Chapter 18

# Science and Technology

## Policy

National science and technology (S&T) policy is the responsibility of the Minister of Arts, Culture, Science and Technology, Dr Ben Ngubane.

The intellectual framework for policy is the National System of Innovation (NSI), in which a set of functioning institutions, organisations, individuals and policies interact in the pursuit of a common set of social and economic goals.

The *White Paper on Science and Technology,* published in 1996, sets the stage for processes to be implemented by the then Department of Arts, Culture, Science and Technology in its mission to realise the potential of science and technology.

On 1 August 2002, the Department was split into two new departments, namely Arts and Culture, and Science and Technology.

S&T constituted 60% of the Department's expenditure in 2000/01.

In April 2002, Mark Shuttleworth did South Africa proud by becoming the first African in space. On Freedom Day, 27 April, President Thabo Mbeki spoke with Shuttleworth via satellite from the Free State Rugby Stadium in Bloemfontein shortly after he docked at the International Space Station. Shuttleworth uses the journey to promote science and mathematics education in South Africa.

Additional amounts of R30 million, R18 million and R22 million were allocated from the Poverty-relief Fund.

Over the past five years, the Science Vote has increased by 27,6%. The Innovation Fund is a major initiative introduced by the White Paper. It promotes large-scale projects, involving participation from throughout the NSI. It focuses attention on the major themes of government, namely competitiveness, quality of life, environmental sustainability and the harnessing of information technology (IT) to address the needs of society and the economy.

### National Advisory Council on Innovation (NACI)

Government has a constant need for informed advice on the development and implementation of S&T policy and the stimulation of innovation. The NACI is responsible for carrying out inquiries, studies, policy research and consultations in respect of the functioning of the NSI as requested by the Minister.

The Council enables the Department to consolidate and develop the NSI in an informed and proactive manner. It provides a focused mechanism to access and target critical S&T research and information for the purpose of socio-economic development.

The members of the NACI are broadly representative of government and the higher education, business and non-profit sectors.

## Public understanding of science, engineering and technology (PUSET)

Getting information about science across to different sections of the population is a big challenge. The Department's efforts to improve the situation include the following:

- The Department of Science and Technology and the American Association for the Advancement of Science (AAAS) have established the Science Radio Journalism Fellowship Programme with the objective of building a critical mass of science radio journalists who can communicate science to the public in the South African indigenous languages. In 2001, several fellowship awards were granted. During the four-week programme, fellows received state-of-the-art training in science radio journalism at the AAAS headquarters in Washington DC, United States of America (US). Fellows from the journalism community learned how to research, write and produce science stories of the highest industry standard, while those from the science community learned how to communicate effectively with the media.
- The Reference Group of Women in S&T is aimed at the creation of an environment in which women contribute to, participate in and share benefits equally with their male counterparts in the science, engineering and technology (SET) fields, whether from a policy-making or research perspective. The interim committee formed by the Department of Science and Technology completed all the necessary groundwork in 2001 for the Reference Group to be launched during 2002/03. The project, aimed at ensuring that girls are motivated and influenced to choose mathematics and science as subjects before they reach the critical stage of choosing their careers, was hosted by the Western Cape, Gauteng, and the North West. Some 360 girls and 30 educators were involved.

The Department of Science and Technology contributed more than R12,86 million in the past three years towards the National SET Week.

The Department has established partnerships with business, parastatals, universities and technikons, non-governmental organisations (NGOs) and community-based organisations (CBOs) in various provinces to implement the SET project.

An estimated 80 000 people visited exhibition centres in the three provinces, Mpumalanga, Free State and Gauteng, that hosted the project in 2002.

The Department launched the Human Resource Development Project aimed at empowering local science, mathematics and technology teachers. A workshop, held in Pretoria in July, explored the challenges associated with the presentation of scientific ideas at secondary school level while maintaining focus on teaching for understanding.

## International science and technology co-operation

### Implementing S&T policy and the objectives of the NSI

The establishment of the interdepartmental Science and Technology Co-operation Committee (SATCCOM), representing all relevant departments, with the Chair and Secretariat provided by the Department of Science and Technology, was approved by Cabinet. It promotes and guides the participation of government departments in international S&T co-operation.

Against this background the:

- manual on bilateral S&T co-operation was approved and distributed
- survey of government departments' approach to and conducting of international S&T co-operation was completed.

This initiative gave SATCCOM an overview of the management, promotion and utilisation of research and development (R&D) and S&T within government departments with an S&T component. These guidelines were submitted to Cabinet for approval.

The Department has embarked on the establishment of a database on international co-operation in SET. Major international initiatives include the South African Coelacanth Conservation and Genome Resource Programme launched at Sodwana Bay, with research co-ordinated by the South African Institute for Aquatic Biodiversity (SAIAB) and involving several Southern African Development Community (SADC) neighbours, promoting co-operation in marine biodiversity conservation, environmental education and capacity-building. Countries such as Mozambique, Tanzania and Madagascar will participate. Another international initiative is the establishment of a long-term ecological research site in southern Africa. This site will join an international network of ecosystem observatories which help regions manage natural resources in a sustainable manner. The Satellite Laser Ranging System at Hartebeesthoek is operated in conjunction with the National Aeronautics and Space Administration (NASA) in the US. The System's annual operational costs are approximately R1 million.

The South African Large Telescope (SALT) under construction at Sutherland in the Northern Cape is a multimillion Rand project involving Germany, Poland, the US, New Zealand and the United Kingdom (UK).

On completion in 2005, SALT will be the largest single optical telescope in the southern hemisphere.

### Science and Technology Agreements Committee (STAC) Fund

Since its inception in 1996, STAC has, through the offices of the National Research Foundation (NRF), effectively serviced intergovernmental S&T agreements and multilateral activities. For the period January 2000 to March 2001, the STAC budget allocation exceeded R9 million and serviced over 27 bilateral and multilateral agreements.

### Lead Programmes Fund

This Fund was established to enhance existing international co-operation in the fields of biotechnology, new materials, information and communication technology (ICT), environmental management, rural development and urban renewal. During the first period from 1999 to 2001, the Lead Programmes Fund successfully leveraged international R&D support and established viable consortia between South African science councils, the *Centre de Coopération Internationale en Recherche Agronomique pour le Développement* (France), ALCOA (US), Rolls Royce (UK) and the IVL Swedish Environmental Research Institute, among others.

### Southern African Development Community Fund

The main priority areas previously identified include water management, cross-border pollution, food technology, indigenous knowledge systems, ICT, soil management, HIV/AIDS, etc.

**Information**

On 25 April 2002, South African space tourist Mark Shuttleworth blasted off in a Russian Soyuz shuttle for a 10-day trip to the International Space Station (ISS). The Soyuz TM-34 shuttle carrying Shuttleworth (28), Russian mission commander Yury Gidzenko and Italian cosmonaut Roberto Vittori, lifted off from the Baikonur cosmodrome in Kazakhstan. They docked at the Station within two days, and returned to the arid Kazakh steppe on May 5. Internet entrepreneur Shuttleworth is the second amateur to have paid his way to the ISS, following United States millionaire Dennis Tito's trip to the space outpost in 2001.

On his return to South Africa, Shuttleworth went on a roadshow to schools and other public venues across the country as part of the Hip 2b Square Project. The Project is aimed at encouraging children to take mathematics and science at school.

Shuttleworth was presented with a gold medal in recognition of his public relations profile by the South African Public Relations Institute in October 2002. He was also named Newsmaker of the Year by the Johannesburg Press Club.

## Technology diffusion and transfer

The Department facilitates the promotion of small, medium and micro enterprises (SMMEs) through the *Tshumisano* Programme for technology stations.

These are being rolled out at various technikons. Since January 2000, seven technikons have been participating in the following sectors:

- electronics (Technikon Pretoria)
- chemicals (Mangosuthu and North West technikons)
- metals (Technikon Free State)
- clothing and textiles-testing technologies (Peninsula Technikon)
- automotive components (Port Elizabeth Technikon)
- composites technologies (Vaal Triangle Technikon).

## Technology roadmapping exercise

Subsequent to the launch of the National Research and Technology Foresight exercise, the then Department of Arts, Culture, Science and Technology embarked on technology roadmaps.

While the Foresight exercise had provided the country with a window into the future regarding which technological futures will exist and what can be expected in terms of emerging technologies in the 10 to 20-year time frame, a detailed mapping-out of the technological landscape is required. Roadmaps provide a long-term strategy for attaining industry-wide goals by providing specific and quantifiable performance targets.

Three of the sectors were selected for road-mapping, namely ICTs, biotechnology and bio-informatics, and advanced manufacturing.

These sectors' highest priority is to contribute towards the growth and development of South Africa's economy.

The output of this exercise will be an industry-driven document outlining the following:

- the industry vision for the future and its possible realisation
- a strategy to create partnerships among industries, and other supporting institutions to accelerate technology research development and deployment
- the key goals in the areas of products, markets, materials technology, manufacturing technology, environmental technology and regulations, human resources and research, and development within the industry
- a roadmap of the technologies necessary to reach the industry's goals.

## National Biotechnology Strategy (NBS)

As part of the implementation of the recommendations of the Foresight exercise, the Department was tasked by government to be the lead department in the development of the NBS.

The Strategy is intended to inform government, industry and the broad research community in South Africa on the necessary steps to be taken to realise the potential for biotechnology to contribute to the economic development of South Africa.

The Strategy outlines the existing situation with respect to legislation, practices or status with regard to research and technology development, resources for developing R&D in biotechnology, and private and public support for the growth of skills and industry in biotechnology. Areas of uncertainty, the existence of knowledge gaps and varying perspectives about the effects and benefits of biotechnology within the South African economy are noted, as well as future trends and developments in the field.

The Department is engaged in the implementation of the Strategy, which will see three Biotechnology Regional Innovation Centres established with R60 million each in funding between 2002 and 2003 as well as the establishment of a National Bio-information Facility. The NACI will be setting up a Biotechnology Advising Centre and a Bioethics Committee.

### *Godisa* Programme

The departments of Science and Technology and of Trade and Industry with the support of the European Union (EU) have launched the *Godisa* National Incubation Programme. The *Godisa* Programme aims at encouraging technology transfer and capacity to enable small business to compete in the global economy.

*Godisa* aims to address:

- outdated technologies employed by SMMEs
- low engagement rates of SMMEs in value-adding activities
- high failure rate of start-up SMMEs
- poor access to facilities for testing and promoting SMMEs' innovative ideas.

By mid-2002, the following centres had been established:

- Softstart Software Technology Incubation in Pretoria (IT)
- KwaZulu-Natal Innovation Support Centre in Durban (IT)
- Zenzele Technology Demonstration Centre in Johannesburg (mining)
- Egoli Biotechnology Incubator in Johannesburg (biotechnology)
- Mbombela Horticultural Incubator in Nelspruit (horticulture)
- Arcon Technology Incubator (life science)
- Chemin Fine Chemicals Incubator in Port Elizabeth (chemicals).

## Science councils

The statutory science councils are a key part of South Africa's NSI. Through them, government is able to directly commission research in the interest of the nation and support technology development in its pre-competitive phase.

### National Research Foundation

As the government's national agency responsible for promoting and supporting basic and applied research as well as innovation, the NRF upholds excellence in its investments in knowledge, people, products and infrastructure. The NRF provides services and grants to support research and postgraduate research training, vital to the development of S&T in South Africa. It is the NRF's vision to be a key instrument in the creation of an innovative and knowledge-driven society where all citizens are empowered to contribute to a globally competitive and prosperous South Africa.

Funding from the NRF is largely directed towards academic research, developing high-level human resources, and supporting the nation's national research facilities. The NRF's task is to advance research in all fields of the humanities, social and natural sciences, engineering, and technology, including indigenous knowledge. By forging strategic partnerships locally and internationally, it extends the resources that researchers need to foster and expand South Africa's research capabilities and, ultimately, improve the quality of life for all.

Other areas of its core business are to promote research capacity development, to unlock the full creative potential of the research community, and to establish equity and redress. The NRF fosters strategic partnerships and knowledge networks to make South Africa globally relevant and competitive. It provides research information and strategic advice.

The NRF received 1 188 authorised grant applications for 2001, of which 957 were in the natural sciences and engineering, and 231 in social sciences and the humanities. The total amount requested by prospective grantholders was over R308 million, which exceeded available funding.

The NRF's Research Support Agency invests funds, granted mainly by Parliamentary vote, to institutions, teams and individuals engaged in research. South African researchers received research grants to the value of more than R162 million in 2001. The Parliamentary grant is supplemented by joint ventures with other funding partners.

### Technology for Human Resources for Industry Programme (THRIP)

The flagship of such ventures is the THRIP, a joint initiative of industry, research and education institutions and the Department of Trade and Industry. During 2002, at least R260 million was expected to be invested in R&D activities designed to improve the competitiveness of the South African industry. Some 200 THRIP projects have been approved for S&T research grants, ranging from R5 000 to R8 million.

Of the R260 million, government made R130 million available through the Department of Trade and Industry, with the other half comprising private-sector funds from small and large industrial companies. Government and industry match each other's financial support through THRIP due to researchers tackling problems to find solutions to existing challenges facing industry. Projects supported by THRIP cover a wide range of technology areas, including agriculture, bioprocessing, food, forestry, health care, materials, mining, manufacturing, and power systems.

THRIP addresses the expressed need for interventions that focus on challenges in industrial development and competitiveness. In addition to supporting focused research and technology development with well-defined output, THRIP funds contributed towards the training of more than 1 800 post-graduate students in 2002. Of these, more than 700 were black students and more than 550 were women.

### Innovation Fund

The administration of the Innovation Fund was transferred to the NRF during 2001. The Fund is designed to encourage large-scale, collaborative research and technology development programmes, a multidisciplinary approach to problem-solving and application-based research. The Innovation Fund's economic and S&T policies recognise the process of innovation, one of the agents driving technological change. Many countries believe innovation is primary to economic growth. The Innovation Fund is an investment by government that gives effect to this concept.

Under the management of the NRF, the Fund directs large grants (between R1 million and R5 million per year) to consortia of researchers for the final-stage research process in which knowledge is translated into new or improved products, productivity processes and services. The Fund assists in the conversion of research ideas into commercially useful end-products by funding necessary items such as equipment, R&D expertise, access to managerial skills, the securing of intellectual property rights and the construction of prototypes.

The Innovation Fund is a policy instrument to lever economic and social resources. It seeks to address socio-economic challenges by harnessing South Africa's S&T competencies to simultaneously develop and maintain cutting-edge global competitiveness and address the needs of citizens unable to assert themselves in the market-place.

The Fund has increased every year, and it is envisaged that it will ultimately absorb a significant portion of the research budget of central government. It focuses on specific priority areas that are reviewed regularly. The Innovation Fund will support projects to the value of R136 million over the next three years.

### Research Support Agency focus areas

The NRF Research Support Agency has a suite of funding programmes that are in line with South Africa's priorities and needs. The focus areas are:

- unlocking the future: advancing and strengthening strategic knowledge
- distinct South African research opportunities
- economic growth and international competitiveness
- sustainable livelihoods: the eradication of poverty
- conservation and management of ecosystems and biodiversity
- ICTs and the information society

- the socio-political impact of globalisation: the challenge for South Africa
- education and indigenous knowledge systems.

### Cross-cutting themes

From an organisational perspective, cross-cutting priorities include:

- positioning, developing and strengthening the social sciences and humanities
- building research capacity
- African interaction – specific targeted interventions to build strengths and exploit African competitive advantages through collaboration with colleagues on the continent
- evaluation and quality assessment
- developing new business – the leveraging of resources from sources other than the Science Vote
- positioning the NRF in the knowledge era
- enhancing operational effectiveness.

### Research Capacity Development (RCD) programmes

Institutional RCD programmes focus on boosting historically black universities and technikons that are committed to the research process. In addition, the *Thuthuka* Programme, launched in 2001, supports individual researchers. It comprises three subprogrammes, namely Research in Training, Women in Research and Research Development for Black Academics. All the NRF's RCD initiatives aim to boost the output of high-level black human resources (both academics and research students at all higher education institutions); develop a postdoctoral research culture; strengthen weak, yet critically important disciplines; improve gender equity; and renew outdated research equipment.

### Student support

The NRF provides two types of postgraduate student support that complement each other, namely:

- free-standing bursaries, scholarships and fellowships
- grantholder-linked bursaries.

Free-standing bursaries, scholarships and fellowships are awarded directly to students on a competitive basis, while grantholder-linked bursaries are granted to researchers within their NRF support package and may be awarded to students selected by the NRF grantholder.

The NRF offers a limited number of travel grants for a research period abroad.

### Knowledge management

The NRF's research information programme has two main components:

- The NEXUS database consisting of a set of databases related mainly to the humanities and social sciences. It was expanded in 2001 to include the natural sciences and engineering.
- The South African Data Archive is an archive of computerised raw quantitative data of large-scale regional, national and international research projects mainly in the humanities and social sciences.

The NRF makes these databases available to the research community.

### Strategic advice

The NRF's Strategic Advice Unit ensures that the necessary data and recommendations are available to internal and external decision-makers.

### International science liaison

International Science Liaison aims to forge and maintain strategic and intellectual alliances between individuals, institutions and organisations in the national and international science research communities to support the international competitiveness of the country. Of special significance during 2001/02 was the formalisation of bilateral research co-operation with Norway, Italy and Iran. This brought to 19 the total number of S&T agreements signed by South Africa and managed by the NRF.

The South African International Council for Science (ICSU) Secretariat serves the South

African scientific community and most of the ICSU unions and affiliates that South Africa adheres to. The Secretariat is administered by the NRF as part of its science liaison activities.

## National research facilities

The NRF is responsible for managing South Africa's five national research facilities. These are:

- Hartebeesthoek Radio Astronomy Observatory (HartRAO) near Krugersdorp, Gauteng
- SAIAB in Grahamstown
- iThemba Laboratory for Accelerator-based Sciences in Faure, Western Cape
- South African Astronomical Observatory (SAAO) in Cape Town, Western Cape, and Sutherland in the Northern Cape
- Hermanus Magnetic Observatory (HMO).

### Hartebeesthoek Radio Astronomy Observatory

HartRAO uses a 26-m radio telescope to carry out research in radio astronomy and related fields, serving local and international science communities. When arrayed with telescopes on other continents, HartRAO forms part of a network of super telescopes able to see details hundreds of times smaller than can be seen using the best optical telescopes.

Because of its unique location, HartRAO is in great demand for international projects such as studies of the dynamics of the earth's crust and variations in its rate of rotation.

A new, state-of-the-art facility at HartRAO enables South Africa to measure with pinpoint accuracy the orbits of satellites and the movement of continents. The satellite laser-ranging equipment – named Moblas-6 – provides accurate measurement of the physical changes of sub-Saharan Africa, and allows scientists to better monitor the potentially devastating El Niño effect. Moblas-6 forms part of an international network of 40 measuring stations in different parts of the globe. The US' NASA developed Moblas-6, while the Department of Science and Technology is funding the operation of the instrument.

### South African Institute for Aquatic Biodiversity

Previously the JLB Smith Institute, the SAIAB is a leading centre for the study of fish and biodiversity in Africa and the surrounding seas. The Institute is responsible for the national collection of fish (more than 450 000 specimens) and promotes knowledge and awareness of fish and aquatic conservation. The collection catalogue includes a computerised database, a library and information services. Researchers at the Institute played a role in the discovery of a population of coelacanths off Sodwana Bay in KwaZulu-Natal in November 2000.

In April 2002, the South African Coelacanth Conservation and Genome Resource Programme was officially launched at Sodwana Bay by the Minister of Arts, Culture, Science and Technology. The SAIAB co-ordinates this research project, which promotes co-operation in marine biodiversity conservation, environmental education and capacity-building. Countries such as Mozambique, Tanzania and Madagascar will participate. The Institute's educational programme for pupils and the public includes illustrated lectures and guided tours of, among other things, the experimental fish farm.

### iThemba LABS

Previously the National Accelerator Centre, iThemba LABS provides modern research facilities to users in science, medicine and industry. From being a facility facing possible shutdown just a few years ago, iThemba LABS has established itself as a major commercial centre for radiation medicine and is forging strategic partnerships with the private and public sectors to leverage capital, as well as the skills and expertise required for an initiative of this magnitude. By establishing a major oncology centre, this national facility has created more space for training in physics and radiation sciences. An example of iThemba

LABS boosting its income sources is its radionuclide sales, which hit record levels of over R6,5 million in 2001/02. The income generated from such initiatives is ploughed back into research, infrastructure and human resource development in radiation science. Valuable experience in using sophisticated equipment is gained by senior students in many experimental sciences at iThemba LABS. Much of the research is carried out in collaboration with scientists from local and foreign universities.

**South African Astronomical Observatory**

The SAAO in Cape Town and Sutherland has seven telescopes at Sutherland, used for optical and infra-red observations. It provides an international facility for research in astronomy in Africa, and educates and informs the community.

Construction on the multimillion Rand, 10 m SALT in Sutherland is well under way and will be completed in 2005. SALT will collect light and infra-red rays with a mirror mosaic of 91 hexagonal segments, each 1 m wide, making it the largest single optical telescope in the southern hemisphere. It is being funded by five international partners and the South African government, which has committed R50 million over five years.

**Hermanus Magnetic Observatory**

The HMO was declared a national research facility in July 2001. The HMO was transferred to the NRF from the Council for Scientific and Industrial Research (CSIR) as a result of a study on the future of the Observatory. The study emphasised the importance of the HMO as a national asset and suggested that it be upgraded to a national facility. High-level human resource training and research capacity-building are top priorities to transform the Observatory into a national facility.

The expertise vested in the HMO is of great strategic importance, and it will become a significant player in space and earth sciences, as well as geospatial information. The challenge is to reposition the HMO within the NRF and the NSI to improve the quality of life of all the people of South Africa.

## The Agricultural Research Council (ARC)

The ARC is a statutory parastatal body established in terms of the Agricultural Research Act, 1990 (Act 86 of 1990). It is committed to the promotion of agriculture and related sectors through research, technology development and technology transfer.

Through its wide network of research institutes and experimental farms, the ARC provides a strong scientific base and a broadly distributed technology-transfer capacity for the entire agricultural industry in South Africa. In support of national and household food security, ARC research empowers both commercial and resource-poor farmers.

Farmers are provided with appropriate technologies to improve production. Training of farmers and agricultural extension staff in new technologies is an integral component of the ARC's activities.

### Rural development

The ARC collaborates with government and the Independent Development Trust in the development of an Integrated Sustainable Rural Development Strategy for South Africa. The ARC advises the M-17 group of Ministers under the Chairpersonship of the Deputy President on the development of a planning tool, based on geographic information systems (GIS).

To share information and assess the use-options of resources in a particular area, the South Africa Integrated Spatial Information System is being developed to provide a user-friendly framework for informed decision-making.

The relevant basic data, interpreted planning information and decision-support system will provide a number of rural-development options for a specific area, but will also indicate constraints.

Information can be geographically/spatially

illustrated within the system and accessed via the Internet. It has the advantage of a single interface from which relevant data/information from all departments can be accessed and integrated.

The proposed Decision Support System will encapsulate the principles of multicriteria decision-making and expert systems by capturing political and scientific thinking in a structured environment.

The impact and wide scope of the ARC sustainable rural development thrusts are evident in all provinces. The ARC empowers people through research, information and appropriate training that address economic and social challenges.

ARC-generated technologies also underpin SMMEs that aim to create new job opportunities through agribusiness. Its research impacts on agriculture and related disciplines such as applied S&T, health and nutrition, food safety, education, the environment and natural resource conservation.

The ARC interfaces with national, provincial and local governments as well as various agricultural unions and farmers' associations in South Africa. Apart from research collaboration with these stakeholders, the ARC also partners with other science councils.

More than 90 joint research projects are conducted with local universities.

Since becoming a member of the Consultative Group on International Agricultural Research in 1996, the ARC has had an increase in international contacts.

On a regional level, the ARC is involved in agricultural research activities of the SADC, with links to other African role-players in the Special Programme for African Agricultural Research.

The ARC is active in over 50 regional networks, and has 47 research projects in Africa, involving one or more countries. Some of the regional initiatives include SARRNET (root and tuber network), SAFRINET (network to promote entomological taxonomic capacity) and MWIRNET (maize and wheat research network).

The ARC is also active in international collaboration, especially with universities in the US, UK, Europe, Australia, New Zealand and Africa. The ARC has contracts and research agreements with over 112 organisations in 35 countries. At present, the ARC has Memoranda of Understanding with numerous scientific role-players in other countries.

Other international collaborators and donors include the Commonwealth Scientific and Industrial Research Organisation, *Centre de Coopération Internationale en Recherche Agronomique pour le Développement*, Food and Agricultural Organisation, EU, *Institut National de la Recherche Agronomique*, Natural Resource Institute, CAB International, Department for International Development, Network Organisation for Research and Development, *Deutsche Gesellschaft für Technische Zusammenarbeit*, Danish Agency for Development Assistance and the Swedish International Development Co-operation Agency.

South Africa is recognised globally as one of the five leading countries in the field of the biological control of alien invasive plants, with the highest success rate in terms of control per numbers of agents released. This research, to guard the country's natural biodiversity from being systematically reduced and replaced by alien vegetation, is driven by the ARC and, apart from the local impact, has benefited many other African countries.

Research activities are governed by five research programmes that are in line with the precepts of the *White Paper on Science and Technology* as well as the government's national agricultural priorities. The programmes are:

- public support services
- sustainable rural livelihoods
- grain and industrial crops
- horticulture
- livestock.

The ARC supports agricultural development that promotes sustainable natural resource utilisation.

Biodiversity is promoted through the ARC's guidance regarding the conservation, management and sustainable use of South Africa's unique fauna and flora. The ARC encourages indigenous knowledge systems, promotes the sustainable use of indigenous plants and animals, and is conducting research to ensure maximum benefit to all communities in South Africa.

The ARC maintains numerous plant genebanks for the benefit of farmers and to expand the food and feed base in South Africa. These genebanks include:

- indigenous vegetables, cassava, other vegetables, sweet potato and potato
- an oil-seeds collection comprising groundnuts, sunflower, soya beans, dry beans, lupines and cowpeas
- a subtropical crops collection comprising avocado, banana, citrus, coffee, granadilla, guava, litchi, macadamia, mango, pecan and pineapple
- a small grains collection comprising wheat, barley, oats, rye, triticale and durum
- a deciduous fruit collection comprising apples, peaches, plums, pears, berry fruits, tree nut crops, *rooibos* tea, dates, olives, kiwi fruit and hops
- table, raisin and wine grapes, and a yeast genebank.

Other crops conserved in genebanks are cotton and fibre crops, indigenous plants, medicinal plants, bulb flowers and *fynbos*. These plants offer small-scale farmers new commercial opportunities. In support of animal production, a plant voucher specimen collection, a vegetation database and a forage genebank are maintained.

ARC research contributes to food security. The quality of healthy and nutritious foods is maintained through improved shelf life, post-harvest technologies, monitoring spoilage points in production lines, safe use of products, and general hygiene recommendations. New products and market opportunities are identified. Processing technologies for food and industrial crops are developed. Research into sanitary and phytosanitary issues facilitates access to domestic and export markets. ARC technologies and prototypes enhance SMME development.

One of the ARC's largest contributions involves the breeding of new plant cultivars that are better adapted to South African production conditions than imported cultivars or races.

The ARC currently holds registered plant breeder's rights on 273 cultivars of all the major plant types that are commercially produced in South Africa. Export figures over the last 20 years indicate the growth in production and international demand for South African cultivars.

ARC institutes have localised research and demonstration trials at about 40 sites. These include strategic research farms and satellite stations located within some provincial agriculture departments.

### ARC-Institute for Soil, Climate and Water

The ARC-Institute for Soil, Climate and Water in Pretoria, Gauteng, promotes the characterisation, sustainable utilisation and protection of natural resources.

Research activities cover soil science, agrometeorology, water utilisation and analytical services. Through remote sensing and GIS, the Institute applies computer technology to capture and store maps (spatial) and alpha-numerical data (non-spatial) in integrated databases to provide decision-making support to farmers and policy-makers.

### ARC-Institute for Agricultural Engineering

Situated in Pretoria, the Institute is active in agricultural mechanisation, resource conservation, farm structures, irrigation, alternative energy, aquaculture and product-processing.

Research is directed at a wide range of clients from subsistence farmers using animal traction to commercial farmers and manufacturers requiring scientific performance evaluations of advanced equipment. Innovative energy sources and applications are devel-

oped for rural areas. Prototypes and pilot equipment with numerous applications, especially for resource-poor agriculture, are also developed.

### ARC-Plant Protection Research Institute

The ARC-Plant Protection Research Institute in Pretoria concentrates on national agricultural and environmental problems. It is committed to the promotion of economic and environmentally acceptable pest control. Research focuses on biosystematics, ecology and epidemiology of vertebrates, as well as fungi, pathogenic and useful bacteria and viruses.

The Institute researches the control of pests and invasive plants through effective pesticide management, as well as biological and integrated control strategies. A variety of services are provided, ranging from quarantine of imported biocontrol agents, advice on apiculture, quality control of legume inocula, provision of cultures of biocontrol agents and identification of organisms important in agriculture, to specialised information on pesticide appli cation, biological control and forest entomology. The Institute also houses the Plant Genetic Resource Unit that centralises and co-ordinates plant genetic resource activities. It liaises with regional and international agencies and is responsible for the documentation of ARC germplasm and safety-base collection facilities.

### ARC-Grain Crops Institute

This Institute, situated in Potchefstroom, North West, is responsible for research into the improvement and cultivation of grain crops such as maize, sorghum and millet as well as oil-and-protein seeds such as sunflower, groundnut, soya beans, dry beans, cowpeas, sweet white lupin and bambara. Research activities involve plant-breeding, evaluation of cultivars, grain quality, plant physiology and other production factors.

### ARC-Small Grain Institute

The ARC-Small Grain Institute in Bethlehem, Free State, concentrates on the improvement and cultivation of small grain crops such as barley, wheat, oats, triticale and rye. Research activities include plant-breeding, evaluation of cultivars, grain quality, plant physiology, tillage, weed science, plant pathology, entomology and yield potential.

### ARC-Institute for Industrial Crops

This Institute in Rustenburg, North West, is involved in all fundamental and applied research in the interest of the tobacco and cotton industries. Research is also conducted on other fibre crops such as hemp, sisal and flax that have potential as new crops in rural areas.

### ARC-Institute for Tropical and Subtropical Crops

The ARC-Institute for Tropical and Subtropical Crops in Nelspruit, Mpumalanga, is responsible for research into all aspects of the cultivation of tropical and subtropical fruits such as citrus, pineapple, banana, avocado, mango, litchi, guava, papaya and granadilla. Other crops on which production research is conducted include tea, coffee and spices, as well as pecan, macadamia and cashew nuts. Lesser-known exotic crops with potential are also evaluated, such as cocoa, coconut, feijoa, annona types, carambola, jaboticaba and white sapote.

Research activities comprise horticulture, cultivar development, plant nutrition and irrigation.

### ARC-Roodeplaat Vegetable and Ornamental Plant Institute

Situated outside Pretoria, this Institute concentrates on a wide range of horticultural crops. Research is conducted on commercial vegetables such as onions, potatoes, tomatoes and sweet potatoes. Traditional and indigenous vegetables receiving attention include amaranthus, cassava, plectranthus, Zulu round potato, pigeonpeas, cowpeas and bambara.

Research on the production and development of ornamentals and indigenous flora such as *fynbos*, woody ornamentals and bulbs has led to a new growth industry.

### ARC-Infruitec/Nietvoorbij

ARC-Infruitec/Nietvoorbij in Stellenbosch, Western Cape, is responsible for research on the cultivation and post harvest technology of deciduous fruit such as apples, peaches, plums and pears. Other assigned crops are berry fruits, tree nut crops, *rooibos* tea, honeybush tea, dates, olives, kiwi fruit and hops. It is also responsible for research on the cultivation of table, raisin and wine grapes as well as the production of wine and brandy.

### ARC-Animal Improvement Institute

The ARC-Animal Improvement Institute at Irene, outside Pretoria, provides the livestock industry with technologies for the improved quality of animals.

It has established genetic and physiological methods to identify and study superior breeding material to improve the efficiency of the national herd.

### ARC-Animal Nutrition and Animal Products Institute

Situated near Irene, this Institute develops environment-friendly technologies to promote animal production through improved nutrition.

Research is conducted on beef and dairy cattle, sheep, pigs, goats and poultry. It also evaluates technologies to enhance the quality of meat and dairy products.

### ARC-Onderstepoort Veterinary Institute

The ARC-Onderstepoort Veterinary Institute, north of Pretoria, is responsible for the prevention and control of animal diseases. It also provides a public health service with regard to animal products such as milk, meat and eggs.

The Institute conducts research on specialised diagnostics, parasitology, toxicology and related disciplines. Various vaccines and other biological products are developed and produced. The Institute also houses a high-security facility for research into infectious diseases such as foot-and-mouth disease and African swine fever. It serves as a regional centre for diagnostic services, advice and training.

### ARC-Range and Forage Institute

The Institute, situated in Pretoria, focuses on the development of holistic and integrated land-use strategies. It provides guidelines for sustainable livestock and rangeland management systems. Research is conducted on vegetation, rehabilitation ecology, animal nutrition and management, pasture agronomy and vegetation biology.

## Council for Scientific and Industrial Research

The CSIR is the largest community and industry-directed scientific and technological research, development and implementation organisation in Africa.

It delivers scientific and technological services in areas where industry, parastatals or government clients require support, as well as innovative leadership in the development of new technologies, which can be further developed and exploited by the private sector.

The CSIR has major offices in Pretoria, Johannesburg, Cape Town, Stellenbosch, Port Elizabeth and Durban, with representatives in all other provinces.

Approximately 7 000 clients are served every year, and 60% of the CSIR's income is funded externally. The CSIR's functions are centred in eight market-oriented business units:

- Food, Biotechnology and Fine Chemicals Technology
- Building and Construction Technology
- Defence Technology
- Water, Environment and Forestry Technology
- ICT
- Manufacturing and Materials Technology
- Mining Technology
- Roads and Transport Technology.

The activities of the business units are aimed at the following:

- supporting the technological competitiveness of South African industry in both the formal and informal sectors
- providing technological solutions to improve the quality of life of urban and rural communities

- providing scientific and technological support for decision-making in the private and public sectors.

The CSIR focuses on team work, building relationships, forging strategic alliances and working with consortia:

- the client-contractor principle always applies (for both external income and parliamentary grant-funded projects)
- it invests to build competence, and to develop innovative product/service offerings
- as an honest broker, it provides independence and objectivity
- it harnasses the integrated power of the organisation, which is underpinned by IT in its offerings and operations.

In line with its mandate, the CSIR is strongly committed to serving the national imperatives of crime prevention, HIV/AIDS, human resource development, job creation, regional integration, rural development and urban renewal. In these endeavours, it draws on skills from across the organisation and collaborates with partners in science councils and other agencies, including local, provincial and national government.

The CSIR is empowered by the Measuring Units and National Measuring Standards Act, 1973 (Act 76 of 1973), as amended by Act 24 of 1998, to maintain all national measurement standards through its National Metrology Laboratory.

Internationally, the CSIR works with 18 African countries, has co-operation agreements with major R&D organisations and companies, and is a registered consultant with the World Bank, African Development Bank, United Nations Development Programme and others.

The CSIR is well-positioned to provide services to Africa in support of the African Renaissance and its delivery programme, the New Partnership for Africa's Development (NEPAD). The combination of its scientific and technical expertise, its understanding of the African continent and its developing strategic relationship network with key African private, public and official development-assistance sectors make the organisation an ideal partner to support Africa's economic development through specific interventions. These are primarily aimed at the environment, ICTs, infrastructural services and manufacturing. The CSIR also supports the utilisation of indigenous knowledge systems as well as capacity-building to secure Africa's position in the knowledge economy.

A five-year compound growth of almost 26% in international external income has resulted from long-term relationships with multinational companies and knowledge-intensive organisations.

## Mintek

The mining and metallurgical industry is a well-developed and economically significant cluster in South Africa. Not only does it account for approximately 8% of the gross domestic product and close to half of the country's exports, but it is also a major employer. The significance of Mintek's work stems from the need to maintain and strengthen South Africa's position as a major supplier of mineral commodities, and to uphold the country's reputation as a leading source of scientific and engineering skills in the field of metals and minerals.

Mintek strives to be the global leader in the field of mineral and metallurgical R&D and technology transfer. It develops and applies improved technology to facilitate new industrial operations and improve the cost-effectiveness of existing ones on a world-wide basis. It is also closely involved in identifying and developing applications and markets for minerals and mineral products. Particular emphasis is placed on increasing earnings from minerals by turning them into higher-value products before they are exported. Much of the work is done in close liaison with the South African mining and metallurgical industries, and a number of co-operative programmes are carried out with international partners.

In terms of the Mineral Technology Act, 1989 (Act 30 of 1989), Mintek is an auto-

nomous organisation whose core activities are financed by the State. It is, however, responsible for financing an increasing proportion of its own activities through operational income earned from industry clients. Mintek's annual income is about R188 million, of which the State provides about R78 million, with the balance being made up of operating income from R&D contracts, consulting investigations and joint ventures, and the marketing of technological products. Just under half of this operating income derives from international sources.

Mintek employs some 430 permanent staff, about 260 of whom are scientists, engineers, technicians and associated professionals.

### Technology development

Mintek is engaged in the full spectrum of minerals research, from the mineralogical examination of ores, to extraction and refining technologies and the manufacture of end products. To ensure focus and market orientation, Mintek's R&D activities are grouped into programmes that are based largely on industry structure.

- The gold industry programme focuses on developing and introducing improved technologies, such as biotechnology and ion-exchange processes to simplify processing and increase recoveries, particularly from ores that are difficult to treat. A major joint venture with industry and other research groups is exploring new industrial uses of gold.
- The platinum-group metals (PGMs) industry programme aims to increase the cost-effectiveness of PGM production and stimulate industrial demand for PGMs. Much testwork is carried out for new mining projects and expansions in South Africa.
- The ferrous metals industry programme develops products and technical services to increase the cost-effectiveness of steel, stainless steel and ferro-alloy production, as well as improved alloys.
- The non-ferrous metals industry programme includes the processing of aluminium, cobalt, copper, lead, magnesium, nickel and zinc. A major emphasis is on the introduction of cleaner technologies.
- The industrial minerals industry programme includes a major R&D effort towards the beneficiation of titaniferous raw materials, which constitutes one of the country's most significant mineral resources. Mintek's research into waste management and environmental problems also fall under this programme.
- A sixth programme, opportunity enhancement, deals with cross-cutting projects largely of a regional or educational nature.

### Promoting industrial growth

Mintek is engaged in a number of initiatives to promote major new industrial projects, based on mineral beneficiation and utilising both existing and newly developed technologies, with the aim of boosting the economy and creating employment opportunities. These projects include the:

- production of hot briquetted iron from Sishen ore fines, utilising natural gas as the fuel and reductant
- recovery of PGMs from chromite tailings. Mintek has demonstrated a flotation procedure that can produce a saleable concentrate, and is carrying out a pre-feasibility study in conjunction with an industrial partner
- establishment of a new electrolytic manganese dioxide (EMD) plant in South Africa. Mintek has developed considerable expertise in production technology for high-purity EMD, which is a key ingredient in the manufacture of dry cell batteries, particularly alkaline batteries.
- production of ferronickel from imported ores using Mintek's DC-arc smelting technology. This project can be considered similar to the production of aluminium at Richards Bay, in that it would be an important foreign exchange earner, while making South Africa self-sufficient in nickel for stainless steel and nickel-bearing alloys.

- establishment of a local magnesium industry, using a novel thermal production route being developed in conjunction with industry partners.

Extensive work has been done in support of new mineral projects in Africa south of the Sahara.

A number of studies have been undertaken in support of the government's spatial development initiatives, with the aim of encouraging investment in the metallurgical and mineral industries both in South Africa and the SADC.

## Small-scale business development and support

Mintek is a founder member of the National Steering Committee (NSC) of Service-providers to Small Mines, which includes the Department of Minerals and Energy, other science councils and private-sector organisations. Mintek also undertakes projects on an individual basis, by providing high-quality experimental and consulting services with the emphasis on the transfer of knowledge and skills, and refers projects needing follow-up to the NSC.

Mintek's specialised Small-scale Mining Unit develops and sources simplified equipment and assists with flowsheet development, as well as proactively searching for opportunities from which artisanal and small-scale miners can benefit. The aim is to establish small-scale mineral-beneficiation projects with the emphasis on adding maximum value to the raw materials by manufacturing end-products.

The Zenzele Technology Demonstration Centre, which was established in 2001 in co-operation with the EU and the then Department of Arts, Culture, Science and Technology, demonstrates mineral beneficiation techniques and assists with their implementation in the field, hosts workshops and seminars, and assesses likely deposits for small-scale exploitation.

## Environment

Mintek continues to focus on the development of environmentally responsible technologies for the recovery and recycling of metals from metallurgical residues. The emphasis remains on jigging technology, DC-arc furnace treatment of metallurgical waste, the bioleaching of base metal sulphide ores and residues, and technologies for gold refining for the small-scale mining industry.

Work on effluent treatment has expanded to include waste and recycle streams from individual processing plants. A major programme is in place to monitor cyanide species after discharge in various locations around gold-plants, from both an environmental and a processing point of view. Mintek's environmental technologies and services are provided to industry via a co-operative agreement with an established environmental consulting group.

## Education

There is a shortage of engineers and scientists within Mintek's field of expertise in South Africa. Mintek sees a strong and definite role for itself to 'train the nation' to maintain and develop the country's expertise base in these areas. The undergraduate bursary scheme assists in supplying Mintek with a steady stream of suitable new graduates, and also in fulfilling Mintek's commitment to promote education in the minerals-related engineering disciplines. The postgraduate bursary scheme is a source of top-class researchers at MSc, MTech and PhD levels.

The EnqTrain and TechTrain programmes focus on university and technikon students who require in-service training to complete their qualifications.

Mintek continues to support pre-tertiary activities to encourage young people to pursue careers in S&T. The two primary efforts in this regard are Minquiz, an annual scientific quiz for science pupils on a national basis, and the Edumap programme, which affords young people from disadvantaged educational backgrounds the opportunity to prepare for tertiary education.

## Human Sciences Research Council (HSRC)

The HSRC is an independent statutory organisation established in 1968. As one of the science councils in South Africa, the HSRC focuses its research on social sciences.

The HSRC has 11 national research programmes, initially called 'new priority areas' during the restructuring process. Three of the programmes are led from the Cape Town office, and one from Durban (where the HSRC's new office will be opened soon).

The three programmes led from Cape Town are Knowledge Management, Social Aspects of HIV/AIDS and Health, and Social Cohesion and Integration.

Knowledge Management concerns itself with the way that organisational knowledge is harnessed toward innovation. Through this new programme, the HSRC will be assisting government to better utilise its information resources towards more effective services. The programme will also give careful consideration to the workings of the NSI. In particular it will, with partners, conduct the national survey of R&D in South Africa on behalf of the Department of Science and Technology.

This survey will feed into the overall set of indicators that government uses to direct and measure policy-making and implementation, economic growth and service delivery. In particular, it would permit measurement of the strengths and weakness of the S&T system, as well as the impact of S&T on the development of a knowledge-based economy, enhancing quality of life, economic growth by leveraging technical progress (improvement and innovation) and the development of human resources for S&T. Components of this system, which include internationally bench-marked surveys of R&D, innovation and other statistical measures of S&T input and output, will form an integral part of the National Statistics System as conceived by Statistics South Africa.

Social Aspects of HIV/AIDS and Health focuses on studying key socio-cultural, political, economic and demographic determinants that increase or reduce vulnerability to HIV-infection. It also includes the study of social epidemiology of major public health conditions in South Africa and the SADC. The public health component also focuses on health system issues necessary for disease control within a social development context. This national programme also generates knowledge that will be used in designing HIV prevention, care and impact-mitigation. One of the key studies the programme is undertaking is to evaluate the impact of HIV/AIDS on the health sector. This study is being carried out in health facilities located in all provinces.

To optimise its collaborative outreach, this programme has set up what is called SAHARA (Social Aspects of HIV/AIDS Research Alliance). SAHARA is a flexible alliance of sub-Saharan research partners, who are committed to conducting or supporting quality research specifically to inform policy and programme development.

The research programme on Social Cohesion and Integration operates in the areas of the arts, sport, religion, history, family, education, media and the social dimensions of science. Its principal concerns are about understanding, celebrating and actively building leadership that encourages new and more durable forms of social cohesion, based on the country's history, constitutional values and norms of ordinary human civility. A major project is the Africa Human Genome Initiative and an international conference on the Social, Ethical, Legal, Educational and Biotechnological Implications of the Human Genome Diversity Project, which will be held at the Spier Estate in the Western Cape in March 2003.

## Medical Research Council (MRC)

The MRC was established in 1969. Its mission is to improve the nation's health status and quality of life through relevant and excellent research aimed at promoting equity and development.

The MRC is an autonomous body but reports to the national Department of Health.

It receives 60% of its budget from the government Science Vote.

The MRC's research activities are aligned to the health priorities of the nation, in line with the national S&T Imperatives and the health priorities defined by the Department of Health under the philosophy of Essential National Health Research, and are grouped into the following six national programmes:

### National programme for research in molecules to disease

This group undertakes research on human and microbial genetics, genomics, bio-informatics, cell and molecular biology, tissue engineering and clinical research.

### National programme for health systems and policy research

The scientists in this programme conduct research on health systems, clinical epidemiology, biostatistics, health policy, burden of disease and telemedicine.

### National programme for infection and immunity research

The research units in this programme are involved in research on tuberculosis (TB), malaria, immunology of infectious disease, diarrhoeal diseases, inflammation and amoebiasis.

It also incorporates the MRC National HIV/AIDS Lead Programme, whose divisions co-ordinate the South African AIDS Vaccine Initiative, various aspects of biomedical research including mother-to-child transmission and microbicides, and prevention of transmission through behavioural change. (See chapter: *Health*.)

### National programme for non-communicable disease research

This group undertakes research on heart disease (both laboratory, clinical and public health research), nutritional intervention, diabetes, sports science, crime, violence and injury, anxiety and stress disorders, dental issues, bone disease and medical imaging.

### National programme for environment and development research

In this entity, research on health promotion, health and development, sports science and technology transfer is undertaken.

### National programme for women and child health research

This programme undertakes research on many aspects of women's health, including high blood pressure during pregnancy, health-care strategies in maternal and infant health, and perinatal mortality.

The MRC's 47 research units within these six national programmes employ over 300 scientists engaged in 600 research projects, supported by 200 support staff.

Twenty-seven of the units are situated at medical schools and research institutes – six of these in historically disadvantaged institutes. The MRC also funds 350 short-term researchers at academic institutions throughout South Africa.

It has a new research grants management system, using electronic databases and software to ensure equitable and efficient disbursement of health-research funding.

The MRC is increasingly Africanised in terms of its research and organisational philosophy, its gender and ethnic profile, and its collaboration with other African countries. It is also increasingly internationalised through collaboration with most of the world's leading health research agencies, including the National Institutes of Health and Centres for Disease Control and Prevention in the US, the Gates Foundation, the World Health Organisation, the Wellcome Trust, the Pasteur Institute, the Kenya Medical Research Institute and the Blair Institute in Zimbabwe.

It works with national and provincial departments of health to ensure its research findings feed into policy formulation and health-care practice.

### South African National Health Knowledge Network

The South African National Health Knowledge

Network was established in 1999 at the MRC with funding from the government's Innovation Fund.

It operates under the tradename SA HealthInfo and is available on the Internet at *http://www.sahealthinfo.org*, providing a one-stop interactive forum or resource for quality-controlled and evidence-based health research information.

The Knowledge Network's Modules serve as strategic mini-portals, and the following modules (information clearing-houses for focused areas) are available: Alcohol and drug abuse; Bio-informatics; Chronic diseases of lifestyle; Ethics in health research; Evidence-based medicine; HIV/AIDS; Malaria; Medical inventions; Mental health; Nutrition; Traditional medicine; TB; and Violence and injury surveillance.

This Internet portal caters for three types of audiences: health researchers and health-care professionals; health consumers and related organisations; and policy-makers. It also serves as a gateway to other trusted health resources.

In July 2001, a high-level meeting of HIV/AIDS role-players was held in Durban, where it was recommended that the MRC should provide a centralised information service on HIV/AIDS research, with the necessary databases and access via the Web. A new portal for HIV/AIDS in southern Africa – *AfroAidsInfo* (*www.afroaidsinfo.org*) – is being developed. The project has secured external funding from the XIII International AIDS Conference organisers and BMS Secure the Future. The HIV/AIDS portal has been endorsed by the Department of Health and will be developed at the MRC with the involvement of various southern African and other international partner organisations.

In response to the needs of researchers and in line with government's biotechnology focus, as well as NEPAD, the MRC has initiated a process to establish an African Biotechnology Information Centre, in collaboration with a consortium of universities.

The Knowledge Network also provides a unique access point to online full-text publications.

## Council for Geoscience (CGS)

The CGS is a statutory body established on 1 November 1993, in terms of the Geoscience Act, 1993 (Act 100 of 1993), to manage the functions of the Geological Survey of South Africa. The main functions of the CGS are:

- the systematic documentation of the surface of the earth within the borders of South Africa; the compilation of geological, geophysical, geochemical and other geoscientific information; and the publication of this information in the form of maps and documents
- geoscientific research on rocks, minerals, ores, fossils, etc. in South Africa, and the publication of research results in national and international journals
- collection and conservation of all geoscientific information and data on South Africa in national collections and electronic databases
- supply of geoscientific services and advice to the national and provincial governments to ensure informed decisions regarding the optimal and efficient use of the surface of the earth.

The objectives of the CGS are to:

- minimise the geological and geoscientific investment risk for national and international entrepreneurs in the South African mining sector (the quality of available geological information, which is known as the 'geological risk grading', contributes to about 61% of the investment risk in any country)
- supply the country with basic geoscience data to establish a safe, cost-effective physical infrastructure without sterilising valuable mineral resources
- supply basic knowledge to ensure safe, cost-effective and environmentally acceptable urbanisation and housing development
- carry out research on raw materials needed to clothe, transport, feed and provide shelter for the nation.

To accomplish these functions and objectives, the CGS maintains a specialised work-force, consisting of earth scientists supplemented by technical, support and administrative staff at its headquarters in Pretoria, as well as branch offices in the nine provinces.

To perform its functions, the following national institutions are maintained by the CGS:

- The National Geoscience Library in Pretoria is probably the most comprehensive geoscience library on the African continent. It includes the National Geoscience Map Library, which contains a collection of South African and African geoscience maps.
- The National Core Library contains a representative stratigraphic borehole core collection, representing most of the lithological units located within the borders of South Africa. This collection is housed in a modern facility at Donkerhoek, east of Pretoria.
- The Geoscience Museum in Pretoria contains a unique collection of minerals and fossils, catering for the earth-science education of the public, especially schoolchildren.
- An extensive laboratory to analyse rock and soil samples, using various specialised techniques.

The geoscience information and services provided by the CGS are particularly important for sustainable development. In South Africa's arid region, the management of groundwater resources (both the quantity and quality thereof) is aimed at providing enough clean water to communities.

A new map series, the 1:50 000 geotechnical map series, covering the rapidly developing areas of South Africa, can be used to locate land that is geotechnically suitable for development and free of geohazards such as sinkholes. These maps also show the locations of building-material resources.

Through its membership of the NSC, the CGS helps mining entrepreneurs, particularly those from previously disadvantaged groups, to exploit South Africa's mineral resources in a cost-effective and environmentally friendly way.

The CGS plays a leading role in the SADC, and has been chairing the Geological Subcommittee for several years. Several geoscience publications covering the region have been produced by this Subcommittee.

An exciting service is provided by two microlight aircraft capable of performing high-resolution aerial geophysical surveys. This development is breaking new ground and is unique in the world.

In addition to its national responsibilities, the CGS is also active internationally, mainly in Africa. Geological and metallogenic maps of, among others, Angola, the Democratic Republic of the Congo, Mozambique, Gabon and Morocco have been produced.

A map indicating seismic activity in sub-Saharan Africa has been produced, as well as a publication on the gold deposits of the SADC region.

A digital edition of the *Metallogenic Map of South Africa*, at a scale of 1:1 000 000, has been released recently. The product gives information on all known mineral deposits and occurrences in South Africa in a handy CD-ROM format.

A metallurgic map of Africa, at a scale of 1:5 000 000, is in press and a digital version of this map will also be available in CD-ROM format.

## South African Bureau of Standards (SABS)

The core business of the SABS is the production, maintenance and dissemination of standards. In terms of the Standards Act, 1993 (Act 29 of 1993), the objectives of the SABS include:

- promoting standardisation in industry and commerce
- undertaking educational work in connection with standardisation
- administering compulsory standards on behalf of the State
- collaborating with relevant international organisations to protect and advance South Africa's interests
- assisting government departments, public

bodies, provincial and local government in the preparation of any specification or code of practice they require.

The Certification Strategic Business Unit of the SABS runs a product certification scheme, several quality system certification schemes such as the SABS ISO 9000 Quality Management Certification Scheme and SABS ISO 14001 Environmental Management Certification Scheme, and a consignment inspection service.

The extensive state-of-the-art testing capability of the SABS forms the backbone of the organisation's commercial activities and contributes a significant portion of turnover. Goods can be inspected, tested and analysed against private, voluntary or compulsory standards while precision-measuring and scientific equipment can be tested and calibrated for clients in both the public and private sectors.

Consequently, most of the 66 testing laboratories within the SABS are accredited by the South African National Accreditation System for the competent performance of tests in accordance with ISO/IEC Guide 25, the general requirements for the competence of calibration and testing laboratories.

The SABS is a founding member of the independent South African Quality Institute, which was established in 1991.

By means of its focused training programmes, the SABS actively assists industry in creating an overall awareness of quality and the environment. It provides a country-wide service in training quality-system and environmental auditors.

The core business units of the SABS are financed by monies allocated for that purpose under the Science Vote, and administered by the Department of Science and Technology. Inspections and tests, which are carried out for the private sector, industry, national, provincial and local government, as well as the certification of products and systems are funded on a commercial basis by fees charged for services rendered.

The mission of the Institute is to foster the economic and technological development of South Africa through the promotion of design, and to establish it as a centre of design promotion in southern Africa. It focuses on industry, education and information.

The SABS is increasingly involved in a number of activities that flow from the general transformation process in the country, including the introduction of SMMEs to standardisation, and projects undertaken on behalf of the State. These include adopting schools and helping them with science and mathematics projects. It is collaborating with companies such as ABSA and Daimler Chrysler in a multimillion Rand project in the Eastern Cape and Limpopo (formerly the Northern Province). The project supports the Department of Education's effort to showcase mathematics, science and technology in schools.

## Other research organisations

### Sasol

Although the Sasol Group is best known for its petrol, diesel, kerosene, liquid petroleum gas, power paraffin, illuminating paraffin, fuel oils and gas, it is also a major producer of ethylene, propylene, ammonia, phenols, sulphur, road tar, pitch, creosote, alcohols, ketones, solvent blends, alpha olefins, fertilisers, explosives and waxes.

Sasol Technology's R&D Division is responsible for the R&D function of the Sasol Group.

Sasol's unique technology, which produces both fuel and chemical components from coal in a single step, provides it with a significant cost advantage in the production of petrochemical feedstocks. The recovery of the high-value chemical components and placing them in high-value chemical markets is thus an ongoing priority.

Continuous R&D in recent years has enabled Sasol to launch two major, more cost-effective technological innovations: the Sasol Advanced Synthol Process and the Sasol

Slurry Phase Distillate (SSPD) Process. The SSPD process technology evolved from Sasol's extensive expertise in the field of low-temperature FischerTropsch process technology.

Besides the production of high-quality and more environmentally friendly diesel, the proprietary technology can also manufacture high-quality kerosene and naphtha from natural gas.

### Iscor

The technology arm of the minerals and metals company Iscor Limited, ITEC, provides technical and research support for the company.

Areas of operation include minerals beneficiation, new extraction methods, and high-temperature metallurgical processes. ITEC is also involved in environmental control through research into novel warp recycling and effective use of waste material.

### Eskom

Eskom's Technology Services International group is a multidisciplinary industrial laboratory and consulting organisation. It undertakes testing, investigation studies, project management, engineering services and applied research for Eskom and other customers.

### National Health Laboratory Service (NHLS)

The NHLS conducts research into the prevention and treatment of human diseases.

The NHLS was established on 1 October 2001 to form a single public health laboratory service in South Africa. The NHLS comprises about 260 laboratories country-wide, including the former South African Institute for Medical Research, the National Institute for Virology, all provincial diagnostic pathology laboratories (excluding those in KwaZulu-Natal) and tertiary laboratories used by the university medical schools. It has approximately 4 000 employees and consists of four divisions: research, diagnostic laboratory services, production (serum and laboratory reagents), and teaching and training. The NHLS conducts medical research as well as pathology laboratory tests for all provincial hospitals, excluding those in KwaZulu-Natal. Research is conducted on diseases and health dangers that are of specific importance to South Africa.

### Bureau for Economic Research

The Bureau for Economic Research at the University of Stellenbosch, Western Cape, is an independent and objective economic research organisation rendering a service to organisations ranging from small one-person businesses to policy-makers at the highest level of government.

### National Institute for Tropical Diseases

The National Institute for Tropical Diseases at Tzaneen in Limpopo is responsible for the ongoing assessment of the malaria control programmes carried out by various authorities in South Africa.

Control methods are assessed, and recommendations made to the appropriate authorities with regard to equipment, insecticide usage and application. A malaria reference service is also provided. Tests for malaria are carried out by the Institute, and statistical analysis of data pertaining to the programme is undertaken.

## General research areas

### Antarctic research

Research on this southern continent is undertaken by the South African National Antarctic Programme (SANAP) through the Directorate: Antarctica and Islands of the Department of Environmental Affairs and Tourism.

South Africa has been involved in Antarctic research since 1957, and is one of 12 original

signatories to the Antarctic Treaty. The country also ratified the Madrid Protocol on Environmental Protection to the Antarctic Treaty, which was implemented on 14 January 1998.

The South African National Antarctic Expedition (SANAE) IV base at Vesleskarvet can accommodate 20 over-wintering team members and 60 summer take-over personnel.

SANAP allocated R3,6 million to 19 scientific research projects. It supported the South African Weather Service in maintaining stations on Marion and Gough islands, and in completing numerous activities contributing to the database that the Weather Services uses.

The main research conducted from the base is Antarctic magnetosphere, ionosphere groundbase observations and research into cosmic rays. SANAP also conducts research activities on Marion Island, which cover the whole spectrum of the Island's ecology, and operates a meteorological station on Gough Island.

The Marion Island relief voyage was successfully undertaken in April/May 2001. The Directorate is planning the construction of a new research base on Marion Island, the larger of the two sub-Antarctic islands known as the Prince Edward Islands, which are situated about 1 770 km south-east of South Africa in the Southern Ocean. The Prince Edward Islands were designated as a Special Nature Reserve in terms of Section 18 of the Environment Conservation Act, 1989 (Act 73 of 1989).

A research base was established on Marion Island shortly after its annexation in 1947, and since then the base has been expanded and changed on an ad hoc basis. The base is used for collecting weather data, as well as for research into the exceptional biodiversity and natural systems of the two islands.

Due to the extreme climatic conditions on Marion Island, some of the existing buildings have deteriorated to such an extent that they may be dangerous to inhabit in the short term. The Directorate: Antarctica and Islands therefore proposed that a new modern research base be build to cater for the safe accommodation of personnel and for scientific research.

To ensure that the environmental impact of the new base is minimised, the Directorate has appointed independent environmental consultants to carry out environmental scoping.

The 2001/02 Antarctic voyage was a multinational undertaking as Norwegian and South African scientists were deployed on Bouvet Island; a German contingent took airborne geophysical measurements from the South African Emergency Base; and a team of British scientists operated a twin-otter aircraft from the SANAE IV research base.

## Mine-safety research

The activities of the Safety in Mines Research Advisory Committee are aimed at the advancement of the safety of workers employed on South African mines. The Committee is a statutory tripartite subcommittee of the Mine Health and Safety Council. It has a permanent research management office managing the fields of research, namely rock engineering, engineering and mine occupational health.

## Energy research

The Chief Directorate: Energy of the Department of Minerals and Energy manages a policy-directed research programme. This includes transport energy, renewable energy and energy for developing areas, coal, electricity, energy efficiency, energy economy and integrated energy policy formulation.

## Agricultural research

Agricultural research is conducted by the ARC, several universities and a variety of organisations in the private sector. Provinces are responsible for farm management and technological development. These activities are aimed at improving managerial efficiency on farms.

The Directorate: Agricultural Water Use Management of the national Department of Agriculture co-operates with provinces to steer research in the engineering aspects of agriculture.

Biannual meetings are held to debate and agree on research needs, programmes and budgeting. Efforts are made to ensure that the bulk of research serves the needs of small-scale producers.

Research initiatives have been integrated among the various industries in line with the overall objectives of the particular part of the agricultural sector.

## Water research

Water research in South Africa is co-ordinated and funded by the Water Research Commission (WRC) in Pretoria. The Water Research Act, 1971 (Act 34 of 1971), provided for the establishment of the Water Research Fund, which derives income from levies on water consumption. The funds are collected for the WRC on a commission basis by the Department of Water Affairs and Forestry.

The WRC does not undertake research itself, but enters into agreements with other specialist organisations, such as various university departments and institutions, the CSIR divisions, water boards and government departments to carry out research projects.

In terms of the Water Research Act, 1971, the WRC is responsible for promoting research and encouraging the application of research results. In 2000, the WRC's financial support to 318 different research projects totalled R62,1 million.

The WRC also financially supports the development of the Waterlit bibliographic database as well as the Computing Centre for Water Research in Pietermaritzburg, KwaZulu-Natal.

The organisations most active in water research are:

- universities (51,57% of the total number of contracts)
- consultants (21,97%)
- the CSIR (11,32%)
- water boards (3,77%)
- the ARC (4,14%)
- technikons (2,83%)
- government departments (3,46%)
- municipalities (1,26%).

The main areas of research are surface hydrology, groundwater, hydrometeorology, agricultural water utilisation, water pollution, municipal effluents, industrial water and effluents, drinking water, membrane technology, water ecosystems, hydraulics, mine-water management, water policy, developing communities, and the transfer of IT.

The Division: Water, Environment and Forestry Technology (Environmentek) of the CSIR specialises in research into water quality, including technology to meet effluent and water-quality standards and to establish reclaimed water as an additional water source. Environmentek is a world leader in research into activated sludge processes and the biological monitoring of water to detect potentially toxic substances. It is also involved in research on the effects of afforestation and veld management on the quantity and quality of catchment water yield.

## Environmental research

The Chief Directorate: Environmental Management of the Department of Environmental Affairs and Tourism annually finances several research and monitoring programmes.

The programmes comprise subjects such as waste management and pollution, nature conservation, river management, the coastline and marine environment, and the atmosphere.

Some programmes are conducted in collaboration with the NRF, while others are undertaken on behalf of the Department by the CSIR. Universities also carry out research on behalf of the Department.

Research on human-environment interaction sponsored by the Department is co-ordinated by the HSRC.

In addition, institutes of the ARC are concerned with environmental research insofar as environmental problems impact on agriculture or are caused by agricultural practices.

The Department's National Environmental Potential Atlas (ENPAT) provides a visual overview of South Africa's environmental resources. The most important advantage of ENPAT is that environmental implications of land-use decisions are available before any actions are initiated. ENPAT-National contains two main data types, namely environmental and population data. The Atlas also identifies possible conflict areas in the utilisation of natural resources.

The South African Weather Service functions under the Department of Environmental Affairs and Tourism.

The Weather Service delivers public good services, mainly for the protection of life and property, as well as commercial services to the private sector as stipulated in the Weather Service Act, 2001 (Act 8 of 2001).

The public good services are funded by government and commercial services are paid for by the user. The public good services include weather and climate forecasting, a weather disaster warning system, services to subsistence farmers and fishers, the provision of information and advice to government, meeting regional and international treaty and agreement obligations, maintaining a national meteorological library, technical and scientific training in meteorology, and undertaking research to improve services.

The Weather Service operates the Global Atmosphere Watch (GAW) station, situated at Cape Point in the Western Cape. The GAW is an initiative of the World Meteorological Organisation, and serves as an early warning and forecasting system for changes in the background chemical composition and related physical characteristics of the atmosphere.

Atmospheric ozone monitoring at Irene, near Pretoria, is maintained throughout the year.

The NRF directs a multidisciplinary Conservation and Management of Ecosystems and Biodiversity Focus Area, primarily in collaboration with universities and museums, to promote and support research on living resources and the terrestrial, freshwater, marine, coastal and atmospheric ecosystems.

Some 170 projects are approved annually, and global issues such as climate change and biological diversity are also included. The sustainable use of natural resources is a priority area resulting in a growth of projects relying on sociology and the humanities. The NRF also supports a range of environmental research network organisations such as the Arid Zone Ecology Forum, the *Fynbos* Forum, the Indigenous Plant Use Forum, the South African Network for Coastal and Oceanic Research (SANCOR) and the Savanna Ecology Forum.

## Fisheries research

Research into South Africa's fish resources, their conservation and judicious exploitation is carried out by research personnel of the Chief Directorate: Marine and Coastal Management, a division of the Department of Environmental Affairs and Tourism, and by several universities and NGOs. Research is designed, among other things, to provide parameters for estimates of stock sizes and sustainable yields for the different fisheries.

The Branch: Marine and Coastal Management Co-ordination commissioned a large-scale study on the socio-economics of the fisheries industry through the NRF, acting as its research management agency.

## Coastal and marine research

The Chief Directorate: Marine and Coastal Management advises on the utilisation of marine living resources and the conservation of marine ecosystems by conducting and supporting relevant multidisciplinary scientific research and monitoring the marine environment. Sustainable use and the need to preserve future options in the utilisation of

marine ecosystems and their resources are guiding objectives in the research and advice of the organisation.

The NRF supports marine and coastal research in partnership with the Department of Environmental Affairs and Tourism and the SANCOR.

## Private-sector involvement

South Africa's gold-mining industry works at deeper levels and under more difficult circumstances than any other mining industry in the world. The research on gold-mining conducted by the CSIR's Mining Technology is concerned primarily with ensuring the health and safety of the work-force, and covers, among other things, the areas of rock engineering and the underground environment. Mining Technology's coal-mining research takes place on a smaller scale than that of gold-mining, because the coal-mining industry can make use of various overseas developments. Areas in which research is undertaken include strata control, mining, maximising extraction of coal, and the underground environment.

Research is also carried out by a large number of industrial companies with facilities to meet their specific needs.

The more important ones are Anglo American Corporation of South Africa (applied metallurgy, processing of precious metals, base metals and coal); Agricura (synthesis and testing of veterinary remedies, insecticides, herbicides and entomology); Cullinan Holdings (refractories and electrical porcelain); De Beers Industrial Diamond Division (manufacture and application of synthetic diamonds and other super-hard materials); Johannesburg Consolidated Investment Company (metallurgy, mineralogy, chemistry and chemical engineering); National Chemical Products (chemistry, microbiology and animal nutrition); Metal Box Company of South Africa (corrosion mechanism and microbiology); Tellumat (development of electronic instruments); Rembrandt Group (development and improvement of tobacco and liquor products); South African Pulp and Paper Industries (wood technology, paper manufacture and water treatment); and Standard Telephones and Cables SA (long-distance transmission of information, and lightning protection).

# Acknowledgements

Agricultural Research Council
Chamber of Mines of South Africa
Council for Geoscience
Council for Scientific and Industrial Research
Department of Environmental Affairs and Tourism
Department of Science and Technology
Eskom
*Estimates of National Expenditure 2002*, published by the National Treasury
Human Sciences Research Council
Iscor
Medical Research Council
Mintek
National Department of Agriculture
National Health Laboratory Service
National Research Foundation
Sasol
South African Bureau of Standards
Water Research Commission

## Suggested reading

Austin, B. *Schonland*. Johannesburg: Witwatersrand University Press, 2001.
Basson, N. *Passage to Progress: The CSIR's Journey of Change, 1945 – 1995*. Johannesburg: Jonathan Ball, 1995.
Crouch, M, ed. *Sparkling Achievements.* Johannesburg: Chris van Rensburg Publications, 2001. Department of Arts, Culture, Science and Technology. The Year of Science and Technology: Calendar 1998. Pretoria: DACST, 1998.
Kingwill, D. *The CSIR: The First 40 Years.* Pretoria: CSIR Docel, 1990.
Kok, P. and others. *Development Research in South Africa.* Pretoria: Human Sciences Research Council, 1994.
Liebenberg, L. *Tracking: The Origin of Science.* Cape Town: David Philip, 1990.
Macrae, C. *Life Etched in Stone: Fossils of Southern Africa.* Johannesburg: Geological Society of South Africa, 1999.
Sasol. *Sasol Facts 1998.* Johannesburg: Sasol Corporate Communications, 1998.