathogens. Supplementing pawpaw seed to dairy calves from day 4 to 42 improved the daily weight gain of calves, resulting in heavier calves at weaning. Calves fed ground pawpaw seed gained 0.22 kg more daily than the control calves. In addition, during the first 10 days of age, the faecal coliforms and *E. coli* counts were lower in these calves compared to the control calves. Supplementing calves with ground pawpaw seed showed potential for controlling gut pathogens and improving calves' growth performance.



Interaction with dairy cows as part of the Bethel Dairy Chain initiatives.

## EPIDEMIOLOGY OF RABIES

The World Health Organization (WHO) estimates that as many as 60,000 human deaths occur due to rabies annually, and approximately 98% of these are due to dog bites. In South Africa, a unique situation exists because of the presence of canid and mongoose rabies virus (RABV) biotypes within the classical rabies species. The former is maintained principally by domestic dogs in northern South Africa, KwaZulu-Natal (KZN), Mpumalanga and the Eastern Cape provinces, these being canine rabies endemic areas

in the country. The mongoose rabies biotype (also referred to as the herpestid variant), is adapted to a variety of mongooses (small carnivores belonging to the family Herpestidae) and the principal vector species for the mongoose RABV biotype in South Africa is the yellow mongoose.

Approximately 40% of the total annual submissions (n=1200) for RABV to the ARC are positive for the lyssavirus antigen. In 2016, RABVs originating from 14 wildlife carnivore species, two dogs and a feline [all from the North West Province, with the exception of two from black-backed jackals (Limpopo), one each from a dog (Limpopo), feline and mongoose (both from Mpumalanga), were genetically characterised by targeting a partial region of the nucleoprotein (N) gene. Nucleotide sequence analyses of these viruses and two previously characterised RABVs demonstrated that the outbreak viruses (in Madikwe in the North-west province) were indeed canid rabies, phylogenetically clustering with virus isolates originating from black-backed jackals (recovered in 2012 from the North West Province) and domestic dogs from neighbouring communal areas. The findings demonstrate that domestic dog and wildlife carnivore rabies cycles are intrinsically linked, particularly at the human-wildlife interface, and the associated public health risks, can be mitigated through rabies control at its source.

The last rabies outbreak in Gauteng occurred in 2010. Subsequent to the 2010 dog rabies outbreak, there have been incidental rabies cases in this species. However, the first half of 2016 recorded a total of 16 laboratory confirmed RABVs from the province. The rabies viruses were confirmed in the black-backed jackal species (n=10), bovine (n=4), dog (n=3) and a single virus from a honey-badger. Of the confirmed rabies viruses, 8 of these were sequenced by targeting the glycoprotein gene and the data support the notion that the 2016 rabies outbreak resulted from two separate introductions probably from a wildlife (jackal) cycle and the other from a typical domestic dog rabies cycle. This data further underscores the complexity of rabies epidemiological cycles in South Africa and the challenges posed for the elimination of the disease from both domestic and wildlife reservoirs and vector species.

The World Rabies Day is now used as a platform to enhance the awareness of the public about the disease with a view to reduce the number of human rabies cases in rural communities where the disease is endemic.

The work carried out by the Research and Innovation Systems (RIS) division of the Agricultural Research Council primarily supports two of the organisation's strategic goals:

- Strategic Goal 3: To generate knowledge and technologies for the conservation and utilisation of natural resources;
- Strategic Goal 4: To generate knowledge, solutions; and technologies for food safety, quality and improved efficiencies in the agriculture value chain.

However, the research of the RIS division also overlaps with the work carried out in the Crop Sciences and Animal Sciences divisions and thus supports both Strategic Goal 1: To generate knowledge and technologies that will enhance the efficiencies in crop based agriculture, and Strategic Goal 2: To generate knowledge and technologies that will enhance the efficiencies in Livestock based agriculture.

Research in the RIS division focuses on biotechnology, agricultural mechanization and engineering, and natural resource management (soil, climate and water). With a wide range of services, development and research functions for technologies in areas such as genomics, phenomics, remote sensing, agricultural systems modelling and engineering systems.

The main sites of operation for the RIS division are Onderstepoort, Silverton and Arcadia, all in Pretoria, but the division is strategically positioned across most campuses of the ARC. Achievements attained by this division under various ARC programmes for the financial year 2016/17 are highlighted below:

## Research focusing on Biotechnology

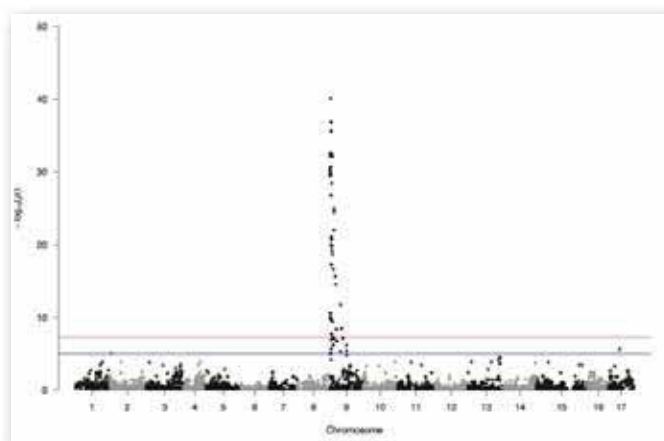
### CHARACTERIZATION OF QTL ASSOCIATED WITH CHILL REQUIREMENT DURING ENDODORMANCY IN *MALUS X DOMESTICA* BORKH.

All deciduous fruit trees, including apples, require a predetermined amount of winter chill to be fulfilled for budding to occur in spring. Chill requirement is variable between species as well as varieties within species. This can, for instance, range from 300 hours for the apple variety "Anna" to 1000 hours for "Granny Smith". Apples are the second most widely produced fruit crop in South Africa and have an annual turnover of approximately R8 billion. One of the biggest threats to apple production is rising temperatures due to global warming. The most widely produced varieties like Granny Smith, Golden Delicious and Royal Gala are unable to fulfil their winter chill requirement. The inability of the plant to fulfil chill requirement causes it to bud and therefore fruit unevenly. Extended fruiting times causes poor fruit quality for export and a drop in the value of the crop. Dormancy braking chemicals have been used to overcome extended budding, but it has been banned in most countries since 2011. Breeding fruit trees with low chill requirement and high fruit quality have become a priority for multiple breeding groups. However, traditional breeding is time consuming and unpredictable therefore molecular breeding has become an important tool in breeding fruit crops. Obtaining good quality genomic data is the first step in molecular breeding. In this study, genomic mapping and subsequent association studies were used to screen for a region of interest that is associated with chill requirement on the apple genome. A single quantitative trait locus (QTL) on chromosome 9 was

discovered to be strongly associated with chill requirement. RNA was extracted from buds at different time points during dormancy and evaluates the expression patterns of the genes with in this region of interest. Approximately 450 genes were predicted within this region of which 60 were expressed during dormancy. The expressed genes include well-known dormancy and flowering associated genes as well as genes that have not previously been associated with the trait. These include transcription factors that are mainly associated with DNA binding, methylation and the plasma membrane and transport of metabolic products through the membrane. Overall, the study indicates that chill requirement during dormancy is a complex trait that is regulated by multiple genes that is all situated in one region of the genome.



Comparison low chill and high chill varieties, early in spring.



QTL associated with chill requirement in a Royal Gala x Anna population.

### COMPUTATIONAL PREDICTION OF EPITOPES ON THE FOOT-AND-MOUTH DISEASE VIRUS CAPSIDS OF SOUTH AFRICAN TERRITORIES (SAT) STRAINS

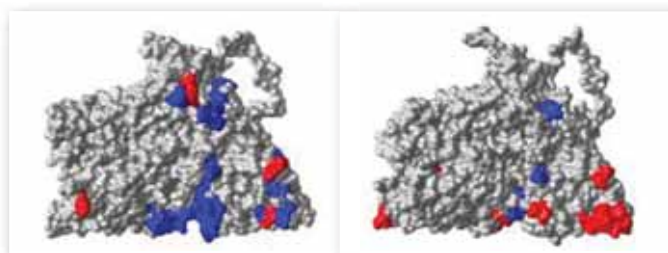
Foot-and-mouth disease (FMD) is a highly contagious and economically important disease that affects even-toed hoofed mammals such as cattle and buffalo. Despite a low mortality rate, the effects of FMD outbreaks are particularly catastrophic since all infected and close-contact animals have to be slaughtered and destroyed. In regions where FMD is endemic, the disease is

controlled mostly through vaccination, and this strategy has been successful in eradicating the disease in parts of Western Europe. There are three strains of the FMD virus that are unique and endemic to Sub-Saharan Africa, known as the South African Territories (SAT) strains. The SAT strains are unique in that they show higher levels of antigenic diversity, thereby making it difficult to design broad-reactive vaccines capable of providing immune protection against all the environmental strains. Farmers are then forced to vaccinate their animals more often, which is not an option for many small-holder farmers.

The ARC has various projects dedicated to the development of improved FMD vaccines. One of these projects focused on the prediction of SAT epitopes, which are located on the surface of the FMD virus. These epitopes are structural sites to which the host recognizes and produces antibodies against, thereby resulting in long-term immune protection. By knowing the epitopes that are common among the SAT viruses in circulation, a vaccine can be rationally designed that is able to afford broad-spectrum immune protection.

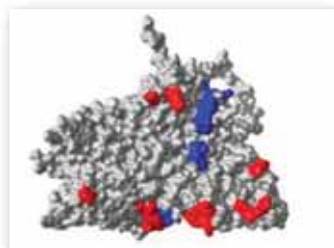
Computational methods were used in this project in order to overcome the time and resource limitations of employing purely experimental methods. Structural models of 18 SAT viruses were built using the homology-modelling programme *Modeller v12*. These structural models were input to two epitope prediction servers, namely *Discotope1.0* and *Ellipro*. Those amino acids predicted by both programmes were defined as putative epitopes, some of which have been confirmed by mutational studies.

A putative novel antigenic site, which has not been seen across all the FMD virus strains was also identified. Furthermore, a potentially novel disulfide bond anchoring the immunodominant GH loop of VP1 was predicted on one of the SAT strains. The conformations adopted by this loop are being investigated through molecular dynamics simulations on the Centre for High Performance Computing cluster. The aim is to achieve microsecond simulations, the time range at which it is expected to observe protein domain movement. The collective results of this study may consequently be used in the rational design of more effective broad-reactive SAT vaccines.



SAT1

SAT2

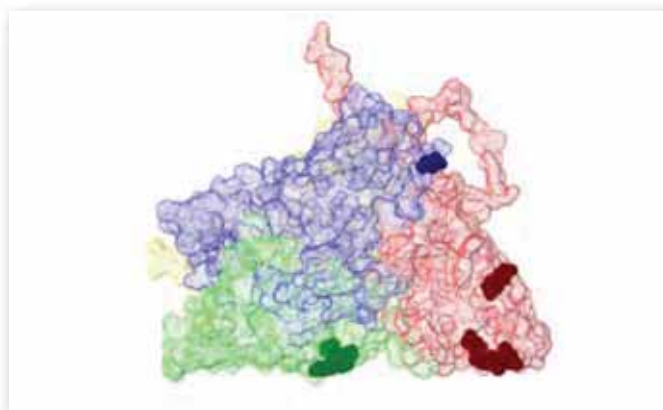


SAT3

SAT epitopes predicted by both *Discotope1.0* and *Ellipro* epitope prediction programmes.

The predicted epitopes are highlighted on three different SAT strains. The novel epitopes are shown in blue, and previously known epitopes on other FMD serotypes are shown in red. The grey represents a

repetitive subsection of each FMD virus capsid.



Consensus epitopes among 18 SAT strains.

Those predicted epitopes that were found in common amongst all the SAT strains are highlighted as spheres. The mesh represents a repetitive subsection of an FMD virus capsid.

### GENETIC ADAPTATION OF SOUTH AFRICAN INDIGENOUS GOATS: LANDSCAPE GENOMICS APPROACH

South Africa has considerable variation in climate and topography with diverse agro-ecological and climatic features such as temperature and rainfall. Indigenous livestock such as goats have demonstrated the ability to thrive and be productive in low input, and unfavorable production landscapes. This adaptation is important for their survival and is especially true for goat populations that are raised under limited or no human intervention.

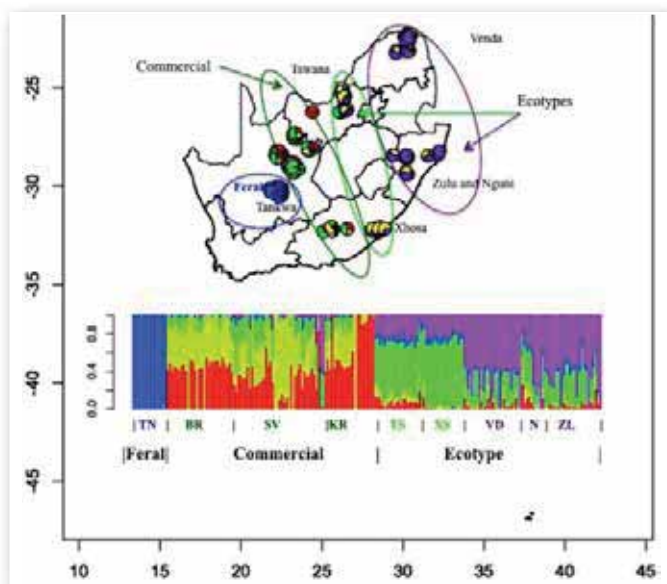
The ARC has numerous programs focused on the application of genomic tools in the goat improvement particularly in the smallholder production sector. The main objective of the study was to unravel the genetic diversity, and population structure and to investigate the factors shaping genetic variation and adaptation in South African indigenous goats. This is important for genetic improvement programs, and genomic selection programs. The study goat population represented the locally developed meat type breeds, the Boer, Savanna, and Kalahari Red, a feral breed of Tankwa, unimproved non-descript village ecotypes from goat procuring provinces of the Eastern Cape (Xhosa), KwaZulu-Natal (Zulu), Limpopo (Venda) and North West provinces, and Nguni (iMbuzi).



These were genotyped using the Illumina Goat SNP50K panel. Higher level of inbreeding and lower levels of genetic diversity was observed in commercial and Tankwa breeds compared to

unimproved non-descript village ecotypes suggesting the effects of different production systems on the genetic diversity in these goat populations. Principal Component Analysis, ADMIXTURE and pairwise  $F_{ST}$  identified Tankwa as a genetically distinct population and supported clustering of the populations according to their production systems and historical origins. Further geographic clustering revealed the Tankwa breed genomic signature was associated with one geographic region of the Northern Cape with homogenous genetic backgrounds with minimal level of admixture, presumed to be as a result of the low gene flow from other regions and between domestic and feral goat populations. These findings suggested that the Tankwa breed should be closely supervised and preservation strategies should be implemented to avoid further inbreeding. The geographic distribution of other populations followed a longitudinal pattern where the Tswana and Xhosa goats were located between 26°- 28° E and the Zulu, Venda and Nguni goats located at 30° E. Commercial breeds shared genetic components origin and harbor different fractions of ancestries suggestive of a common origin of the populations. Commercial breeds with different population genetic components showed a wide geographic spread.

Further analysis of signatures of selection and associated genes revealed genes involved in metabolism and responses to heat, water scarcity and diseases that allow indigenous goats to tolerate environmental pressure in their local production systems. Coupled with this information, this study has potential in goat improvement programs such as community breeding programs.



Map of South Africa. The ADMIXTURE plot represents average coefficients of membership resulting from the genetic structure analysis (best fit model,  $K = 5$ ). Each colour represents a different gene pool. The included barplot represents each accession as a single vertical bar broken into  $K$  colour segments, with lengths proportional to the estimate probability of membership in each inferred cluster.

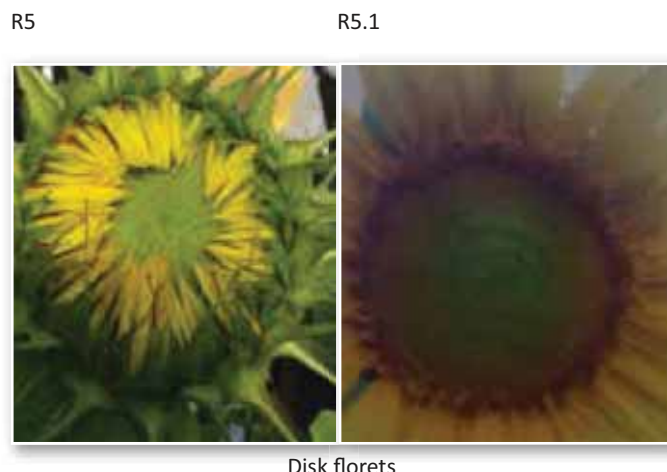
### EXPRESSION ANALYSIS OF SUNFLOWER ACHENE (SEED) DEVELOPMENT.

Sunflower (*Helianthus annuus*) is cultivated worldwide for its edible oil and it is reported to contribute 60% of the oil seeds produced in South Africa. Within the sunflower achene, oil and proteins are synthesized and stored in the cotyledons of the embryo. The byproduct of oil pressing from sunflower achene, the oil cake, is used as feed for livestock. The price value of the oil cake is determined by the amount of protein contained within. Sunflower was identified

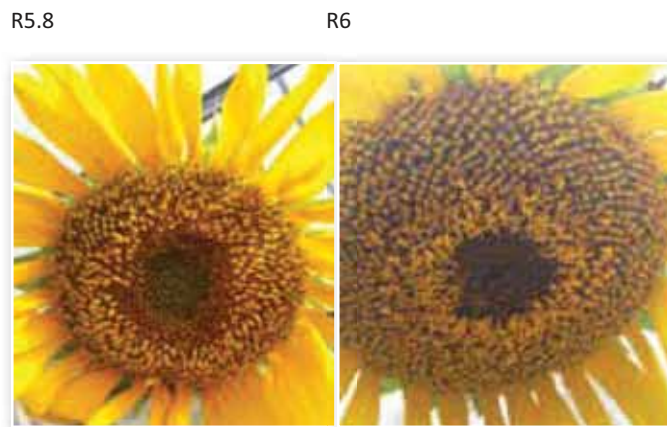
along with canola and soya, as an important candidate for biodiesel production in the Biofuels Industrial Strategy of South Africa.

This study focused on elucidating the underlying mechanisms involved in sunflower seed oil and protein production and accumulation. Sunflower achene were screened and selected from the sunflower germplasm maintained at ARC, Potchefstroom. KP1920, a high-oil sunflower line was grown and maintained in the greenhouse until the plants reached a reproductive stage R4, where anthesis of the disk florets takes place. Developing sunflower achene were collected at different weeks post anthesis till senescence. Total RNA was extracted from the collected achene from ARC germplasm sequenced on the Illumina HighSeq 2500 platform denovo assembled followed by bioinformatics and statistical analysis.

The assembled transcriptome is statistically comparable to an internationally assembled HA412 transcriptome library generated from various tissues (flowers, roots, stems and leaves). Biological processes important in TAG and protein biosynthesis are amongst the GO functions assigned to the assembled transcripts. This library will serve as a reference database for future studies on how these transcripts are expressed over the achene developmental stages and contribute to the observed traits at harvest of sunflower seeds. The information generated will assist ongoing efforts to improve on the oil and protein composition of the cultivated sunflower in South Africa, which will in turn improve the economic output in the Agricultural sector.

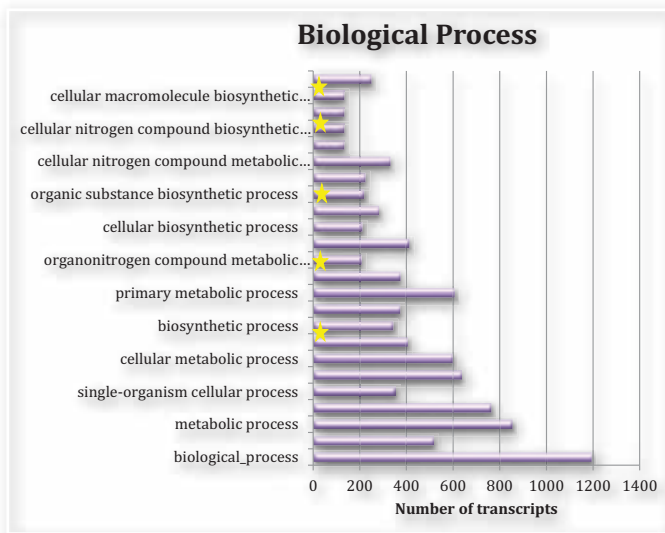


Disk florets



Developing achene

Reproductive stages during sunflower plant development. R5 is the substage of reproduction where the sunflower capitulum/head is ready to start opening. Once opened, the disk florets open in sequence, starting from the outer most part of the head (R5.1) to the center (R6). During this period, hundreds of achenes develop on one sunflower capitulum.



Functional annotation of the assembled transcriptome using Blast2Go analysis.

## Research focusing on Natural Resources (Soil, Climate and Water)

### APPLICATION OF RAINWATER HARVESTING AND BIOGAS PRODUCTION TO ENHANCE HOUSEHOLD FOOD SECURITY AND ENERGY GENERATION

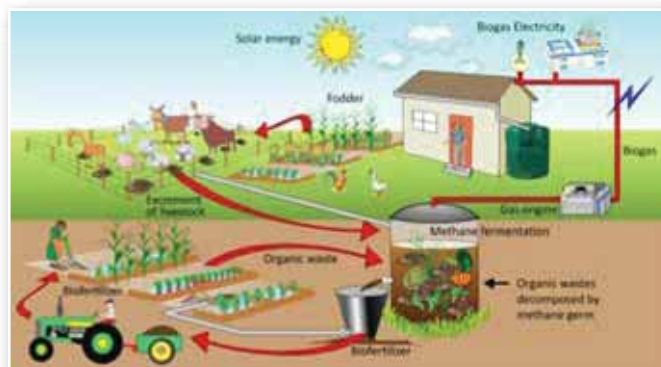
Poverty and food insecurity are generic to many rural villages where villagers depend on rainfed agriculture and the exploitation of natural resources for household consumption and income generation. Much of this land is located in arid or semi-arid areas with marginal soils and low and erratic rainfall, where a large proportion of the precious water is soon lost as surface runoff and evaporation. The recent droughts have highlighted the risks to human beings and livestock, which occur when rains falter or fail. While irrigation may be the most obvious response to drought, it has proved costly and can therefore only benefit a fortunate few. There is now increasing interest in a low cost alternative, generally referred to as rainwater harvesting.

Rainwater harvesting (RWH) is the collection of runoff for productive purposes. Both yields and reliability of production can be significantly improved with this method. The application of appropriate rainwater harvesting and conservation (RWH&C) techniques in homestead gardens, croplands and rangelands in selected rural villages in South Africa could empower villagers to produce their own crops using the arable land more productively and enhance livestock production, hence contributing towards increasing household food security.

Since livestock production is already an important component of many smallholder farming systems, manure can be used to produce biogas, which is a simple, cost-effective, environmentally-friendly, renewable energy source. Biogas is an alternative source of energy to wood that will decrease environmental degradation and erosion resulting from deforestation. It can be derived from sewage, liquid manure from chickens, cattle, pigs and organic waste from agriculture or food processing. Additionally, the by-products from biogas production provide organic waste of superior quality that can be used as fertilizer. The biogas can be used for cooking, heating and lighting and is less harmful to the environment than the smoke from open wood fires. It causes less air pollution and is safer to use. However, for biogas generation, a sustainable water and manure supply is essential for the successful implementation and meaningful impact of this technology. Adequate water for the bio-digester can be collected from rooftops into tanks. The collection of water from roofs

for household and garden use is widely practised across southern Africa. Tanks and containers of all types are a common sight in rural areas.

Although RWH and biogas technologies are used at various sites around the country, there is no single rural village where an integrated approach to economic development based on food, energy and water security has been implemented. This emphasized the importance of conducting a R&D project on RWH in homestead gardens for food and biogas production. By applying suitable RWH&C techniques, especially in-field rainwater harvesting that combines the advantages of RWH, no-till and basin tillage, villagers will be able to produce a variety of crops in their homestead gardens to provide their families with a nutritional meal throughout the year. This can be complemented by adding roof water harvesting for household consumption, supplementary irrigation and a water source for biogas production. RWH and biogas technologies are sustainable and can improve a household's income and livelihood status, and alleviate hunger and poverty in many rural communities.



Diagrammatic representation of the rainwater harvesting and biogas production system.

The Water Research Commission has initiated and funded a project on "Up-scaling of rainwater and conservation on croplands and rangelands for food and renewable fuel (biogas) production" to be conducted over a period of 5 years (2015-2020) in Krwakrwa village near the town of Alice as well as Fort Cox College of Agriculture and Forestry in the Eastern Cape. The multi-disciplinary project team comprises researchers, officials and students from the ARC, Eastern Cape Department of Rural Development and Agrarian Reform, Fort Cox College of Agriculture and Forestry and the University of Fort Hare. The stakeholders are smallholder farmers (who are the main beneficiaries), ward councillors and traditional leaders.

The aim of the project is to assess the up-scaling of RWH&C practices on croplands and rangelands for food and renewable fuel (biogas) production, that will improve rural livelihoods without impacting negatively on the environment. The three main objectives are to:

- demonstrate and evaluate appropriate RWH&C techniques for increased crop and livestock production and biogas as a source of renewable energy;
- evaluate socio-acceptability and economic feasibility of biogas generation to meet energy demands; and
- evaluate sustainability, effectiveness and application of effluent as a liquid fertilizer.

Roof water harvesting systems and underground fixed dome and Chinese balloon bio-digesters are in the process of being installed at selected households in Krwakrwa village. As soon as this is completed, community members can start to feed the digesters with a mixture of water and cow dung to produce biogas. Each digester

will be connected to a gas stove in the house of the community member, where the biogas will be used for cooking.



Construction of a bio-digester in Krwakwa village, Eastern Cape.

Crop production among smallholder farmers in Krwakwa is constrained by low and variable rainfall, as well as poor soil fertility. Furthermore, the majority of community members are constrained by lack of financial resources to purchase fertilizers. Hence, the use of organic manures and their recycling has been considered as an alternative in ensuring sustainable land use and agricultural production. Therefore, in an attempt to improve food security in Krwakwa village the project team has introduced the recycling of animal manure through the implementation of bio-digesters, where the effluent can be applied as organic fertilizer to enhance soil fertility and increase crop yields. However, little knowledge exists on nutrient release patterns of bio-slurry and factors that affect them. Therefore, with this project an attempt is being made to evaluate the most effective method of applying bio-slurry and to compare its fertilizer value with organic manure and inorganic fertilizers.

Unfortunately, the project has been challenged by the recent drought and a lack of active participation by community members.



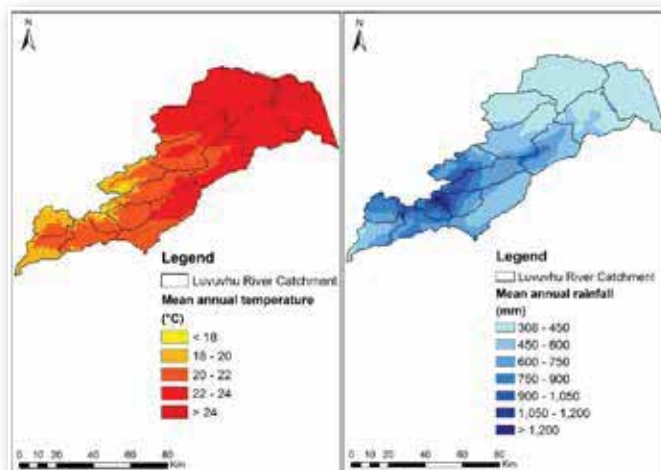
Implementation of in-field rainwater harvesting basins at an old age centre in Krwakwa village, Eastern Cape.

### CLIMATOLOGY OF RAINY SEASON, DROUGHT AND FLOODS IN LUVUVHU RIVER CATCHMENT

Weather and climate variability is the major factor affecting inter-annual variability of crop production and yield in much of the rain-fed agricultural region of South Africa. It is recommended that weather and climate information at all locations be continually reviewed to assist the farming community to cope.

In a study funded by the Water Research Commission, rainy season characteristics, drought and flooding climatology are being investigated with a view to assisting farmers in the Luvuvhu River Catchment, Limpopo Province, to adapt to changes in climate. The project is approached in three main ways: 1) Analysis of climate

information and making useful deductions that would be beneficial to the farming community; 2) Setting up of trials to investigate environmental conditions affecting production as well as the calibration of crop models; and 3) Communication of agriculture and climate information in workshops and Internet platforms.



Long-term mean annual temperature and mean annual rainfall in the Luvuvhu River Catchment, Limpopo.



Planting of trials, crop growth and development monitoring in the Luvuvhu River Catchment, Limpopo.

### FUTURE SURFACE WATER QUALITY IN SOUTH AFRICA AND JAPAN

The quality of natural resources in general and specifically water resources is a vital factor that decides the sustainability of using these resources. Surface water systems represent the major source of water supply for economic and domestic uses in both Japan and South Africa. Water quality information is needed for understanding the current conditions of natural water bodies and future trends in changes of water quality indicators, for better management and allocation of water resources.

The National Research Foundation (NRF) and the Japan Society for the Promotion of Science (JSPS) are funding a 2-year study to investigate the spatio-temporal impact of climate change and land use changes on surface water quality in Japan and South Africa. The project is a collaboration between five research and academic institutions in the two countries: the ARC (South Africa lead organization), University of the Witwatersrand, Shimane University (Japan lead organization), Tottori University and Hiroshima University. The two major objectives are:

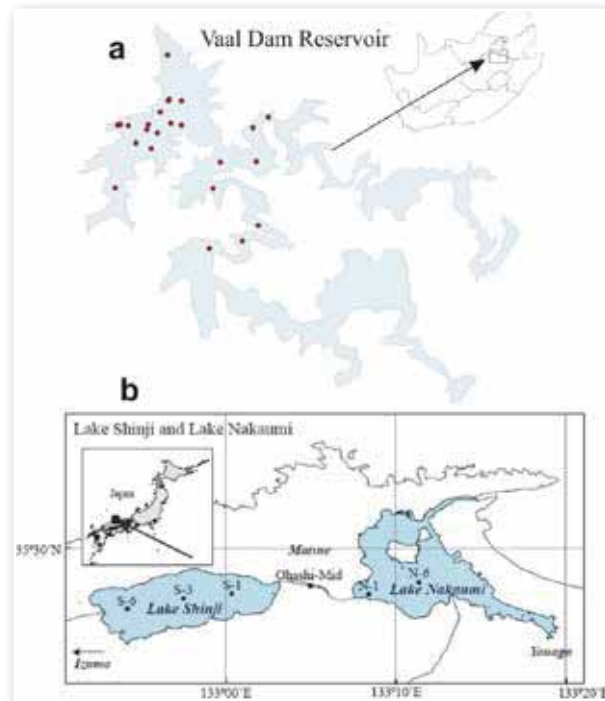
- To assess the potential of remote sensing technologies on surface water quality evaluation under semi-arid-sub-humid and humid environments.
- Simulation of alternative climate and land use change scenarios and their impact on water quality indicators under Japanese and South African environments.

A combination of remote sensing water quality indicators and a three-

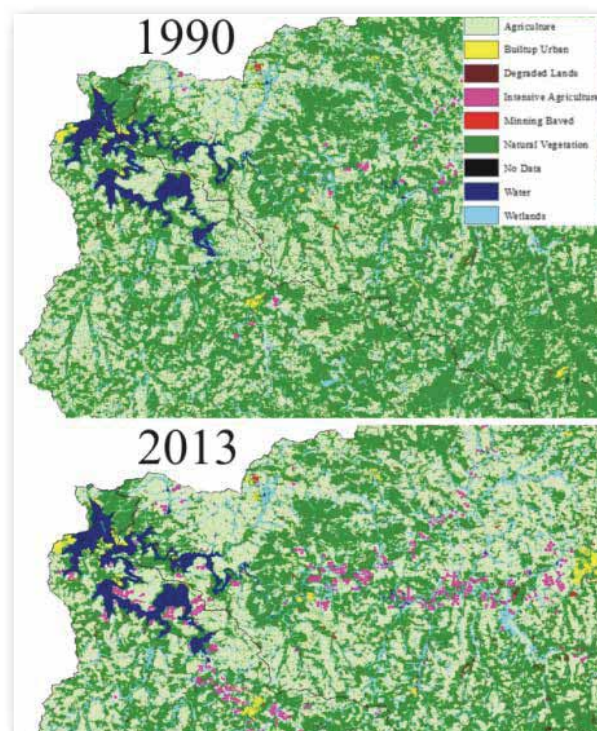
dimensional eco-hydrological simulation approach are being used to examine various climatic and land use changes scenarios and their impact on water quality indicators. Understanding the alternative future scenarios will assist decision makers in future planning of water resources allocation and agricultural and industrial expansion impacts. The surface water environment is critical from several points of view. Surface water bodies are highly sensitive to various pollutants from both point and non-point sources. The point source water pollution can be traced to a single source whereas non-point sources pollutants are diffused across the landscape with the movement of water. The non-point sources are usually associated with climate, landscape processes such as soil erosion, land use management, and human activities within the catchment. The deterioration in water quality by high sediment loads, dissolved geobiochemical and organic and inorganic constituents is a significant issue for public health, disease vectors, sanitation and grey water recycling, economic productivity of agriculture and industry, and potable water security. Thus, treating, managing and monitoring of water quality in surface waters can cost both countries large amounts of money, especially in light of ongoing climate change and increased water demands. Moreover, the deterioration of water quality may affect catchments' entire ecosystems, the food chain, and environmental quality. Thus, the systematic monitoring and assessment of surface water quality are critical for managing and improving such water resources. The motivation of this project is to develop a methodology that can capture and evaluate changes in water quality at a synoptic scale that is relevant to existing management frameworks in South Africa and Japan, and which operates as a function of regional-scale climatic and land use changes. The changes in climate and land use have an impact on water quality and this research will concentrate on developing monitoring and modelling methodologies that simulate the impact of these two factors.

The major factors that affect measured water quality in surface water bodies include suspended sediment (turbidity), algae (i.e. chlorophylls, carotenoids), chemicals (nutrients, pesticides, metals), dissolved organic matter (DOM), water temperature and circulation, aquatic vascular plants, pathogens, and oil. Suspended sediment, DOM, vascular plants and thermal properties can be detected directly using remote sensing techniques as the changes in these properties change the spectral characteristics of the surface water. However, chemical pollutants and pathogens can only be detected indirectly. The reported ability of remote sensing to monitor water quality spatially and temporally points to the potential of the technology to identify water quality problems, within a short time frame. The application of remote sensing techniques in water quality monitoring dates back to the 1970s. Equations have been developed to estimate suspended sediment concentration based on statistical relationships between measured spectral characteristics and water quality parameters.

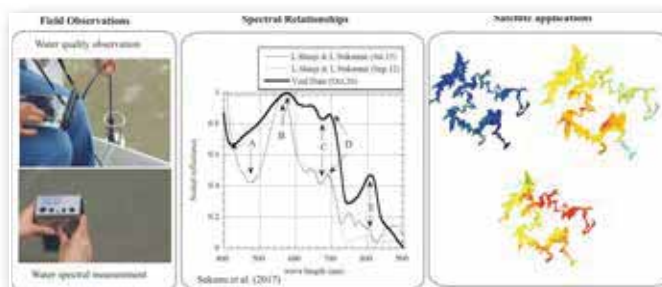
Two research sites in Japan (Lakes Shinji and Nakaumi) and South Africa (Vaal Dam reservoir) were selected for the study. Field and laboratory observations are taking place using advance ground and remote sensing technologies to evaluate and simulate the water quality in the two water bodies in their current and future conditions, respectively. Two National Land Cover datasets (1990 and 2013) were used to assess the land use and cover changes in the Upper Vaal Catchment. The land use datasets have been reclassified to anthropogenic and non-anthropogenic factors that affect the water quality. The agriculture classes have been divided into conventional and intensive agriculture as there is a high expectation to use more chemicals inputs under irrigated systems compared to rain-fed agricultural systems. Future land use scenarios will be combined with the climate projection data to evaluate the impact of various land use and climate change scenarios on the water quality in the Vaal Dam reservoir (South Africa) and Lakes Shinji and Nakaumi (Japan). The evaluation of water quality using remote sensing data will be used to validate the model output distribution in a spatial context.



Study sites in (a) South Africa and (b) Japan and location of water quality monitoring stations (●).



Land use in the Upper Vaal Catchment.



Hyper- and multi-spectral remote sensing for water quality monitoring.

## SEDIMENT YIELD MODELLING IN THE TSITSA RIVER CATCHMENT

The Department of Water and Sanitation (DWS) is considering the Tsitsa River Catchment, on the Mzimvubu River in the Eastern Cape Province, as a potential site for a water resource development. The Mzimvubu River is South Africa's largest river without a dam. The catchment is considered one of the poorest and least developed regions in South Africa and it is envisioned that a dam will spark economic growth while also helping to secure current and future water resources.

Previous studies conducted in the Tsitsa River Catchment have highlighted extensive soil erosion. This is a major concern for any water resource development plans as it leads to large amounts of runoff and sediment yield, which will have serious detrimental effects on the lifespan and productivity of any water resource development. Furthermore, dams are envisioned to last several decades and with projected climate and possible land use changes not only is it important to understand the current soil erosion phenomenon but also the effects that changing climate and land use will have on the future soil erosion scenarios. Thus, it is important to model soil erosion and the consequent sediment yield before the development takes place in order to mitigate their negative effects and ensure that the dam remains viable.



Soil erosion in the Tsitsa River Catchment.

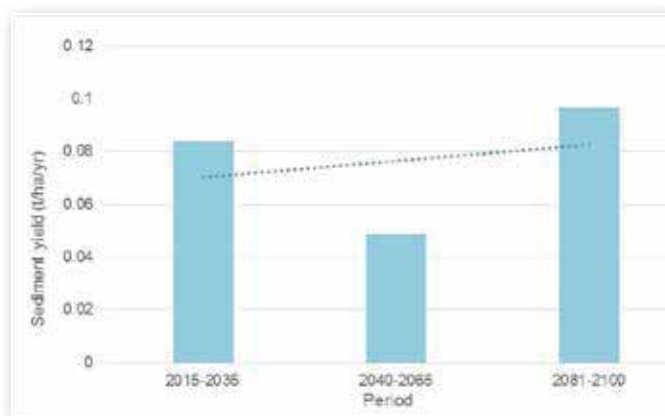
A PDP MSc study aimed to model the major soil erosion processes under projected climate change and possible land uses and to determine the sediment yield at the proposed dam site at Ntabalenga in the upper Tsitsa River Catchment. The Soil and Water Assessment Tool (SWAT) hydrological model was used to model the sediment yield using projected climate and land use data. The objectives of the study were:

- to create a model of the sediment yield for the upper Tsitsa River Catchment using SWAT from observed data (2007-2012) to act as a control;
- To determine the impacts of projected climate change (2015-2100) on sediment yield in the catchment using SWAT; and
- To determine the impacts of proposed land use change under tillage and no-till scenarios on sediment yield in the catchment using SWAT.

Climate data acquired from six CGCM simulations from the A2 Special Report on Emissions Scenarios (SRES) for the period 1961-2100 was used. Potential agricultural crops have also been identified in the Tsitsa River Catchment including sweet potato, sugarcane, cabbage, avocado orchards and corn. These crop types and climate variables were simulated in SWAT to determine how they would affect soil erosion.

Future sediment yield from sheet and rill erosion was estimated to increase to 2100. The results of the land use change showed that the

current land use is optimal for minimal erosion and that converting to maize crops will have the greatest impact on sediment yield.



Predicted increase in sediment yield with climate change in the Tsitsa River Catchment.

A R450 million project initiative has been funded by government to prevent and rehabilitate soil erosion in the Tsitsa River Catchment. It is hoped that this study can shed some light on the effects of soil erosion on the dam as well as the effects of potential land use and climate change on sediment generation in the catchment. The results will facilitate DWS in decision making and catchment management particularly with regard to increasing agriculture. The study showed that if a dam is to be built they will need to rehabilitate the existing soil erosion sites which will increase the expenses of the dam construction budget. Furthermore, continuous monitoring of the catchment and the dam will need to be undertaken.

The results of the study will also assist DAFF to decide the best crops to be cultivated if they wish to reduce sediment yield as well as develop agriculture, as certain crops will have a greater impact on siltation. The NDP has identified agriculture as an area of importance and as such set a target of increasing agriculture in South Africa to aid food security and create jobs. This study can aid decision makers to determine the best strategy for improving agricultural production without sacrificing our precious water resources.

## STOCKPILING OF COAL MINE SOILS

A study of various aspects of the soil stockpiling process on open-cast coal mines was recently completed for the Coaltech Research Foundation. The main objectives of the 3-year project were to:

- characterize stockpiled soils in terms of their physical, chemical and mineralogical properties;
- compare these soils with adjacent unmined soils as well as with rehabilitated soils; and
- provide guidelines as to how the soil stockpiling phase can be improved in order to benefit the soil rehabilitation process as a whole.

Given the loss of high potential agricultural land to coal mining across much of Mpumalanga Province, any improvement of the rehabilitated soil environment will make a significant contribution to the sustainable long-term utilization of the natural resources.

Four trial sites on different mines were identified in the vicinity of Emalahleni (Witbank) and Kriel, where various soil stockpiles were present. Over 250 samples were collected for analysis. Determinations that were carried out included a range of physical, chemical and microbiological analyses.

The more important findings of the study can be summarized as follows:

## Texture

Overall, soil texture changed from unmined soils to those sampled from the stockpiles with clay content increasing by an average of 50% (from 11.8 to 17.7% clay), indicating that poor stripping practices are causing more clay-rich materials to be included in the soil stockpiles.

## Sum of cations

Interestingly, despite the increase in clay content from unmined soils to stockpiled soils, the levels of exchangeable cations (Ca, Mg, Na, K) present in the soil fell by more than half (from 2.61 to 1.24 cmol kg<sup>-1</sup>), showing how much of these nutrients are being removed, mostly through leaching, in the stockpiling process.

## Organic carbon

One of the clearest effects of stockpiling is that of a loss of organic carbon, due to the disturbance of the surface vegetation layer and the tendency of the stockpiled soils to form a surface crust, making re-vegetation difficult. For unmined soils, average organic carbon values were 1.14% for the topsoil and 0.43% for the subsoil. With stockpiling, however, these fell to 0.66% for the topsoil, while the subsoil remained relatively constant at 0.44%. The logical conclusion is that by stripping surface vegetation, a large percentage of the naturally occurring soil organic matter is lost.

## Bulk density

This gives an indication of how compacted the soil is. Under natural conditions the topsoil will remain relatively loose, but where stripping, often with heavy machinery, takes place, there is a significant compacting action. Average bulk density values of 1.497 t m<sup>-3</sup> for unmined soils rose to 1.554 t m<sup>-3</sup>, but this included some old, crusty stockpiles with values as high as 1.9 t m<sup>-3</sup>, as well as some looser materials with lower values that had been dumped separately, thus showing the value of minimizing heavy vehicle traffic on the soil surface. Interestingly, for the rehabilitated soils sampled the average value was 1.65 t m<sup>-3</sup> (even higher than the stockpiles), showing how difficult it is to alleviate compaction, even after a number of years of re-establishment of vegetation.

## Microbiology

Molecular analysis (microbial community fingerprinting/DGGE) showed that unmined soils have greater bacterial diversity than stockpiled soils. The bacterial isolates from the stockpiled and unmined soils showed the potential to fix nitrogen. The microorganisms (both fungi and bacteria) from stockpiled soils showed the potential to solubilize insoluble phosphate; however, the phosphate solubilizing efficiency of the isolates from stockpiled soil was lower in comparison to that of unmined soil isolates. The fungal isolates from stockpiles soils were able to produce IAA.

## Age of stockpiles

There did not seem to be a clear difference in many of the physical or chemical soil parameters with age, rather the method of storage seemed to be important. Where high (+/- 5 m or more) stockpiles had been established, the probability that excessive vehicle compaction was used could clearly be seen in compacted soils and no topsoil development (Figure 1). Where lower stockpiles had been established, presumably by simple dumping of soil heaps, these soils were clearly looser, as well as supporting more surface vegetation.



High soil stockpile showing enhanced degree of soil compaction.



Lower, heaped soil stockpile showing less compaction and more vegetation.

The soil stripping process is a complex one, with many contributing factors. The great challenge is the basic need for power, which can only be satisfied by coal extraction, despite the predictable environmental degradation.

There are several specific problems involved in soil storage/stockpiling:

- Baseline soil maps of mine sites are, in many cases, not used in the stripping process, leading to under-stripping or over-stripping of soil, with consequent problems.
- The use of heavy machinery, while presumably desirable to the mines from the point of view of cost-effectiveness, has a devastating effect on the soil material being stored. This persists into the rehabilitation phase.
- Most of the critical soil parameters show clear deterioration in the stockpiling process, leading to poorer soil conditions.
- There are currently no fixed guidelines for stockpile establishment, either in size or age of stockpile or in the method used for soil movement.

It is hoped that the results obtained from this project will form the basis for a thorough review of stockpiling, so that the detrimental effects on the soil resources of the mining area can be lessened as far as possible. A follow-up project, looking specifically at microbiological soil indicators, is currently underway. Stakeholders targeted by these projects will include the mining companies, where improved stockpiling practices will lead to better rehabilitation, as well as the Department of Agriculture, Forestry and Fisheries, which is constantly faced with a decreasing amount of available high potential land for basic food production.

## Research focusing on Agricultural Mechanisation and Engineering

The programme promotes utilisation of modern tools, structures and equipment in the agricultural production system. It conducts research into agricultural mechanisation, irrigation and infrastructure technologies to increase the productivity and efficiency of agriculture. The aim of mechanisation and engineering research and development is to develop and test appropriate farm machinery and equipment to improve the timeliness of farm operations and to reduce the drudgery of farming activities. This improve the quality of work and products, leading to enhance output and economic competitiveness of the farm. Highlights of the work undertaken in this programme during 2016/17 include the following:

### SOUTH AFRICAN IRRIGATION DESIGN AND USER MANUAL

The Irrigation Design Manual and the Irrigation User Manual, both

written and published by the ARC is now in a process of being updated with funding from the Water Research Commission (WRC). An opportunity to influence irrigation water use efficiency across a wide spectrum of stakeholders has been identified in the urgent need for the revision and updating of both these manuals, which are used extensively for training of irrigation designers and managers. It is also used as a platform for sound irrigation designs and management of irrigation systems in South Africa. The Design Manual was first completed and published in 1996 and updated in 2003, while the User Manual was first published in 2002. Workshops were conducted to receive inputs from designers who are using these manuals and a questionnaire survey was concluded with various stakeholders to get the newest information and technologies available to update the manuals.



Irrigation design manual is used for designing the systems correctly.

## WATER RESOURCES MANAGEMENT SERVICES:

In South Africa as a water scarce country, water resources management is of huge importance and engineers of the ARC assisted a number of small scale farmers with irrigation designs, complimented with specifications. The aim is to assist them with the correct way of applying water to grow vegetables and to improve farmer productivity and food security in local communities as well as for commercialising the production of the crops.

ARC engineers also tested and evaluated Travelling Irrigators to determine its performance to advice farmers how the utilize the equipment correctly.



Evaluation of travelling irrigators to determine its performance.

## MUSHROOM CONSTRUCTION AND IRRIGATION PROJECT

The Blue Economy concept is one of many innovations which

convert waste or by-products into new products and form part of a broad movement to positively balance humankind, economy and nature. Though mushroom farming, the organic waste product can be converted into protein for both consumption and generation of disposable income for the indigent families. Responding to high level of unemployment and food insecurity in the City of Johannesburg, the Zeri Foundation presented a proposal to the Mayoral Lekgotla to launch income generating initiatives which aim to increase the cash flow of the local economies by creating small scale centres of production and consumption. A total of 100 mushroom production units were proposed to be supplied to 100 farmers across the City. This mega project entailed the design and construction of mushroom production units and irrigation systems for City of Johannesburg. One of the areas was Eikenhoff farm as one of the flagship projects which will be converted into an Agri-park in partnership with Gauteng Department of Agriculture and Rural Development. The farm is 279 ha in extent which is suitable for both crop and livestock production. The designs were completed and recommendations, design report and specifications were supplied to the City of Johannesburg.

## PROMOTION OF IRRIGATION ENGINEERING TECHNOLOGIES FOR IMPROVED FARMING

Through this project, cost-effective and sustainable utilisation of irrigation water was promoted through appropriate technology development and dissemination of information.

Two scientific presentations were made on "Irrigation towards stable agricultural production and food security: A look at the water status in Mpumalanga Province" at the Department of Agriculture Mpumalanga Province's Nkangala- and Ehlanzeni North district's Agricultural Summit.

At the 4<sup>th</sup> African Regional Conference on Irrigation and Drainage, with the theme Agricultural Land and Water Management for Sustainability under Climate Variability, ARC delivered a keynote paper on: "Improving agricultural water management in Africa". The Conference was organised by the Egyptian National Committee on Irrigation and Drainage as a member of the International Commission on Irrigation and Drainage and took place in Aswan City, Egypt during the period 26 – 28 April 2016.

A keynote address on: "Sustainable use of water resources and water management options in arid and semi-arid regions to mitigate the impact of drought and enhance livelihoods" was also delivered at the 7<sup>th</sup> Biennial National LandCare Conference in October 2016 at the Mittah Seperepere Convention Centre, Kimberly, Northern Cape. Another keynote address by ARC on "Drought Impact Mitigation and Prevention to Enhance Sustainable Agriculture Development: Irrigation Application Methods to drive Agriculture Productivity in Drought Periods" was delivered at a National Conference on Rural local governance and re-inventing agriculture and rural development to combat rural economic stagnation and poverty for Mayors, Speakers, Whips, Councillors and Traditional Leadership.

On the 1 March 2017, the International Commission on Irrigation and Drainage (ICID) hosted their very first Webinar in its 67 year history under "ICID Webinar Services", to bring a common understanding on the term "Water Use Efficiency" among the water policy makers, irrigation managers and wider international water research community. The Webinar was introduced from India by the Secretary General of ICID, Avinash Tyagi and the delegates from all over the world was welcomed from Iran by the President, Dr Saeed Nairizi. Dr Chris Perry provided the introduction from England and the first and only South African presenter was from the ARC. The PowerPoint presentation, gave insight for successful irrigated farming through efficient irrigation by applying and understanding the water balance approach. The newly developed water balance framework for

irrigation efficiency as approved by ICID was provided and explained. Through research by the ARC, South Africa has adapted this framework and developed a South African framework for improved water use efficiency. The framework was applied to re-assess the system efficiency indicators typically used by irrigation designers when making provision for losses in a system and converting net to gross irrigation requirements. A new set of system efficiency values for design purposes was therefore developed and presented.

## IRRIGATION EQUIPMENT EVALUATION

The ARC is the only irrigation equipment testing facility in the SADC region and is well positioned to determine whether such equipment is suited for South African conditions to ensure optimal water use efficiency. It also protects the farming community from equipment that is not suitable for South African conditions. The demand on our already scarce water resources is increasing. It is therefore of the utmost importance that the agricultural sector, which uses 60% of the country's water, has to take all possible steps to improve its water usage efficiency. Amongst the many ways to save water, efficient irrigation equipment and even more the correct use of it is of utmost importance. To ensure functional efficiency and the ultimate success of irrigation systems, the equipment that is used in these systems must comply with certain performance standards.

Evaluation of irrigation equipment in these world class test laboratories of the ARC help the designer to design an irrigation system that will enable the farmer to make optimal use of available water. The ARC is an independent evaluation authority on the performance of irrigation equipment and systems. Both laboratory and field evaluations are carried out according to locally developed and internationally recognized standards and procedures.

The performance and quality of irrigation equipment such as sprinklers, drippers, micro sprayers, filters and hydraulic valves are tested and evaluated. Reader friendly test reports enable the designer to make an optimal choice between various products.



Sprinkler testbench control system to determine the performance of sprinklers.

## SURFACE & SUBSURFACE DRAINAGE RESEARCH

Planning and design of sub-surface drains has been undertaken since 1965 by members of the then staff of the Department of Agriculture and the original Design manual was developed in 1983. Various techniques were used by the engineering practitioners in the field to determine the layout spacing, pipe diameter, drain slope, etc., from various inputs. These practices, approaches and design techniques for drainage were reviewed, upgraded and compiled recently by the ARC in a 5-year research project funded by the Water Research Commission and comprehensive reports were published.

With these research reports, an advanced subsurface drainage design course was presented over a period of three days at three venues, namely Pretoria, Stellenbosch and Pietermaritzburg. After completion of the course, the learners:

- understood the origin and extent of drainage problems in South Africa.
- are aware of legislative requirements for drainage systems.
- are able to determine the hydraulic permeability of soils.
- are able to undertake the lay-out of subsurface drainage systems.
- know the different sub-surface drainage products that are commercially available.
- are able to calculate drain depths, spacing and pipe sizes for typical situations.
- are able to calculate the constructions quantities for installation of sub-surface drains.
- understood the different installation practices and their applications.

## IRRIGATION TRAINING BEYOND OUR BORDERS FOR SUSTAINABLE IRRIGATION

The UNESCO-Institute for Water Education (UNESCO-IHE) based in Delft, The Netherlands presents on an annual basis different Master Degree programmes for prospective students.

The mission of the Institute is to contribute to the education and training of professionals and to build the capacity of sector organisations, knowledge centres and other institutions active in the fields of water, the environment and infrastructure, in developing countries and countries in transition. UNESCO-IHE is located in Delft, an internationally renowned centre of excellence in civil engineering and in water related sciences. They maintain intensive relations with national and international institutions to ensure a continuous exchange of knowledge and experience and to promote the sustainable use of water.

The ARC lectured the module "Sprinkler and Drip design" for sustainable irrigation to a group of 10 students that attended the Master degree programme and they came from 8 countries: Ethiopia, Gambia, Indonesia, Kenya, Malawi, Swaziland, Tanzania and Zimbabwe. Apart from the formal lectures, they also completed assignments to complete the Module.



UNESCO-IHE Master Degree Students.

## PROMOTING AND ACCELERATING THE ADOPTION OF SMALL SCALE BIOGAS DIGESTERS IN SOUTH AFRICA

The ARC conducted research biogas projects which resulted in the installation of about 50 small scale biogas digesters for smallholder farmers in the Eastern Cape, Free State, Gauteng, Limpopo and North West Provinces. These projects were made possible through funding from DAFF, GDARD, the National Research Foundation and the Research Council of Norway.



6m<sup>3</sup> pre-fabricated biogas digester.



12 m<sup>3</sup> brick biogas digester.



Proud owner of a biogas stove.

These digesters which range in size from 6 to 12 m<sup>3</sup>, were installed by unemployed youth from the project sites who received training on the installation of the biogas digesters. Two types of digesters were used, pre-fabricated plastic biogas digesters, manufactured by a local South African company.

Additionally, the ARC has set up a biogas laboratory at its Soil Climate and Water campus in Pretoria to analyze different biogas feedstock and run experiments to optimize biogas production.



ARC biogas laboratory with testing instruments and equipment.

The ARC continues to promote biogas technology for rural households in the country and is establishing itself as a center of excellence in the field of biogas research.

## EVALUATION OF DRYING METHODS FOR THE DRYING OF MANGOS

ARC conducted three drying experiments at Ukulinga Research Farm of UKZN at Pietermaritzburg. An oven dryer, open air uncontrolled drying (sun drying) and a greenhouse solar dryer with modified ventilation (using wind ventilator and plastic window louvers) were compared in drying mangos. Tommy Atkins mangos received from the Limpopo Province were tested and quality features such as colour and texture were analysed. The fruit was cut in 3 mm, 6 mm and 9 mm thickness. The oven dryer temperature was set at 70, open air uncontrolled drying depended on ambient conditions, between 20-30 and relative humidity of 40-30% and the solar greenhouse dryer had variable conditions. During the drying period the dryer increased the ambient temperature to 50 and lowered relative humidity of the ambient air to below 20%. The oven dryer dried for 7 hours, the solar greenhouse dryer dried mango for 13 hours and the open air uncontrolled solar drying took 6 days. It was found that longer drying periods resulted in fruit browning. Furthermore, during sun drying some samples were blown by wind and it took longer to dry because of rainfall. A greenhouse solar dryer with modified ventilation drying brings a solution closely to the oven drying method. It preserves quality of fruit and protects produce from harsh weather conditions; it is a sustainable solution with no electricity required, consequently it is drying method which can improve productivity and the economy of farmers.



Greenhouse solar dryer.

The Agricultural Economics and Capacity Development Division predominantly supports Strategic Goal 5 of the ARC, which focuses on translation of research outputs. This is achieved through three dedicated programmes:

- **Smallholder Agricultural Development** which entails extension support; diagnostic and analytical services; targeted development initiatives; and farming systems research.
- **Agricultural Economics and Commercialisation** deals with enhancing sector competitiveness by facilitating access to intellectual property for commercial exploration; development support for agricultural enterprises; and SMMEs as well as agricultural economic analysis, providing decision support and establishing the impact of our R & D.
- **Training and Extension** relates to training and information services to farmers and extension staff. Access to relevant technical information from the ARC contributes extensively to sector productivity, especially of smallholders.

The division operates from ARC Central Office in Pretoria, but works strategically across the organization, with campuses spread across the country.

## Smallholder Agricultural Development

Some key initiatives in this programme increased productivity and income of smallholders. ARC staff and partners collaborated in the construction and revitalization of 25 livestock structures in communal areas of the Eastern Cape, KwaZulu Natal and Limpopo; two vegetable nurseries in the Eastern Cape and an auction facility in KwaZulu Natal. Critical financial support from Treasury's Economic Competitiveness Support Package (ECSP) was utilised in this infrastructural development, and coupled with specialised skills training for extension and farmers on aspects of animal health, business and product management and marketing. This assisted livestock farmers in managing animal health aspects that influence output and viability of animals and thus revenue. A very good example is the revitalised auction facility at Ndawana resulting in significantly more animals auctioned and income received. Local farmers earned R3.5million in the past year through sales of 300 cattle selling at ±R12 000 on average.



Strydskraal Crush pen. The neck clamp enables the handling of livestock for dehorning, tagging, etc.

## Capacity Development

Initiatives are aimed at building skills and providing information to extension personnel, scientists and farmers, to inform decision-making and increase productivity. Collaboration and dialogue with provincial departments and institutions, the private sector and farming communities were prioritised.



Hydroponics and vegetable production training.

Most farmer training is conducted on-farm and is practical. In the year under review, 5474 farmers were trained in various aspects of animal health, livestock production, crop production and plant health. A survey to establish farmers' willingness to pay for extension services was conducted with 700 farmers in KwaZulu-Natal, Mpumalanga, Limpopo and Eastern Cape. This will support design and its commercialisation as well as policy development.

## Extension

Extension training focused on strengthening interaction between R&D and Extension and testing ideas through various platforms. Courses in the systems approach, priority setting, farm economics and business planning took place. Research staff were skilled in extension and advisory support, soft skills (communication) and technology packaging for different clients. Forty-five scientists and 821 extension officers were capacitated in the year under review.

A Knowledge Brokering project exploring opportunities for young unemployed graduates was launched and 28 Knowledge Brokers capacitated in providing extension services this year. The Brokers mentored 560 farmers in the initial phase, which revealed challenges in their mobility and stature with farmers that are also not accustomed with paying for information. Emanating from this pilot, a policy brief was developed to establish lessons, challenges and recommendations on commercialisation of Extension and Advisory Services in agricultural development. The brief was published on the DST website: [http://www.dst.gov.za/images/2017/2017\\_pdfs/16-946-ICT4Agriculture-Extension-project.pdf](http://www.dst.gov.za/images/2017/2017_pdfs/16-946-ICT4Agriculture-Extension-project.pdf).

## Working together

The collaborative research consortium with the Universities of KwaZulu-Natal, Fort Hare and Limpopo continued with 53 (36 MSc and 17 PhD) students conducting R&D focused on smallholder climate change strategies and agro-processing.

The Collaborative Centre on Economics of R & D supports 10 Masters and 3 PhD students at Universities of Limpopo, Fort Hare and Pretoria conducting priority economic impact studies.

The ARC collaborated with 27 European and African partners in the ProIntensAfrica project, facilitating the development of a governance mechanism for African agriculture and a proposal for funding thereof to the EU.

Another project investigated inclusive fruit value chains in Vhembe with partners from the Netherlands and a local commodity organisation, Subtrop. A participatory research action resulted in a scientific production support plan for lead macadamia farmers.

The ARC also works in the SADC and extension staff in Lesotho were trained in innovation platform management as part of a project funded by the Food and Agriculture Organization (FAO) of the UN.

## Agricultural Economics

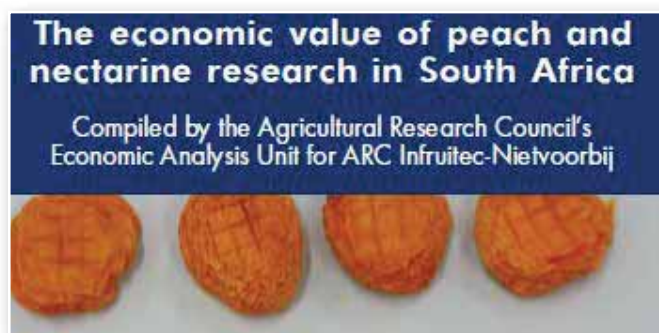
The Economic Analysis Unit released summarised reports on completed impact studies, highlighting the impact of the ARC's programmes on Peach and Nectarine Breeding, Plum Breeding and Bio-Control. The summarised reports were translated into four page brochures that enable communication of scientific research findings to a broader audience. The Peach and Nectarine Impact study showed that the ARC's Infruitec-Nietvoorbij has released 96 peach and nectarine cultivars since 1937. Tree planting density improved from 609 trees/ha to 956 trees/ha through ARC research. Furthermore, the investment in the breeding programme resulted in a return of R1.56 for every R invested. All the peach cultivars used in the canning industry in SA are ARC bred cultivars. Plum researchers in the ARC released 16 of the 39 top varieties exported from South Africa. A study on the economic contribution of smallholder agriculture in former homeland areas was completed. The study found that this sub-sector contributed 1%, 0.6% and 1.5% of Gross Farm Income in 2008, 2011 and 2012 respectively. Despite the low monetary contribution to the sector, the social and cultural contributions of smallholder agriculture were significant. The study recommended consistent capturing of smallholder production information and sustainable support to the sector. Implementation of the Citrus Breeding, Wheat Quality, National Beef Cattle Improvement Scheme and Vaccine Development impact studies continued.

The Economic Analysis Unit successfully completed a study, commissioned by the Food and Agricultural Organisation (FAO) in support of DAFF's efforts to develop a strategy for South-South Cooperation for Agriculture and Food Security. The study, which involved participation of 21 organisations, suggested a roadmap towards development of the strategy and identified some thematic areas to be incorporated in the strategy. These included Food safety, Trade and investment, Meteorology and disaster management, Increasing market access, Changes in land use, Entrepreneurship, Governance and Indigenous knowledge systems. Both FAO and DAFF commended ARC for the successful implementation of the study. The contract with DST to investigate agri-innovation hubs, which enable farmers to collaborate with various stakeholders in enterprise development was finalised. The study, based on policy analyses, expert opinion and collective evaluation, recommended possible

areas for locating the hubs and how to establish the hubs. The final results were aligned with the Agri-parks initiative, and suggested pilot sites in Pretoria, Ceres and Bushbuckridge.

ARC Economists actively participated in several activities of the Agricultural Economics Association of South Africa (AEASA). The ARC successfully chaired the Local Organising Committee for the AEASA 2016 annual conference. Five papers and two posters were presented by ARC Economists at the conference. Collaboration with the University of Arkansas, culminated in a one-day training workshop given by Prof Lanier Nalley and the implementation of an impact study on the ARC's wheat breeding programme. The Agricultural Economics and Capacity Development Division continued co-leadership of the Work Package 5 of the ProIntens Africa Project. A report titled *"Governance mechanisms for Africa-European Union partnerships in agricultural research and innovation: Lessons and strategic options for IntensAfrica"* was finalised and submitted.

Outputs delivered by the Economic Analysis unit included five peer reviewed publications, 10 presentations in local, regional and international conferences. One of the publications was based on an impact study of the ARC's dry bean breeding programme.



Some brochures of Impact Studies on ARC Research Programmes

## Commercialization

To address commercial challenges of different types of farmers, this programme deals with protection and commercialisation of IP generated by ARC R&D programmes.

Several technologies developed by the ARC were licenced to commercial partners in the year under review. This includes an early litchi cultivar, three onion lines, three ruminant feed technologies and three clones with potential usage as laboratory reagents in biotechnology. An inoculant against crown gall was commercialised under licence to assist the vine industry and six Lachenalia cultivars were transferred under license to the ornamental flower industry for commercialization.

## Enterprise development

The ARC and Masisizane Fund concluded a Service Level Agreement. Funds will be used for support and mentoring of farm workers; expert advice; soil analysis and farm mapping for cooperatives in the uMzimkhulu area. The Moengnyana Hydroponic Cooperative in Motswedding, North West and Tendergate Tunnel Farming Initiative in Queenstown, Eastern Cape are participating. The ARC provides technical and business support to 50 people in five cooperatives to set up farm based tunnels, stimulating food security and job creation.

## Information Dissemination and Stakeholder Engagement

The ARC utilises various platforms to communicate with stakeholders and respond to industry needs. Events held in the year under review included workshops, exhibitions and open days. Stakeholders engaged include DAFF, DST, Universities, CCARDESA, FAO, provincial Departments of Agriculture and many others. Engagements included the Extension Recovery Programme, the RUFORUM Conference co-hosted with five universities, the Agricultural Economics Association of South Africa conference.

One of the highlights of the year was the successful co-hosting of the Third Global Conference on Agricultural Research for Development (GCARD 3). GCARD3 brought together representatives of key sectors active in agricultural research and innovation and connected many others around the world. The dialogues identified five key challenges to realizing the full development value from agricultural and food innovation systems:

- Ensuring better rural futures
- Keeping science relevant and future-focused
- Scaling up: from research to impact
- Showcasing results and demonstrating impact
- Sustaining the business of farming



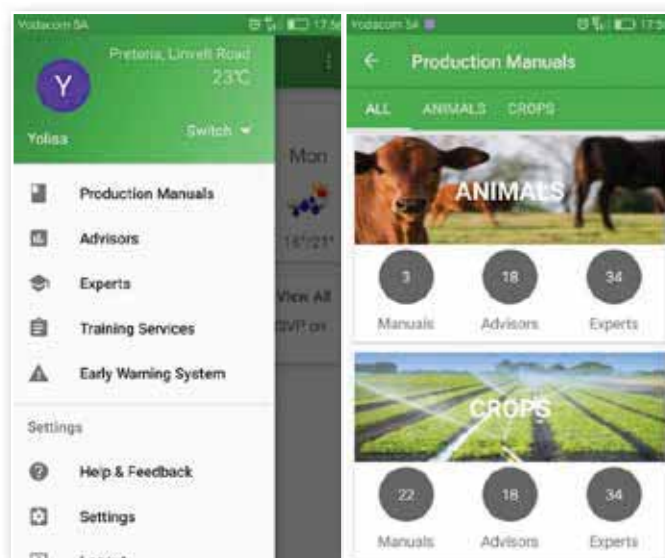
As part of the event, the ARC hosted an "ARC Day" at the Roodeplaat campus where a full exhibition of ARC research was arranged. Discussion forums on pertinent issues regarding agricultural research in South Africa and beyond were also part of the programme. Other South African entities were invited to exhibit alongside the ARC on the day, making it a very successful South African event.

GCARD 3 participants acknowledged the pivotal role of agri-food research and innovation in achieving the United Nations Sustainable Development Goals (SDGs) and agreed on three key implementation principles:

- National partners will work with rural communities to shape their own futures, taking an integrated, multi-sectoral approach to address capacity needs and constraints in innovation systems.
- CGIAR, and other international research systems, will actively engage with national agricultural systems, strengthen and add value to national partners, and help deliver on national development objectives. Site integration and systems approaches will bring new synergies and avoid duplication.
- Public, private and civil partners will find new ways of bringing together finance and capacity development, embedded in wider development investments and operating through community-driven, nationally led and regionally and internationally supported mechanisms.

The Division also hosted Dr S Rajaram, the 2014 World Food Prize Laureate with the NRF for a seminar on advancing pulses. The ARC made a significant contribution to the development of the National Policy on Extension and Advisory Services which was subsequently approved by Cabinet.

During the year, 90 Farmers' Days were held and 337 popular publications published whilst 1878 news events (print, broadcast and online) with a value of ±R100million featured the ARC. Exhibitions displaying ARC's expertise, products and services totalled 114. They were held across SA and at the African Agriculture Science Week in Rwanda, engaging stakeholders and marketing the organisation. Mobile applications (apps) with information for extension and farmers are being developed to strengthen the link between R&D and Extension and improve farmer's access to information. The design of an Info Hub mobile app was finalised in consultation with clients. Most information to be made available with the app has been collected across the ARC and phase one of the mobile application.



Screenshot of ARC information Hub mobile app.

## OVERVIEW AND HIGHLIGHTS OF HUMAN RESOURCES AND LEGAL SERVICES

Supporting the core business divisions, the Agricultural Research Council has several strategic functions, namely human resources; marketing and communications; finance; information technology and communication; facilities management; risk and planning; and internal audit, all organized under the Administration and Corporate Affairs division and led by different executives and managers. These groups operate from the Agricultural Research Council's main office in Pretoria and aim to achieve good governance, financial sustainability and a high performing and visible organization.

The various units in this division operate mainly from the head office but have representatives in all other ARC locations. Achievements attained under the Administration and Corporate Affairs programme for the financial year 2016/17 are highlighted below:

### Administration and Corporate Affairs Programme

#### Human Resource Division

The ARC currently has a total headcount of 3169 employees of which 2387 is permanent and 782 temporary employees.

**Leadership Development Program:** Leadership Development for Middle and Senior Managers is an Essential training to equip the Middle and Senior Managers with Leadership skills. The Leadership Development for Middle Managers training focuses on Management Principles; Understanding the fundamental of management function and its elements in a business; Understanding the interface of management with leadership; Know how to plan and manage time effectively; Monitor consistent performance participation; Deal with motivation and conflict; Impact of restructuring teams and getting buy-in from your team.

**Adult Education Training (AET):** The Adult Education and Training proposes to solve the problem by improving access to learning by greatly increasing the resources devoted to AET. Adult Education and Training is the basic phase in the provision of lifelong learning and consists of levels along a continuum of learning aimed at adults who have very little or no formal schooling and who have the equivalent of a compulsory school-leaving certificate.

#### Capacity Building

During this reporting period, 342 students participated in the Professional Development Programme. All the students are engaged with formal studies, which falls within the critical and scarce skills areas identified by the business. The students' progress is measured on an ongoing basis through structured mentoring programme. The table below reflects a summary of the current ARC students per study programme.

#### Combined ARC PDP students and students funded from Projects / Industry

Study Programme	Male	Female	TOTAL
Post Doc	10	9	19
PhD	77	34	111
D Tech	0	6	6
MSc	46	104	150
M Tech	5	15	20
BSc Hons	6	4	10

Study Programme	Male	Female	TOTAL
BSc Engineering	2	1	3
BSc	1	0	1
BTech	2	1	3
N Dipl	7	8	15
Matric	3	1	4
<b>TOTAL</b>	<b>159</b>	<b>183</b>	<b>342</b>

### Staff Development Formal Training

The Table below gives an indication of the number of staff members per study programme:

Study Programme	Male				Female				TOTAL
	A	C	I	W	A	C	I	W	
PhD	37	8	0	16	32	0	2	35	130
MSc	27	4	0	1	22	2	3	7	66
BSc Hons	7	0	0	0	6	2	0	1	16
BSc	1	0	0	0	2	1	0	0	4
D Tech	0	0	0	2	1	0	0	0	3
M Tech	4	1	0	0	7	0	1	1	14
B Tech	8	1	0	0	20	0	1	3	33
NDipl	14	0	0	1	5	1	0	1	22
MBA MBL MPHIL MCom	4	0	0	0	2	0	0	0	6
N Dipl Public Relations	1	0	0	0	4	0	0	0	5
B Degree	4	0	0	1	6	1	0	0	12
Prof Certificate	15	1	0	1	21	2	1	2	43
<b>TOTAL</b>	<b>122</b>	<b>15</b>	<b>0</b>	<b>22</b>	<b>128</b>	<b>9</b>	<b>8</b>	<b>50</b>	<b>354</b>

### Informal training

The table below gives an indication of the number of staff who enrolled for informal training courses during 2016/17 per quarter.

Quarter	Male	Female	Total
Q1	108	112	220
Q2	153	170	323
Q3	76	80	156
Q4	69	106	175
<b>Total</b>	<b>406</b>	<b>468</b>	<b>874</b>

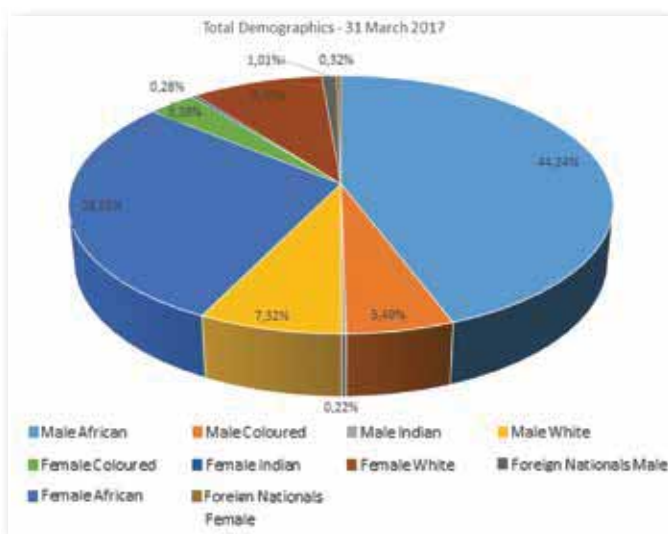
## Qualifications

The following table gives an indication of the number of existing core staff qualifications in the ARC:

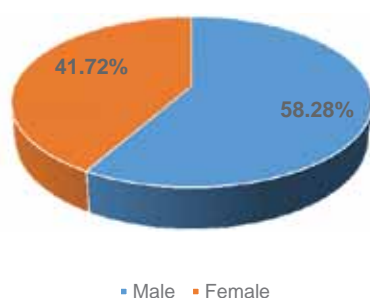
	Core staff qualifications (SET: Science, Engineering & Technology)	31/3/2017 (number includes YTD resignations from April 2016)	End of 2015/16 financial year	% of Permanent employees (2387)	% of Research staff (773)
a*	Research staff with Masters degrees. (Excluding Executives & Senior Managers).	225	222	9,43%	29,11%
b*	Research staff with Doctoral degrees (Excluding Executives & Senior Managers).	221	222	9,26%	28,59%
	(a*) Including Research staff with an MTech qualification				
	(b*) Including Research staff with DTech qualification				

## Equity Profile and HR Patterns

Currently the ARC has 77,46% black employees and 41,72% female employees. (Permanent appointed employees).



## ARC Capacity per Gender Fulltime Employees - 31 March 2017



## Appointments

During the 2016/17 financial year (1 April 2016 to 31 March 2017), the ARC appointed 178 permanent employees. From all the appointments during the 2016/17 financial year, 27, 93% (50) were from the Core Business Category of the ARC.

## Terminations

During the reporting period, 457 temporary employees exited the ARC due to the short term or temporary nature of these appointments. 38,71% (12) of the exits of permanent staff during this quarter were from the Core Business categories, namely: Researchers, Research Technicians and Research Team Managers.

During the reporting period, eleven (43 %) staff members retired (normal and early retirement), and this represented 32% of all categories of terminations.

For the 2016/17 financial year stated above, 134 permanent employees exited the ARC. 43,28% of these exits were from the Core business categories of the ARC. 32,09% were due to retirement and early retirement and 45.52% were due to voluntary resignation.

The staff turnover rate of permanent employees for 2016/17 is 3,33% which shows an improvement from the last financial year. The 2016/17 turnover rate for Researchers was 7,31% and 3,05% for Research Technicians.

Occupational Level	Year to date Turnover rate
Top Management	0,00%
Senior Management	4,35%
Professionally qualified and experienced Specialists and Middle Management	5,96%
Skilled Technical and Academically qualified workers, Junior Management, Supervisors, Foremen and Superintendents	4,62%
Semi-skilled and discretionary decision making	2,30%
Unskilled and defined decision making	1,35%
<b>TOTAL</b>	<b>3,33%</b>

## Awards and Recognition

- Dr M Mulumba received an award for the best presentation at the 14th Annual Congress of the Southern African Society for Veterinary Epidemiology and Preventive Medicine (SASVEPM) for a presentation titled "A Candid Assessment of Trade in Livestock Products for countries in the SADC Region from a Regional and International Perspective" held 24-26 August 2016 in Cape Town.
- Dr K Labuschagne was awarded the Senior WO Neitz Medal for the best PhD submitted titled "The Culicoides Latreille (Diptera: Ceratopogonidae) species of South Africa", at the 45th Conference of the Parasitological Society of Southern Africa (PARSA) held 28-31 August 2016 in Cape Town.
- Ms L Son was awarded Academic Honorary Colours by the Student Representative Council of the University of Pretoria for achieving a distinction for a Master of Science Thesis. The thesis title is "Identification and Characterization of T cell epitopes of Erum2550, -2580 and -2590 proteins of Ehrlichia ruminantium", under the supervision of Dr M van Kleef and co-supervised by Dr

- A Pretorius.
- Dr J Tjelele was appointed by The Centre for African Conservation Ecology as an Advisory Board Member at Nelson Mandela Metropolitan University (NMMU).
  - Ms A Zwane won the award for Best Poster in Animal Genetics at the 49th South African Society for Animal Science (SASAS) Congress held 3-6 July 2016 in Stellenbosch, Western Cape.
  - Dr D Nkosi was Awarded a C2 National Research Foundation (NRF) Rating.
  - Dr P Strydom was appointed Professor Extraordinary at the Department of Animal Science, University of Stellenbosch.
  - Ms MC Mokolobate received a Young Scientist Award at the 1st International Conference on Tropical Animal Science and Production held 26-29 July 2016 in Bangkok, Thailand.
  - Prof MM Scholtz received the award for the Best Oral Presentation in Animal Breeding and Genetics at the 1st International Conference on Tropical Animal Science and Production held 26-29 July 2016 in Bangkok, Thailand.
  - Prof MM Scholtz received the President's Award for research from the Afrikaner Cattle Breeder's Society at the Afrikaner Cattle Expo held on 25 August 2016 at the Jacaranda Agricultural Show in Pretoria.
  - Mr FJ Jordaan received a certificate for Exceptional Research done on the Afrikaner breed for his MSc thesis titled "Genetic and environmental trends in landrace beef breeds and the effect on cow productivity" from the Afrikaner Cattle Breeder's Society at the Afrikaner Cattle Expo held on 25 August 2016 at the Jacaranda Agricultural Show in Pretoria.
  - Mrs L Pienaar (van der Westhuizen) received a similar certificate for her thesis titled "Genetic diversity in the Afrikaner cattle breed" from the Afrikaner Cattle Breeder's Society at the Afrikaner Cattle Expo held on 25 August 2016 at the Jacaranda Agricultural Show in Pretoria.
  - ARC received Royal Show gold medallion award for best display in Pietermaritzburg 27 May - 05 June 2016.
  - ARC received the 2016 Royal Industrial Floating Trophy Award in Pietermaritzburg 27 May - 05 June 2016.
  - The ARC won best exhibition award at the South African National Science Festival, Grahamstown, 8 -14 March 2017.
  - Ms MB Matabane received an award of recognition for publication at the 9th Agricultural Research Symposium held at St Georges Hotel, 2 June 2016. The Symposium is hosted by the GDARD to acknowledge researchers for the outstanding scientific contribution on projects they have financially supported
  - Dr DB Nkosi received Career Recognition Award during the 2nd Annual ARC Employee Excellence Awards held on 26 October 2016 at the Blades in Kameeldrift East, Pretoria.
  - Ms T Phasha received Administrative Excellence Award during the 2nd Annual ARC Employee Excellence Awards held on 26 October 2016 at the Blades in Kameeldrift East, Pretoria.
  - Ms M Malebane received an award for the best PhD oral presentation titled "Dietary effects of Marula nut meal on growth performance, metabolic substrates, internal organs and general health of growing Dorper ram lambs" during the 3rd Professional Development Programme Conference held on 24 - 25 October 2016 at ARC-CO, Hatfield, Pretoria.
  - Ms D Linde received an award for the best poster presentation titled "Performance of Bonsmara and Nguni cattle on different energy diets" during the 3rd Professional Development Programme Conference held on 24 - 25 October 2016 at ARC-CO, Hatfield, Pretoria.
  - Ms Z Dlamini received the 2nd price for the best MSc presentation titled "Can probiotics can replace antibiotics in pig feed" during the 3rd Professional Development Programme Conference held on 24 - 25 October 2016 at ARC-CO, Hatfield, Pretoria
  - Ms Nikki Combrink received the SASHS Best Poster Award at the Combined Congress held in Bela Bela from 23-26 January 2017.
  - Dr Karin Hannweg received the SASHS Award for the Best Published paper in a peer-reviewed International Journal at the Combined Congress held in Bela Bela from 23-26 January 2017.
  - Mr Etienne van der Walt won the award for the Best Oral Presentation: Crop Production and Biotechnology category, at the 9th Annual GDARD Agricultural Research Symposium, held in Pretoria 2nd June 2016.
  - Dr A. Dippenaar-Schoeman was awarded the 'Bonnet award for services to the community' by the International Society of Arachnology. The award recognizes her pivotal and inspirational role in developing African Arachnology, through encouraging a new generation of students in South Africa and beyond.
  - Dr Robert Nofemela was congratulated by Thomson Reuters on being named a 2016 Highly Cited Researcher, having achieved recognition as a valuable and significant researcher in his field as a result of his publication citations.
  - Ms Nicola Wessels, a PDP student at ARC-PPRI received the award for the Best Student Presentation at the 50th Southern African Society of Plant Pathology (SASPP) Congress, held in the Drakensberg 15-18 January 2017. This is the first time ever that a talk from the virology subject field received this award at the SASPP.
  - Ms Lesley Henderson received the SAAB (South African Association of Botanists) Silver Medal award in January 2017, for her significant contribution to South African Botany.
  - Mr Musa Mtileni was awarded a floating trophy for "the best most applicable presentation" during the 34th SASAT Annual congress held in Upington, Northern Cape, 6-9 September 2016.
  - Mr Francois Kruger was awarded the 3rd prize for best paper presentation during the 34th SASAT Annual congress
  - Dr S Venter received Management Excellence Award at the 2nd Annual ARC Employee Excellence Awards, 26 October 2016.
  - Ms S Laurie received Outstanding Contribution by a Female award at the 2nd Annual ARC Employee Excellence Awards, 26 October 2016.
  - TS Chiloane received Technical Support Excellence award at the 2nd Annual ARC Employee Excellence Awards, 26 October 2016.
  - PI Maponya received Young Researcher Award at the 2nd Annual ARC Employee Excellence Awards, 26 October 2016.
  - Ms MA Mmboyi, received an award for the best MSc oral presentation at the during the 3rd Professional Development Programme Conference held on 24 - 25 October 2016 at ARC-CO, Hatfield, Pretoria
  - Ms Jenifer Koen of the Crop Development division received the prize for the best poster presentation at the 7th SEST conference held in Pretoria.
  - Dr D de Beer, a Specialist Researcher at the Post-Harvest and Wine Technology Division, was recently appointed as Extraordinary Associate Professor at Stellenbosch University's Food Science Department.
  - Mr S Matsikidze MSc student, (co-promotor Ms WJ Botes) won 3rd prize for his poster titled 'Dynamics of long-term closed ventilation cold storage conditions for Fynbos (*Leucospermum*) products as relevant for sea freighting' at the 2nd PHI Symposium held from 21-22 November 2016 at Spier Estate in Stellenbosch.
  - Natal Palesa Lesuthu won the Best Student Poster Award at the 50th Congress of the Southern African Society for Plant Pathology (SASPP) held from 15-19 January 2017 at Champagne Sports Resort in the Drakensberg, KwaZulu-Natal.
  - Human C.F. 2016. Awarded best paper presentation at 34th Annual SASAT Congress, Upington, 6-9/09/2016.
  - Combrink N.K. 2016. 3rd place for poster presentation at 34th Annual SASAT Congress, Upington. 6-9/09/2016.
  - Hannweg K. 2016. Nominated and elected ISHS Awards Committee member representing Africa, 2016-2020.
  - Thuto Ntsowe received an award as second best oral presenter in the PhD category at the ARC PDP Award ceremony held in October 2016
  - Dr Muchadeyi was recognized by the USDA for her achievements

in goat genomics research. Her research profile was showcase during The United Nations International Day of Women and Girls in Science (11 February). Link is found on: <https://www.ars.usda.gov/office-of-international-research-programs/scientists/scientists-speak-women-and-girls-in-science-muchadeyi/>

- Dr MA Mofokeng received a certificate of best presentation award for her paper presentation “Estimation of genetic diversity in sorghum accessions using agro-morphological and nutritional traits” at the 19th International Conference on Plant Breeding and Molecular Breeding (ICPPBB 2017) held in Durban, 13-14 January 2017

- Dr E Hugo received best poster award for “Effect of glyphosate application in combination with foliar plant nutritional products on the levels of macro- and micro elements in maize” at Combined Congress 2017, Bella-Bella, Limpopo, 23-26 January 2017
- Ms L Malan, a PDP student received best student paper for “Biology and germination characteristics of *Urochloa mosambicensis* and *Urochloa panicoides*” at the Combined Congress 2017, Bella-Bella, Limpopo, 23-26 January 2017

## Background

The ICT & Infrastructure Report provides an overview of the work performed during the 2016-2017 Financial Year. The background against which the performance of the division is based has remained consistent with prior years in that the business plan targets have been multi-year. The ICT strategy developed in prior years has been fully implemented however, owing to developments in the ICT industry, and ensuring the ARC stay on top of the technology development, this strategies is continuously updated to address any ICT short comings. This will ensure the future performance of ICT in the ARC.

Similarly the asset management plan which has been the basis of performance planning for Infrastructure has also remained subject to multi-year implementation. The asset management plan, while also undergoing review, will remain one of the key drivers of the division's performance going forward.

A brief summary of the division's performance during the 2016-2017 financial year is outlined below.

## Information Communication Technology (ICT)

### ICT GOVERNANCE

As part of ongoing governance improvement, a single integrated ICT Policy was developed from multiple policies which existed previously. This approach was taken to ensure ease of compliance with both the governance of ICT as well as responsible use of ICT and related computing resources. Looking ahead, developments around the Cybercrimes Bill, Protection of Personal Information (POPI) Act and the ever-increasing use of mobile devices will require conscious and deliberate incorporation into the ARC's ICT governance framework and policies to ensure continued good governance, controls and risk mitigation.

### VIDEO CONFERENCING SOLUTION

A video conferencing solution was implemented during the year. This is one of the initiatives ICT implemented in order to enable efficiencies in operations and to reduce the financial burden associated with inter-institute travel and in some cases travel abroad where video conferencing can be used successfully. While this has primarily focused on institutes furthest from Pretoria the plan remains to increase the video conferencing footprint in order to further reduce travel costs overall. This is also in response to the increasing demand for video conferencing services.

### SOUTH AFRICAN NATIONAL RESEARCH NETWORK (SANREN) MIGRATION

Since the migration to the SANReN network commenced during 2013-2014, 92% of the ARC sites have to-date been successfully migrated. This process has been dependent on the progression of the SANReN project over which the ARC as a user has neither control nor influence. However, in more than 40% of the migrations the ARC had to invest in some cabling as well as satellite infrastructure to facilitate the connection of campuses situated far off the SANReN main paths.

## KNOWLEDGE AND COLLABORATION PLATFORMS

A number of initiatives implemented towards the development of knowledge management and collaboration platforms include the following:

- Agromet

This is a tool used for reporting long-term graphical comparative weather data specifically by the institute for Soil Climate and Water (ISCW).

- Collaboration Workspaces and Portals

These are virtual workspaces on the ARC intranet that enable either common interest participants, departments or committees to share and/or edit documents. The following workspaces and portals created during the year:

- Legal Compliance Workspace
- Bid Evaluation Committee Workspace
- ICT Steering Committee Portal
- Mobile Plant Clinic Portal
- Security Services Portal
- International Relations Portal

These initiatives are aimed at achieving improved collaboration, knowledge preservation and sharing, as well as optimising the use of information resources within the organisation.

## RESEARCH AND DEVELOPMENT INITIATIVES

- Germplasm Resource Information Network (GRIN)

The Germplasm Resource Information Network (GRIN) was implemented at the Small Grains Institute, with further implementations earmarked for later. This system holds the information from the Genebank. It will enable efficient and effective global network of Genebanks to permanently safeguard plant genetics resources vital to global food security.

## Infrastructure and Security Services

The following is an overview of key work activities performed during the 2016/17 financial year:

### ASSET MANAGEMENT PLAN

While the development of new business cases for the implementation of the asset management plan has been slow during the year, some significant progress has been made with regard to obtaining Ministerial approval in accordance with the Agricultural Research Act (Act no.86 of 1990, as amended) for all business cases previously approved by the ARC Council. These include among others disposals of certain properties in Bethlehem, Nelspruit and Onderstepoort. Among these are two schools belonging to the ARC which will, following due process, be transferred to the respective Provincial Departments of Basic Education.

The drive to increase external income has resulted in the division

engaging activities to increase space/property rentals to 3<sup>rd</sup> parties where surplus capacity became available. An average 7% increase in rental income excluding escalation rates was achieved. The challenge remains that this is a diminishing opportunity as surplus capacity gets taken up. Among the new leases secured during the year were pieces of land used for the installation of mobile communications towers.

## INFRASTRUCTURE PROJECTS

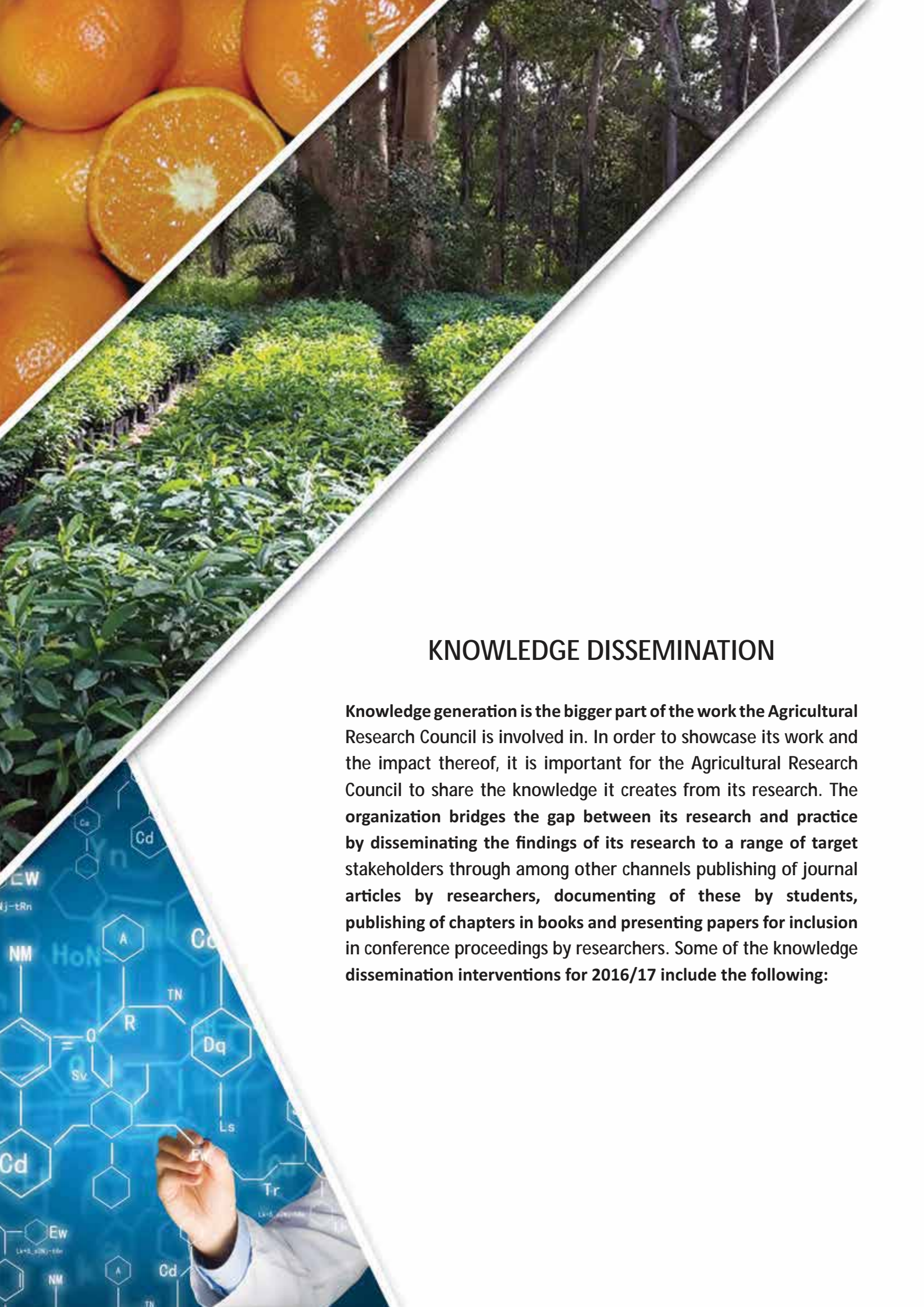
While there were no new construction projects during the period, the division oversaw a number of significant projects namely:

- Relocation of a section of the Plant Protection Research team (PPR) which was based at Rietondale, where they took occupation of the newly constructed quarantine facility at Roodeplaas. This relocation has resulted in the team now consolidating in one location which in turn is expected to have a cost saving as well as an operational efficiency impact on Plant Protection Research.
- The acquisition and installation of emergency power supply as

a risk mitigation for research critical infrastructure and other operational activities was completed during the year. This process involved the sourcing of backup generators through tender and the subsequent installation and commissioning of the generators to provide backup power in the event of failure or loss of primary power supply.

## SECURITY SERVICES

New security service contracts were concluded during the year. This is part of the efforts to improve the security of ARC staff and assets, which are particularly vulnerable and susceptible to violation through acts of theft and vandalism. These incidents have been experienced before with examples where even research material was violated to the detriment of the affected research projects. While this intervention provides some assurance of protection, a lack of technological sophistication in our security infrastructure remains a challenge as it depends on funding. However looking forward, the implementation of security technologies will be a point of focus starting in the new financial year as we seek to shift reliance from guarding services to technology surveillance at our campuses.



## KNOWLEDGE DISSEMINATION

Knowledge generation is the bigger part of the work the Agricultural Research Council is involved in. In order to showcase its work and the impact thereof, it is important for the Agricultural Research Council to share the knowledge it creates from its research. The organization bridges the gap between its research and practice by disseminating the findings of its research to a range of target stakeholders through among other channels publishing of journal articles by researchers, documenting of these by students, publishing of chapters in books and presenting papers for inclusion in conference proceedings by researchers. Some of the knowledge dissemination interventions for 2016/17 include the following:

## Journal Articles

- Adegoke, A., Aiyegoro, A., & Stenstrom, T. 2016. Effect of Interaction of Methanol Leaf of *Spondias mombin* (Linn) and Amoxicillin on Some Diarrheagenic *Escherichia coli*. *Tropical Journal of Pharmaceutical Research* 15(3):475-480.
- Akinpelu, D., Odewade, J., Aiyegoro, A., Ashafa, A., & Akinpelu, O. 2016. Biocidal effects of stem bark extract of *Chrysophyllum albidum* G. Don on vancomycin-resistant *Staphylococcus aureus*. *BMC Complementary and Alternative Medicine* 16:105.
- Aumer, D., Allsopp, M.H., Lattorff, H.M., Moritz, F.A. & Jarosch-Perlow, A. 2017. Thelytoky in Cape honeybees (*Apis mellifera capensis*) is controlled by a single recessive locus. *Apidologie* doi:10.1007/s13592-016-0484-0.
- Bajgain, P., Rouse, M.N., Tsilo, T.J., Bhavani, M.S., Jin, Y. & Anderson, J.A. 2016. Nested Association Mapping of Stem Rust Resistance in Wheat Using Genotyping by Sequencing. *PLOS One* DOI:10.1371, May 2016.
- Balicki, E.K., Tanguler, H., Jolly, N.P. & Erten H. 2016. Influence of *Lachancea thermotolerans* on Cv. Emir Wine Fermentation. *Yeast* DOI: 10.1002/yea/3166.
- Baloyi, M.A., Mostert, L. & Halleen, F. 2017. First report of *Cryptosphaeria multicontinentalis* associated with dieback and canker of poplar in the Western Cape Province of South Africa. *Plant Disease (International)* DOI 10 1094 /PDS-12-16-1748-PDN.
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- Bester, C., Joubert, M.E. & Joubert, E. 2016. A breeding strategy for South African indigenous herbal teas. *Acta Horticulturae* 1127: 15-22.
- Bester, R., Pepler, P.T., Aldrich, D.J. & Maree, H.J. 2017. Harbin: A quantitation PCR analysis tool. *Biotechnology letters* 39: 171-178.
- Beukes, D.J. & Swanepoel, C.M. 2017. The effects of conservation tillage practices and fertiliser management on soil structural properties at an experimental farm. *South African Journal of Plant and Soil* 34: 19-26.
- Beukes, I., Rose, L.J., Shephard, G.S., Flett, B.C. & Viljoen, A. 2017. Mycotoxigenic *Fusarium* species associated with grain crops in South Africa – A review. *South African Journal of Science. Volume 113(3/4): 25-36.*
- Bezuidt, O.K.I., Pierneef, R., Gomri, M.A., Adesioye, F., Makhwanyane, T.P., Kharroub, K., Cowan, D.A., & The Geobacillus Pan-Genome. 2016. Implications for the Evolution of the Genus. *Frontiers in Microbiology* 7, doi 10.3389/fmicb.2016.00723.
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- Biondi, M., Frasca, R., Grobbelaar, E. & D'Alessandro, P. 2016. Supraspecific taxonomy of the flea beetle genus *Blepharida* Chevrolat, 1836 (Coleoptera: Chrysomelidae) in the Afrotropical Region and description of *Afroleparida* subgen.nov. *Insect Systematics & Evolution* doi 10.1163/1876312X-48022152.
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- Carlucci, A., Lops, F., Mostert, L., Halleen, F. & Raimondo, M.L. 2017. Occurrence fungi causing blackfoot on young grapevines and nursery rootstock plants in Italy. *Phytopathologia Mediterranea* DOI: 10.14601/Phytopathol\_Mediterr-18769.
- Carpenter, S., Mellor, P.S., Fall, A.G., Garros, C. & Venter, G.J. 2017. African Horse Sickness Virus: History, transmission, and current status. *Annual Review of Entomology* 62: 343-358.
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# **CORPORATE GOVERNANCE**

# REPORT ON GOVERNANCE

## ARC BOARD

The ARC Council appointed by the Executive Authority (the Minister responsible for the ARC) in terms of the Agricultural Research Council Act, 1990 (Act no. 86 of 1990) governs the ARC.

## MEMBERS OF THE ARC BOARD

The members of the Board serving in the year under review were:

**Prof S Vil-Nkomo**  
(Chairperson - appointed, effective from 1 September 2014)  
**Prof M Kahn Deputy**  
(Chairperson - appointed, effective from April 2015)  
**Dr W Jansen van Rijssen**  
**Dr J Chitja**  
**Prof F Swanepoel**  
**Ms D Msomi**  
(Resigned as of October 2015)  
**Mr M Dyasi**  
**Prof L Hoffman**  
**Mr G Martin**  
**Mr R Nicholls**  
**Ms J Mashiteng**  
**Ms D Ndaba**  
**Mr C Kneale**  
**Mr A Bishop**  
**Mr I Motala**  
**Dr SR Moephuli**  
(President and CEO)

## RESPONSIBILITIES OF THE BOARD

The statutory functions of the ARC Council are determined in terms of the provisions of the Agricultural Research Council 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 organization.

The Council is responsible inter alia for approval of the prepared Annual Financial Statements that accurately reflect the ARC's 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.

## BOARD MEMBERS' REMUNERATION

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 Minister of Agriculture, Forestry & Fisheries.

Members of the Audit & Risk Committee are remunerated in accordance with an agreed tariff set by the ARC.

Detailed information on fees, emoluments, bonuses and subsistence and travel claims paid to Council members, Audit & Risk Committee members and executive members as required per Treasury Regulation 28.1.1 is provided in note 27 of the notes to the Annual Financial Statements.

## BOARD MEMBERS' INTERESTS IN CONTRACTS

None of the Board members are involved in/ have any interest in contracts entered into by the ARC in the year under review.

## PUBLIC FINANCE MANAGEMENT ACT

The ARC is fully committed to comply with the provisions of the Public Finance Management Act (PFMA). The internal and External auditors continue to provide the Council with assurance on the degree of compliance with the PFMA.

## MATERIALITY FRAMEWORK

In accordance with the PFMA and Treasury Regulations 28.1.5 the ARC has developed a Framework of acceptable levels of materiality and significance.

During the year under review, the following Council members attended the six (6) Council meetings scheduled:

**COUNCIL MEMBER NO. OF MEETINGS ATTENDED**

<b>Name</b>	<b>Designation in terms of Board</b>	<b>Date appointed</b>	<b>Date resigned/ term ended</b>	<b>Qualifications</b>	<b>Area of expertise</b>	<b>Board of Directors</b>	<b>Other committees (e.g. task teams)</b>	<b>Number of meetings attended</b>
Prof S Vil-Nkomo	Chairperson	01/09/2010		BA MA, PhD	Research	Yes		4
Prof M Kahn	Deputy Chairperson	01/09/2010	30/11/2016	Master of Arts, DIC; Doctor of Philosophy, Bachelor of Science (Honours)	Research	Yes	Research	4
Mr A Bishop	Member	01/09/2013		B. Comm Honours B. Compt Honours	Audit	Yes	Audit & risk Research	3
Dr J Chitja	Member	01/09/2010		PhD food science M. Soc. Sci, Bachelor of Science in Agriculture	Research	Yes	Research	3
Mr M Dyasi	Member	01/09/2013	30/11/2016	Diploma in Information Admin, Certificate in Affirmative Action, Certificate in Basics of Research	Finance	Yes	Finance & HR	4
Prof L Hoffman	Member	01/09/2013	30/11/2016	PhD (Meat Science)	Research	Yes	Research	3
Dr W Jansen Van Rijssen	Member	01/09/2013	30/11/2016	PhD (Paraclinical Sciences), MSc (Plant biochemistry), MSc (Toxicology), Honns (Pharmacology), Master in Public Administration.	Research	Yes	Research & HR	4
Mr C Kneale	Member	01/09/2013	30/11/2016	FCIS, F.INST.D, FCIBM, Fellow of the Society of Risk Managers SA, Associate member of Financial Management Institute of SA	Finance	Yes	Finance & HR	4
Mr G Martin	Member	01/09/2013	30/11/2016	BSc, National Diploma (Economic Management), M Com (Wine Business Management)	Human resource	Yes	HR	3
Ms J Mashiteng	Member	01/09/2013		Masters, Post Cert Management, Masters cert in nuclear	Finance	Yes	Finance, investment	3
Mr I Motala	Member	01/09/2013	30/11/2016	-	Finance	Yes	Finance, investment	4
Ms D Ndaba	Member	01/09/2010	30/11/2016	BTech in Transport Logistics, Diploma in Transport, Diploma in Marketing & Management, Diploma in Nursing	Human Resource	Yes	HR	3

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)	Number of meetings attended
Mr R Nicholls	Member	01/09/2013	30/11/2016	B.Comm, CA(SA), Computer Audit Specialist (NACCA), CIA Certified Internal Auditor, MICS (Certificate of Chartered Shipbrokers/UK)	Finance	Yes	Finance, Investment	3
Prof F Swanepoel	Member	01/09/2010	30/11/2016	PhD (Animal Science)	Research	Yes	Research	4

## STATEMENT OF ADHERENCE

The ARC, as Public Entity, confirms its commitment to the principles of transparency, integrity and accountability as advocated in the King III report on Corporate Governance. The ARC Council takes note of the principles contained in the King III Report and will ensure that the ARC complies with these principles to the extent that they apply.

### CORPORATE STRUCTURE AND RESPONSIBILITY

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, Forestry & Fisheries 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 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 advice if deemed necessary.

### GOVERNANCE STRUCTURES

In order to comply with these principles, the ARC has and continues to design and implement appropriate governance structures across the organization. ARC acknowledges that, for it to set up an effective governance framework, robust governance structures need to be in place. The following Council Committees operates as at 30 November 2016 together with their respective terms of reference in the form of Committee Charters:

#### EXECUTIVE COMMITTEE

During the year under review one Executive Committee meeting was held.

Council member	No. of meetings attended
Dr SR Moephuli (CEO)	1
Prof S Vil-Nkomo - Chairperson	1
Prof M Kahn - Deputy Chair	1
Ms J Mashiteng	1
Prof F Swanepoel	1
Mr G Martin	1

Human Resources and Remunerations, Social and Ethics Committee (Four (4) meetings held)

COMMITTEE	NO. OF MEETINGS	NO. OF MEMBERS	NAME OF MEMBERS
Human Resource, Remuneration and Social Committee	4 Meetings	5 Meetings	Mr G Martin
			Ms Dora Ndaba
			Mr M Dyasi
			Dr W Jansen Van Rijssen
			Mr C Kneale

Research, Development & Evaluation Committee (Three (3) meetings held)

COMMITTEE	NO. OF MEETINGS	NO. OF MEMBERS	NAME OF MEMBERS
Research, Development & Evaluation Committee	3 Meetings	5 Meetings	Dr F Swanepoel
			Prof L Hoffman
			Dr W Jansen Van Rijssen
			Mr A Bishop
			Dr J Chitja

Finance, Investment & ICT Governance Committee (Three (3) meetings held)

COMMITTEE	NO. OF MEETINGS	NO. OF MEMBERS	NAME OF MEMBERS
Finance, Investment and ICT Governance	3 Meetings	5 Meetings	Ms J Mashiteng
			Mr I Motala
			Mr C Kneale
			Mr N Nicholls
			Mr M Dyasi

# AUDIT AND RISK COMMITTEE REPORT

## REPORT OF THE AUDIT COMMITTEE

We are pleased to present our report for the financial year ended 31 March 2017.

### AUDIT COMMITTEE AND ATTENDANCE

The function of the Audit and Risk Committee (Committee) of the Agricultural Research Council (ARC) is to assist the Council of the ARC in discharging its duties relating to the safeguarding of assets, the operation of adequate systems, control processes and the preparation of financial reports and statements.

These tasks are conducted in line with all applicable legal requirements and accounting standards as prescribed in the Public Finance Management Act of 1999 (Act no.1 of 1999) (the PFMA). The Committee operates in terms of a written Terms of Reference (The Audit and Risk Committee Charter) which provides clear guidelines with regards to membership, authority and responsibilities. The Audit & Risk Committee Charter was reviewed and updated recently to accommodate new and extended responsibilities.

The membership of the Committee as at 31 March 2017 comprised of 5 (five) independent external members and two members of Council and their attendance is reflected in the table below.

### ATTENDANCE AT MEETING

Name of Member:	20/05/16	21/07/16SP	16/08/16	15/11/16	14/02/17
Mr. VK. Naicker	✓	✓	✓	✓	✓
Mr. H McBain	✓	✓	✓	✓	✓
Mr. L Mangquku	✓	X	✓	X	✓
Ms. J Bruinders	✓	X	✓	X	✓
Ms. P Mokoena	✓	✓	✓	✓	✓
Mr. A Bishop (ARC Council)	✓	✓	✓	✓	X
Mr. R Nicholls (ARC Council)	✓	✓	✓	✓	X

\*SP refers to Special Meeting

The CEO, CFO, Internal Audit Manager and the General Manager: Risk and Planning have a standing invitation to attend the meetings of the Committee. For the year under review the Committee met five times to discharge its mandate outlined in its charter. These meetings were well attended by Committee members. The Auditor General and Internal Audit Service Providers are invited to attend all the meetings of the Committee. The ARC Company Secretary acts as secretary of the Committee.

The Committee hereby also, confirms that Members of the Audit and Risk Committee met with Senior Management of the ARC, Internal Audit and the Auditor-General, individually and collectively, to address risks and challenges facing the ARC. A number of in-committee meetings were held to address control weaknesses within the ARC which matters were handed to management for follow up.

## AUDIT AND RISK COMMITTEE RESPONSIBILITY

The Audit and Risk Committee confirms that it has complied with its responsibilities arising from section 77 of the PFMA and Treasury Regulation 27 including the adoption of formal terms of reference as its Audit and Risk Committee Charter and has regulated its activities in compliance with this Charter and has discharged all its responsibilities as contained therein.

In the conduct of its duties, the Committee has, inter alia, reviewed the following:

- The effectiveness of the internal control systems;
- The operational risk areas covered in the scope of internal and external audits;
- The adequacy, reliability and accuracy of financial information provided to management and other users of such information;
- Any accounting and auditing concerns identified as a result of internal and external audits;
- Compliance with legal, accounting and regulatory frameworks;
- The activities of the Internal Audit Function, including its annual work program, co-ordination with external auditors, the reports of significant investigations and the response of management to specific recommendations;
- Where relevant, the independence and objectivity of external auditors.

### THE EFFECTIVENESS OF INTERNAL CONTROL AND INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) GOVERNANCE

In line with the PFMA and the recommendations from King III Report on Corporate Governance requirements, Internal Audit provides the Audit Committee and Management with assurance that the internal controls are appropriate and effective. This is achieved by means of the risk management process, as well as the identification of corrective actions and suggested enhancements to the controls and processes. The Audit and Risk Committee, based on the outcome of the independent audit by the Auditor-General is very disappointed in the weaknesses identified in the control environment specifically relating to the following areas:

1. The management of property, plant and equipment.
2. Recording and recognition of exchange transactions.
3. The management of debtors in particular the treatment of payments received in advance from other National Departments.
4. The impairment of Debtors due to the failure of obtaining the relevant debtor confirmations. However it is important, that whilst the AG raises its failure to obtain confirmations on the debtor's balances from National Departments and Entities, the Audit Committee repeatedly raised its concerns in the quarterly meetings and had times advised that legal action be instituted to recover such balances. This will be pursued with vigilance in the next financial year.
5. Procurement and Contract Management.

The Audit and Risk Committee is also concerned with the identified weaknesses emerging from the implementation of the ERP system and will ensure that a full assurance audit is undertaken in the next financial year.

The ARC continues to make improvements in the management of

performance information and the Audit Committee acknowledges the efforts of management in this regard.

The Audit and Risk Committee based on the Auditors-General's report is disappointed with the lack efforts by management to close out prior year Auditor-General findings and will increase oversight and validation efforts to ensure that there is no re-occurrence of such a failure to close out previous year findings.

The Audit and Risk Committee also reviewed the progress with respect to the ICT Governance in line with the ICT Framework issued by the ARC. During the financial year increased efforts were made in strengthening the ICT control environment which resulted in a positive outcome.

As a result of the independent audit outcome the Audit Committee and the Council have prioritized a strategic review to develop a course of action to reverse the qualified audit opinion received in the current year. Significant oversight and validation will be scheduled at regular intervals to correct and improve the deficiencies identified in the audit.

## INTERNAL AUDIT

The Committee directs, monitors and evaluates the activities of the Internal Audit Function. The Internal Audit Function is managed by an in sourced chief audit executive, who is assisted by an independent service provider acting as the internal auditors. During the financial year the Chief Audit Executive had resigned and the lack of leadership of the audit function has raised some concerns with the Audit Committee.

The Audit and Risk Committee will, together with the Chief Executive, prioritise the appointment of the Chief Audit Executive and to ensure that function increases its effectiveness in providing the Audit Committee with the necessary assurance it requires.

## RISK MANAGEMENT

The Audit and Risk Committee is satisfied that the risk management continues to be managed at an advanced level within the organization and continues to receive attention and refinements in line with its business model. Embedding of risk and mitigation around risk is now a continuous process and is ably led by the General Manager: Risk and Planning.

## FORENSIC INVESTIGATIONS

Investigations into alleged financial irregularities, financial misconduct and fraud were completed during the year under review. Various measures were recommended, including taking action against the identified officials and this was in the process of finalization. The recommendations are at various stages of implementation. There are no outstanding matters of significant nature which require to be requested here.

## EVALUATION OF ANNUAL FINANCIAL STATEMENTS

The Audit and Risk Committee has:

- Reviewed and discussed the audited Annual Financial Statements to be included in the Annual Report, with the AGSA and the Accounting Officer;
- Reviewed the Audit Report of the AGSA;
- Reviewed the AGSA's Management Report and Management's response thereto;
- Reviewed the Entity'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 Auditor General, more notably the emphasis on material misstatements and financial record keeping and accepts that there is further room for improvement in the accounting function and elements of the internal control environment.

The Committee notes the potential future difficulties associated with the on-going status of the ARC, as this is highly dependent on the extent of support from Government and the extent of the Parliamentary Grant. The Committee considers that the statement relating to the on-going status of the organization contained in the Annual Financial Statements remains appropriate. This is further substantiated by the Auditor-General raising its concern on the going concern status of ARC. The incurrence of a loss by the Council and its influence on the qualified opinion is duly noted and will be a key matter to be address by both the Council and the Audit Committee.

The Audit and Risk 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 under-funding of the organization. Such continuous under funding places a considerable strain on the financial resources of the ARC, which in turn places at risk the ARC's ability to fulfill its mandates.

The monitoring of the organization's performance is a key function of management, executive management and the Council. The Committee has no direct line responsibility for the Council's performance measurement. However, the Committee has ensured, principally 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.

## ONE-ON-ONE MEETING WITH THE ACCOUNTING AUTHORITY

The Audit and Risk Committee has met with the Accounting Authority for the Council to address unresolved issues.

Each meeting of the committee is requested at council as an agenda item.

## AUDITOR-GENERAL OF SOUTH AFRICA

The Audit and Risk Committee has met with the AGSA to ensure that there are no unresolved issues.

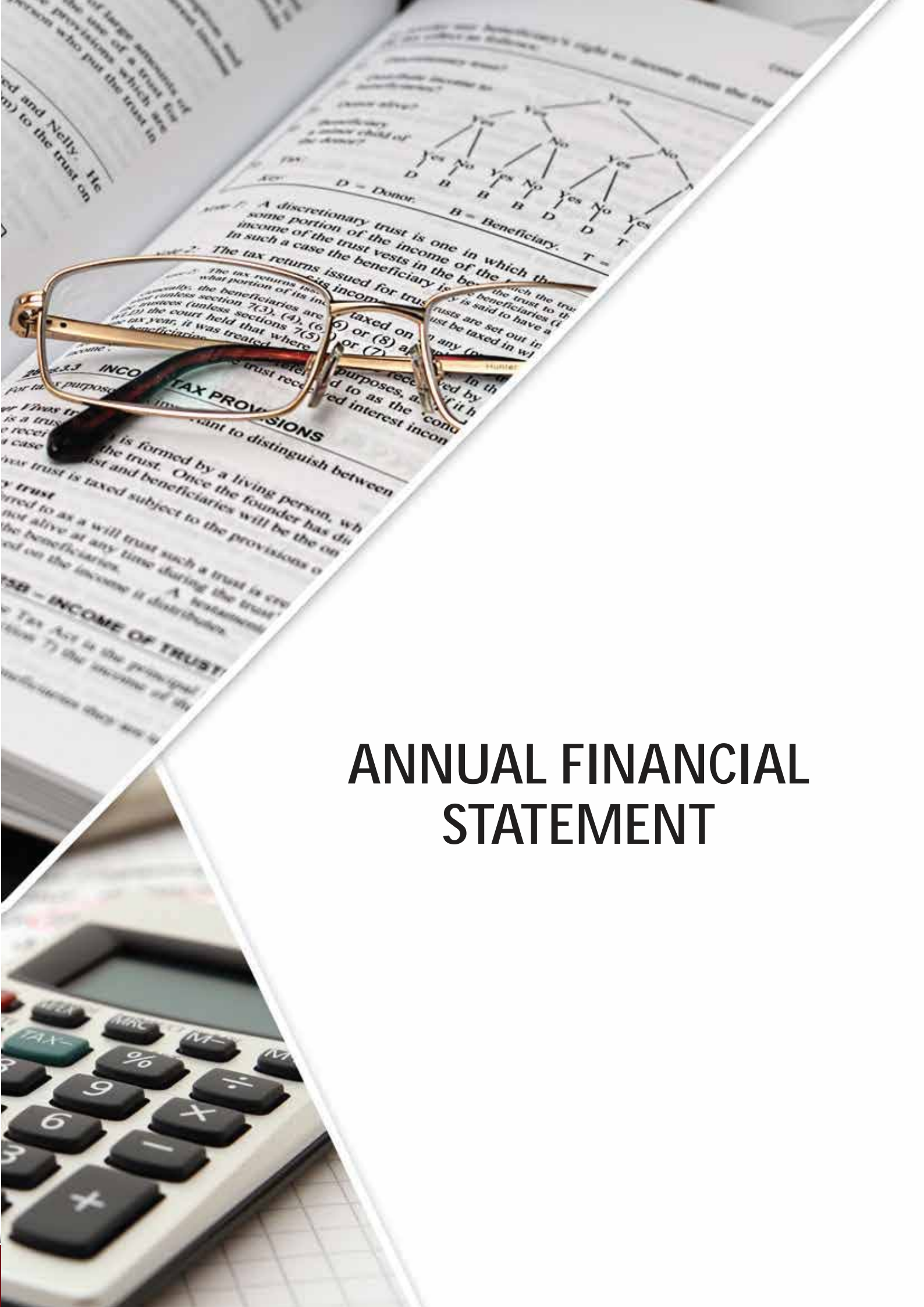
## IN CONCLUSION

The Committee is disappointed with the audit outcome for the financial year and will increase its efforts to increase its validation efforts on the identified areas for improvement. Management is encouraged to prioritise the matters identified by the Audit-General and engage with its accountable National Department to support its mandate and provide support in relation to the adequacy of its going concern and the collection of the outstanding debtors, specifically those owed by National Departments.

I would like to thank all the council, members of management and members of the Committee for their personal and professional contributions made during the reporting year.



Vishnu Naicker  
Chairperson of the ARC Audit & Risk Committee  
31 July 2017



# ANNUAL FINANCIAL STATEMENT

## Report of the auditor-general to Parliament on the Agricultural Research Council

### REPORT ON THE AUDIT OF THE FINANCIAL STATEMENTS

#### Qualified opinion

1. I have audited the financial statements of the Agricultural Research Council set out on pages 96 to 140, which comprise, statement of financial position as at 31 March 2017, the 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 my report, the financial statements present fairly, in all material respects, the financial position of the Agricultural Research Council as at 31 March 2017 and its financial performance and cash flows for the year then ended, in accordance with the South African Standards of Generally Recognised Accounting Practice (SA Standards of GRAP) and the requirements of the Public Finance Management Act of South Africa, 1999 (Act No. 1 of 1999) (PFMA).

#### Basis for qualified opinion

##### Property, plant and equipment

3. The public entity did not recognise all items of property, plant and equipment when they are available for use, i.e. when they are in the location and condition necessary to operate in the manner intended by management, as required by GRAP 17, *Property, plant and equipment*. Prior year additions to property plant and equipment were incorrectly recognised in the current financial year and assets under construction from prior years were not capitalised and depreciated when they are available for use. Consequently, current year property, plant and equipment additions were overstated by R35,556 million and assets under construction to the value of R30,504 million were not transferred to the relevant classes of assets when the assets were available for use. Additionally there was a resultant impact on the surplus for the period and on the accumulated surplus in the financial statements.
4. The financial statements were further materially misstated, as the public entity did not depreciate property, plant and equipment in accordance with GRAP 17, *Property, plant and equipment*. Property, plant and equipment were depreciated without taking into account the useful lives and residual values of the assets as determined in the accounting policy. Consequently, the net carrying amount of property, plant and equipment was overstated by R15,992 million (2016: R13,107 million), with a resultant impact on the surplus for the period and on the accumulated surplus in the financial statements.
5. Furthermore, items of property, plant and equipment disposed and/or destroyed and assets still in transit could not be verified

because of inadequate processes to maintain the fixed asset register. Consequently, property, plant and equipment were overstated by R51,859 million. There is a resultant impact on the surplus for the period in the financial statements.

##### Receivable from exchange transactions

6. I was unable to obtain sufficient appropriate audit evidence for other debtors as the public entity did not have adequate systems to maintain records of other debtors. In addition, other debtors were not recognised in accordance with the definition of a financial asset as required by GRAP 104, *Financial instruments*, resulting in other debtors being overstated by R8,221 million. I was unable to confirm other debtors by alternative means. Consequently, I was unable to determine whether any further adjustments were necessary to other debtors stated at R46,532 million as disclosed in note 9 to the financial statements.
7. Furthermore, the public entity offset other payables against other debtors, contrary to the requirements of GRAP 1, *Presentation and disclosure*, resulting in other debtors being understated by R16,363 million and other payables understated by the same amount.
8. The public entity did not recognise and measure trade debtors in accordance with GRAP 104, *Financial instruments*. Trade debtors with objective evidence of impairment were not provided for and some trade debtors were further recorded at incorrect amounts. Consequently, trade debtors were overstated by R69,475 million, revenue overstated by R7,046 million and debt impairment understated by R54,950 million. There was also a resultant impact on the surplus for the period and on the accumulated surplus in the financial statements.

##### Payables from exchange transactions

9. I was unable to obtain sufficient appropriate audit evidence that other payables were properly accounted for in accordance with GRAP 1, *Presentation and disclosure*. Assets and liabilities were offset inappropriately and adequate internal controls were not established for reconciliation of control accounts used for revenue recognition on projects. This resulted in revenue being recognised without recognising the related asset in the statement of financial position. I could not confirm other payables by alternative means. Consequently, I was unable to determine whether any adjustment to other payables stated at R154,533 million (2016: R175,289 million) in note 16 to the financial statements were necessary.
10. In addition, the public entity recognised amounts as liabilities which do not meet the definition of liabilities in accordance with GRAP 1, *Presentation and disclosure*. As a result other payables were overstated by R27,939 million. There is a resultant impact on surplus for the period and on the accumulated surplus in the financial statements.
11. Furthermore, I was unable to obtain sufficient appropriate audit evidence for payments received in advance as the public entity did not have adequate systems to maintain accurate records. In addition, items that did not meet the definition of liabilities, as required by GRAP 1, *Presentation and disclosure*, were recorded as payments received in advance. This resulted in payments received in advance being overstated by R18,320 million. I was unable to confirm the payments received in advance by

alternative means. Consequently, I was unable to determine whether any further adjustments were necessary to payments received in advance stated at R133,019 million (2016: R139,572 million) in note 16 to the financial statements.

12. I conducted my audit in accordance with the International 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.

13. I am independent of the public entity in accordance with the International Ethics Standards Board for Accountants' *Code of ethics for professional accountants* (IESBA code) and the 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.

14. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my qualified opinion.

#### Material uncertainty related to going concern

15. I draw attention to note 31 in the financial statements, which indicate that the public entity incurred a net loss of R86,064 million (2016: R68,261 million) during the year ended 31 March 2017 and, as of that date the entity's current liabilities exceeded its current assets by R26,995 million. As stated in note 31, these events or conditions, along with other matters as set forth in note 31, indicate that a material uncertainty exists that may cast significant doubt on the public entity's ability to continue as a going concern. My opinion is not modified in respect of this matter.

#### Emphasis of matters

16. I draw attention to the matters below. My opinion is not modified in respect of these matters.

#### Material impairments – trade debtors

17. As disclosed in note 9 to the financial statements, material impairments to the amount of R15,249 million were incurred as a result of slow collection response.

#### Uncertainty relating to the future outcome of litigation

18. With reference to note 25 to the financial statements, the public entity is a defendant in a number of litigation claims. The ultimate outcome of the matters cannot presently be determined and therefore no provision for any liability that may arise has been made in the financial statements.

#### Responsibilities of accounting authority for the financial statements

19. The council, which constitutes the accounting authority, is responsible for the preparation and fair presentation of the financial statements in accordance with SA Standards of 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.

20. In preparing the financial statements, the accounting authority is responsible for assessing the ARC'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 intention is to liquidate the public entity or cease operations, or there is no realistic alternative but to do so.

#### Auditor-general's responsibilities for the audit of the financial statements

21. My objectives are to obtain reasonable assurance about whether

the financial statements as a whole are free from material misstatement, 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 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.

22. A further description of my responsibilities for the audit of the financial statements is included in the annexure to the auditor's report.

## REPORT ON THE AUDIT OF THE ANNUAL PERFORMANCE REPORT

#### Introduction and scope

23. In accordance with the Public Audit Act of South Africa, 2004 (Act No. 25 of 2004) (PAA) and the general notice issued in terms thereof, I have a responsibility to report material findings on the reported performance information against predetermined objectives for selected programmes presented in the annual performance report. I performed procedures to identify findings but not to gather evidence to express assurance.

24. My procedures address the reported performance information, which must be based on the approved performance planning documents of the public entity. I have not evaluated the completeness and appropriateness of the performance indicators included in the planning documents. My procedures also did not extend to any disclosures or assertions relating to 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.

25. 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 objectives presented in the annual performance report of the public entity for the year ended 31 March 2017:

Programmes	Page in the annual performance report
Programme 1 – Crop Production, Improvement and Protection	141
Programme 2 – Animal Health, Production and Improvement	141
Programme 3 – Natural Resource Management	141
Programme 5 – Agro-Processing, Food Technology and Safety	142
Programme 6 – Smallholder Agricultural Development	142
Programme 7 – Agricultural Economics and Commercialisation	142

26. 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.

27. I did not raise any material findings on the usefulness and reliability of the reported performance information for the following programmes:

- Programme 1 - Crop Production, Improvement and Protection
- Programme 2 - Animal Health, Production and Improvement
- Programme 3 - Natural Resource Management
- Programme 5 - Agro-Processing, Food Technology and Safety
- Programme 6 - Smallholder Agricultural Development
- Programme 7 - Agricultural Economics and Commercialisation.

#### Other matter

28. I draw attention to the matter below.

#### Achievement of planned targets

29. Refer to the annual performance report on pages 141 to 143 for information on the achievement of planned targets for the year and explanations provided for the under/overachievement of a number of targets.

## REPORT ON AUDIT OF COMPLIANCE WITH LEGISLATION

#### Introduction and scope

30. 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.

31. The material findings in respect of the compliance criteria for the applicable subject matters are as follows:

#### Annual financial statements

32. The financial statements submitted for auditing were not prepared in accordance with the prescribed financial reporting framework, as required by section 55(1)(a) of the PFMA. Material misstatements of the cash flow statement, related party disclosure and conditional grant liability identified by the auditors in the submitted financial statements were corrected, but the uncorrected material misstatements resulted in the financial statements receiving a qualified audit opinion.

#### Budgets

33. Expenditure was incurred in excess of the approved budget, in contravention of section 53(4) of the PFMA.

#### Expenditure management

34. Effective steps were not taken to prevent irregular expenditure amounting to R199,263 million (2016: R205,177 million) as disclosed in note 33 to the annual financial statements, in contravention of section 51(1)(b)(ii) of the PFMA.

35. Contributions received by the public entity in terms of section 20(1)(g) of the Agricultural Research Act (Act No. 86 of 1990) (ARC Act) were not spent in accordance with the conditions imposed by the contributor concerned, as required by section 20(2)(c) of the ARC Act.

#### Revenue management

36. Effective and appropriate steps were not taken to collect all money due, as required by section 51(1)(b)(i) of the PFMA and/or treasury regulation 31.1.2(a) and (e).

#### Asset management

37. Proper control systems to safeguard and maintain assets implemented were not adequate, as required by sections 50(1)

(a) and 51(1)(c) of the PFMA.

#### Procurement and contract management

38. Sufficient appropriate audit evidence could not be obtained that all contracts were awarded and quotations were accepted in accordance with the legislative requirements as deviation submissions recorded by the public entity were not provided to determine whether the deviation was approved and justifiable and resulted in an award.

## OTHER INFORMATION

39. The ARC's accounting authority is responsible for the other information. The other information does not include the financial statements, the auditor's report thereon and those selected programmes presented in the annual performance report that have been specifically reported on in the auditor's report.

40. 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 thereon.

41. 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 programmes presented in the annual performance report or my knowledge obtained in the audit, or otherwise appears to be materially misstated. If, based on the work I have performed on the other information obtained prior to the date of this auditor's report, I conclude that there is a material misstatement of this other information, I am required to report that fact.

42. I have not yet received the annual report. When I do receive this information and I conclude that there is a material misstatement therein, I am required to communicate the matter to those charged with governance and request that the other information be corrected. If the other information is not corrected I may have to re-issue my auditor's report, amended as appropriate.

## INTERNAL CONTROL DEFICIENCIES

43. 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 thereon. The matters reported below are limited to the significant internal control deficiencies that resulted in the basis for qualified opinion and the findings on compliance with legislation included in this report.

#### Leadership

44. Management has not provided adequate direction and oversight of the control environment, financial management and compliance with laws and regulations. Key controls designed and implemented to monitor the activities and transactions of the various institutes forming the basis of the financial statements were not adequate. This resulted in inaccurate and incomplete financial statements being submitted for audit and non-compliance with applicable legislation.

45. Action plans implemented by management did not adequately address root causes of previously raised audit findings. This resulted in inadequate implementation and monitoring of the audit action plan.

46. Management did not adequately implement consequence management at all times, with the result that internal control deficiencies were still noted.

#### Financial and performance management

47. Management did not formulate and implement record management policies and procedures to ensure that all supporting documentation is properly controlled, readily available and easily accessible to facilitate timely retrieval on

request.

48. Adequate daily and monthly financial processing and reconciliations did not always take place. Where reconciliations were prepared, reconciling items were not resolved timeously and review measures were not adequate to detect this
49. Compliance monitoring controls implemented by the public entity were not adequate to prevent material non-compliance with specific matters in key legislation.
50. The business processes implemented by management were not fully supported by the information system and where deficiencies were noted, manual controls were not implemented to prevent and detect material misstatements.

*Auditor-General.*

Pretoria  
31 July 2017



AUDITOR-GENERAL  
SOUTH AFRICA

*Auditing to build public confidence*

## Annexure A – 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 objectives 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 the 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 governing body, which constitutes 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 ARC's ability 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 the opinion on the financial statements. My conclusions are based on the information available to me at the date of the auditor's report. However, future events or conditions may cause a public entity to cease operating as a going concern.
  - evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and 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 confirm to the accounting authority that I have complied with relevant ethical requirements regarding independence, and communicate all relationships and other matters that may reasonably be thought to have a bearing on my independence and, where applicable, related safeguards.

## GENERAL INFORMATION

<b>Country of incorporation and domicile</b>	South Africa
<b>Nature of business and principal activities</b>	Conduct research, develop technology, and to transfer technology that promotes agriculture and industry.
<b>Registered office</b>	1134 Park Street, Hatfield, 0083
<b>Business address</b>	1134 Park Street, Hatfield, 0083
<b>Postal address</b>	P.O. Box 8783, Pretoria, 0001
<b>Controlling entity</b>	Department of Agriculture, Forestry and Fisheries
<b>Economic entity</b>	Department of Agriculture, Forestry and Fisheries
<b>Auditors</b>	Auditor General of South Africa, Chartered Accountants (S.A.)
<b>Company secretary</b>	Ayanda Ndamase

# INDEX

The reports and statements set out below comprise the annual financial statements presented to the council:

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## ACCOUNTING AUTHORITY'S RESPONSIBILITIES AND APPROVAL

The Council is required by the Public Finance Management Act (Act 1 of 1999) and the Agricultural Research Act No. 86 of 1990 as amended, 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 Council 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 were given unrestricted access to all financial records and related data.

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 acknowledges 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 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 ARC and all employees are required to maintain the highest ethical standards in ensuring the ARC's business is conducted in a manner that in all reasonable circumstances is above reproach. The focus of risk management in the ARC is on identifying, assessing, managing and monitoring all known forms of risk across the ARC. While operating risk cannot be fully eliminated, the ARC 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 is 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 have reviewed the ARC's cash flow forecast for the year to 31 March 2018 and, in the light of this review and the current financial position, they are satisfied that the ARC has or has access to adequate resources to continue in operational existence for the foreseeable future.

We draw your attention to the fact that the net deficit of the ARC was R 86 064 057 (2016: deficit R 68 261 408).

The ARC has received a letter of allocation for funding covering a period of three years from 1 April 2017 to 31 March 2020. Management has embarked on cost containment measures to deal with the effects of the current economic downturn. The annual financial statements are prepared on the basis that the ARC is a going concern and that the ARC has neither the intention nor the need to liquidate or curtail materially the scale of operations.

Although the accounting authority is primarily responsible for the financial affairs of the ARC, it is supported by the external auditors.

The external auditors are responsible for independently reviewing and reporting on the ARC's annual financial statements. The annual financial statements have been examined by the ARC's external auditors and their report is presented on page 92.

The annual financial statements set out on pages 99 to 140, which have been prepared on the going concern basis, were approved by the accounting authority on 31 May 2017 and were signed on its behalf by:



**Prof S Vil Nkomo (Chairperson)**  
Chairperson



**Dr SR Moephuli**  
President and CEO

# STATEMENT OF FINANCIAL PERFORMANCE

Figures in Rand	Note(s)	2017	2016 Restated*
<b>Revenue</b>			
<b>Revenue from exchange transactions</b>			
Sale of goods in agricultural activities		22 252 569	20 189 221
Rendering of services		369 360 527	391 485 626
Royalty income		14 800 101	11 520 940
Rental of facilities and equipment		15 232 353	11 478 239
Interest received	4	16 159 151	26 732 350
Dividends received	4	165 553	45 855
<b>Total revenue from exchange transactions</b>		<b>437 970 254</b>	<b>461 452 231</b>
<b>Revenue from non-exchange transactions</b>			
<b>Transfer revenue</b>			
Government grants	5	758 581 844	787 438 341
<b>Total revenue</b>	3	<b>1 196 552 098</b>	<b>1 248 890 572</b>
<b>Expenditure</b>			
Employee related costs		(744 492 069)	(768 053 041)
Depreciation and amortisation		(42 578 453)	(42 473 853)
Impairment loss/ Reversal of impairments	6	-	2 044 951
Finance costs		(128 741)	(29 993)
Lease rentals on operating lease	7	(25 439 193)	(11 098 681)
Debt Impairment		(3 654 019)	(127 054)
Operating and administrative expenses		(466 447 207)	(498 383 210)
<b>Total expenditure</b>		<b>(1 282 739 682)</b>	<b>(1 318 120 881)</b>
<b>Operating deficit</b>	7	<b>(86 187 584)</b>	<b>(69 230 309)</b>
Gain on disposal of assets		123 527	968 901
<b>Deficit for the year</b>		<b>(86 064 057)</b>	<b>(68 261 408)</b>

# STATEMENT OF FINANCIAL POSITION AS AT 31 MARCH 2017

Figures in Rand	Note(s)	2017	2016 Restated*
<b>Assets</b>			
<b>Current Assets</b>			
Inventories	8	15 414 307	7 487 963
Receivables from exchange transactions	9	258 450 606	273 289 412
Cash and cash equivalents	10	97 372 612	301 526 198
		<b>371 237 525</b>	<b>582 303 573</b>
<b>Non-Current Assets</b>			
Investment property	11	98 648	98 648
Property, plant and equipment	12	1 013 362 613	966 191 869
Intangible assets	13	35 465 153	39 863 379
Heritage assets	14	223 167	223 167
Other financial assets	15	5 233 530	5 016 606
		<b>1 054 383 111</b>	<b>1 011 393 669</b>
<b>Total Assets</b>		<b>1 425 620 636</b>	<b>1 593 697 242</b>
<b>Liabilities</b>			
<b>Current Liabilities</b>			
Operating lease liability		49 485	-
Payables from exchange transactions	16	328 855 592	375 767 525
VAT payable		5 319 971	5 713 365
Provisions	17	64 007 634	91 774 710
		<b>398 232 682</b>	<b>473 255 600</b>
<b>Non-Current Liabilities</b>			
Employee benefit obligation	18	15 059 000	16 641 000
Conditional grants	19	132 892 976	138 062 351
		<b>147 951 976</b>	<b>154 703 351</b>
<b>Total Liabilities</b>		<b>546 184 658</b>	<b>627 958 951</b>
<b>Net Assets</b>		<b>879 435 978</b>	<b>965 738 291</b>
Capital fund	20	111 986 013	111 986 013
Insurance reserve		2 393 323	2 631 579
Accumulated surplus		765 056 642	851 120 699
<b>Total Net Assets</b>		<b>879 435 978</b>	<b>965 738 291</b>

## STATEMENT OF CHANGES IN NET ASSETS

Figures in Rand	Capital fund	Insurance reserve	Accumulated surplus	Total net assets
Opening balance as previously reported	111 986 013	2 631 579	870 024 713	984 642 305
Adjustments				
Prior year adjustments	-	-	49 357 394	49 357 394
<b>Balance at 01 April 2015 as restated*</b>	<b>111 986 013</b>	<b>2 631 579</b>	<b>919 382 107</b>	<b>1 033 999 699</b>
Changes in net assets				
Deficit for the year	-	-	(68 261 408)	(68 261 408)
Total changes	-	-	(68 261 408)	(68 261 408)
<b>Restated* Balance at 01 April 2016</b>	<b>111 986 013</b>	<b>2 631 579</b>	<b>851 120 699</b>	<b>965 738 291</b>
Changes in net assets				
Deficit for the year	-	-	(86 064 057)	(86 064 057)
Decrease in reserves	-	(238 256)	-	(238 256)
Total changes	-	(238 256)	(86 064 057)	(86 302 313)
<b>Balance at 31 March 2017</b>	<b>111 986 013</b>	<b>2 393 323</b>	<b>765 056 642</b>	<b>879 435 978</b>

# CASH FLOW STATEMENT

Figures in Rand	Note(s)	2017	2016 Restated*
<b>Cash flows from operating activities</b>			
<b>Receipts</b>			
Sale of goods and services		436 267 432	282 820 872
Grants		739 464 378	744 677 901
Interest income		16 159 151	26 732 350
		<u>1 191 890 961</u>	<u>1 054 231 123</u>
<b>Payments</b>			
Employee costs		(765 672 733)	(763 841 925)
Suppliers		(543 992 431)	(394 698 696)
Finance costs		(128 741)	(29 993)
		<u>(1 309 793 905)</u>	<u>(1 158 570 614)</u>
<b>Net cash flows used in operating activities</b>	22	<u><b>(117 902 944)</b></u>	<u><b>(104 339 491)</b></u>
<b>Cash flows from investing activities</b>			
Purchase of property, plant and equipment	12	(85 451 608)	(103 313 560)
Proceeds from sale of property, plant and equipment	12	338 881	943 636
Purchase of other intangible assets	13	(1 137 915)	-
		<u>(86 250 642)</u>	<u>(102 369 924)</u>
<b>Net cash flows used in investing activities</b>		<u><b>(86 250 642)</b></u>	<u><b>(102 369 924)</b></u>
<b>Net decrease in cash and cash equivalents</b>		<u><b>(204 153 586)</b></u>	<u><b>(206 709 415)</b></u>
Cash and cash equivalents at the beginning of the year		301 526 198	508 235 613
<b>Cash and cash equivalents at the end of the year</b>	10	<u><b>97 372 612</b></u>	<u><b>301 526 198</b></u>

# STATEMENT OF COMPARISON OF BUDGET AND ACTUAL AMOUNTS

Budget on Cash Basis						
Figures in Rand	Approved budget	Adjustments	Final Budget	Actual amounts on comparable basis	Difference between final budget and actual	Reference
<b>Statement of Financial Performance</b>						
<b>Revenue</b>						
<b>Revenue from exchange transactions</b>						
Sale of goods in agricultural activities	28 032 981	-	<b>28 032 981</b>	22 252 569	<b>(5 780 412)</b>	#1
Rendering of services	355 772 630	-	<b>355 772 630</b>	369 360 527	<b>13 587 897</b>	#2
Royalty income	9 255 335	-	<b>9 255 335</b>	14 800 101	<b>5 544 766</b>	#3
Rental of facilities and equipment	16 810 366	-	<b>16 810 366</b>	15 232 353	<b>(1 578 013)</b>	
Interest received	27 494 000	-	<b>27 494 000</b>	16 159 151	<b>(11 334 849)</b>	#4
Dividends received	-	-	-	165 553	<b>165 553</b>	
<b>Total revenue from exchange transactions</b>	<b>437 365 312</b>	<b>-</b>	<b>437 365 312</b>	<b>437 970 254</b>	<b>604 942</b>	
<b>Revenue from non -exchange transactions</b>						
<b>Transfer revenue</b>						
Government grants	752 622 281	-	<b>752 622 281</b>	758 581 844	<b>5 959 563</b>	
<b>Total revenue</b>	<b>1 189 987 593</b>	<b>-</b>	<b>1 189 987 593</b>	<b>1 196 552 098</b>	<b>6 564 505</b>	
<b>Expenditure</b>						
Personnel	(818 429 685)	-	<b>(818 429 685)</b>	(744 492 069)	<b>73 937 616</b>	#5
Depreciation and amortisation	(37 000 000)	-	<b>(37 000 000)</b>	(42 578 453)	<b>(5 578 453)</b>	#6
Finance costs	-	-	-	(128 741)	<b>(128 741)</b>	
Lease rentals on operating lease	(13 124 210)	-	<b>(13 124 210)</b>	(25 439 193)	<b>(12 314 983)</b>	#7
Debt Impairment	-	-	-	(3 654 019)	<b>(3 654 019)</b>	#8
Operating and administrative expenses	(234 445 205)	-	<b>(234 445 205)</b>	(466 447 207)	<b>(232 002 002)</b>	#9
<b>Total expenditure</b>	<b>(1 102 999 100)</b>	<b>-</b>	<b>(1 102 999 100)</b>	<b>(1 282 739 682)</b>	<b>(179 740 582)</b>	
<b>Operating deficit</b>	<b>86 988 493</b>	<b>-</b>	<b>86 988 493</b>	<b>(86 187 584)</b>	<b>(173 176 077)</b>	
Gain on disposal of assets and liabilities	-	-	-	123 527	<b>123 527</b>	
<b>Deficit before taxation</b>	<b>86 988 493</b>	<b>-</b>	<b>86 988 493</b>	<b>(86 064 057)</b>	<b>(173 052 550)</b>	
<b>Actual Amount on Comparable Basis as Presented in the Budget and Actual Comparative Statement</b>	<b>86 988 493</b>	<b>-</b>	<b>86 988 493</b>	<b>(86 064 057)</b>	<b>(173 052 550)</b>	

## COMMENTS AND VARIANCE ANALYSIS

### #1 Sale of goods in agriculture activities

Some budgeted contracts did not materialize during the year.

### #2 Rendering of Services

More contracted research activities occurred than budgeted during the year.

### #3 Royalty income

The volumes of sales on which licensees pay royalties were higher than anticipated.

### #4 Interest Received

The budget cuts and slow paying government departments affected the level of cash available for short-term investment.

### #5 Personnel cost

In order to mitigate the effect of budget cuts, the filling of vacancies was curtailed. Budgeted performance bonuses were also not paid.

### #6 Depreciation and amortisation

This relates to externally funded capex that were not budgeted for during the budget process.

### #7 Lease Rental on Operating Cost

A new lease agreement for computers was signed during the financial year. The tender was awarded at an amount higher than anticipated due to the unfavorable Rand – Dollar exchange rate

### #8 Debt Impairment

Provision for bad debts was increased due to a higher number of long outstanding debtors.

### #9 Operating and Administrative expense

The bulk of our operating and administrative cost are fixed. In light of the budget cuts, it was impossible to cover all our fixed cost and still be able to do research without exceeding the budget. The actual costs are at the levels comparable to the previous year.

## 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) as amended and Agricultural Research Act No. 86 of 1990.

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.

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.

### 1.1 GOING CONCERN ASSUMPTION

These annual financial statements have been prepared based on the expectation that the entity will continue to operate as a going concern for at least the next 12 months.

### 1.2 CRITICAL ACCOUNTING POLICIES WITH KEY MANAGEMENT JUDGEMENT

Certain critical accounting policies require the use of judgement in their application or require estimates of inherently uncertain matters. Although the accounting policies are in compliance with Standards of Generally Recognised Accounting Practice (GRAP), a change in the facts and circumstances of the underlying transactions could significantly change the implication of the accounting policy and the resulting financial statement impact.

Listed below are those policies that the Council believe are critical and require the use of complex judgement in their application:

#### Property, plant and equipment

The entity's management determines useful lives, residual values and related depreciation charges for its property, plant and equipment with reference to the estimated periods that the entity intends to derive future economic benefits from the use of these assets. Residual values and estimated useful lives are assessed on an annual basis. The residual values of vehicles are estimated on published second hand vehicle values as well as trading history.

Land and buildings residual values are estimated using market conditions that will exist at end of the useful life. This includes management using its estimates between the periods where a sworn valuer is not used for valuation.

The estimates relating to equipment land and buildings are included in the plant and equipment accounting policy.

#### Intangible assets

The useful life is determined by management at the time the software is acquired and brought into use and is regularly reviewed for appropriateness.

#### Post retirement benefits

The present value of the post retirement obligation depends on a number of 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 18.

#### Post-retirement medical benefits

The accounting for post-retirement medical and end of service benefits requires the Council to make certain assumptions that have a significant impact on the expenses and liabilities that are recorded for these employment benefits. These assumptions are included in the notes to the annual financial statements.

Because of the typically long-term nature of the entity's obligations in its post employment benefit schemes, and the short term volatility of financial markets, the Council recognises any impact of a modification of such assumptions over the expected remaining active life of beneficiaries.

The accounting for defined benefit pension benefit requires the Council to make certain assumptions that have a significant impact on the expenses and liabilities that are recorded for these employment benefits.

### 1.3 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 or for
- administrative purposes, or
- sale in the ordinary course of operations.

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 installments over the useful life of the property, which is as follows:

Item	Useful life
Property - buildings	40 to 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.

## 1.4 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.

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 carried at cost less accumulated depreciation and any impairment losses.

Buildings and infrastructure in the course of construction for production, rental or administrative purposes, or for purposes not yet determined, are carried at cost, less any recognised impairment loss. Cost includes professional fees, acquisition costs, construction and, for qualifying assets, borrowing costs are capitalised in accordance with the ARC accounting policy. These assets are depreciated on the same basis as other buildings and depreciation commences when the assets are ready for their intended use. Buildings under construction are not depreciated. Buildings and or infrastructure available for use are accounted for at cost less accumulated depreciation and accumulated impairments.

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
Land	Straight line	Not depreciated
Buildings	Straight line	3 to 70 years
Machinery & Farming Equipment	Straight line	3 to 60 years
Office Furniture & 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

The depreciable amount of an asset is allocated on a systematic basis over its useful life.

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 no future economic benefits or service potential are expected from its use or disposal.

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 discloses relevant information relating to assets under construction or development, in the notes to the financial statements (see note 12).

## 1.5 INTANGIBLE ASSETS

An intangible asset is an identifiable non-monetary asset without physical substance.

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.

Intangible assets are measured initially at cost. 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.

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.

- 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.

The amortisation period and the amortisation method for intangible assets are reviewed at each reporting date.

Amortisation of intangible assets is included in the depreciation and amortisation line item in the statement of financial performance.

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

Intangible assets are derecognised:

- on disposal; or
- when no future economic benefits or service potential are expected from its use or disposal.

## 1.6 HERITAGE ASSETS

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.

### 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 assess 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.

## 1.7 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 through the use of an allowance account) for impairment or uncollectibility.

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.

### 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
Trade and other receivables	Financial asset measured at amortised cost
Cash and cash equivalents	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

### Initial recognition

The entity recognises a financial asset or a financial liability in its statement of financial position when the entity becomes a party to the contractual provisions of the instrument.

### Initial measurement of financial assets and financial liabilities

The entity measures a financial asset and financial liability initially at its fair value plus transaction costs that are directly attributable to the acquisition or issue of the financial asset or financial liability.

### Receivables from exchange transactions

Trade receivables are measured at initial recognition at fair value, and are subsequently measured at amortised cost using the effective interest rate method. Appropriate allowances for estimated irrecoverable amounts are recognised in surplus or deficit when there is objective evidence that not all amounts due will be collected according to original terms of the receivables. Significant financial difficulties of the debtor, probability that the debtor will enter bankruptcy or financial reorganisation, and default or delinquency in payments are considered indicators that the trade receivable is impaired. The allowance recognised is measured as the difference between the asset's carrying amount and the present value of estimated future cash flows, discounted at the effective interest rate computed at initial recognition.

The carrying amount of the asset is reduced through the use of an allowance account, and the amount of the deficit is recognised in

surplus or deficit within operating expenses. When a trade receivable is uncollectible, it is written off against the allowance account for trade receivables. Subsequent recoveries of amounts previously written off are credited against operating expenses in surplus or deficit.

#### **Payables from exchange transactions**

Trade payables are initially measured at fair value, and are subsequently measured at amortised cost, using the effective interest rate method.

#### **Cash and cash equivalents**

Cash and cash equivalents comprise cash on hand and short-term deposits held on call with banks, all of which are available for use by the ARC. Cash equivalents comprise of highly liquid investment that are convertible to cash with insignificant risk of changes in value. These are initially and subsequently recorded at fair value.

#### **Subsequent measurement of financial assets and financial liabilities**

The entity measures all financial assets and financial liabilities after initial recognition using the following categories:

- Financial instruments at fair value.
- Financial instruments at amortised cost.
- Financial instruments at cost.

#### **Impairment and uncollectibility of financial assets**

The entity assess at the end of each reporting period whether there is any objective evidence that a financial asset or group of financial assets is impaired.

#### **Financial assets measured at amortised cost:**

If there is objective evidence that an impairment loss on financial assets measured at amortised cost has been incurred, the amount of the loss is measured as the difference between the asset's carrying amount and the present value of estimated future cash flows (excluding future credit losses that have not been incurred) discounted at the financial asset's original effective interest rate. The carrying amount of the asset is reduced directly OR through the use of an allowance account. The amount of the loss is recognised in surplus or deficit.

If, in a subsequent period, the amount of the impairment loss decreases and the decrease can be related objectively to an event occurring after the impairment was recognised, the previously recognised impairment loss is reversed directly OR by adjusting an allowance account. The reversal does not result in a carrying amount of the financial asset that exceeds what the amortised cost would have been had the impairment not been recognised at the date the impairment is reversed. The amount of the reversal is recognised in surplus or deficit.

#### **Financial assets measured at cost:**

If there is objective evidence that an impairment loss has been incurred on an investment in a residual interest that is not measured at fair value because its fair value cannot be measured reliably, the amount of the impairment loss is measured as the difference between the carrying amount of the financial asset and the present value of estimated future cash flows discounted at the current market rate of return for a similar financial asset. Such impairment losses are not reversed.

#### **Derecognition**

##### **Financial assets**

The entity derecognises a financial asset only when:

- the contractual rights to the cash flows from the financial asset expire, are settled or waived;
- the entity transfers to another party substantially all of the risks and rewards of ownership of the financial asset; or
- the entity, despite having retained some significant risks and

rewards of ownership of the financial asset, has transferred control of the asset to another party and the other party has the practical ability to sell the asset 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:

- derecognise the asset; and
- recognise separately any rights and obligations created or retained in the transfer.

If, as a result of a transfer, a financial asset is derecognised in its entirety but the transfer results in the entity obtaining a new financial asset or assuming a new financial liability, or a servicing liability, the entity recognise the new financial asset, financial liability or servicing liability at fair value.

On derecognition of a financial asset in its entirety, the difference between the carrying amount and the sum of the consideration received is recognised in surplus or deficit.

If the transferred asset is part of a larger financial asset and the part transferred qualifies for derecognition in its entirety, the previous carrying amount of the larger financial asset is allocated between the part that continues to be recognised and the part that is derecognised, based on the relative fair values of those parts, on the date of the transfer. For this purpose, a retained servicing asset is treated as a part that continues to be recognised. The difference between the carrying amount allocated to the part derecognised and the sum of the consideration received for the part derecognised is recognised in surplus or deficit.

If a transfer does not result in derecognition because the entity has retained substantially all the risks and rewards of ownership of the transferred asset, the entity continue to recognise the transferred asset in its entirety and recognise a financial liability for the consideration received. In subsequent periods, the entity recognises any revenue on the transferred asset and any expense incurred on the financial liability. Neither the asset, and the associated liability nor the revenue, and the associated expenses are offset.

#### **Financial liabilities**

The entity removes a financial liability (or a part of a financial liability) from its statement of financial position when it is extinguished — i.e. when the obligation specified in the contract is discharged, cancelled, expires or waived.

The difference between the carrying amount of a financial liability (or part of a financial liability) extinguished or transferred to another party and the consideration paid, including any non-cash assets transferred or liabilities assumed, is recognised in surplus or deficit. Any liabilities that are waived, forgiven or assumed by another entity by way of a non-exchange transaction are accounted for in accordance with the Standard of GRAP on Revenue from Non-exchange Transactions (Taxes and Transfers).

#### **Presentation**

Interest relating to a financial instrument or a component that is a financial liability is recognised as revenue or expense in surplus or deficit.

Dividends or similar distributions relating to a financial instrument or a component that is a financial liability is recognised as revenue or expense in surplus or deficit.

Losses and gains relating to a financial instrument or a component that is a financial liability is recognised as revenue or expense in surplus or deficit.

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).

## 1.8 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.

Assets held under finance leases are recognised as assets of the ARC at their fair value at the inception of the lease or, if lower, the present value of the minimum lease payments. The determination of whether an arrangement contains a lease and the classification of the lease is based on the substance of the transaction at inception date. The assets are capitalised if the minimum lease payments are 85% or more of the assets' fair value at inception of the lease. The corresponding liability to the lessor is included in the statement of financial position as a finance lease obligation.

### 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.

## 1.9 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, weighted average cost and net realisable value.

Consumable stores are valued at the lower of cost and current replacement cost. 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.

Farm 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. Excess farm produce harvested for resale is treated as inventory and valued at fair value less estimated point of sale costs.

Vaccines for foot-and-mouth disease are at lower of cost and net realisable value.

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. 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.

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.

## 1.10 IMPAIRMENT OF CASH-GENERATING ASSETS

Cash-generating assets are assets managed with the objective of generating a commercial return. An asset generates a commercial return when it is deployed in a manner consistent with that adopted by a profit-oriented entity.

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 managed 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. Depreciation (Amortisation) is the systematic allocation of the depreciable amount of an asset over its useful life.

Fair value less costs to sell is the amount obtainable from the sale of an asset in an arm's length transaction between knowledgeable, willing parties, less the costs of disposal.

Recoverable amount of an asset or a cash-generating unit is the higher its fair value less costs to sell and its value in use.

Useful life is either:

- (a) the period of time over which an asset is expected to be used by the entity; or
- (b) the number of production or similar units expected to be obtained from the asset by the entity.

Criteria developed by the entity to distinguish cash-generating assets from non-cash-generating assets are as follow:

## 1.11 IMPAIRMENT OF NON-CASH-GENERATING ASSETS

At each reporting date, the ARC reviews the carrying amounts of its tangible and intangible assets to determine whether there is any indication that those assets have suffered an impairment loss. If any such indication exists, the recoverable amount of the asset is estimated in order to determine the extent of the impairment loss (if any). Where it is not possible to estimate the recoverable amount of an individual asset, the ARC estimates the recoverable amount of the cash-generating unit to which the asset belongs.

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.

Recoverable service amount is the higher of a non-cash-generating asset's fair value less costs to sell and its value in use.

### **Identification**

When the carrying amount of a non-cash-generating asset exceeds its recoverable service amount, it is impaired.

The entity assesses at each reporting date whether there is any indication that a non-cash-generating asset may be impaired. If any such indication exists, the entity estimates the recoverable service amount of the asset.

### **Recognition and measurement**

If the recoverable service amount of a non-cash-generating asset is less than its carrying amount, the carrying amount of the asset is reduced to its recoverable service amount. This reduction is an impairment loss.

An impairment loss is recognised immediately in surplus or deficit. Any impairment loss of a revalued non-cash-generating asset is treated as a revaluation decrease.

After the recognition of an impairment loss, the depreciation (amortisation) charge for the non-cash-generating asset is adjusted in future periods to allocate the non-cash-generating asset's revised carrying amount, less its residual value (if any), on a systematic basis over its remaining useful life.

### **Reversal of an impairment loss**

The entity assesses at each reporting date whether there is any indication that an impairment loss recognised in prior periods for a non-cash-generating asset may no longer exist or may have decreased. If any such indication exists, the entity estimates the recoverable service amount of that asset.

An impairment loss recognised in prior periods for a non-cash-generating asset is reversed if there has been a change in the estimates used to determine the asset's recoverable service amount since the last impairment loss was recognised. The carrying amount of the asset is increased to its recoverable service 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 non-cash-generating asset is recognised immediately in surplus or deficit.

Any reversal of an impairment loss of a revalued non-cash-generating asset is treated as a revaluation increase.

After a reversal of an impairment loss is recognised, the depreciation (amortisation) charge for the non-cash-generating asset is adjusted in future periods to allocate the non-cash-generating asset's revised carrying amount, less its residual value (if any), on a systematic basis over its remaining useful life.

## **1.12 CAPITAL FUND**

The capital fund represents the cost of land when the ARC was transferred out of the Department of Agriculture, Forestry and Fisheries.

## **1.13 EMPLOYEE BENEFITS**

### **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.

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 expected cost of surplus sharing and bonus payments is recognised as an expense when there is a legal or constructive obligation to make such payments as a result of past performance.

### **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.

### **Defined benefit plans**

For defined benefit plans the cost of providing the benefits is determined using the projected credit method.

Actuarial valuations are conducted on an annual basis by independent actuaries separately for each plan.

Consideration is given to any event that could impact the funds up to end of the reporting period where the interim valuation is performed at an earlier date.

Past service costs are recognised immediately to the extent that the benefits are already vested, and are otherwise amortised on a straight line basis over the average period until the amended benefits become vested.

To the extent that, at the beginning of the financial period, any cumulative unrecognised actuarial gain or loss exceeds ten percent of the greater of the present value of the projected benefit obligation and the fair value of the plan assets (the corridor), that portion is recognised in surplus or deficit over the expected average remaining service lives of participating employees. Actuarial gains or losses within the corridor are not recognised.

Gains or losses on the curtailment or settlement of a defined benefit plan is recognised when the entity is demonstrably committed to curtailment or settlement.

The amount recognised in the statement of financial position represents the present value of the defined benefit obligation as adjusted for unrecognised actuarial gains and losses and unrecognised past service costs, and reduces by the fair value of plan assets.

Any asset is limited to unrecognised actuarial losses and past service costs, plus the present value of available refunds and reduction in future contributions to the plan.

### **Other post retirement obligations**

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 amount recognised in the statement of financial position represents the present value of the post-retirement medical aid obligation as adjusted for unrecognised actuarial gains and losses.

### **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.

## 1.14 PROVISIONS AND CONTINGENCIES

A provision is a liability of uncertain timing or amount.

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 deficits.

A constructive obligation to restructure arises only when an entity:

- has a detailed formal plan for the restructuring, identifying at least:
  - the activity/operating unit or part of a activity/operating unit concerned;
  - the principal locations affected;
  - the location, function, and approximate number of employees who will be compensated for services being terminated;
  - the expenditures that will be undertaken; and
  - when the plan will be implemented; and
- has raised a valid expectation in those affected that it will carry out the restructuring by starting to implement that plan or announcing its main features to those affected by it.

Contingent assets and contingent liabilities are not recognised. Contingencies are disclosed in note 25.

## 1.15 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.

## 1.16 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.

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.

### 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 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.

Diagnostic services revenue is recognised by reference to the stage of completion of the tests at the reporting date.

### 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 recognised, in surplus or deficit, using the effective interest rate method as it accrues.

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.

## 1.17 REVENUE FROM NON-EXCHANGE TRANSACTIONS

Revenue received from conditional grants, donations and funding are recognised as revenue at fair value of the consideration received to the extent that the entity has complied with any of the criteria, conditions or obligations embodied in the agreement. To the extent that the criteria, conditions or obligations have not been met a liability is recognised.

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

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.

## 1.18 INVESTMENT INCOME

Investment income is recognised on a time-proportion basis using the effective interest method.

## 1.19 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.

## 1.20 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.

## 1.21 INSURANCE RESERVE

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.

## 1.22 COMPARATIVE FIGURES

Where necessary, comparative figures have been reclassified to conform to changes in presentation in the current year.

## 1.23 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 year 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.

## 1.24 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; or
- (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.

National Treasury practice note no. 4 of 2008/2009 which was issued in terms of sections 76(1) to 76(4) of the PFMA requires the following (effective from 1 April 2008):

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.

## 1.25 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.

## 1.26 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.
- the expenditure attributable to the asset during its development can be measured reliably.

## 1.27 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 an accrual basis and presented by economic classification linked to performance outcome objectives. 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.

## 1.28 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.

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 reporting to the parent department are considered to be related parties.

Key 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. All individuals from the level of Group Executive up to the Council are regarded as key management.

Close members of the family of a person are considered to be those family members who may be expected to influence, or be influenced by, that management in their dealings with the entity.

Only transactions with related parties not at arm's length or not in the ordinary course of business are disclosed.

## 1.29 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.

### 1.30 OFFSETTING

Transactions are offset when such offsetting reflects the substance of the transaction or event. Where a legally enforceable right of offset exists for recognised financial assets and financial liabilities, and there is an intention to settle the liability and realise the asset simultaneously, or to settle on a net basis all related financial effects are offset and the accounting standard permits.

# NOTES TO THE ANNUAL FINANCIAL STATEMENTS

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## 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:
<ul style="list-style-type: none"> <li>GRAP 18: Segment Reporting</li> </ul>	01 April 2016	The adoption of this has not had a material impact on the results of the company, but has resulted in more disclosure than would have previously been provided in the financial statements
<ul style="list-style-type: none"> <li>GRAP 17 (as amended 2015): Property, Plant and Equipment</li> </ul>	01 April 2016	The impact of the is not material.
<ul style="list-style-type: none"> <li>GRAP 16 (as amended 2015): Investment Property</li> </ul>	01 April 2016	The impact of the is not material.

### 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 2017 or later periods:

Standard/ Interpretation:	Effective date: Years beginning on or after	Expected impact:
<ul style="list-style-type: none"> <li>Directive 12: The Selection of an Appropriate Reporting Framework by Public Entities</li> </ul>	01 April 2018	Unlikely there will be a material impact
<ul style="list-style-type: none"> <li>GRAP 109: Accounting by Principals and Agents</li> </ul>	01 April 2017	Unlikely there will be a material impact
<ul style="list-style-type: none"> <li>GRAP 32: Service Concession Arrangements: Grantor</li> </ul>	01 April 2017	Unlikely there will be a material impact

Figures in Rand	2017	2016
<b>3. Revenue</b>		
Sale of goods	22 252 569	20 189 221
Rendering of services	369 360 527	391 485 626
Royalty income	14 800 101	11 520 940
Rental of facilities and equipment	15 232 353	11 478 239
Interest received - investment	16 159 151	26 732 350
Dividends received	165 553	45 855
Government grants	758 581 844	787 438 341
	<b>1 196 552 098</b>	<b>1 248 890 572</b>
<b>The amount included in revenue arising from exchanges of goods or services are as follows:</b>		
Sale of goods	22 252 569	20 189 221
Rendering of services	369 360 527	391 485 626
Royalty income	14 800 101	11 520 940
Rental of facilities and equipment	15 232 353	11 478 239
Interest received - investment	16 159 151	26 732 350
Dividends received	165 553	45 855
	<b>437 970 254</b>	<b>461 452 231</b>
<b>The amount included in revenue arising from non-exchange transactions is as follows:</b>		
<b>Transfer revenue</b>		
Parliamentary grant	758 581 844	787 438 341
<b>(a) Parliamentary grant</b>		
Grant received during the year	739 464 378	744 677 901
Grant received in prior year	19 117 466	42 760 440
	<b>758 581 844</b>	<b>787 438 341</b>
<b>(b) External earnings</b>		
Gross revenue	554 665 135	574 245 582
Less: Received in advance (note 16)	(133 019 585)	(139 571 556)
	<b>421 645 550</b>	<b>434 674 026</b>
<b>External revenue</b>		
Total exchange revenue	437 970 254	461 452 231
Less: Interest and dividends received (note 4)	(16 324 704)	(26 778 205)
	<b>421 645 550</b>	<b>434 674 026</b>

Figures in Rand	2017	2016
<b>4. Investment revenue</b>		
<b>Dividend revenue</b>		
Listed financial assets - Local	165 553	45 855
<b>Interest revenue</b>		
Bank	16 159 151	26 732 350
	<b>16 324 704</b>	<b>26 778 205</b>
<b>5. Government grants</b>		
<b>Operating grants</b>		
Government grant (operating)	666 424 481	699 651 135
<b>Capital grants</b>		
Government grant (capital)	92 157 363	87 787 206
	<b>758 581 844</b>	<b>787 438 341</b>

#### Conditional and Unconditional

Included in the capital grant is R5,169,375 (2016: R5,177,202) that relate the conditional grant specifically and exclusively allocated for the construction of the FMD facility.

#### 6. Impairment of assets

##### Reversal of impairments

Property, plant and equipment	-	(2 044 951)
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An impairment review was completed during 2015 financial year. The review revealed impairments to land and buildings which are either not in use or maintained inadequately.

Impairment reversal year relate to impairment conditions which do not exist any more.

Figures in Rand	2017	2016
<b>7. Operating deficit</b>		
Operating deficit for the year is stated after accounting for the following:		
<b>Remuneration, other than to employees, for:</b>		
Administrative services	1 062 440	1 828 907
Auditors remuneration	5 148 646	5 583 150
	<b>6 211 086</b>	<b>7 412 057</b>
<b>Operating lease charges</b>		
Premises		
• Contractual amounts	1 786 608	932 404
Motor vehicles		
• Contingent amounts	51 066	112 391
Equipment		
• Contractual amounts	23 601 519	10 053 886
	<b>25 439 193</b>	<b>11 098 681</b>
Gain on sale of property, plant and equipment	123 527	968 901
Amortisation on intangible assets	5 536 141	5 458 796
Depreciation on property, plant and equipment	37 042 312	37 015 057
Employee costs	744 492 069	768 053 041
Reversal of impairment	-	(2 044 951)
<b>8. Inventories</b>		
Work in progress	-	204 426
Finished goods	15 414 307	7 283 537
	<b>15 414 307</b>	<b>7 487 963</b>

Figures in Rand	2017	2016
<b>9. Receivables from exchange transactions</b>		
Trade debtors	195 821 188	185 151 392
Staff debtors	14 304 818	10 439 010
Deposits	191 894	293 897
Prepaid expenses	1 600 921	2 127 200
Other debtors	46 531 785	75 277 913
	<b>258 450 606</b>	<b>273 289 412</b>

Trade receivables are shown net of impairment losses.

Services rendered by the ARC are generally on a cash basis and mostly settled in 30 days. Trade receivables are stated at amortised cost.

Of the receivables balance at the end of the period; R54 million is due from the largest customer, R42 million is due from the second largest customer and R30 million is due from the third largest customer. The fourth and fifth largest customers owe 5% and 4% of the total balance respectively. There are no other customers who represent more than 1% of the total balance of trade receivables.

Staff debtors are made up of travel advances. These are recovered on a monthly basis by employees paying back the amount owed or ARC deducting the amount owed from the employee salary.

Of the R83 million in 150 days R59 million is due from the three major customers. This amount is not impaired as it is due from slow payers.

#### Trade and other receivables past due but not impaired

The ageing of amounts past due but not impaired is as follows:

30 days	8 265 071	20 165 685
60 days	1 592 780	2 070 371
90 days	6 203 462	9 546 224
120 days	16 497 532	6 907 874
150+ days	82 711 848	69 855 855
	<b>115 270 693</b>	<b>108 546 009</b>

#### Reconciliation of provision for impairment of trade and other receivables

As at 31 March 2017, receivables at nominal value of R15 248 980 (2016: R11 976 978) were impaired and provided for. Receivables that have passed due and not impaired represent slow paying clients. Although a significant balance is due from three largest customers these customers are not provided for as the risk is regarded to be low. Movement in the provision for impairment of receivables were as follows:

Opening balance	11 976 978	10 669 031
Provision for impairment	3 314 986	1 307 947
Bad debts recovered	(42 984)	-
	<b>15 248 980</b>	<b>11 976 978</b>

The receivable's impairment was estimated based on irrecoverable amounts and reference to the past default. Other than the concentration mentioned above, credit risk is limited due to customer base being large and unrelated. Accordingly Council members believe that there is no further impairment provision required in excess of the current allowance for doubtful debts.

Figures in Rand

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#### 10. Cash and cash equivalents

Cash and cash equivalents consist of cash on hand and balances with banks and investments in money market instruments.

Cash and cash equivalents consist of:

Cash on hand	88 793 389	42 868 053
Short-term deposits	8 579 223	258 658 145
	<b>97 372 612</b>	<b>301 526 198</b>

#### 11. Investment property

	2017			2016		
	Cost	Accumulated depreciation and accumulated impairment	Carrying value	Cost	Accumulated depreciation and accumulated impairment	Carrying value
Investment property	125 435	(26 787)	98 648	125 435	(26 787)	98 648

#### Reconciliation of investment property - 2017

	Opening balance	Total
Investment property	98 648	98 648

#### Reconciliation of investment property - 2016

	Opening balance	Total
Investment property	98 648	98 648

#### Details of property

This investment property is located in the Eastern Cape province, Queenstown and is being let out to the South African Police Service for rental income.

#### Amounts recognised in surplus or deficit

Rental revenue from Investment property	300 075	274 877
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## 12. Property, plant and equipment

	2017			2016		
	Cost	Accumulated depreciation and accumulated impairment	Carrying value	Cost	Accumulated depreciation and accumulated impairment	Carrying value
Land	120 040 673	(5 012 085)	115 028 588	120 040 673	(5 012 085)	115 028 588
Buildings	530 445 583	(151 319 315)	379 126 268	494 430 008	(149 135 057)	345 294 951
Machinery and farming equipment	107 373 206	(40 207 610)	67 165 596	93 196 722	(35 890 930)	57 305 792
Office furniture and equipment	37 777 260	(30 527 782)	7 249 478	35 314 894	(28 503 352)	6 811 542
Motor vehicles and aircraft	90 521 925	(54 496 644)	36 025 281	81 589 291	(47 505 762)	34 083 529
Computer equipment	70 798 141	(42 505 123)	28 293 018	54 214 257	(38 278 417)	15 935 840
Infrastructure	44 542 791	(4 688 581)	39 854 210	26 241 260	(3 897 549)	22 343 711
Laboratory equipment	378 975 990	(127 925 077)	251 050 913	350 254 330	(112 964 599)	237 289 731
Assets under construction	89 569 261	-	89 569 261	132 098 185	-	132 098 185
<b>Total</b>	<b>1 470 044 830</b>	<b>(456 682 217)</b>	<b>1 013 362 613</b>	<b>1 387 379 620</b>	<b>(421 187 751)</b>	<b>966 191 869</b>

### Reconciliation of property, plant and equipment - 2017

	Opening balance	Additions	Disposals	Assets capitalised during the year	Scrapping of assets	Depreciation	Total
Land	115 028 588	-	-	-	-	-	115 028 588
Buildings	345 294 951	11 797 033	-	24 218 543	-	(2 184 259)	379 126 268
Machinery and farming equipment	57 305 792	570 403	-	14 176 484	(537 708)	(4 349 375)	67 165 596
Office furniture and equipment	6 811 542	2 488 409	-	-	(133)	(2 050 340)	7 249 478
Motor vehicles and aircraft	34 083 529	6 721 668	(141 127)	2 554 918	-	(7 193 707)	36 025 281
Computer equipment	15 935 840	18 269 202	(66 064)	-	(485 357)	(5 360 603)	28 293 018
Infrastructure	22 343 711	17 383 322	-	918 209	-	(791 032)	39 854 210
Laboratory equipment	237 289 731	27 387 592	(8 163)	1 494 749	-	(15 112 996)	251 050 913
Assets under construction	132 098 185	833 979	-	(43 362 903)	-	-	89 569 261
	<b>966 191 869</b>	<b>85 451 608</b>	<b>(215 354)</b>		<b>- (1 023 198)</b>	<b>(37 042 312)</b>	<b>1013 362 613</b>

### Reconciliation of property, plant and equipment - 2016

	Opening balance	Additions	Disposals	Depreciation	Impairment reversal	Total
Land	115 028 588	-	-	-	-	115 028 588
Buildings	340 946 676	4 600 294	-	(2 296 970)	2 044 951	345 294 951
Machinery and farming equipment	57 173 043	4 430 936	25 267	(4 323 454)	-	57 305 792
Office furniture and equipment	8 679 479	461 167	-	(2 329 104)	-	6 811 542
Motor vehicles and aircraft	37 084 694	4 187 421	(2)	(7 188 584)	-	34 083 529
Computer equipment	19 087 055	2 662 864	-	(5 814 079)	-	15 935 840
Infrastructure	20 379 193	2 652 226	-	(687 708)	-	22 343 711
Laboratory equipment	214 629 009	37 035 878	-	(14 375 156)	-	237 289 731
Assets under construction	84 815 411	47 282 774	-	-	-	132 098 185
	<b>897 823 148</b>	<b>103 313 560</b>	<b>25 265</b>	<b>(37 015 055)</b>	<b>2 044 951</b>	<b>966 191 869</b>

**12. Property, plant and equipment (continued)****Other information****Property, plant and equipment fully depreciated and still in use (Gross carrying amount)**

Buildings	28 953 051	28 953 051
Computer equipment	24 025 830	24 025 830
Infrastructure	1 270 438	1 270 438
Laboratory equipment	22 731 253	22 731 253
Machinery and farming equipment	10 233 535	10 233 535
Motor vehicles and aircraft	25 730 197	25 730 197
Office furniture and equipment	18 865 805	18 865 805
	<b>131 810 109</b>	<b>131 810 109</b>

ARC is using some assets that have reached end of economic life as they cannot be replaced due to budget constraints.

**Reconciliation of Work-in-Progress 2017**

	<b>Buildings</b>	<b>Laboratory equipment</b>	<b>Computer equipment</b>	<b>Infrastructure</b>	<b>Other PPE</b>	<b>Total</b>
Opening balance	71 227 126	5 125 093	13 627 765	5 146 084	36 972 117	132 098 185
Movement	(33 501 822)	(5 153 569)	(3 189 289)	(3 943 575)	3 259 331	(42 528 924)
	<b>37 725 304</b>	<b>(28 476)</b>	<b>10 438 476</b>	<b>1 202 509</b>	<b>40 231 448</b>	<b>89 569 261</b>

**Reconciliation of Work-in-Progress 2016**

	<b>Buildings</b>	<b>Laboratory equipment</b>	<b>Computer equipment</b>	<b>Infrastructure</b>	<b>Other PPE</b>	<b>Total</b>
Opening balance	36 299 829	5 125 093	13 627 765	5 146 084	24 616 640	84 815 411
Additions	34 927 297	-	-	-	12 355 477	47 282 774
	<b>71 227 126</b>	<b>5 125 093</b>	<b>13 627 765</b>	<b>5 146 084</b>	<b>36 972 117</b>	<b>132 098 185</b>

**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**

Goods and services procured for repairs and maintenance	32 114 228	22 902 383
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Contractual commitments for the acquisition for property, plant and equipment are included in note 24.

**13. Intangible assets**

	2017			2016		
	Cost	Accumulated amortisation and accumulated impairment	Carrying value	Cost / Valuation	Accumulated amortisation and accumulated impairment	Carrying value
Computer software	49 201 415	(13 736 262)	35 465 153	48 062 616	(8 199 237)	39 863 379

**Reconciliation of intangible assets - 2017**

	Opening balance	Additions	Amortisation	Total
Computer software	39 863 379	1 137 915	(5 536 141)	35 465 153

**Reconciliation of intangible assets - 2016**

	Opening balance	Write off	Amortisation	Total
Computer software	46 131 196	(809 021)	(5 458 796)	39 863 379

**Transitional provisions****14. Heritage assets**

	2017			2016		
	Cost	Accumulated impairment losses	Carrying value	Cost	Accumulated impairment losses	Carrying value
Historical buildings	223 167	-	223 167	223 167	-	223 167

**Reconciliation of heritage assets 2017**

	Opening balance	Total
Historical buildings	223 167	223 167

**Reconciliation of heritage assets 2016**

	Opening balance	Total
Historical buildings	223 167	223 167

Heritage assets consist of a building. This building is currently a museum displaying Sir Arnold Theilers office and the equipment which he used when he started veterinary science in Onderstepoort. Arnold Theiler is regarded as the father of veterinary science in South Africa.

The equipment used by Sir Arnold Theiler has not been valued as the ARC is still in the process of determining the value of the equipment.

Figures in Rand	2017	2016
<b>15. Other financial assets</b>		
<b>Designated at fair value</b>		
Capevin (KWV unbundling)	4 415 038	4 536 711
510 409 shares market price R 8.65 (2016: 510 409 shares at R 8.888)		
La Concorde Holdings Limited (formerly KWV Holdings LTD)	615 044	276 447
51 041 shares market price R 12.05 (2016: 51 041 shares at R 5.416)		
	<b>5 030 082</b>	<b>4 813 158</b>
<b>Residual interest at cost</b>		
De Doorns Winery	5 434	5 434
9 880 shares at R0.55 (2016: 9 880 shares at R0.55)		
Lutzville 2009 Co operative Limited	1 070	1 070
107 000 shares at R0.01each (2016: 107000 shares at R0.01 each)		
Burpak Limited	1 948	1 948
1 948 shares at R1.00 each (2016: 1 948 shares at R1.00 each)		
Lutzville Vineyard Co operative	44 867	44 867
44 867 shares at R1.00 each (2016: 44 867 shares at R1.00 each)		
Lutzville Vineyard Co operative	10 700	10 700
1 070 000 shares at R0.01each (2016: 1 070 000 shares at R0.01 each)		
Hex Valley Coolrooms	8 046	8 046
16 092 shares at R0.50 each (2016: 16092 shares at R0.50 each)		
Mcgregor Co operative Limited	110 320	110 320
110 320 shares at R1.00 each (2016: 110 320 shares at R1.00 each)		
Lanko Co operative Limited	21 063	21 063
21 063 shares at R1.00 each (2016: 21 063 shares at R1.00 each)		
	<b>203 448</b>	<b>203 448</b>
<b>Total other financial assets</b>	<b>5 233 530</b>	<b>5 016 606</b>
<b>Non-current assets</b>		
Designated at fair value	5 030 082	4 813 158
Residual interest at cost	203 448	203 448
	<b>5 233 530</b>	<b>5 016 606</b>
<b>16. Payables from exchange transactions</b>		
Trade payables	41 303 496	60 907 371
Payments received in advanced - contract in process	133 019 585	139 571 556
Other payables	154 532 511	175 288 598
	<b>328 855 592</b>	<b>375 767 525</b>
Trade payables are settled within thirty days. Exceptions may arise where an account is settled after thirty days.		
<b>Fair value of trade and other payables</b>		
Current	40 018 340	58 951 520
Up to 60 days	434 949	392 177
90 days	90 546	59 534
91-120 days	7 096	53 661
121 -150days	129 115	426 950
+150 days	623 450	1 023 529
	<b>41 303 496</b>	<b>60 907 371</b>

**17. Provisions****Reconciliation of provisions - 2017**

	<b>Opening Balance</b>	<b>Additions</b>	<b>Utilised during the year</b>	<b>Reversed during the year</b>	<b>Total</b>
Leave pay provision	56 774 710	65 353 103	(58 120 179)	-	64 007 634
Bonus provision	35 000 000	-	-	(35 000 000)	-
	<b>91 774 710</b>	<b>65 353 103</b>	<b>(58 120 179)</b>	<b>(35 000 000)</b>	<b>64 007 634</b>

**Reconciliation of provisions - 2016**

	<b>Opening Balance</b>	<b>Additions</b>	<b>Utilised during the year</b>	<b>Total</b>
Leave pay provision	58 941 300	12 764 447	(14 931 037)	56 774 710
Bonus provision	47 243 404	19 867 563	(32 110 967)	35 000 000
	<b>106 184 704</b>	<b>32 632 010</b>	<b>(47 042 004)</b>	<b>91 774 710</b>

The leave pay obligation is the balance of employee leave days outstanding at period-end, reflected as a rand value. The amounts are based on total cost of employment and leave days due.

## 18. Employee benefit obligations

### Retirement funds

The ARC has made provision for pension and provident fund schemes covering substantially all employees. At the end of the financial year the following funds were in existence:

- ARC Pension fund (Category D), operating as a defined contribution fund
- ARC Provident fund, operating as a defined contribution fund

Members pay a contribution of 7.5%. The employer's contribution of 16% is expensed when incurred. All funds are governed by the South African Pension Fund Act No. 24 of 1956.

### Post retirement medical aid benefits

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 postmedical 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). This restructuring was not completed and the defined benefit obligation remained. 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 31 March 2016. 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.

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 at 31 March 2017. 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 postretirement 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	15 059 000	16 641 000
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#### Changes in the present value of the defined benefit obligation are as follows:

Opening balance	16 641 000	20 230 000
Current service cost	543 000	683 000
Interest cost	1 222 000	1 168 000
Benefits paid	(3 144 239)	(2 904 974)
Actuarial (gains) losses	(202 761)	(2 535 026)
	<b>15 059 000</b>	<b>16 641 000</b>

#### Key assumptions used

Assumptions used at the reporting date:

Discount rate used	7,34%	6,00%
Membership of the fund at 31 March	427	454

Figures in Rand	2017	2016
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## 18. Employee benefit obligations (continued)

### Defined contribution funds

Employer contributions and membership for the period were as follows:

ARC Pension Fund (Option D)	40 790 595	38 184 569
ARC Provident Fund	13 628 416	6 155 937
<b>Membership</b>		
ARC Pension Fund (Option D)	1 409	1 278
ARC Provident Fund	964	864

Management estimated that ARC will contribute R 43 034 078 to option D pension fund and R 14 377 979 the provident fund in 2018.

## 19. Conditional grants

Government grants received that will be recognised in future accounting periods. These conditional revenue will be recognised in future period upon completion of the Exotic disease and the Wild suide facilities . The construction of the Exotic disease and Wild suide facilities is in progress.

### Movement during the year

Balance at the beginning of the year	138 062 351	143 239 553
Income recognition during the year	(5 169 375)	(5 177 202)
	<b>132 892 976</b>	<b>138 062 351</b>

This grant relates to construction of the Exotic Disease and Wild Suide facilities.

## 20. Capital fund

Capital fund	111 986 013	111 986 013
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The capital fund represents the cost of land when the ARC was transferred out of the Department of Agriculture, Forestry and Fisheries.

## 21. Taxation

The ARC is exempt from Income Tax in terms of section 10(1) (a) of the Income Tax Act no.58 of 1962.

**22. Cash used in operations**

Deficit	(86 064 057)	(68 261 408)
<b>Adjustments for:</b>		
Depreciation and amortisation	42 578 453	42 473 853
Loss on sale of assets and liabilities	(123 527)	(968 901)
Gain on foreign exchange	(64 360)	-
Impairment reversals	-	(2 044 951)
Increase in provision for bad debts	3 272 002	127 054
Bad debts written off	382 017	-
Movements in operating lease assets and accruals	49 485	-
Movements in retirement benefit assets and liabilities	(1 582 000)	(3 589 000)
Movements in provisions	(27 767 076)	(14 409 994)
Movement in reserves	(238 256)	-
Fair value adjustment	(216 924)	245 507
Asset write off	-	809 020
Scrapping of assets	1 023 198	-
Stock write off	1 887 543	13 073 715
<b>Changes in working capital:</b>		
Inventories	(9 813 887)	(8 145 537)
Receivables from exchange transactions	11 254 088	(151 980 203)
Payables from exchange transactions	(46 916 874)	100 583 694
VAT	(393 394)	(7 075 134)
Conditional grants	(5 169 375)	(5 177 206)
	<b>(117 902 944)</b>	<b>(104 339 491)</b>

**23. Financial instruments disclosure****Categories of financial instruments****2017****Financial assets**

	<b>At fair value</b>	<b>At amortised cost</b>	<b>At cost</b>	<b>Total</b>
Other financial assets	5 030 082	-	203 448	5 233 530
Trade and other receivables from exchange transactions	-	242 544 867	-	242 544 867
Cash and cash equivalents	-	97 372 612	-	97 372 612
	<b>5 030 082</b>	<b>339 917 479</b>	<b>203 448</b>	<b>345 151 009</b>

**Financial liabilities**

	<b>At fair value</b>	<b>At amortised cost</b>	<b>At cost</b>	<b>Total</b>
Trade and other payables from exchange transactions	-	195 836 007	-	195 836 007

**2016****Financial assets**

	<b>At fair value</b>	<b>At amortised cost</b>	<b>At cost</b>	<b>Total</b>
Other financial assets	4 813 158	-	203 448	5 016 606
Trade and other receivables from exchange transactions	-	260 723 202	-	260 723 202
Cash and cash equivalents	-	301 526 198	-	301 526 198
	<b>4 813 158</b>	<b>562 249 400</b>	<b>203 448</b>	<b>567 266 006</b>

**Financial liabilities**

	<b>At fair value</b>	<b>At amortised cost</b>	<b>At cost</b>	<b>Total</b>
Trade and other payables from exchange transactions	-	236 195 969	-	236 195 969

Figures in Rand	2017	2016
<b>24. Commitments</b>		
<b>Authorised capital expenditure</b>		
<b>Already contracted for but not provided for</b>		
• Buildings	211 102	2 765 177
• Computer equipment	389 447	882 490
• Infrastructure	1 219 990	1 746 758
• Laboratory equipment	1 560 692	8 276 914
• Machinery and farming equipment	2 097 432	1 231 724
• Motor vehicles	1 106 941	2 321 724
• Office furniture and equipment	205 712	75 018
	<b>6 791 316</b>	<b>17 299 805</b>
<b>Total capital commitments</b>		
Already contracted for but not provided for	6 791 316	17 299 805
<b>Operating leases - as lessee (expense)</b>		
<b>Minimum lease payments due</b>		
- within one year	17 955 573	19 790 766
- in second to fifth year inclusive	17 685 580	35 587 152
	<b>35 641 153</b>	<b>55 377 918</b>

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.

## 25. Contingencies

### There are contingent liabilities in respect of:

Guarantees on municipal and electricity accounts	1 075 360	1 075 360
Litigations	42 712 036	2 068 246
Pending labour disputes	7 108 079	7 336 241
	<b>50 895 475</b>	<b>10 479 847</b>

The guarantee on municipal and electrical accounts relate to the City of Tshwane municipality to ensure a continued service to the ARC - Onderstepoort Veterinary Institute. The timing of these contingent liabilities is not known and ARC does not expect any reimbursement of the contingent liabilities.

Labour dispute contingent liability relate to outstanding labour matters that are at CCMA and labour court.

Litigation relate to civil matters against ARC for which the outcome of the court cannot be determined reliably.

### Contingent assets

The ARC has launched legal proceedings to recover the amount of R502 707, arising from a lease agreement concluded with Mr Pretorius t/a Vastrap Boerdery ("the Defendant").

The ARC is confident of its prospects of success, particularly as the Defendant had previously attempted to settle the amount outstanding by way of a cheque which was returned as unpaid.

**26. Related parties****Relationships**

Executive managers are regarded as related parties

Ultimate controlling entity

Controlling entity

Public entity - (With significant influence over the ARC)

Public entity - (Under common control with ARC)

Public entity - (Under common control with ARC)

Public entity - (Under common control with ARC)

Public entity - (Under common control with ARC)

Department of Agriculture, Forestry and Fisheries

Department of Agriculture, Forestry and Fisheries

Department of Science and Technology

National Agricultural Market Council

Onderstepoort Biological Products

Perishable Products Export Control Board

South African Veterinary Council

**Related party balances**

Department of Agriculture Forestry and Fisheries - Other Grants	41 955 434	29 621 323
Onderstepoort Biological Products	6 516 756	2 287 977
Onderstepoort Biological Products	(201 139)	(17 593)
Department of Agriculture Forestry and Fisheries	(4 877 451)	(4 877 451)
Department of Agriculture Forestry and Fisheries FMD	(128 015 525)	(133 184 900)
Department of Science and Technology	29 162	-
Department of Science and Technology	-	(13 491 455)

**Related party transactions**

Department of Agriculture Forestry and Fisheries - Parliamentary Grant	(713 148 598)	(705 204 212)
Department of Agriculture Forestry and Fisheries - PBR registrations	46 765	1 749
Department of Agriculture Forestry and Fisheries	340 848	-
Department of Agriculture Forestry and Fisheries - Services	(127 696 125)	(133 257 303)
Department of Science and Technology - Other Revenue Grants	(51 112 911)	(53 652 326)
Department of Science and Technology - Parliamentary Grant	(26 315 789)	(39 473 685)
Onderstepoort Biological Products - Services	363 370	166 314
Onderstepoort Biological Products - Utilities recovery	(6 169 274)	(4 469 942)
National Agricultural Market Council - Services	-	750 000
Perishable Products Export Control Board - Training Services	265 676	802 369
South African Veterinary Council	38 000	-
Department of Agriculture Forestry and Fisheries FMD	(5 169 375)	(5 177 202)

Executive Managers' remuneration is disclosed in note 27.

In terms of GRAP the ARC is not required to disclose transaction which are not at arms length price. the ARC has however decided to disclose the transaction and balances of entities under common control with the ARC.

**27. Council, Executive Managers and Audit Committee remuneration****Executive****2017**

	Emoluments	Subsistence and travel	Pension paid	Medical aid	Total
Dr SR Moephuli	2 522 146	78 992	322 056	58 338	2 981 532
Mr GM Maluleke	2 061 518	12 440	222 871	58 739	2 355 568
Dr DJG Rees	1 599 897	134 601	236 037	24 880	1 995 415
Dr MA Magadlela	1 688 955	24 782	118 804	37 312	1 869 853
Mr F Monkwe	1 647 336	821	177 028	37 312	1 862 497
Ms MH Umlaw	1 734 805	25 452	161 234	-	1 921 491
Dr N Motete	1 641 089	8 206	174 569	20 186	1 844 050
Dr LL Magingxa	1 626 308	73 175	177 027	58 338	1 934 848
	<b>14 522 054</b>	<b>358 469</b>	<b>1 589 626</b>	<b>295 105</b>	<b>16 765 254</b>

Figures in Rand

2017

2016

**2016**

	<b>Emoluments</b>	<b>Subsistence and travel</b>	<b>Pension paid</b>	<b>Bonus</b>	<b>Medical aid</b>	<b>Leave payout</b>	<b>Total</b>
Dr SR Moephuli	2 344 438	30 421	302 400	189 000	53 162	-	2 919 421
Mr GM Maluleke	1 912 932	7 197	209 269	141 289	57 684	-	2 328 371
Dr M Jeenah	533 950	50 446	36 509	-	-	255 965	876 870
Dr DJG Rees	1 487 189	7 074	221 631	112 226	22 672	-	1 850 792
Dr MA Magadlela	1 483 535	46 277	93 334	86 450	34 398	-	1 743 994
Mr F Monkwe	1 531 740	2 015	166 223	80 162	33 529	-	1 813 669
Ms MH Umlaw	1 557 227	3 438	149 931	105 765	-	-	1 816 361
Dr N Motete	380 958	-	40 979	-	4 924	-	426 861
Dr LL Magingxa	1 512 104	93 404	166 223	112 226	53 162	-	1 937 119
	<b>12 744 073</b>	<b>240 272</b>	<b>1 386 499</b>	<b>827 118</b>	<b>259 531</b>	<b>255 965</b>	<b>15 713 458</b>

**Non -executive**

**2017**

	<b>Committees fees</b>	<b>Subsistence and travel</b>	<b>Total</b>
Prof S Vil Nkomo (Chairperson)	74 265	12 439	86 704
Prof MJ Kahn	139 635	8 898	148 533
Dr FW Jansen van Rijssen	86 052	1 797	87 849
Ms J Mashiteng	88 815	5 271	94 086
Dr JM Chitja	48 189	650	48 839
Mr M Dyasi	86 052	2 217	88 269
Prof L Hoffman	27 537	-	27 537
Mr A Bishop	61 957	7 456	69 413
Ms D Ndaba	102 584	5 382	107 966
Prof FJC Swanepoel	55 073	4 080	59 153
Mr C Kneale	68 842	5 111	73 953
Mr G Martin	48 189	4 211	52 400
Mr R Nicholls	58 921	295	59 216
Mr I Motala	48 189	10 333	58 522
	<b>994 300</b>	<b>68 140</b>	<b>1 062 440</b>

**2016**

	<b>Committees fees</b>	<b>Subsistence and travel</b>	<b>Total</b>
Prof S Vil Nkomo (Chairperson)	147 356	2 584	149 940
Ms J Mashiteng	215 136	8 651	223 787
Prof MJ Kahn	297 083	33 466	330 549
Dr JM Chitja	78 176	1 668	79 844
Mr M Dyasi	64 640	1 995	66 635
Prof L Hoffman	87 264	3 483	90 747
Mr A Bishop	87 568	9 405	96 973
Dr FW Jansen van Rijssen	122 816	1 358	124 174
Ms D Ndaba	153 728	16 609	170 337
Prof FJC Swanepoel	103 424	7 118	110 542
Mr C Kneale	67 872	8 643	76 515
Mr G Martin	113 120	11 419	124 539
Mr R Nicholls	47 320	5 911	53 231
Mr I Motala	77 568	13 526	91 094
Dr NS Msomi	40 000	-	40 000
	<b>1 703 071</b>	<b>125 836</b>	<b>1 828 907</b>

**Prescribed officers****2017**

	<b>Emoluments</b>	<b>Other benefits*</b>	<b>Total</b>
Mr VN Naicker (Chairperson)	64 009	-	64 009
Mr LM Mangquku	42 742	477	43 219
Ms K Mokoena	45 450	3 594	49 044
Mr JH Mcbain	45 450	6 015	51 465
Ms JA Bruinders	6 313	434	6 747
	<b>203 964</b>	<b>10 520</b>	<b>214 484</b>

**2016**

	<b>Fees</b>	<b>Other benefits*</b>	<b>Total</b>
Mr VN Naicker (Chairperson)	83 625	382	84 007
Mr LM Mangquku	41 875	1 745	43 620
Ms K Mokoena	67 500	2 995	70 495
Mr JH Mcbain	45 000	894	45 894
	<b>238 000</b>	<b>6 016</b>	<b>244 016</b>

\* Other benefits comprise travel allowance and subsistence allowance

**28. Change in estimate****Property, plant and equipment**

During the current period management revised useful lives of certain items of property, plant and equipment.

Useful lives of assets in the accounting policy were reviewed as follows:

<b>Item</b>	<b>Old</b>	<b>New</b>
Buildings	40 to 70 years	3 to 70 years
Machinery & Farming Equipment	15 to 40 years	3 to 60 years
Office Furniture & Equipment	5 to 20 years	5 to 30 years
Motor vehicles and air craft	4 to 15 years	4 to 20 years
Computer equipment	3 to 10 years	3 to 15 years
Laboratory equipment	15 to 40 years	15 to 60 years

**29. Prior period errors and reclassifications**

Certain comparative figures have been reclassified and prior period errors had to be corrected.

Certain items of revenue had to be reclassified from sale of goods in agricultural activities to rendering of services.

Revenue relating to the conditional grant was recognised in prior year.

Profit on sale of assets was reclassified from operating and administrative expenses to gain on disposal of assets.

The effects of the reclassification are as follows:

**Statement of financial position****2015**

	Note	As previously reported	Error	Restated
Conditional grants		192 596 947	(49 357 394)	143 239 553
Accumulated surplus		870 024 713	49 357 394	919 382 107
		<b>1 062 621 660</b>	<b>-</b>	<b>1 062 621 660</b>

**2016**

	Note	As previously reported	Error	Restated
Receivables from exchange transactions	9	213 725 800	59 563 612	273 289 412
Payables from exchange transactions	16	316 203 913	59 563 612	375 767 525
Conditional grants	19	192 596 947	(54 534 596)	138 062 351
Accumulated surplus		796 586 103	54 534 596	851 120 699
		<b>1 519 112 763</b>	<b>119 127 224</b>	<b>1 638 239 987</b>

**Statement of financial performance****2016**

	Note	As previously reported	Error	Restated
Revenue from exchange transactions	3	59 494 389	(39 305 168)	20 189 221
Rendering of services		352 170 953	39 305 168	391 476 121
Government grants		782 261 139	5 177 202	787 438 341
Operating and administrative expenses		(497 414 309)	(968 901)	(498 383 210)
Gain on disposal assets		-	968 901	968 901
<b>Surplus for the year</b>		<b>696 512 172</b>	<b>5 177 202</b>	<b>701 689 374</b>

**Cash flow statement****2016**

	Note	As previously reported	Error	Restated
<b>Cash flow from operating activities</b>				
Sale of goods and services		378 358 449	(95 537 577)	282 820 872
Employee costs		(768 053 041)	4 211 116	(763 841 925)
Suppliers		(485 102 111)	90 403 415	(394 698 696)
		<b>(874 796 703)</b>	<b>(923 046)</b>	<b>(875 719 749)</b>
<b>Cash flow from investing activities</b>				
Proceeds from sale of property, plant and equipment		(25 265)	968 901	943 636

**29. Prior period errors and reclassifications (continued)****Fully depreciated assets and still in use**

It was identified that fully depreciated assets still in use must be disclosed at cost instead of the carrying amount.

	Comparative figures previously reported	Error	After correction
Buildings	833	28 952 217	28 953 050
Computer equipment	3 843	24 021 987	24 025 830
Infrastructure	2	1 270 436	1 270 438
Laboratory equipment	11 392	22 719 861	22 731 253
Machinery and farming equipment	4 318	10 229 217	10 233 535
Motor vehicles and aircraft	507	25 729 690	25 730 197
Office furniture and equipment	36 456	18 829 349	18 865 805
<b>Total</b>	<b>57 351</b>	<b>131 752 757</b>	<b>131 810 108</b>

**Related parties**

During the current year it was noted that there were entities disclosed in the previous financial year that did not meet the definition of related parties per GRAP 20, thus the comparative figures were adjusted. The effects are as follows:

During the year it was noted that there was an incorrect accounting for the conditional grant and it was subsequently corrected in the current year.

**Related party balances**

	As previously reported	Error	Restated
Department of Public Works	232 167	(232 167)	-
Department of Water Affairs	8 816	(8 816)	-
Department of Environmental Affairs	54 974 222	(54 974 222)	-
Department of Education	36 018	(36 018)	-
Department of Rural Development and Land Reform	49 783 381	(49 783 381)	-
Department of Water Affairs	964 947	(964 947)	-
Department of Water Affairs and Forestry	(10 330)	10 330	-
Department of Agriculture Forestry and Fisheries FMD	(126 790 987)	(6 393 913)	(133 184 900)
	<b>(20 801 766)</b>	<b>(112 383 134)</b>	<b>(133 184 900)</b>

**Related party transactions**

	As previously reported	Error	Restated
Department of Rural Development and Land Reform -Services	(128 393 097)	128 393 097	-
Department of Environmental Affairs - Services	(30 573 524)	30 573 524	-
Department of Education	(162 132)	162 132	-
Department of Public works - Services	(347 089)	347 089	-
Department of Public works - Services	141 118	(141 118)	-
Department of Water Affairs and Forestry	112 663	(112 663)	-
Department of Water Affairs	131 216	(131 216)	-
Department of Agriculture Forestry and Fisheries FMD	-	(5 177 202)	(5 177 202)
	<b>(159 090 845)</b>	<b>153 913 643</b>	<b>(5 177 202)</b>

### 30. Risk management

#### Financial risk management

The Council members monitor and manage the financial risks relating to the operations of the entity through internal risk reports which analyse exposures by degree and magnitude of risks. These risks include market risk (including currency risk, fair value interest rate risk, cash flow interest rate risk and price risk), credit risk and liquidity risk.

Compliance with policies and exposure limits is reviewed by the internal auditors on a continuous basis. The entity does not enter into or trade financial instruments, including derivative financial instruments, for speculative purposes.

#### Liquidity risk

Liquidity risk refers to the risk that an entity will encounter difficulty in meeting obligations associated with financial liabilities. The Council members are satisfied that the entity will be able to settle its financial liabilities (payables and leave pay accrual) in the normal course of business. Liquidity risk is managed by cash forecasting.

#### Credit risk

Credit risk consists mainly of cash deposits, cash equivalents, derivative financial instruments and trade debtors. The entity only deposits cash with major banks with high quality credit standing and limits exposure to any one counter-party.

Financial assets which potentially subject the ARC to concentrations of credit risk consist principally of cash short-term deposits placed with high credit quality financial institutions. Trade receivables are presented net of an allowance for doubtful receivables. Currently only five of the entity's largest debtors exceed 2% of the total trade receivables balance as disclosed in note 9. The ARC does not have any significant exposure to any other individual customer or 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.

#### Market risk

##### Interest rate risk

ARC is exposed to interest rate risk as it places funds at both fixed and floating interest rates. The risk is managed through investing the surplus funds at fixed and floating interest rates with reputable banks.

The following demonstrates the sensitivity to a reasonable change in interest rates, with all being constant and the impact on net surplus:

##### Sensitivity analysis

##### South African Rand (ZAR)

Increase by 50 base points	486 863	1 507 631
Decrease by 50 base points	(486 863)	(1 507 631)
	-	-

The following table identifies the period within which the financial instruments that are sensitive to interest rate risk reprice. ARC surplus funds are invested in terms of its investments policy as approved by its Council:

Current cash balances	88 793 389	42 868 053
Short -term cash deposits	8 579 223	258 658 145
	<b>97 372 612</b>	<b>301 526 198</b>

#### Foreign exchange risk

The entity does not hedge foreign exchange fluctuations.

The ARC incurs currency risk as a result of purchases and sales in foreign currencies, hence exposure to exchange rate fluctuations arise. The currencies in which the Council primarily deals are US Dollars and Euro's. No forward cover is taken out for these transactions. The Council members consider the foreign currency risk to be insignificant.

**30. Risk management (continued)****Price risk**

The ARC is exposed to price risk on its purchases. Prices for future purchases, sales of goods and services are generally established on normal commercial terms. The risk is managed by the application of procurement policy that encourages obtaining goods and services at best prices.

The Council members consider the price risk to be insignificant.

**Fair value hierarchy**

As at 31 March 2017, the entity held the following financial instruments carried at fair value on the statement of financial position:

The entity uses the following hierarchical technique for determining and disclosing the fair value of financial instruments:

Level 1: quoted prices in active markets for identical assets or liabilities

Level 2: other techniques for which all inputs which have a significant effect on the recorded fair value are observable, either directly or indirectly

Level 3: techniques which use inputs that have a significant effect on the recorded fair value that are not based on observable market data.

The fair value of financial assets and financial liabilities is determined as follows:

<b>Assets measured at fair value</b>	31 March 2017	Level 1	31 March 2016	Level 1
Financial assets at fair value	5 030 082	5 030 082	4 813 158	4 813 158

**Category of financial instruments and maturity profile**

<b>31 March 2017</b>	0-1 years R	>1 year R	Total
Investments	-	5 233 530	5 233 530
Cash and cash equivalents	97 372 612	-	97 372 612
Trade and other receivables	242 544 867	-	242 544 867
Trade and other payables	(195 836 007)	-	(195 836 007)
	<b>144 081 472</b>	<b>5 233 530</b>	<b>149 315 002</b>
<b>31 March 2016</b>	0-1 Years R	>1 year R	Total
Investments	-	5 016 606	5 016 606
Cash and cash equivalents	301 526 198	-	301 526 198
Trade and other receivables	260 723 202	-	260 723 202
Trade and other payables	(236 195 969)	-	(236 195 969)
	<b>326 053 431</b>	<b>5 016 606</b>	<b>331 070 037</b>

### 31. Going concern

For the year ended 31 March 2017, the ARC incurred a deficit of R 86 064 057 (2016: deficit R 68 261 408) and had net current liabilities of R 26 995 157. In the same period the entity had operating cash outflows of R 117 902 944 (2016 R 104 339 491).

The cash flow forecast for the next 12 months prepared by management has indicated that the entity will have an operating cash outflow.

The following matters have been considered by the council in determining the appropriateness of the going concern basis of preparation in the financial statements:

- The ARC has a letter of allocation from the shareholder confirming funding for the period of at least three years.
- The ARC is able to pay its debts as they become due and the ARC does not have any off balance sheet financing.
- Furthermore, the parent department is paying the amount allocated to the ARC subsequent to year end.
- Management has embarked on cost containment measures to deal with the effects of the current economic downturn.

Though the ARC will continue to face underfunding, it is believed that based on the initiatives implemented to date, the support from the shareholder, the absence of any indication that it should no longer execute its statutory obligations, and by continuing to work with its service providers, that the ARC will be able to meet its obligations arising.

### 32. Fruitless and wasteful expenditure

Fruitless and wasteful expenditure	128 741	265 258
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The 2017 fruitless and wasteful expenses were incurred by paying interest charged on late payment

The 2016 fruitless and wasteful expenses. R34,111 incurred as a result of work performed twice. Disciplinary action has been initiated against the official involved. R148,626 relates to SARS interest of late declaration and R82,521 relates to employees paid after termination of service.

### 33. Irregular expenditure

Opening balance	205 177 358	648 209
Add: Irregular Expenditure - current year	199 263 480	-
Add: Irregular Expenditure - relating to prior years identified in current year	-	205 177 358
Less: Amounts condoned	-	(648 209)
	<b>404 440 838</b>	<b>205 177 358</b>

#### Details of irregular expenditure – current year

	<b>Disciplinary steps taken/criminal proceedings</b>	
ARC incurred expenses in excess of the approved expense budget	To be determined	168 620 567
Unspent conditional grant monies used to fund operating activities	To be determined	30 642 913
		<b>199 263 480</b>

### 34. Events after the reporting date

On 1 April 2017, a new council was appointed by the Minister of Agriculture, Forestry and Fisheries.

On 30 March 2017, a deposit of R23 million was received however management did not know which customer the deposit related to thus allocated the amount to unknown deposits. Subsequent to year end, the bank confirmed that the deposit was received from Gauteng Provincial Government. The amount was subsequently allocated to Gauteng Provincial Government.

### 35. Segment information

#### General information

#### Identification of segments

The entity is organised and reports to management on the basis of three major functional areas: animal sciences, crop sciences and research and innovation systems. 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 the South Africa in 8 provinces. Segments were aggregated on the basis of services delivered as management considered that the economic characteristics of the segments throughout South Africa were sufficiently similar to warrant aggregation.

#### 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

Animal Sciences  
Crop Sciences  
Research and Innovation Systems

#### Goods and/or services

Animal health and production  
Improvement and cultivation of various crops  
Agricultural Engineering and Biotechnology

#### Segment surplus or deficit, assets and liabilities

#### 2017

	Animal Sciences	Crop Sciences	Research and Innovation Systems	Total
<b>Revenue</b>				
Revenue from non-exchange transactions	164 832 400	285 981 503	67 094 818	517 908 721
Revenue from exchange transactions	139 557 730	214 737 803	35 311 906	389 607 439
Interest revenue	-	10 315	-	10 315
<b>Total segment revenue</b>	<b>304 390 130</b>	<b>500 729 621</b>	<b>102 406 724</b>	<b>907 526 475</b>
<b>Entity's revenue</b>				<b>907 526 475</b>
<b>Expenditure</b>				
Salaries and wages	216 031 862	350 099 953	72 569 310	638 701 125
Other expenses	171 194 223	165 035 832	56 787 784	393 017 839
Depreciation and amortisation	11 750 489	9 080 198	15 759 500	36 590 187
<b>Total segment expenditure</b>	<b>398 976 574</b>	<b>524 215 983</b>	<b>145 116 594</b>	<b>1 068 309 151</b>
<b>Total segmental surplus/(deficit)</b>				<b>(160 782 676)</b>
Interest expense				128 741

Figures in Rand

2017

2016

**2016**

	<b>Animal Sciences</b>	<b>Crop Sciences</b>	<b>Agricultural Engineering and Biotechnology</b>	<b>Total</b>
<b>Revenue</b>				
Revenue from non -exchange transactions	170 068 292	298 143 563	62 897 852	531 109 707
Revenue from exchange transactions	146 344 590	240 153 369	35 584 750	422 082 709
Interest revenue	-	7 774	-	7 774
<b>Total segment revenue</b>	<b>316 412 882</b>	<b>538 304 706</b>	<b>98 482 602</b>	<b>953 200 190</b>
<b>Entity's revenue</b>				<b>953 200 190</b>
<b>Expenditure</b>				
Salaries and wages	221 175 474	339 493 546	68 878 970	629 547 990
Other expenses	153 652 313	199 132 659	45 309 757	398 094 729
Depreciation and amortisation	9 601 177	15 857 197	8 886 963	34 345 337
<b>Total segment expenditure</b>	<b>384 428 964</b>	<b>554 483 402</b>	<b>123 075 690</b>	<b>1 061 988 056</b>
<b>Total segmental surplus/(deficit)</b>				<b>(108 787 866)</b>
Interest expense				29 993

## ARC PERFORMANCE INFORMATION 2016/17

PROGRAMME	KEY OUTPUTS	INDICATOR 2016/17	TARGETS	ACTUALS	VARIANCE	REASON FOR VARIANCE
<b>GOAL 1 TO GENERATE KNOWLEDGE AND TECHNOLOGIES THAT WILL ENHANCE THE EFFICIENCIES IN CROP BASED AGRICULTURE</b>						
Crops Production, Improvement and Protection	Knowledge Generated	<i>Number of scientific publications</i>	97	160	63	Publications accepted faster than anticipated
	Technologies Development	<i>Number of Cultivars registered</i>	11	5	(6)	Registrar demands further observations on performance in the field.
	Scientific Services rendered	<i>Number of Diagnostic and Analytical services rendered</i>	587	741	154	Higher demand for ARC services
	Information Disseminated	<i>Number of technical reports and manuals</i>	248	409	161	Higher demand for ARC services
		<i>Number of field trial sites</i>	348	401	53	More field trials due to good rains
<b>GOAL 2 TO GENERATE KNOWLEDGE AND TECHNOLOGIES THAT WILL ENHANCE THE EFFICIENCIES IN LIVESTOCK BASED AGRICULTURE</b>						
Animal Health, Production and Improvement	Knowledge Generated	<i>Number of scientific publications</i>	91	106	15	Publications accepted faster than anticipated.
	Technologies Developed	<i>Number of patents registered</i>	1	1	0	-
	Scientific Services rendered	<i>Number of Diagnostic and Analytical services rendered</i>	24 705	15122	(9583)	In retrospect the targets for analytical services were overstated following a change in the mode of counting
	Information Disseminated	<i>Number of technical reports and manuals</i>	13	15	2	Higher demand for ARC services
		<i>Number of farmers participating in animal improvement schemes</i>	350	429	79	High demand for Beef Improvement Scheme services
<b>GOAL 3 TO GENERATE KNOWLEDGE AND TECHNOLOGIES FOR THE CONSERVATION AND UTILISATION OF NATURAL RESOURCES</b>						
Natural Resources Management	Knowledge generated	<i>Number of scientific publications</i>	74	88	14	Publications accepted faster than anticipated.
	Technologies Developed	<i>Number of prototypes Developed</i>	10	0	(10)	Delays in development of prototypes
	Scientific Services rendered	<i>Number of Analytical and Advisory services rendered</i>	1 161	1185	24	Higher demand for ARC services
	Information Disseminated	<i>Number of technical reports and manuals</i>	154	157	3	Slow rate in the development of technical reports and manuals
		<i>Number of field trial sites</i>	102	102	0	-

PROGRAMME	KEY OUTPUTS	INDICATOR 2016/17	TARGETS	ACTUALS	VARIANCE	REASON FOR VARIANCE
<b>GOAL 3 TO GENERATE KNOWLEDGE AND TECHNOLOGIES FOR THE CONSERVATION AND UTILISATION OF NATURAL RESOURCES</b>						
Mechanisation and Engineering	Knowledge generated	<i>Number of scientific publications</i>	8	13	5	Publications accepted faster than anticipated
	Technologies Developed	<i>Number of prototypes developed</i>	4	8	4	Prototypes developed faster than anticipated
	Scientific Services rendered	<i>Number of Analytical and Advisory services rendered</i>	11	16	5	Higher demand for ARC services
	Information Disseminated	<i>Number of technical reports and manuals</i>	26	32	6	Higher demand for technical reports and manuals
<b>GOAL 4 TO GENERATE KNOWLEDGE, SOLUTIONS AND TECHNOLOGIES FOR FOOD SAFETY, QUALITY AND IMPROVED EFFICIENCIES IN THE AGRICULTURE VALUE CHAIN</b>						
Agro-processing, Food Technology and Safety	Knowledge generated	<i>Number of scientific publications</i>	45	60	15	Higher output from collaborative projects and student projects.
	Scientific Services rendered	<i>Number of Analytical and Advisory services rendered</i>	174	153	(21)	Lower request for ARC services than anticipated
	Information Disseminated	<i>Number of technical reports and manuals</i>	31	100	69	Higher demand for ARC services
<b>GOAL 5 TO TRANSLATE RESEARCH OUTPUTS IN ORDER TO GENERATE KNOWLEDGE, FACILITATE DECISION MAKING AND CONTRIBUTE TO THE TRANSFORMATION IN THE AGRICULTURE SECTOR</b>						
Agriculture Economics & Commercialisation	Knowledge Generated	<i>Number of scientific publications</i>	9	8	(1)	Delays in acceptance for publications
		<i>Number of Economic Impact Study Reports</i>	3	3	0	-
	Technologies released to the agriculture sector	<i>Number of technologies transferred under license</i>	30	22	(8)	Licensing agreements are still under negotiation
Smallholder Agriculture Development	Scientific Services Rendered	<i>Number of smallholder farmers supported</i>	467	1577	1110	Higher demand for services by the SHF.
		<i>Number of smallholder farmers participating in KyD</i>	8000	8404	404	More farmers anticipated in KyD than anticipated
Training and Extension	Information Disseminated	<i>Number of farmer field days</i>	48	90	42	Higher demand from farmers for ARC guidance
		<i>Number of popular publications</i>	181	337	156	More publications developed than expected
	Training	<i>Number of farmers trained</i>	2305	5560	3255	Higher demand for ARC training
		<i>Number of extension officers trained</i>	286	746	460	Higher demand for ARC training

PROGRAMME	KEY OUTPUTS	INDICATOR	TARGETS	AUDITED ACTUALS	VARIANCE	REASON FOR VARIANCE
			16/17	YTD		
<b>GOAL 6: APPLY RESOURCE MANAGEMENT PRACTICES, TOWARDS A HIGH PERFORMING AND VISIBLE ORGANISATION</b>						
Administration & Corporate Affairs	Improved Postgraduate SET Base	<i>Number of students obtaining postgraduate degrees, with: Masters</i>	46	40	(6)	This is due to student unrest and the drought that affected the trial periods
		<i>Doctoral</i>	19	11	(8)	
		<i>Number of employees appointed with: Masters Degrees</i>	15	9	(6)	This is affected by the slow progress from Masters graduates as a pipeline for succession
		<i>Doctoral Degrees</i>	6	17	11	Intake from last year's pipeline of students
	Improved staff profile	<i>Number of employees with: Masters</i>	265	235	(29)	This is affected by the slow progress from Masters graduates as a pipeline for succession
		<i>Doctoral Degrees</i>	228	249	15	Intake from last year's pipeline of students
		<i>Percentage staff turnover</i>	3.50%	3,33%	0.17%	There has been stability in our labour turnover
		<i>Percentage increase in employment equity ratio's in the designated groupings in core business, in respect of: Black</i>	5%	1,26%	(3.74%)	Fewer appointments made within designated groupings
		<i>Female</i>	3%	0,86%	(2.14%)	
	<i>Disability</i>	1%	0,62%	(0.38%)		
	Optimal investment in training and development	<i>Training spend a % of salary bill</i>	1.5%	4%	3.5%	There was an increase in training as an investment.
	Funding and Revenue Generation	<i>Rand Value of external income</i>	R365mil	R384mil	R19mil	External income was higher than anticipated.
		<i>Rand Value of royalty income</i>	R9mil	R15mil	R6mil	The volume of sales on which licensees pay royalties were higher than anticipated.
		<i>Current Ratio</i>	1:1	1:1.1	-	-
		<i>BEE spend</i>	R138mil	R232mil	R94mil	The pool of qualifying BEE suppliers increased due to the participation in the Centralised Supplier Database (CSD).
		<i>ARC BBBEE rating</i>	Level 4	Level 3	1 Level	Rating results were higher than expected.
	Optimal use of information resources	<i>Number of initiatives implemented towards the development of a KM platform</i>	3	3	0	-
		<i>Number of national assets collections digitised</i>	3	3	0	-
		<i>Number of stakeholder-interactive platforms developed</i>	3	8	5	More platforms developed than was anticipated.
	Optimal utilisation of assets	<i>Percentage increase in rental income</i>	5%	12.15 %	7.15 %	Rental income was higher than anticipated.
		<i>Number of business cases developed for implementation of Asset Management Plan</i>	4	2	(2)	Fewer Business cases developed than expected.









