

CSIR ADVANCED AGRICULTURE AND FOOD

The CSIR harnesses opportunities afforded by transformative technologies to develop agriculture and associated processing industries for inclusive growth and rural development, while improving industry's competitiveness through research, development and innovation, as well as business innovation.



science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



CSIR
Touching lives through innovation



ABOUT THE CSIR

The Council for Scientific and Industrial Research (CSIR) is a leading scientific and technology research organisation that researches and develops transformative technologies to accelerate socioeconomic prosperity in South Africa.

The organisation's work contributes to industrial development and supports a capable state. The CSIR is an entity of the Department of Science and Innovation.

The organisation plays a key role in supporting public and private sectors through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competences.

Nine high-impact sectors identified by the CSIR to achieve its aims are:

Industry advancement clusters



Advanced Agriculture and Food



NextGen Health



Future Production: Chemicals



Future Production: Mining



Future Production: Manufacturing



Defence and Security

Industry and society enabling clusters



Smart Places



Smart Mobility



NextGen Enterprises and Institutions





KEY STRATEGIC AREAS

The CSIR harnesses opportunities afforded by transformative technologies to develop agriculture and associated processing industries for inclusive growth and rural development, while improving industry's competitiveness through research, development and innovation, as well as business innovation.

The Advanced Agriculture and Food (AAF) Cluster works across the following key strategic areas:

- **PRECISION AGRICULTURE:** Leveraging multidisciplinary expertise, including climate modelling, remote sensing, geographic information systems, drone technologies, digitisation, big data analytics, artificial intelligence and machine learning. Tools and services based on these technologies enable better yield predictions, input cost optimisation, decision support and better surveillance for pests and diseases.
- **AGRO-PROCESSING:** Optimising South Africa's biodiversity by formulating high-value products based on indigenous plants; developing high nutritive ready-to-eat foods enriched with plant or insect-based proteins; and reducing post-harvest losses through processing and developing green solutions for post-harvest management.

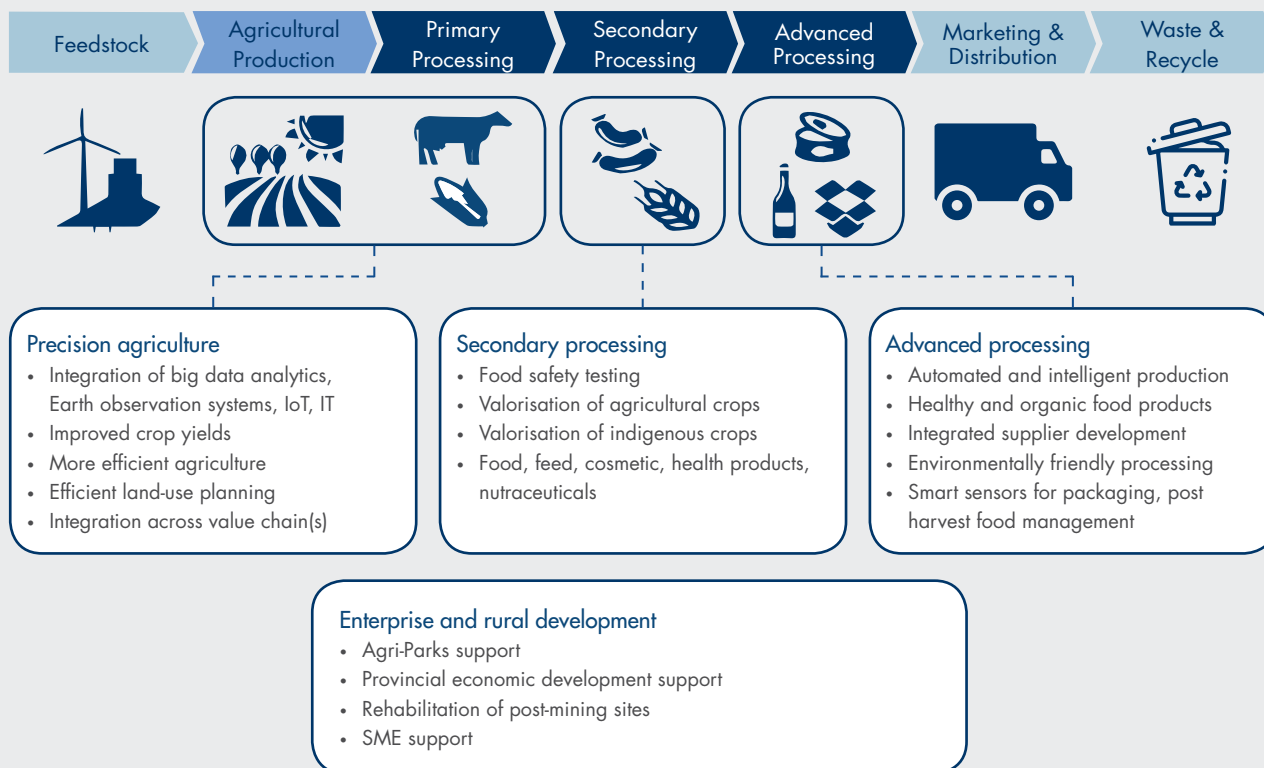
- **FOOD SAFETY:** Improving food safety testing to reduce foodborne illness and support the South African export market. Expertise leveraged across the CSIR include Blockchain and Internet of Things technologies that enable higher control and traceability to improve supply chain logistics; sensing devices to improve monitoring, rapid on-site surveillance and routine testing technologies (for mycotoxins, pesticides and pathogens).
- **ENTERPRISE CREATION FOR DEVELOPMENT:** Backing sustainable agri-businesses as a driver for socio-economic development in rural communities through diffusion of mainstream agro-processing technologies into rural businesses.

Drawing on its multidisciplinary skills base, the CSIR supports the food and agriculture industry, government, as well as regional and continental organisations through implementation of their programmes. This skills base includes robotics and sensor technologies, green energy solutions, water and waste management solutions, green packaging solutions, point-of-care diagnostic tools, vaccine development and bio fertilisers.



A VALUE CHAIN APPROACH TO IMPROVING SOUTH AFRICA'S FOOD SYSTEM

The cluster integrates 4IR technologies such as digitisation to support the public and private sectors. Collectively, the competences in the cluster provide solutions across the entire value chain, as illustrated below:



Research Groups

The CSIR's expertise relevant to AAF covers everything from understanding the raw materials to end-product innovation.

PRECISION AGRICULTURE GROUP

Precision agriculture involves observing, measuring and responding to field variability in crop growth parameters to optimise production via variable application of inputs. The process is facilitated using modern geospatial technologies such as remote sensing, geographic positioning systems and geographic information systems, as well as fourth industrial technologies such as machine learning, artificial intelligence and Internet of Things.

The CSIR aims to help transform agricultural production (food crop, livestock, forestry) through innovative and adaptive use of these technologies. The organisation is supporting industries along the agricultural value chain with actionable farm-level data or intelligence to enable precision agriculture and cost-effective business decisions at all levels of the value chain.

Offerings

The CSIR uses drone and satellite-sensing data to derive value-added data or actionable information built in a decision-support system that fosters decision-making at all levels of the agriculture value chain. The precision agriculture platform uses big data analytics to add value to earth observation data, and climate services to support precision farm management and efficacies in the agricultural service industry.

Specific capabilities include:

1. **DIGITAL FARMING PLATFORM:** A geospatial information system that provides near real-time data on farm-scale soil moisture and organic matter, crop stress (due to drought, pest and disease infestation as well as weed infestation), yield forecasting and weather forecasting.
2. **EXPERTISE:** Big data analytics (spatial statistics, artificial intelligence, deep learning and block chain technologies); satellite and unmanned aerial vehicle data processing; cloud computing-based automation; image interpretation and classification, geographic information systems and app development.
3. **HARDWARE:** Field spectroradiometer (Analytical Spectral Device and Unmanned Aerial Vehicles (UAV) or drone hyperspectral and LiDAR (all integrated on board the UAV) sensors, precision GPS equipment, as well as leaf-level (SPAD chlorophyll sensor) and leaf-area index meter (Plant Canopy Analyzer, LiCOR LAI-2200).



CASE STUDY

The CSIR is harnessing its capabilities in satellite farming, climate modelling and services, and fourth industrial technologies to establish a precision agriculture information system to provide near real-time actionable information to farmers. The system is built using a combination of field, UAV/drone and satellite-based datasets within a cloud computing and artificial intelligence modelling environment. In its initial phase of implementation, the focus has been on maize crops in selected farms in Vereeniging, Bronkhorstspuit and Magaliesburg. The UAV-based system will help farmers with a range of challenges, from assessing field status, soil variations, crop health and growth, to optimisation of cultivation area and estimation of plant densities per hectare, estimation of harvesting and production yields, detection of weeds and/or pests, evaluation of crop damage as a result of hail and other climatic conditions, assessments of irrigation patterns, irregularities and leakages in irrigation systems, as well as in monitoring soil erosion patterns. Data derived from the system includes maps of soil parameters (such as soil organic matter, pH and sodium) before the start of the growing season and crop growth parameters (such as stem height, canopy cover, stem diameter, canopy chlorophyll) during the growing season, on a weekly basis.

AGRO-PROCESSING GROUP

Agro-processing remains key to the economy, accounting for 4.8% of the Gross Domestic Product (GDP) and contributing 28.7% of South Africa's manufacturing output.

In 2021, the sector's contribution to employment was 4%. Agro-processing industries have the potential to contribute to the broader national objective of transforming the economy through the creation of jobs and business opportunities for small and medium enterprises.

The current agro-processing capabilities span product and process development, Indigenous Knowledge Systems (IKS), circular economy and post-harvest management. As part of the group's offerings, the CSIR is currently developing technologies to support the cannabis industry with product and processing solutions, e.g. alcohol and carbon dioxide extraction units, new and re-formulated product development and analytical testing. CSIR research scientists are part of a Minister of Health Advisory Committee on cannabis and they contribute to the National Cannabis Master Plan working group. In addition, the CSIR works closely with the South African Health's Products Regulatory Authority (SAHPRA) to provide scientific based evidence in shaping the regulatory framework for the cannabis industry in South Africa.



AGRO-PROCESSING: PROCESS AND PRODUCT RESEARCH AND DEVELOPMENT



Offerings

- Process and product research and development on fruits, grains, vegetables and other foods
- Scale up: piloting agro-processing products from bench to 400L scale
- Milling and drying capabilities (over 8 tons) and expertise for raw material processing
- Cannabis research: extraction, analysis and product re-formulation and formulation
- Development of ingredients from indigenous crops to produce highly nutritious products like porridges, soups, drinks and biscuits
- Value addition to African Traditional Medicines and reformulations to produce high-quality safe products like tinctures, tea bags, petroleum jellies, ice teas and capsules
- Product and process prototype development and optimisation for SMMEs and bigger industry clients
- Circular economy: food waste beneficiation.
- Valorisation of South African indigenous plants to produce cosmetic products and nutraceuticals
- Food product testing for regulatory compliance and health claim formulation and
- Training on agro-processing technologies and product formulation

Outputs

- Highly nutritious food products, cosmetics, nutraceuticals and traditional medicines
- Technical and business skill development in agro-processing and
- New SMMEs and job creation



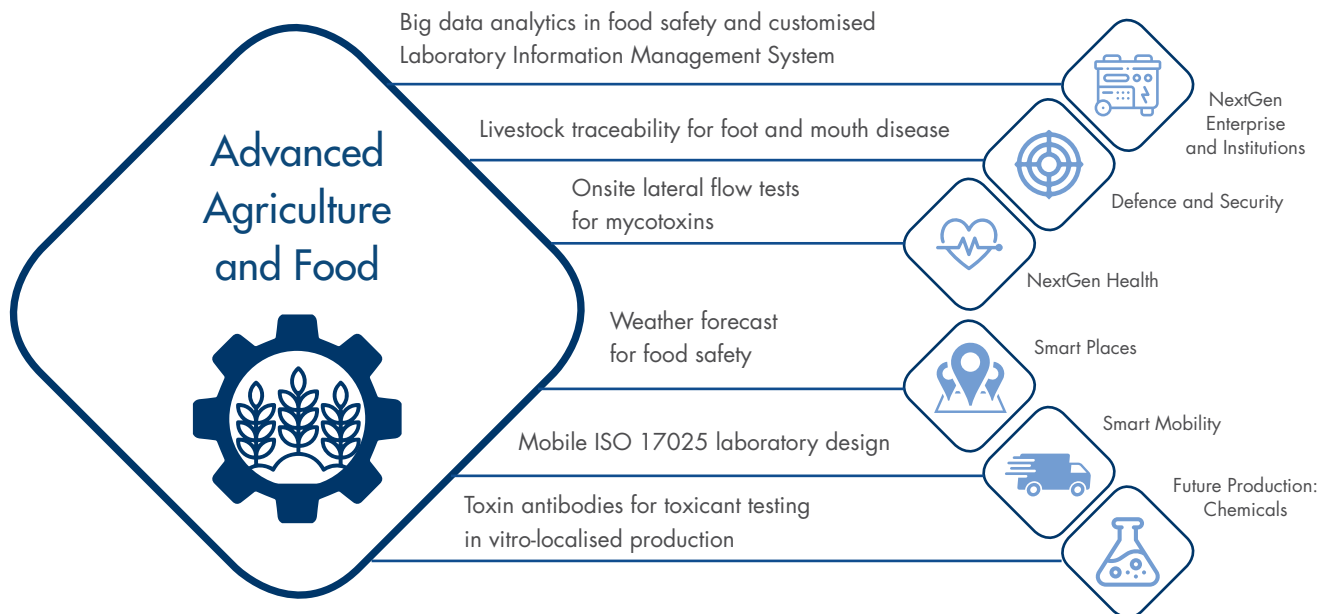
FOOD SAFETY

Food safety is about producing, handling, storing and preparing food in such a way as to prevent infection and contamination in the food production chain, and to help ensure that food quality (taste, colour, smell, labelling) and wholesomeness are maintained to promote good health (WHO, 2015). As food trade expands throughout the world, food safety has become a shared concern among both developed and developing countries.

The cost of unsafe food goes beyond human suffering. Contaminated food hampers socio-economic development, overloads healthcare systems and damages the economy, trade and tourism of a country. Economic opportunities inherent in the international food market are lost to countries that are unable to meet international food safety standards.

An increasingly globalised food supply means that risks from unsafe food can rapidly escalate from a local problem to an international emergency, exposing populations worldwide to food hazards.

The CSIR leverages its multidisciplinary capabilities to improve food safety along the food value chain.



Offerings

- **Food safety systems for safety testing:** A mobile laboratory and other testing systems
- **Traceability:** An innovative livestock biometric system
- **Nanotechnology for food safety:** Nano-sensors for food safety
- **Big data analytics:** Laboratory services and technologies such as the Lab Information Management System

Key food safety projects

- Developing and production of a prototype mobile laboratory that is ISO 17025 accredited
- Data analytics platform to provide suitable visualisation tools to support export markets
- Production of mycotoxin standards to assist with testing foods for mycotoxin contamination
- Production of Multiplex screening systems for mycotoxins
- Laboratory design and optimisation for food safety testing
- Implementation strategy of a livestock traceability system



ENTERPRISE CREATION FOR DEVELOPMENT

The Enterprise Creation for Development group uses science and technology solutions, from the CSIR and other partners, to create sustainable enterprises in South Africa. The group has been implementing such solutions for more than 26 years and focuses on national priorities with a developmental, rather than a commercial-gain. The group has strong engineering and science backgrounds and well-developed, tried and tested tools for enterprise development.



Offerings

The group has five main offerings that are deployed to selected industry sectors:

- **OPPORTUNITY IDENTIFICATION:** Two tools are used to identify economic development opportunities geographically (raid reviews) and at a sector or value chain level (sector studies and strategies).
- **OPPORTUNITY ASSESSMENT AND PACKAGING:** This offering covers due diligence of existing business plans and facilities, techno-economic feasibility studies and the development of business plans.
- **ENTERPRISE CREATION AND DEVELOPMENT:** This offering is designed to take a business idea through the various enterprise development stages of enterprise creation, incubation and competitiveness improvement.
- **ENTERPRISE SUPPORT PROGRAMMES:** Developing and managing SMME support programmes and economic infrastructure such as incubators, incubation programmes, industrial parks, and enterprise and supplier development programmes.
- **CAPACITY BUILDING FOR LOCAL ECONOMIC DEVELOPMENT:** Training and capacity development is provided for local economic development, including enterprise development.

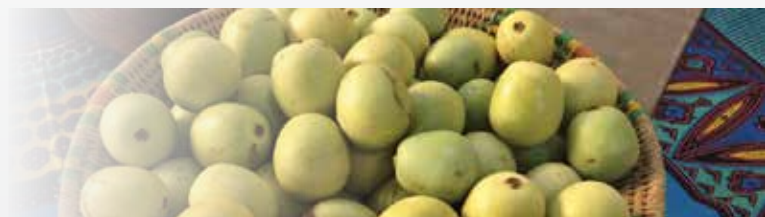
These offerings contribute to three aspects of the National Development Plan, namely: economy and employment, economic infrastructure and rural development.

PROJECT EXAMPLES

- **FEASIBILITY STUDY: Hemp Cultivation and Processing for Moses Kotane Institute**



- **FEASIBILITY STUDY: Marula Industrial Hub for Limpopo Economic Development Agency**



- **Development of an Integrated Enterprise Development Strategy for North West Province**



- **Development of the Biodiversity Strategy for North West Province**



- **Feasibility studies and development of eight Agri-park Master Business Plans for Department of Agriculture, Land Reform and Rural Development**



AUDA-NEPAD SOUTHERN AFRICA NETWORK FOR BIOSCIENCES

As part of its support for regional and continental programmes, the CSIR hosts the Southern Africa Network for Biosciences (SANBio), a programme of the African Union Development Agency New Partnership for Africa's Development (AUDA-NEPAD).

SANBio is a part of one of the five centres of excellence that have been set-up in South Africa, the AUDA-NEPAD Centre of Excellence on Science Technology and Innovation. This centre, in partnership with the CSIR and the Stellenbosch University, aims to stimulate and broker mutual linkages and collaborations across policy-science-practices. This would encourage blended public-private initiatives for change and impact on the continent's development trajectories.

SANBio focuses on:

- Contributing to scaling-up health and nutrition innovations
- Promoting knowledge sharing and technology transfer
- Implementing the Science, Technology, and Innovation Strategy for Africa and Agenda 2063.

Established in 2005, SANBio also serves as a regional platform that adopts a multi-country approach in coordinating and implementing projects in the field of biosciences in southern Africa. It achieves this by maintaining a large network of select member and partner research and development institutions. It drives innovation in support of the development of a knowledge economy in Southern Africa by:

- creating and maintaining an effective and dynamic regional research network,
- enhancing bioscience human and infrastructure capacity of its members, and
- developing and commercialising innovation products in health and nutrition.



To enhance its work, SANBio has transformed into a self-sustaining and efficient institution with a wide-ranging funding base and multiple revenue streams. Accordingly, SANBio is offering a range of products to institutions, enterprises, small, medium and micro enterprises, government entities and the international community to improve their productivity, enhance their performance and meet development aspirations. These products build on the demonstrated success in bringing innovative products to market and managing complex regional R&D projects.

In the last five years, SANBio has supported 17 academia-industry projects, with the participation of 15 universities and 10 private companies. The programme has also created 6 start-up companies, introduced 7 products to the market, facilitated 26 industry-academia collaborations in sectors such as health, human and animal nutrition, in vitro diagnostics, and, in the process, created 50 jobs.

For more on SANBio, see www.nepadsanbio.org

Test-it™ *Brucella bovine* lateral flow test



Key features:

- measures IgTotal
- uses blood or serum
- >90% sensitivity vs CFT
- >97% specific
- better performance than RB
- ideal for screening and/or confirmation
- no interference from RB51 vaccination
- on-the-spot results in 15 minutes



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