

National Agricultural Research and Development Strategy

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National Agricultural Research and Development Strategy

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Foreword



Ms Lulu Xingwana

The importance of agriculture in contributing to broad-based economic growth worldwide has long been recognised. Globally there has been a shift from resource-based economies to knowledge-based economies and the Millennium Development Goals call for commitment towards increased efforts in poverty alleviation, improved health, gender equality and environmental sustainability.

As a country we are facing many challenges which, amongst others, include droughts, floods, climate change, recurring disease outbreaks, increased production costs, high food prices, lack of adequately skilled labour and access to markets. Agricultural research will be meaningful if it addresses the challenges we face and ensures that benefits translate into increased productivity, improvement of the quality of life and wealth creation.

This strategy sets the scene for a paradigm shift to accelerate investments towards strategic research priorities to sustain and improve growth within the agricultural sector. The cost of generating economic growth on a sustainable basis is often linked to the capacity to develop and generate technological solutions to address the many challenges

facing production and processing throughout the commodity value chain. One of the greatest challenges in the research fraternity is getting the technologies to farmers who need these most. I am therefore especially looking forward to agricultural technologies being disseminated through women's groups, farmers' unions and cooperatives, among other approaches.

Role players who should be involved in influencing research should, amongst others, include the resource-poor farmers, women and the youth. I am conscious that implementation of technologies that require few inputs and little cash, will be particularly attractive to participants in the second economy. The benefits will be even greater to the wider population of South Africa through lower-priced food, more jobs, reduction of poverty and improved standards of living.

The National Agricultural Research and Development Strategy incorporates strategic management and prioritisation of research needs at all levels in the sector. Therefore an integrated approach with commitment from all partners is necessary for implementation. My department will remain focused and vigilant to ensure adequate resourcing, and effective implementation of this strategy.

A handwritten signature in black ink, appearing to read 'Lulu Xingwana', written over a white background.

Ms Lulu Xingwana (MP)
MINISTER FOR AGRICULTURE AND LAND AFFAIRS

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Acronyms

AAS	African Academy for Sciences
AGIS	Agricultural Geo-referenced Information System
AIMS	Agricultural Information Management System
AIS	Agricultural Innovation System
ARC	Agricultural Research Council
ASGISA	Accelerated Shared Growth Initiative of South Africa
ASTI	Agricultural Science and Technology Indicators
ATHRP	Agricultural Technology and Human Resources Programme
AU	African Union
CAADP	Comprehensive African Agricultural Development Programme
CBO	Community-based organisations
CGIAR	Consultative Group for International Agricultural Research
CSTP	Committee for Science and Technology Policy
DBSA	Development Bank of Southern Africa
DoA	Department of Agriculture
DoE	Department of Education
DEAT	Department of Environmental Affairs and Tourism
DNA	deoxyribonucleic acid
DST	Department of Science and Technology (formerly the Department of Arts, Culture, Science and Technology [DACST])
dti	Department of Trade and Industry
FANR	SADC's Food, Agriculture and Natural Resources directorate
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	United Nations Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FTE	full-time equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure for Research and Development
GFAR	Global Forum for Agricultural Research
GNP	Gross National Product
HEI	Higher Education Institution
HEMIS	Higher Education Management Information System
HG	higher grade
HR	human resources
IA	impact assessment
ICT	information communication technology
IDRC	International Development Research Centre
IFS	International Foundation for Science
IHDP	International Human Dimensions Programme on global environmental change
IKS	Indigenous Knowledge Systems
IP	Intellectual Property
IPR	Intellectual Property Rights
ISNAR	International Service for National Agricultural Research
IT	Information Technology

IUCN	World Conservation Union
JICA	Japan International Cooperation Agency
JpoA	Joint Plan of Action
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
NARF	National Agricultural Research Forum
NARI	National Agricultural Research Institute
NARS	National Agricultural Research System
NEPAD	New Partnership for Africa's Development
NGO	Nongovernmental organisation
NRF	National Research Foundation
NSI	National Spatial Information
NWGA	National Wool Growers' Association of South Africa
OECD	Organisation for Economic Cooperation and Development
PDA	provincial department of agriculture
R&D	Research and Development
R&T	Research and Technology
RISDP	Regional Indicative Strategic Development Programme
RTD	Research and Technology Directorate of the Department of Agriculture
SADC	Southern Africa Development Community
SAKSS	Strategic Agricultural Knowledge Support System
SASRI	South African Sugar Research Institute
S&T	science and technology
SET	science, engineering and technology
SETI	Science, Engineering and Technology Institute
SONA	State of the Nation Address
TWAS	Third World Academy of Sciences
TWOS	Third World Organisation for Women in Science
WOCAT	World Overview of Conservation Approaches and Technologies



Overview



Ms Njabulo Nduli

This National Agricultural Research and Development (R&D) Strategy is a product of intense consultations within the National Agricultural Research System (NARS) that provides a long-term vision for accelerated efforts and investments in agricultural research, development and transfer of technology. This strategy was developed within the context of the Sector plan (2001) priorities, among which was recognition for coordinated and focused research priorities aimed at equity, enhanced natural resource management and sustained competitiveness of the agricultural sector.

Over the past decade, public investment in agricultural research has lagged behind compared to other sectors of the South African economy. This strategy provides a framework for resource mobilisation in support of agricultural research and technology generation aimed at addressing key national priorities in the sector. The agricultural sector faces monumental challenges such as adaptation to the vagaries of climate change, crop production to meet the needs of the biofuel industries as well as for food security, biosecurity, etc. The solutions to some of these challenges seem veiled in the complexity requiring greater collaborative research effort

and partnerships, as well as optimal utilisation of limited resources.

This strategy heralds a new era in the agricultural sector, whereby research for the sake of research becomes a practice of the past and public investments should be directed towards key strategic programmes of national interest. The strategy also calls for a stronger collaborative effort and partnership in agricultural research for development. Emanating from this strategy will be the development of a national agricultural research agenda, with broad stakeholder inputs. Additionally, the strategy provides structured mechanisms for realisation of the research agenda and priorities.

As these events and processes unfold, the Department of Agriculture (DoA), through the National Agricultural Research Forum (NARF) will bring even greater efficiency, efficacy, transparency, accountability and participation on new perspectives and new approaches to research for development concerns. These are some of the inherent principles that will guide the implementation of the strategy.

A continuous theme throughout this strategy is the importance of retaining competent human capital to undertake the required strategic research. It will, therefore, be possible within this research strategy framework to develop human capital to alleviate chronic shortages of critical skills and experts within the South African NARS. Furthermore this strategy will create a platform to attract and retain the best researchers, as well as to recognise, reward and honour excellence within the NARS.

Having adopted the strategy, the challenge now is implementation and the availability of resources will be of critical importance. My department will spearhead the process of implementation and coordinate national level activities. I extend an invitation to the private sector to partner with Government in the implementation of this important strategy.

A handwritten signature in black ink, appearing to read 'Njabulo Nduli'.

Ms Njabulo Nduli
DIRECTOR-GENERAL: DEPARTMENT OF AGRICULTURE

1. Introduction

1.1 Background

Following the advent of democracy in South Africa, a number of significant actions relating to policy initiatives concerning agriculture were launched. Historical dualism characterised the nature of the agricultural sector. To redress the problems created by this dualism, the DoA embarked on a strategic framework to broaden access and participation in agriculture through the Broadening Access to Agriculture Thrust (BATAT) process. This process identified, amongst others, the following R&D related constraints:

- Lack of policy and long-term strategic management in research and the linkage mechanisms between agricultural research institutions and their clients.
- Lack of clarity on how linkages should be strengthened to improve the farmer-extension-researcher linkages.
- The need to design and establish suitable institutional linkages to support effective coordination and prioritisation of research needs at all levels.

In addition, the former Department of Arts, Culture, Science and Technology (DACST) undertook a number of initiatives, including the National Technology Foresight Project (1997) with a view to anticipating the future drivers of the South African science and technology (S&T) system; improving the quality of life, competitiveness and a shared democratic culture for all South Africans.

For the agricultural sector the mandate of the Foresight study was to ensure that research and technology would address the social and economic challenges regarding the performance of agriculture and the agro-processing sector. The Foresight study identified potential, and recommended the concentration of efforts, in the following areas: Agro-production systems, biotechnology, natural resource management, market development, processing, novel technologies as well as transfer of technology together with an enabling culture of innovation in agriculture, strategic funding in agriculture, infrastructure and the establishment of a NARS.

The White Paper on Science and Technology (1996) established a policy framework for S&T based on the concept of a National System of Innovation (NSI) that seeks to enable innovation through mutually reinforcing activities of the main role players, namely Government, research institutions, business and higher education. This sets the tone for a paradigm shift in R&D thinking and further informed the South African National R&D Strategy (2002), which is based on three pillars, namely innovation; science, engineering and technology (SET) human resources and transformation; and creating an effective S&T system.

A further significant action was the response to the State President's invitation to industry (AgriSA and NAFU) to join Government in developing a mutual agricultural perspective. This led to the *The strategic plan for South African agriculture* (2001) with a vision which calls for a united and prosperous agricultural sector based on three core strategies, namely access and participation; competitiveness and profitability; and sustainable resource management. These are underpinned by the complementary strategies on good governance, integrated and sustainable rural development, knowledge and innovation, international cooperation and safety and security, all of which require research and scientific interventions having significance in the development of an R&D Strategy. *The strategic plan for South African agriculture* (2001) recommends specific action regarding research, science and technology; in particular to raise investment in agricultural research, education and extension from the current low levels of 1,04 % of agriculture's contribution to the Gross National Product (GNP) to meet the international benchmark of 3 % of agricultural GNP, which is comparable to the 3,7 % in the USA; 4 % in Australia and 2,1 % in the EU.

1.2 Current status of the National Agricultural Research System

An agricultural research system consists of a number of elements such as organisations, funders, service providers and clients. For the South African NARS, the key categories include Government (national and provincial), statutory bodies and science councils, higher education

and development institutes, private/business sector, farmer organisations, civil society and financial institutions. Their differentiated roles are summarised below:

TABLE 1 – Current stakeholders in the agricultural R&D system

Categories	Roles and responsibilities
Government	Development and implementation of policy and legislation on agriculture, environment, biodiversity, agro-forestry, water, science and technology and the promotion of innovation.
Parastatals/Statutory bodies/ Science councils	Scientific research, generation and transfer of technology (or promotion of the application of knowledge and innovation) in agriculture, biodiversity, agro-processing, socio-economic development and impact.
Higher education and development institutions	Curriculum development, training, research (pure and adaptive) and transfer of technology.
Organised agriculture	Transfer of technology; provision of a commercial base for procurement, advocacy for policy, priority setting, facilitate resource allocation; articulate the needs of the 2 nd economy.
Civil society/Community-based organisations	Development, training, capacity strengthening, adaptive research, transfer of technology, support services.
Financial institutions	Lending and mortgages, socio-economic research and general financing to the agricultural sector.

Within the agricultural sector, a number of prominent issues need addressing and these include dual economy and related socio-technological issues (empowerment, land tenure); integrated natural resource management (soil, water, biodiversity, veld and natural pastures); competitiveness (value-chain addition, post-harvest processing and storage, profitability, food safety, crop and animal health), cross-sectoral issues (health, energy, education, transport); production systems; risk management and climate change; policy and institutional issues; globalisation; human resource capacity for agricultural R&D and protection of the environment.

The current NARS arrangement is, however, largely incapable of addressing these issues in a coherent manner. In particular, a number of weaknesses, challenges and opportunities have been identified. These include lack of a coordinating mechanism at national level; inadequate mechanisms to establish priorities; lack of a national system to allocate resources to priorities; lack of institutionalised monitoring, evaluation and impact assessments; land degradation, lack of R&D capacity; lack of an intellectual property rights (IPR) management system; poor partnerships (public-private, public-public, private-private); ineffective linkages among knowledge and information generators and users; inadequate linkages internationally; lack of participation of the second economy in the formal system of innovation; low level of investment in agricultural research; overlapping mandates of role players and lack of clarification of the role and responsibilities of different role players; poor access to information, weak or inadequate value-addition technologies; biased approach towards technology-directed research *versus* policy and socio-economic research; insufficient resources for maintenance of national assets and infrastructure; lack of trust among stakeholders; declining science and technology capacity and negative perception of agriculture as being 'rural', associated with unskilled labour and poverty, making agriculture unattractive to the youth and potential students who may contribute to R&D.

The contribution of the agricultural sector to the accelerated and shared growth initiative will require focused efforts in tackling and responding to identified challenges and opportunities. These will include a core of competent researchers that needs to be optimised; political commitment and support for agricultural R&D; comparative and competitive advantage; strong higher education institutions (HEIs); good basic research infrastructure; potential or opportunity for innovative funding mechanisms; potential to strengthen existing international linkages; identification and equitable exploitation of indigenous technologies; and strengthened and sustainable linkages between research institutions and tertiary education. Input to the curricula of primary and sec-

ondary education must be provided from this level in order to provide a better foundation for the importance of agriculture and its products in livelihoods and the economy; strengthening of links between researchers and extension services; understanding the second economy and its needs within the poverty framework; promoting agriculture at school level; and providing incentives for teachers in mathematics and science, and in agriculture in particular.

The set of challenges, weaknesses and opportunities identified within the agricultural research system provides a compelling basis for developing an effective and well-supported Agricultural R&D Strategy for South Africa.

1.3 Need for the National Agricultural Research and Development Strategy

As South Africa enters its second decade of democracy, agricultural research in South Africa is again at the crossroads where urgent and quick action is needed to decide on an appropriate, effective and sustainable NARS and to promote an Agricultural Innovation System (AIS) that would, simultaneously, be able to address the objectives of poverty alleviation and food security on the one hand and increased competitiveness and profitability on the other. Following the recent implementation of the new governance framework for science and technology, science councils are transferred back to the full administrative responsibility of the relevant line function departments. In view of this development, the DoA is repositioning itself for this responsibility and as such intends to explore alternative options for effective coordination, resourcing, development and oversight for the NARS. It now presents the DoA with the opportunity to address the issues relating to limited resources, insufficient national coordination as well as an institutional framework.

Recent developments in the context of agricultural R&D present certain challenges to agricultural research and innovation in developing countries. These include:

- 1.3.1 Confronting new priorities in a rapidly changing world (e.g. stronger demand for competitive and quality-conscious agriculture) and adapting to changes within a more complex innovation system framework where there are a greater number of actors and linkages to consider.
- 1.3.2 Redefining the role of Government in agricultural research and service provision and defining the role of the private sector, civil society and end users.
- 1.3.3 Strengthening the demand side of agricultural research and services to ensure that programmes are more responsive and accountable to end users, but also anticipating demand as new and emerging technologies dominate the landscape.
- 1.3.4 Developing a clear understanding of the institutional structures needed at the national, regional and subregional levels for agricultural research and service provision and of whether, and how, this understanding would imply changes in the current structures present at national, regional and global levels.
- 1.3.5 Developing a clear understanding of the institutional structures needed at every level for agricultural education within the emerging food and agricultural innovation systems. This includes strengthening the capacity and refocusing the mandates of colleges of agriculture.
- 1.3.6 Ensuring stakeholder participation and developing local, regional and global partnerships and alliances.
- 1.3.7 Facilitating development of innovative funding instruments that make public institutions more sustainable, reduce donor dependence and encourage co-financing by end users and others.
- 1.3.8 Assisting in developing mechanisms through which internal and external support for food and agricultural innovation systems in developing countries are better coordinated.
- 1.3.9 Strengthening system linkages and coordination, including linkages between agricultural research policy and wider policies for science and technology.
- 1.3.10 Addressing climate change and issues relating to emerging technologies, especially biotechnology and information communication technology.

One of the objectives of agricultural development must be to attain a cadre of qualified, experienced and motivated world-class agricultural R&D specialists, managers and policy makers to lead South Africa towards achieving the long-term goals of food security and poverty alleviation, international competitiveness in agriculture and enhancement and sustainability of the natural resource base.



A sectoral (agriculture) analysis of the State of the Nation Addresses (SONAs) suggests a number of priority areas in response to the challenges posed by the President. These include generation of knowledge to achieve sustainable natural resource utilisation, management and biodiversity conservation; developing sustainable cost-effective interventions in support of the needs of the 2nd economy and to accelerate the progress with regard to the 1st economy to achieve higher levels of economic growth and development; crop estimate models/forecasting models; developing risk-management strategies for agricultural production to address natural disasters, climate change and disease and pest outbreaks; improving production systems, post-harvest and processing technologies to enhance nutrition, food security and safety; enhancing competitiveness of the South African agricultural sector to enable it to access existing and new markets and be viable in the global market; identifying, protecting and commercialising indigenous knowledge systems (IKS), more specifically agri-indigenous knowledge systems, to enhance the benefits to the agricultural sector and applying biotechnology to create new opportunities and overcome constraints in crop and animal production through the use of techniques such as marker technologies and fingerprinting.

Given the sweeping reforms that are taking place, R&D systems are facing a transitional period in which they will require restructuring, confronting new demands and adjusting to new political, scientific, institutional and economic environments. As South Africa enters a new phase of policy development under the accelerated and shared growth initiative, giving effect to the implementation of the reconstruction and development programme as supported by sound macroeconomic policies, the agricultural research system must clearly articulate its role in contributing to economic growth. It is against this background and rationale that the Agricultural R&D Strategy has been developed.

2. Strategic objectives

2.1 Vision, mission and goals

The implementation of the Agricultural R&D Strategy will be guided by the **vision** of the Sector plan, namely **a united and prosperous agricultural** sector in order to achieve the strategic goal of the sector.

The **mission** of this research strategy is to guide and direct the generation, adaptation and application of knowledge and innovation for sustainable agricultural development to benefit society.

In pursuit of the vision and mission, the **goal** of the research strategy is to enhance the contribution of agricultural research towards attaining at least a 6 % economic growth rate through sustainable agricultural productivity, sustained competitiveness to ensure food security and eradication of poverty in South Africa. The implementation of this strategy should improve the efficiency and profitability of the sector; improve business opportunities; and ensure social upliftment and improvement of the quality of life for all the citizens of South Africa.

2.2 Objectives of the Agricultural Research and Development Strategy

The main objectives of the Agricultural R&D Strategy are to:

- 2.2.1 Guide the Agricultural Research and Innovation System in the formation and operation of national agricultural R&D programmes;
- 2.2.2 Mobilise resources and enhance their effective use for sustainable agricultural R&D;
- 2.2.3 Guide the generation of knowledge and information in the agricultural sector;
- 2.2.4 Provide a framework for developing research capacity and expertise, funding for agricultural research and innovation, focusing national efforts to strategic priorities and areas of comparative advantage; and ensuring effective transfer of technology, information sharing and communication to the entire spectrum of the farming community;
- 2.2.5 Provide an institutional framework to enhance participation of all stakeholders in agricultural R&D;
- 2.2.6 Engender a culture of learning and innovation through human resource development and management; and to
- 2.2.7 Promote collaboration between the NARS components, regional and international research institutions to refocus on strategic priorities, innovation and adaptive research.

2.3 Guiding principles

The implementation of this strategy will be guided by the following principles:

2.3.1 *Responsibility*

To adopt the principle of responsibility whereby all R&D programmes and activities are located at levels where these can be best handled within the NARS.

2.3.2 *Integrity and trust*

To broaden stakeholder participation in R&D activities and to ensure reliability and integrity in the decision-making processes within the NARS. This will promote trust among partners and ensure integrity of the governance and the decision-making process within the agricultural research system.

2.3.3 *Efficiency and flexibility*

To enhance efforts to ensure adequate flexibility in the advancement of research for technology development and transfer of technology; and to promote efficient coordination and management of national resources for agricultural research and technology development.

2.3.4 *Innovation*

To strive for cutting-edge technologies developed by a well-focused and capacitated (human resources, facilities and funding) research infrastructure. The White Paper on Science and Technology (DACST, 1996) introduced the concept of a national system of innovation to the local discourse in order to focus attention on the institutional environment. Organisations conduct R&D within institutional frameworks that ideally support innovation through interactions among the host of research and technology organisations and institutes. The strength of an innovation system depends on the strengths of its components and the management of its linkages. Developing a clear understanding of the historical, political and institutional dimensions of the system and its components is crucial to draft national policies that not only assist in building capacity in individual R&D actors, but also create incentives and support mechanisms for institutional learning and partnerships that will improve the system's performance.

2.3.5 Competitiveness

To build and support, through R&D, a market-based agricultural production system that enhances and promotes competitiveness of the South African agricultural sector to enable it to access existing and new markets.

2.3.6 Equity

To strive for fair distribution of R&D generated benefits to all relevant stakeholders to ensure enhanced and equitable access to, and participation in, agricultural opportunities.

2.3.7 Complementarity

To give recognition to the mandates and strengths of the different role players to complement rather than compete with each other in the execution of their tasks.

2.3.8 Participation and ownership

To ensure that planning is based on broad participation and consultation in order to engage as many stakeholders as possible in ensuring ownership for the outputs.

2.3.9 Commitment to vision, mission, goals and objectives

To direct focus in the areas identified as being of high national priority, including support for special programmes in these areas.

2.3.10 Mutual benefit

To ensure broad participation in national strategic programmes to benefit all stakeholders.

2.3.11 Accountability and impact orientation

To build accountability into investment portfolios in order to ensure effective use of resources as well as quality research capacities to achieve strategic goals and objectives.

2.3.12 Decentralisation

To establish bases to devolve responsibilities and the flow of funds and decentralisation of research institutions to allow decision making as close to the beneficiaries as possible. However, some basic and strategic research of national importance could be centralised at national level.



2.3.13 *Relevance*

To ensure that targeted research is focused and guided by industry and public needs and that it meets the challenges of today's agricultural environment.

2.3.14 *Elimination of overlaps and duplication*

To stimulate partnerships and collaboration in R&D with expertise and capacities working together.

2.3.15 *Value-adding*

To promote value-adding to primary agricultural production in order to make the South African agricultural sector competitive.

2.3.16 *Transparency*

To facilitate exchange of information with stakeholders and build a mechanism to periodically review and set priorities through a transparent and inclusive process.

3. Key strategic areas and thrusts

3.1 Human capital

The National R&D Survey of 2001/02 (DST, 2004) paints a picture of an ageing and shrinking scientific population, with the higher education sector dominated by white males, with relatively few blacks and women. The current system of education in South Africa still provides systematic and institutional barriers that contribute to the problem of few students doing mathematics and sciences, therefore limiting the pool from which to train, nurture and prepare future scientists. Innovative approaches such as incentives to schools excelling in these subjects, as a joint venture by the DoA and Department of Education (DoE), should be instituted. Although there has been progress with regard to gender and race representation in agricultural science it is still inadequate. Successful resource mobilisation depends on continued investment in professional training for scientists and in assuring the development of scientific research capacity. Therefore, targeted scientific and professional development programmes should be established in agriculture to produce, on a sustainable basis, a cadre of young science graduates, to be mentored by the more mature and retiring or retired scientists, who will feed into agricultural post-graduate training. Government (both national and provincial) should provide financial support to these programmes, in various forms, including but not limited to bursaries, study loans, fellowships and chairs. Adequate financial resources should be made available to create and maintain stability in terms of remuneration and tenure in the agricultural research system.

When dealing with the subject of human capital, the entire spectrum should be considered. Although the focus in this strategy is largely on human capital involved in R&D activities *per se*, extension agents, partners and beneficiaries are equally important to ensure effective transfer, uptake and implementation of innovations. Included are the farmers and farming communities across the board, from developing or emerging to first economy commercial farmers. Skilled human capital is essential for R&D, however, their mere availability is not sufficient for knowledge generation. The international environment characterised by the globalisation of capital markets, trade and services, free movement of people and ideas, has forced new challenges upon South Africa. Mobility of scarce skills is one of the elements of globalisation. There is an inclination to try

to reduce mobility because of the negative consequences of the brain drain. The critical significance of a national mentorship programme cannot be overstated. The steady transfer of experience to new incumbents must be nurtured carefully and protected to ensure full growth towards scientific independence.

Furthermore, developing the human resource potential involves examining the roles and needs of both men and women farmers and other household members who perform diverse duties and have differing requirements with regard to education, health, nutrition and technical knowledge. A low level of human development is characteristic of the developing areas of the country. The serious negative impact of the HIV/Aids pandemic on food security and markets for agricultural production has to be emphasised. Measures should be taken to address the pandemic and the resulting decline in labour productivity in the agricultural sector.

The Agricultural Science and Technology Indicators (ASTI) surveys also provide comparative data on the R&D performance and support in developing and developed countries. The National R&D Survey 2004/05 shows that in South Africa there are some 56 000 full-time equivalent (FTE) R&D personnel, comprising 37 000 FTE researchers, PhD and post-doctoral fellows, indicative of a relatively small science system. In terms of demographics, women researchers constitute 38 % of the total, while white males over 45 years of age, account for 21 % of the research cadre. The aging of the research population without the influx of new researchers is not just a South African problem – it is a matter of serious concern in many Organisation for Economic Cooperation and Development (OECD) states.

The data indicate that the science councils, followed by the universities, are leading the way in committing funds to the biosciences. As a strategic position, South Africa should invest primarily in the training of agricultural scientists and engineers as a first priority, and supplement these with training and production of new open-minded social scientists and researchers likely to analyse current realities and point the way in which organisations and communities are changing.

Information on human resources from the R&D surveys (1992 and 2004) enables the determination of the high-level human resource requirements. These surveys indicate changes in the availability of researchers across the three major sectors over the last decade (Table 2).

TABLE 2 – Full-time equivalent researchers per sector, 1992-2004

Sector	1992	2005
Business	3 395	4 411
Government	2 428	2 342
Higher Education	3 631	3 374
TOTAL	9 454	10 127

Sources: R&D Survey 2003/04, Department of National Education (1993)

Indications are that the research cadre is not growing in line with the population, student numbers or economic growth. Most concerning is that at universities, with their massive student growth, the number of researchers has dropped and this reduction is confirmed by the Higher Education Management Information System (HEMIS) data. South Africa's academics account for some 90 % of academic journal output, with the bulk of the remainder coming from the government sector. Ranked by country share of the most highly cited papers and adjusting for economic size, South Africa was at position 22 in the world, *on par* with Poland and ahead of Greece, South Korea, Singapore, Brazil, Russia, India, Iran and China. This indicates that South Africa has an underlying scientific strength on which to build a competitive economy.

The current capacity of the NARS to perform and deliver research output has been affected by a large exodus of qualified and highly experienced research staff from the government research system as listed in Table 3:



TABLE 3 – Research capacity (researchers, technicians and other support staff) within the NARS

Headcount	2002	2004
Government (National and PDAs)	1 039	869
Universities	602	571
ARC	494	467
Business	403	557
TOTAL	2 538	2 464

However, data from 1992 to 2000 are available only for the Agricultural Research Council (ARC) and indicates an initial growth from 693 (1992) to 749 (1997) and a moderate decline to 691 (2000). A further decline was experienced in 2002, which stabilised thereafter. Comparative figures for the highest numbers (749 in 1992) to the current level (467 in 2004) indicate a decline of 37,7 %.

A real cause for concern is the situation at school level in respect of the key subject area of mathematics at higher grade (HG) as indicated in the matrix for university study in S&T (Table 4).

Table 4 – Mathematics HG passes, 1997–2003 (000s)

Year	1997	1998	1999	2000	2001	2002	2003
Wrote	68,5	60,3	50,1	38,5	34,9	35,5	35,4
Pass	22,8	20,3	19,9	19,3	19,5	20,5	23,4

Source: Department of Education databases

The flow is fairly static at around 20 000 passes annually, which is 5 % of all those that entered the Senior Certificate examination. This does not imply that the entire mathematics HG pass cohort will go on to careers in research. The majority will most likely not pursue careers in research, nor will they become teachers in areas of scarce subject skills such as physical science or mathematics. In this regard, agriculture as an attractive and rewarding career should be communicated widely and effectively to potential students.

To this picture must be added the consequences of migration, through which South Africa has lost large numbers of professionals, while being unable to attract a corresponding inflow of similarly skilled and experienced engineers, scientists, science and mathematics teachers, medical practitioners and technicians. To stop the brain drain of agricultural researchers, five basic requirements should be met, namely a competitive remuneration, incentives for innovation, career path and recognition, equipment and infrastructure that are on a *par* with other competing research groups and free movement to scientific forums and conferences.

The current average cost to maintain one researcher full-time for a year is in the order of R1,5 million, including labour costs, associated support staff, utilities, IT and capital equipment. To move from R10 billion of R&D to the R16 billion per year required by 2008, would require an additional 5 000 to 6 000 researchers in the system. To satisfy this demand, the policies introduced and those already in place, have to reinforce one another. It is necessary to achieve three aims simultaneously:

- Developing our own staff;
- Recruiting staff in foreign countries;
- Nurturing staff.

The policy should focus on producing, retaining and recruiting—that is, providing adequate financial support and security of tenure to researchers and recruiting the best skills in foreign countries. In this regard an effective human resources (HR) policy has to be in place at organisations

employing agricultural researchers and should feature career pathing, opportunities for personal development, incentives and adequate funding. Recognition of community service activities and related popular publications on innovative approaches also require attention.

The introduction of a more uniform funding structure to cover basic manpower costs would go a long way in removing incorrect assumptions about the relative costs of utilising staff from, for example, the provinces as opposed to the parastatals. Added to this, the universities have to produce more PhDs in agricultural and animal health sciences. Mentoring programmes should be established to retain retired scientists as mentors to new scientists. This implies:

- Significant state intervention that will change the face of education. It not only increases the State's share of Gross Expenditure for R&D (GERD), but also envisages researcher development taking place in the science councils, industry and universities.
- That the areas of scarce skills are addressed, for example, through full-cost bursaries as well as foreign recruitment.
- That emphasis is placed on developing adequate capacity to address the new technology challenges and creation of centres of excellence.
- Providing substance to a paradigm of national renaissance through the universities that believe in the ability of the majority of students to obtain quality degrees in the allotted time.

The approach towards science is to do research to underpin the required technology developments, but also to look for opportunities to attract major global science infrastructure and resources. It is imperative for South Africa to develop the people that provide the R&D capability and capacity in order to address livestock systems development, crop diversification and protection, clean production, biomass utilisation, biotechnology, information communication technology (ICT), remote crop management, advanced processing and storage, resource sustainability and poverty reduction.

In view of the above background, the proposed agriculture R&D strategies in regard to human capital are that:

- 3.1.1 The DoA should make available bursaries and contractual study loans to attract top grade students to pursue studies in scarce and critical agricultural specialist fields and disciplines.
- 3.1.2 The DoA should sponsor research fellowships and academic chairs in scarce and critical agricultural fields at universities.
- 3.1.3 The DoA should establish and fund a Mentoring Programme wherein retiring and retired experts are contracted to mentor young agricultural researchers.

3.2 Innovation and transfer of technology

Technology acquisition and transfer into the economy are central to productivity change and growth, leading to increased economic productivity and living standards. There are two aspects of technology change that are important. The first is the international transfer of technology from developed to developing countries and *vice versa* and the second is diffusion of technology, both imported and locally developed, from the importing or innovating company or organisation into the wider economy. In both aspects of transfer of technology, the end results should ideally be that the recipient is able to use, replicate, improve on and possibly resell the technology. For transfer to contribute to sustained and equitable development, it must involve a broad and encompassing process that avoids creation and maintenance of dependency. The process must encompass all elements of origins, flows and uptake of expertise and experience, across and within countries, stakeholder organisations and institutions.

There is no single strategy for successful transfer appropriate to all situations. The traditional mode of transfer, which involves the assumption that technologies developed in the north are eventually transferred to the developing countries, mostly through foreign direct investment, has not always been successful. Although deficient building of capacity to absorb, diffuse and maintain these technologies has been cited as the main reason for the failure, the problem, however, is far more complex and requires innovative approaches. The traditional linear approach of researcher-extension agent– farmer or end-user is limiting in the current South African farming systems. Other approaches, such as participatory action research and farmer-to-farmer learning are more appropriate.



Recipients for transfer of technology should therefore be able to identify and select technologies that are appropriate to their needs. The implementation of transfer in agriculture could be guided by the *Norms and standards for extension and advisory services* (2005). These provide the minimum standards (i.e. skills levels of extension agents and advisors; resources requirements at district, municipal and local offices) to be adhered to in the provision of services to farmers. In this regard, capacitating of extensionists is considered to be very important. Particular success with effective extension has been achieved where centres of excellence around commodity groups have been created and the entire farming spectrum has been serviced. Examples of this are the South African Sugar Research Institute (SASRI), Cotton SA and National Wool Growers' Association (NWGA). All appropriate avenues for effective transfer have to be utilised and these could include AGIS, television, radio, cellphones, rural information centres and paper-based material in local languages, with onsite demonstration of best practice technologies being top priority. The absorptive capacity of the end users is also a critical element that deserves attention.

3.3 Key areas of technology development

Agriculture, being a primary industry, supports many other industries, roughly to the ratio of 1:1,6 regarding job opportunities. Apart from being a catalyst for economic growth generally, agriculture provides food, clothing, employment, tourism, contributes to the alleviation of poverty and promotes international competitiveness.

With the adoption of the National Spatial Information (NSI) into the Agricultural R&D Strategy, it becomes increasingly important to identify, develop, adapt, adopt and transfer appropriate technologies to both the first and second economies. In this way the divide that persists with dualism will hopefully be bridged.

The aim in identifying new and emerging technologies in the South African context is not only to increase global competitiveness, but to ensure household food security and to assist the developing farmers in entering the mainstream. In identifying technologies, stimulating innovative solutions must be encouraged.

Therefore, the proposed agricultural R&D strategies in this regard are that national programmes should be developed, focusing on the development of new and improved emerging technologies in the areas of sustainable natural resource management, biotechnology, information and communication technology, geographic information systems and earth observation technology, product differentiation, macro- and microeconomics of agriculture and value-adding processes, bioenergy, precision agriculture, animal and plant breeding and health, adaptations of crop varieties and animal breeds to climate change, as well as indigenous food crops.

3.3.1 Sustainable natural resource management

Degradation and loss of land, water and agro-biodiversity for agricultural use are widespread and accelerating. This poses an increasing threat to national and individual food security in many parts of South Africa. Agro-ecological systems are resilient up to a point, but subject to collapse when degraded beyond the threshold. While the current picture is not entirely clear, it suggests a close correspondence between areas experiencing significant land and water degradation and areas troubled by high levels of rural poverty. Farmers maximise income and risk in a dynamic context and often under harsh conditions and serious constraints. Research must respond to these challenges through inclusion of technologies to address sustainable natural resource management.





This would include technologies to address conservation agriculture principles relating to soil organic matter decline, soil erosion and degradation, nutrient depletion, loss of biodiversity, prevention of invasion by alien species, maintenance of water quality and veld productivity, optimisation of water use efficiency under both irrigated and rainfed conditions, capturing and storing rainwater (rainwater harvesting) and restoration or creation of new balances in biotic communities. Geographic Information System-based technologies, natural resource inventories and adequate characterisation and monitoring are considered essential.

Irrigated agriculture produces almost 90 % of South Africa's fruit (deciduous, subtropical, citrus, etc.) and vegetables. It is widely recognised that research over a wide range of disciplines and expertise (agricultural engineering, horticultural science, agronomy, viticultural science, soil science, plant pathology, entomology, etc.) is needed to improve the efficiency of irrigated agriculture.

3.3.2 *Biotechnology*

Biotechnology (defined as a set of technologies including, but not limited to, tissue culture and recombinant deoxyribonucleic acid (DNA) techniques, bioinformatics and genomics, proteomics and structural biology, and all other techniques employed for the genetic modification of living organisms, used to exploit and modify living organisms to create/produce new intellectual property, tools, goods, products and services) have the potential to make a considerable contribution to national priorities that include food security and environmental sustainability as well as the maintenance of plant and animal biodiversity and health. There are a number of societal concerns surrounding its use that require attention. The responsible handling of biosafety is a priority.

3.3.3 *Information and communication technology*

South Africa has a number of significant stores of information of importance to agriculture. The real challenge is to make this information available in useful and usable form for information users in well-equipped offices on the one hand and resource-poor rural communities on the other. This entails the interpretation, packaging and dissemination of the information in appropriate and usable form. Modern ICTs and innovations based on the internet, digital satellite television and cellular telephones are required to facilitate access to information. The Agricultural Geo-referenced Information System (AGIS) of the DoA, the nine provincial departments of agriculture (PDAs), the ARC and the Land Bank, have gone a long way in implementing this technology, however, further development is necessary.

This same technology can be utilised for obtaining information such as crop areas and crop yield estimates for agricultural statistics, national collections of pests and disease type organisms. Creative use of global positioning technologies, data loggers and other portable and fixed point ICT devices for the collection of natural resource and other data offers possibilities.

3.3.4 *Earth observation technologies*

These include satellite imagery, airborne imagery and *in-situ* data collection such as weather stations. Data collection and the development of agricultural applications relating to hyperspectral, radar and airborne geophysics are essential for the global competitiveness of the sector. Data fusion and refinement of model parameters can assist in obtaining meaningful stress-related interpretations, such as of soil moisture, pests and diseases.

3.3.5 *Geographic information systems, spatial modelling and scenario planning*

The spatialisation of data, combined with remote-sense imagery ideally using AGIS technology, provides a powerful tool for informed decision making. Spatial technologies used in a modelling environment allow simulation far wider than when using only point data. Applications include agricultural statistics with sample frames, climate change scenarios, forecasts and advisories as well as natural resource inventories and monitoring.

3.3.6 *Product differentiation for global competitiveness*

The identification, development and optimisation of niche markets for global competitiveness are essential. Three areas for R&D are identified, namely: organic products (with emerging farmers in mind), indigenous products (such as rooibos tea and proteas) and health and homeopathic products (devil's claw, traditional remedies, fat branded beef and omega 3 eggs), bearing in mind IKS considerations. In the global (and even local) markets crop quality is the key element of competitiveness. Timing of production to supply markets when prices are at their highest is also a key factor. Research on cultivar suitability and determining how far production of a crop can be stretched outside its optimum climate requirements are key research imperatives.

3.3.7 *Global competitiveness and macro-economics*

Role players, including farmers, active in a global market, need an understanding of the economic dynamics of international trade. Agricultural research has to focus on developing a strategic understanding of the macro-economic environment and relate this to micro-economic decisions required by farmers.

3.3.8 *Systems improvements and value-addition*

Agricultural production is increasingly practised in a systems relationship. This implies optimising the entire production chain from primary production systems, through post-harvesting, storage and preservation, transport and marketing to value addition, both on and off farm.

3.3.9 *Bioenergy and biofuels*

Energy directs all economic activity. Mineral fuels are limited and the agricultural production of biofuels is becoming increasingly viable and desirable. The following research priorities have been identified: identification of suitable crops for biofuel production; development of engineering plants of different capacities; adaptation of farm implements; environmental impact of using biofuel and the economics thereof; value-addition to the protein-rich residue for the feed and food markets.

3.3.10 *Precision agriculture*

Internationally, there is considerable interest in precision farming research. Optimising production inputs and outputs makes both economic sense and is environmentally more responsible and sustainable. R&D in this field should focus on remote sensing, instrumentation, software development and image processing to be able to manage production system variability on a real time basis.

3.3.11 *Animal and plant health*

In order to continue national and international trade in animal and plant products, effective phytosanitary and animal health regimes must be maintained. These should rely on research to improve and develop new vaccines, diagnostic products, surveys and epidemiological studies. This is the context in which an Agricultural R&D Strategy has to provide a selection of areas of the research and technology frontier on which to focus, including effects that climate change could have. In order for new and emerging technologies to be adequately researched and adopted, it is essential that an enabling environment be established and nurtured. This would include capacity (human, institutional and financial), private/public partnerships and networks, adequate resourcing and infrastructure maintenance, knowledge maintenance and technology sharing and uptake. Scientists have to maintain international status and participate in global thrusts through support for international protocols.



3.3.12 *Indigenous food crops*

The importance of indigenous food crops is increasingly being recognised, especially the inclusion of vegetables in healthy diets and their ability to fight diseases that occur frequently. These include not only novel local crops, but also indigenous cultivars of normal crops such as maize and pumpkins that are preferred because of specific advantages. Extremely little agronomic research has been done on these crops and it is urgently needed to optimise their production.

3.3.13 *Production (crop and livestock) efficiency under extreme weather conditions*

Research to improve the production efficiency and profitability in crop and livestock farming is of key importance. Field level eco-physiological research on various crops, livestock and rangelands is urgently required in anticipation of the possible effects of global warming and climate change. New crop varieties and animal breeds capable of high yields under extreme weather conditions would be advantageous.

3.4 **Collaboration and partnerships**

Agriculture inherently has an international character. South Africa shares the global agricultural arena by exporting and importing agricultural products; by shared research interest, activities, education and training; and by complying to the increasingly effective and complex set of international standards and rules governing nearly every aspect of agricultural products. South Africa has relatively strong internationally competitive universities and research institutions playing a critical role in national, international, continental and regional capacity building.

It is no longer possible to attempt to develop and maintain advanced scientific capacities in all areas of agricultural R&D. Agricultural productivity is increasingly dependent on innovation and knowledge. The innovation system consists of a network of organisations directly involved in the development, diffusion and use of scientific and technological knowledge. Innovation is interactive, nonlinear and applicable at various levels. R&D is, therefore, not exclusively the business of specialised research institutions, but the business of the entire value-chain and network of participating institutions.



Collaboration and partnerships among the national and international research organisations are important. Internationally, continentally (Africa) and regionally (southern Africa) there is an array of actors and potential players in agricultural R&D, each with their own mandates, strengths, weaknesses and capacities. These can be broadly classified as global and regional networks of organisations; organisations supporting research, including international and regional organisations, international research organisations, international and regional private firms and international and regional nongovernmental organisations (NGOs); national institutions; investors; and non-traditional research partnerships with sectors such as the environment and public health.

The promotion of partnerships and collaborations with international, continental and subregional organisations should be guided and sustained by the following principles:

- Support and encouragement by Government to foster and develop strong global, continental and regional partnerships;
- A minimum of direct bureaucratic control as it could inhibit scientific cooperation;
- Facilitation and fostering of a wide variety of arrangements for collaboration;
- Strong and effective participation in international, continental and regional networks and programmes of high priority to the country;
- Development of clear agreements and protocols for collaboration, including the protection of intellectual property rights, equity and transparency among partners as clear mutual benefits are necessary for successful long-term partnerships;
- Adequate financial resources to act as incentive for producing good scientific innovations that benefit partners;
- Capacity building, including human resources and institutional arrangements that promote the effective use of human resources and innovativeness. One of the methods is to continue to host foreign students and to sponsor local students to study across the country's borders. Such exchanges build life-long professional relationships and generate new ideas enhancing scientific research outcomes.

The strategy in this regard is that the process and framework for developing and implementing international collaboration and partnerships should involve the following actions:

- Conducting a thorough investigation of the best forms of international collaboration and determining the role, cost and benefits of participation in various international networks and in exchanging university-level students;
- Establishing incentives, programmes and guidelines for international collaboration by scientists;
- Identifying and securing medium to long-term financial resources and potential supplementary sources required for international partnerships;
- Developing a competitive, matching grant system to promote innovative partnerships. The grant system should be a component of the national competitive funding arrangements of the Agricultural R&D Strategy;
- Developing and implementing training programmes in collaborative research for both scientists and research managers to ensure skills development in building and managing collaborative and complex partnerships.

4. Governance and institutional arrangements

The key role players in the agricultural system of innovation (Table 1) have overlapping mandates, roles and responsibilities. The challenge is to create multilevel, multistakeholder approaches that enhance interlinkages and cooperation in participatory governance processes. Therefore, new and innovative

multilevel organisational arrangements (both horizontal and vertical) among Government and government agencies, parliamentary assemblies, business, intergovernmental organisations, international agencies, NGOs and civil society groups offer promising possibilities for mobilising effective, collective action in addressing the multiple needs of vulnerable people and for eradicating poverty and hunger.

Within the agricultural sector, a number of R&D institutions and organisations would need realignment to operate in the wider context of policies for R&D, higher education, trade and investment, financial management, labour relations, modes of production, intellectual property rights and skills development. Concerted and sustained action is required across sectors and among various actors in the R&D system to put in place the governance mechanisms, processes, institutions, rules, guidelines, policies and normative structures to lead to improved performance of the agricultural sector in eradicating poverty and hunger and in developing a prosperous agricultural sector. Despite public pronouncement about *good governance*, much still remains to be learned about getting governance right, that is, establishing the proper and most effective mix of institutions, rules, policies and actors (i.e. public sector, private sector and civil society) to enhance food security at the local, national and regional levels. Reinforcing mechanisms have to be in place at each level for ensuring accountability, effective implementation, monitoring, evaluation and responsive democratic governance.

The agricultural R&D governance model (Fig. 1) will foster and achieve the following:

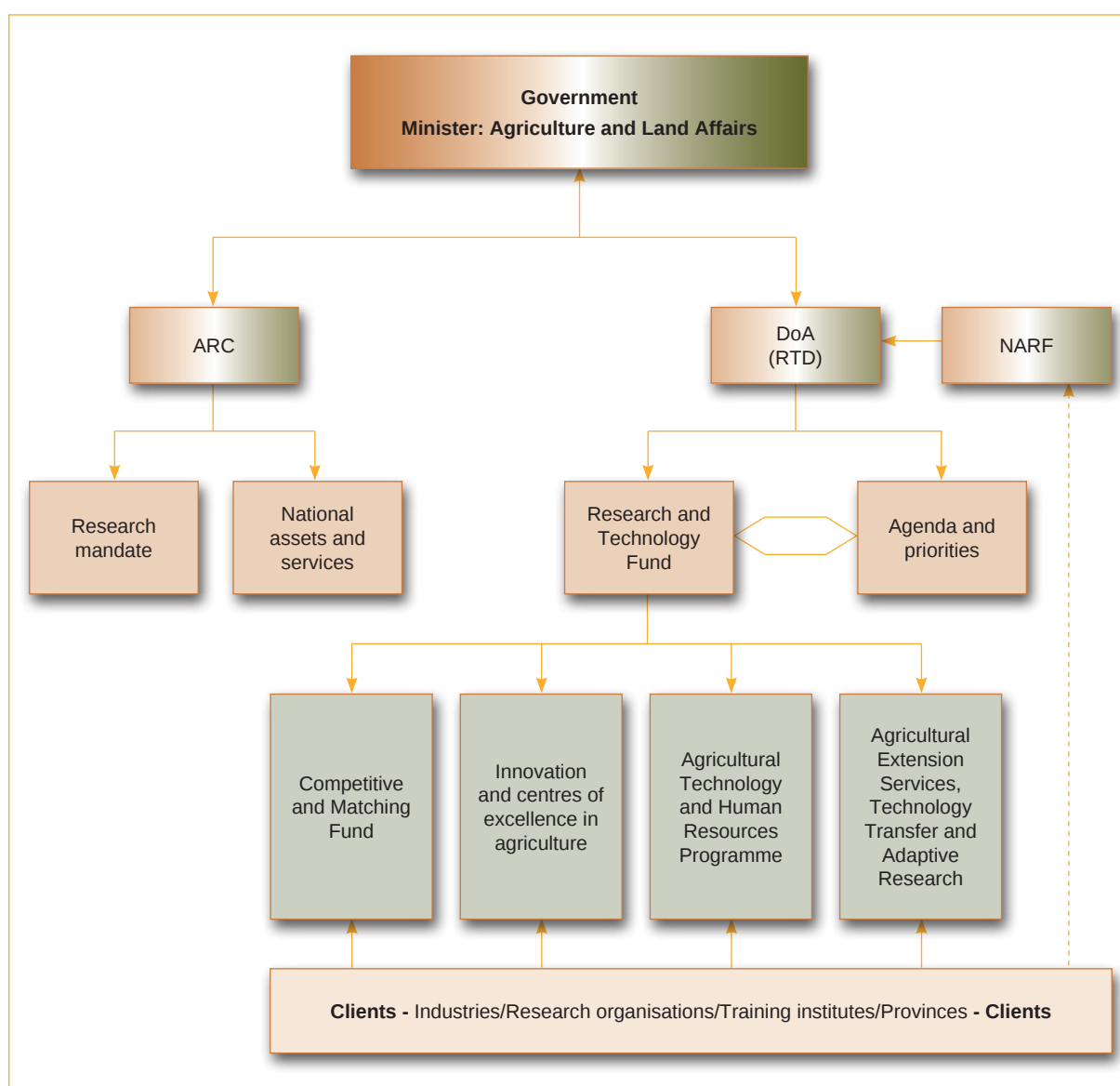


FIG. 1 – Institutional arrangements and lines of communication

- An enabling institutional and policy environment that encourages collective action, learning and capacity building that leads to positive agricultural and rural development outcomes;
- Accountability mechanisms to ensure that key institutions, policies and stakeholders effectively address poverty and food and nutrition security;
- Efficient planning and effective coordination of national programmes;
- Integrity and transparency in the decision-making process and resource allocation;
- Accountability in the management of national resources for research and technology generation;
- Collaborative research work among R&D stakeholders;
- Optimising the utilisation of available and existing resources (i.e. research farms, personnel, equipment, etc.) for implementing the national research agenda and priorities.

The NARS institutional framework shall encompass public, private and civil society organisations in order to promote both horizontal and vertical linkages in the implementation of the Agricultural R&D Strategy.

The DoA will perform central coordination functions for the NARS to ensure, through appropriate means, identification and generation of the national agricultural research agenda and priorities; and the creation of the national agricultural research and technology fund to support national activities under the competitive and matching grants, innovation and centres of excellence, the Agricultural Technology and Human Resources Programme (ATHRP), and adaptive research, transfer of technology and extension services. The NARF should be strengthened within the DoA to provide seamless secretariat services to the entire NARS and the efforts of the DoA in managing the national processes of priority setting to develop the agricultural research agenda.

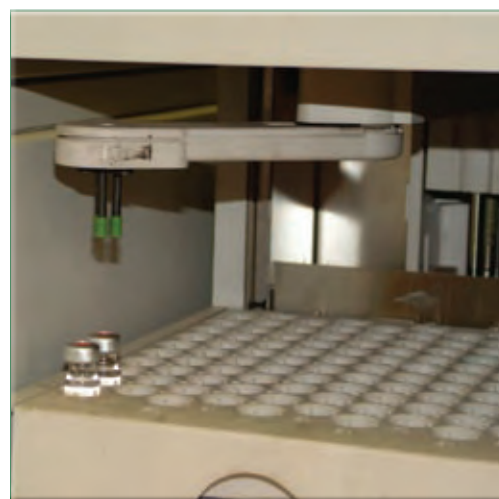
Furthermore, the capacity of the ARC to perform its core research mandate and maintenance of national assets and infrastructure as well as the provision of national services to the agricultural sector should be strengthened and sustained.

4.1 Structures for management and coordination

The establishment of coordination mechanisms and management systems should be in tandem with the national policy-setting environment. The secretariat is necessary to perform various functions, including the facilitation of the priority-setting process and determination of the national R&D agenda and mechanisms; while supported by and linked to a policy development division of the DoA. Therefore, a Research and Technology Division within the DoA, and the NARF should function as elaborated below:

4.1.1 The Division Research and Technology

The Division Research and Technology of the DoA is charged with the responsibility of promoting, supporting and articulating agricultural R&D programmes, as well as resources allocation. The division must report to the Minister for Agriculture and Land Affairs and should provide overall strategic planning and coordination of national agricultural research priorities aligned with *The strategic plan for South African agriculture*, ASGISA, NEPAD/CAADP, FARA, SADC (RISDP) and, in particular, the implementation of the National Medium Term Investment Plan and Multicountry Agriculture Productivity Programme for South Africa. The centrality and placement of this division within the DoA should allow for a transparent priority-setting process for agricultural research; monitoring, evaluation and impact assessment of national research programmes; and provide frameworks for addressing skills development and intellectual property



rights in the sector. The Research and Technology Division (RTD) will provide oversight on the efficiency of the entire NARS. The functions of the RTD should include, but not be limited to:

- Development of a NARF framework and agenda, emanating from the National Agricultural R&D Strategy and its monitoring and coordination thereafter.
- Advocacy for public research budgetary allocation for various types of research programmes to various research institutions within the country on an equitable and competitive basis through the National Agricultural Research and Technology Fund.
- Impact assessments and monitoring of research projects and programmes on various target groups and the entire agricultural sector.
- Linkage with educational systems to address identified gaps in terms of required research competency at various educational levels.

4.1.2 *The National Agricultural Research Forum*

The NARF is constituted on the basis of broad representation of key R&D stakeholders in the agricultural sector under the memorandum of understanding. Its main objective is to facilitate consensus and integrate co-ordination in research, development and transfer of technology to the agricultural sector in order to enhance national economic growth, social welfare and environmental sustainability and seeks to advise Government through the Minister for Agriculture and Land Affairs on all matters pertaining to agricultural research, development and transfer of technology.

The NARF Secretariat should be adequately resourced to provide effective administrative support to the Division Research and Technology of the DoA.

4.2 **Mandates and responsibilities**

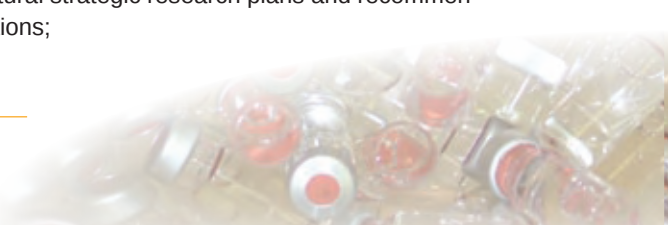
Key actors in the NARS are singled out to ensure clarity of mandates and alignment of roles and responsibilities.

4.2.1 *Public sector*

4.2.1.1 **DEPARTMENT OF AGRICULTURE**

With respect to research, the DoA will develop a coherent approach to support research, facilitate mechanism for coordination between various role players and contribute to international research institutions and multilateral agricultural research institutions in the promotion of the development and dissemination of knowledge of global significance through the development of enabling agricultural policies and legislations. In particular, the DoA's role will include the following:

- Establishing and resourcing adequately an RTD division to perform the functions stipulated under section 4.1.1;
- Formulating, reviewing and enacting legislation, policies and strategies for agricultural research and transfer of technology;
- Monitoring and evaluating the impact of national agricultural research programmes to ensure conformity and compliance to national priorities;
- Soliciting and managing resources for the agricultural research and technology fund to support applied and adaptive research, transfer of technology and extension services, agricultural production inputs, processing, beneficiation and human resource development, innovation and centres of excellence in agriculture, and competitive and matching grants;
- Establish and institute a national priority-setting process to solicit inputs and consensus on national research priorities and agenda;
- Approve the national agricultural strategic research plans and recommendations for resources allocations;



- Support training at colleges of agriculture and universities with Faculties of Agriculture;
- Liaise with, and report regularly to, the Minister for Agriculture and Land Affairs on the national agricultural research agenda and priorities, resource allocations, outcomes and impact of research on agricultural development.



4.2.1.2 PROVINCIAL DEPARTMENTS OF AGRICULTURE

The PDAs will be responsible for undertaking adaptive research; identifying R&D priorities and participation in the national priority-setting process led by the DoA. This will also include mobilising, strengthening and enhancing farmers' empowerment in the technology generation-adoption continuum; providing decentralised, direct resource allocation for agricultural research, e.g. infrastructure at research stations and colleges of agriculture, financial as well as the available expertise; implementing research findings at provincial level, based on the needs identified by its clients, e.g. transfer of technology and innovation development. The PDAs will also be responsible for monitoring and evaluating all relevant R&D activities; integrating agricultural research programmes and plans into the district and municipal development plans; and establishing partnerships with national and international research organisations.

4.2.1.3 DEPARTMENT OF SCIENCE AND TECHNOLOGY

The Department of Science and Technology (DST) is responsible for overall strategic R&D in South Africa. Through a memorandum of understanding with the DoA, the DST should provide appropriate support for the maintenance of key national infrastructure required for performing agricultural research, technology generation and the provision of national services. The cooperation should also include a process of strengthening the extent of the agricultural sector's role within the national system of innovation and improve the level of collaboration within the broader research community through the development of science and technology policies and legislation. The Cooperation Agreement between the DoA and DST should be utilised to improve investments in agricultural research and technology development. The Joint Plan of Action (JPoA) under this agreement should be revised regularly to be in line with the priorities of the NARS.

4.2.1.4 NATIONAL AGRICULTURAL RESEARCH FORUM STEERING COMMITTEE

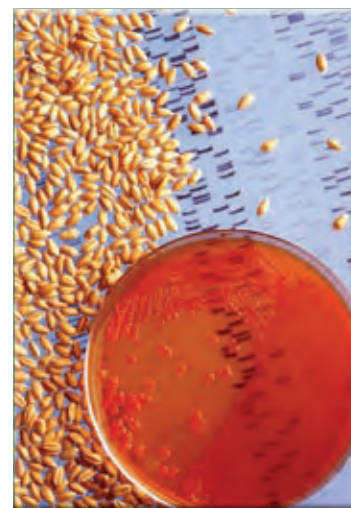
In line with the provisions of the Memorandum of Understanding (MoU) for the establishment of the NARF, the Steering Committee shall be responsible for:

- Providing support to the Secretariat with organisational and administration oversight for the establishment and running the national priority-setting process;
- Ensuring NARS participation in the development and identification of the national research agenda and priorities;
- Formulating recommendations for the DoA on the national priorities and allocations for agricultural research and technology development;
- Preparing documentation for discussion and decision making at forum meetings.

4.2.1.5 AGRICULTURAL RESEARCH COUNCIL

The ARC is the premier national research body responsible for the technological needs in support of production, disaster management (disease outbreaks, adaptation to climate change impact, droughts, floods, etc.) and agro-processing in the agricultural sector. The ARC must be supported through a core budgetary allocation from the parliamentary grant to:

- Maintain adequate competencies (human and infrastructural) required for the competitiveness of the sector nationally, regionally and internationally;
- Undertake key national services such as diagnostics;
- Support the government development agenda as defined from time to time;
- Perform such tasks and services, on behalf of Government, which the private sector would not find attractive from a commercial point of view.



4.2.1.6 UNIVERSITIES, COLLEGES AND DEVELOPMENT INSTITUTES

Universities with agriculture-related faculties and/or schools, colleges of agriculture and the agricultural development institutes constitute a primary source of research, an activity carried out in conjunction with teaching, education and training. These institutions are therefore an important nucleus for capacity building and curriculum development in agriculture. Their roles will be to:

- Develop innovative curricula for the education and training of agricultural researchers, scientists, technicians and research managers;
- Collaborate with others in the NARS to undertake adaptive and strategic research;
- Participate in consortia or centres of excellence focused on specific themes/commodities research.

4.2.1.7 OTHER PUBLIC INSTITUTIONS

There are other public institutions that participate in commissioning, coordination and impact assessment in the socio-economic, socio-developmental and innovative promotion of agricultural research on a competitive basis. These include, but are not limited to, the:

- Department of Environmental Affairs and Tourism for policy on environment and agro-tourism issues.
- Department of Water Affairs and Forestry for legislation and policy on water use, forestry, agro-forestry and woodlands development.
- Department of Health for food safety and control systems.
- Water Research Commission for commissioning and coordination of water related research.
- South African National Biodiversity Institute for collaborative research on the management and sustainable utilisation of biodiversity, including agro-biodiversity.
- Human Sciences Research Council for socio-economic and impact assessment research.

- Council for Scientific and Industrial Research for agro-processing research and commercialisation of agricultural products.
- National Research Foundation for supporting strategic agricultural research and scientific capacity development.
- National Advisory Council on Innovation for promotion of innovation across all sectors of the economy, including agriculture.
- Perishable Products Export Control Board for quality assurance and standards for exporting and importing agricultural products.
- Medical Research Council for collaborative research on diseases that affect humans and animals.

These institutions, including any other public institution whose work is regarded as pertinent and complementary to the conduct of agricultural research, will be encouraged to play a supportive/collaborative role in the implementation of this strategy when the need arises.

4.2.2 *Private sector*

The scope of the South African NARS includes private sector agencies that play a significant role in conducting agricultural research. Their participation in the implementation of this strategy is promoted, especially with regard to the following:

- Providing/offering facilities and infrastructure for conducting agricultural research within the NARS.
- Providing training to researchers and research managers in the public sector.
- Conducting research, technology demonstration and upscaling of best bet technologies.
- Actively participating in commercialisation of R&D products and patenting of IP for the benefit of the South African society and economy.
- Marketing South African research and technology outputs internationally.

4.2.3 *Civil society, farmer organisations and professional associations*

These organisations operate on the basis of demand and supply of agricultural research services to specific end-users and commodity groups. Their roles as key stakeholders in NARS, include policy advocacy, facilitation of resource allocation, development training, capacity strengthening, adaptive research, transfer of technology and provision of support services. Their key roles in implementing this strategy will be, but not limited to:

- Mobilising and building capacity for farmers to participate effectively in agricultural research;
- Lobbying and advocating for increased support for agricultural research;
- Identifying, articulating and prioritising research needs;
- Mobilising and managing own research funds;
- Participating in research, technology demonstration and upscaling;
- Supporting industry-focused own-interest research capacities that may participate in, or host centres of excellence within the NARS;
- Identifying and prioritising problems affecting their farming systems and commodities during production, processing and marketing and seeking appropriate technological interventions.

4.3 **Centres of excellence**

Improving and sustaining agricultural productivity, food security, competitiveness and profitability in the agricultural sector will require an effective network of cutting-edge institutions, all dedicated to innovation and excellence in agricultural R&D. The establishment and strengthening of agricultural science and technology networks form part of the themes of the National R&D Strategy (DST, 2002). Scientific and technological institutions in South Africa are predominantly public,

with the private sector playing a relatively small, yet important role. It is recognised that some agricultural industries have developed and operate fully-fledged R&D capacities focused on specific needs of industries and these developments should be supported. Institutional innovations designed to strengthen the current systems should be explored with a view to providing the opportunity for the formation of centres and networks of excellence at national and regional levels that provide for all research institutions (public and private) to participate on an equal level.

South Africa needs a more effective agricultural research system that, through networking, defines a mutual research agenda, shares research tasks according to institutional comparative advantage and ensures efficient and equitable sharing of research results across the system. Centres of agricultural research excellence should be established to address strategic priorities (national and regional) and should be supported by a ring-fenced grant allocation. Wherever possible, these centres should evolve from and build upon existing national agricultural research systems, international agricultural research centres, university programmes and industry-based research centres, rather than creating another layer of institutions. International agricultural research centres with headquarters and programmes in Africa should retain their international identities. They should, however, operate in more collaborative and complementary modes with national agricultural research institutes and universities and in participatory partnerships with both farmers and consumers. These should also serve to enrich the scientific content of national training and research programmes and expose the South African Scientific Community to international experiences.

4.4 Modalities of operation

The proposed new governance regime in agricultural research should allow for accountability, responsibility, efficiency and decentralisation of the decision-making and resource allocation processes. This effort will require a new arrangement in the agricultural research system with identifiable organs that have clear mandates, roles and modalities of operation and linkages. The proposed structure should also promote objectivity and independence in the coordination and management of the NARS. It should be unbiased in its execution of its tasks; develop, nurture and retain worldclass researchers and seek to promote excellence in agricultural research. The system should also protect the right to freedom of association and self-determination.

4.4.1 *Priority setting*

With the growing pressure on public sector budgets, the potential for the NARS to use scarce resources more efficiently and effectively is widely recognised. The shrinking real research budgets have stimulated several attempts to evaluate economic benefits of agricultural research and to improve procedures for setting priorities among competing research programmes. Accordingly, many NARSs have instituted formal priority-setting exercises to ensure that research resources are allocated in ways that are consistent with national objectives and needs. The aim with priority setting and planning would be to foster consistency of research priorities with goals and objectives and to improve the efficiency of the research system in meeting producer and consumer needs. The priority-setting process should, furthermore, address research on immediate issues as well as strategic research for anticipated concerns likely to manifest in future.

Priority setting will require intensive consultation among and between policy makers, administrators, planners, researchers and beneficiaries. Formal procedures will be required to facilitate this process because they systematise the consideration of key variables and allow an interactive process to develop. Industry specific priority setting is already conducted by the more developed industries. These industries also generally mobilise and manage their own research funding, thereby ensuring accountability to the suppliers of the funds and relieving the national system from having to find a balance between these and national priorities. These developments should be encouraged. A formal priority-setting process should also identify the points at which personal research agendas and national interests appear to be in conflict and avoid these. Although coordinated at the national level, priority setting should be a bottom-up process and should occur at three different levels of research planning. These are:



- At the macroeconomic level among research themes and programmes;
- At programme level among commodities and agro-ecological zones/production zones;
- At project level between different investigations and studies.

In the South African NARS, as is the case elsewhere, priority setting should occur at the following levels:

- At commodity level – between commodities;
- Within a commodity on research thrusts – breeding vs management; and
- Within research thrusts on different technological options.

The criteria used at the macro-level will be different from those at the micro-level as Table 5 illustrates.

TABLE 5 – Simplified view of decision-making levels for priority setting in national research organisations

Decision level	Decision type	Mutual decision maker in supply-led approaches
National	By programme (commodity, factor) sometimes by region across programmes	National DoA supported by the NARF
Programme	By subprogramme (disciplinary or technology type) and by region within programmes	Research programme co-ordinator or institute direction
Sub-programme	By project (technology types and characteristics)	Subprogramme leader or departmental head
Project	By technology characteristics	Lead scientist for project(s)

Adopted from Byerlee, 1999.

Government will lead the national strategic priority-setting exercise and implementation of plans arising from the priority-setting process carried out through the NARF. Policy guidelines are prerequired to provide the level of specificity required to develop clear and consistent national research programmes. Industry organisations should lead the priority-setting and implementation plans at commodity level.

4.4.2 Intellectual property rights management

In South Africa, the IPR policy resides within the Department of Trade and Industry (the dti). However, it requires clear strategies for implementation from various sectors such as agriculture. The prime focus of the dti is on patents and trade-related intellectual property issues. The initiative to amend the Patents Act will incorporate a number of matters relating to the declaration of prior knowledge in respect of IKS. The biodiversity protection and conservation-related property right issues are managed under the Biodiversity Act (2004) of the Department of Environmental Affairs and Tourism (DEAT).

The DST takes responsibility for intellectual property arising from publicly funded research and has, in partnership with a range of stakeholders, developed a policy framework for IKS. The DST has observer status, on behalf of Government, in the Committee for Science and Technology Policy (CSTP) of the OECD. The DoA is responsible for IP issues relating to plant breeders' rights.

The National R&D Strategy (2002) recognises an urgent need for the creation of a proper framework and enabling legislation for the management of intellectual property arising from publicly financed research. The design of a policy framework for IPR management should be directed by the following:

- Recognition of the importance of IP as a basis for economic growth and competitiveness of the agricultural sector.

- Creation of a well-regulated and enabling environment to optimise the value of Intellectual Property (IP), by:
 - Implementing a policy framework that is basic, easy to understand and implement and transparent.
 - Levelling the playing field and aligning the way inventors, research institutions and industries respond to IPR.
 - Reducing the transaction cost of registering patents.
 - Creating an IP centre that can provide the necessary expert advice on the management and commercialisation of IPR in the agricultural sector.
- Seek to protect against the exploitation of indigenous and locally developed plants and animals.
- Requirement for a framework that should not place South African institutions at a disadvantage relative to international practice.
- Establish, as a guiding principle, that no IP arising from the use of public funds, facilities or other public assets may be utilised in any manner, including commercialisation, that is detrimental to the international competitiveness of South African producers.
- Creation of a context for benefit sharing by inventors and innovators.¹
- The obligation of institutions to protect intellectual property developed from publicly financed research should be established¹.
- An acceptable framework for the sale of rights should be established, including the conditions under which the rights can be acquired internationally¹.
- Standardised institutional practices in respect of benefit sharing, invention disclosure and minimum standards for institutional intellectual property management¹.

All IPR relating to public good should reside with Government and be managed accordingly. As a matter of priority, enabling legislation has to be put in place to address the management and ownership of IPR from jointly funded research. This legislation should cater for co-funding of research (public: private partnerships), which will encourage the formation of partnerships and the co-funding of research at or with public research institutions. The legislation should furthermore not impinge on any party's freedom of association in selecting its research partners and research service providers.

4.4.3 *Monitoring, evaluation and impact assessment*

Monitoring and evaluation need to be implemented with a view to assessing the potential impact of research in priority setting and planning; reviewing the performance and quality of research outputs and assessing the



¹ National R&D strategy, 2002 (chapter 7.6)



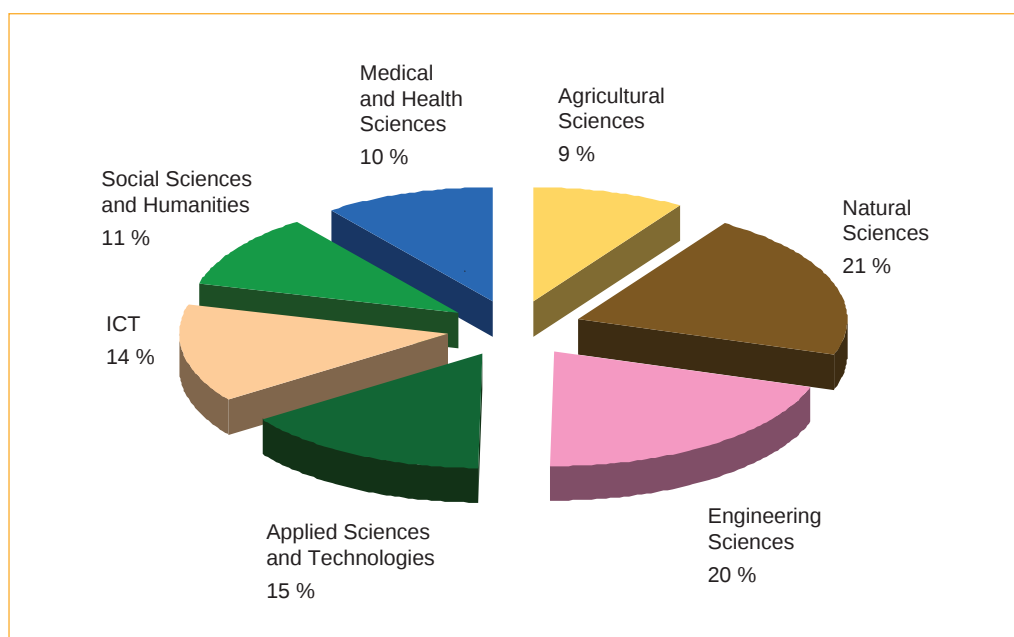


FIG. 2 – Allocation of the Science Vote to different sectors of the economy for the period 1999–2001

relevance of research programmes and their ultimate outcomes and impact on R&D objectives.

All national research programmes should contain clear elements of monitoring and evaluation (M&E) and impact assessment (IA) before approval. The challenge is to institutionalise M&E and IA as management tools for managing and assessing efficiency and cost-effectiveness of investments in R&D and transfer of technology.

The success of the Agricultural R&D Strategy in providing continued funding and promoting long-term research is dependent not only on individual programmes, institutions and infrastructure, but also on interacting “portfolios” of programmes. It is also important to evaluate how national funding of Agricultural R&D programmes interfaces with private sector behaviour, provincial research activities and regional and foreign investment on agricultural R&D. Therefore, appropriate monitoring processes and evaluation methods should be developed that take into account the complexities of multiple levels of decision making and interdependent science programme portfolios. This should be done by developing a set of system indicators that are monitored periodically and used to revitalise the system.

5. Financial mechanisms

The implementation of the new governance system for science and technology in South Africa implies the replacement of the Science Vote (under the DST) by line department budget allocations to the respective Science Councils. Accordingly, the DoA is charged with the duty to develop R&D plans and to provide budget detail for the agricultural sector to National Treasury. The DoA must build sufficient capacity to execute this duty and to promote R&D across the sector through appropriate incentives and investments. The national R&D survey of 2003/04, puts the gross expenditure on R&D (GERD) at R10,1 billion, which translates to ~ 0,81 % of GDP. This places South Africa at the low-end of the OECD countries, but ahead of Argentina, Hungary and Poland. In order for South Africa's GERD to reach 1,0 % of GDP as stipulated in the National R&D Strategy (2002), GERD would have to reach some R16 billion.

Across the sector, business performs the bulk of R&D (55,5 %), followed by Government (21,9 %) with the science councils and universities accounting for roughly equal shares (20,5 %).

In general terms establishing sound financial management and administrative practices is an important first step towards successful resource mobilisation. Moreover, research managers must consider funding strategies to cover research needs as well as recurrent costs. The funding mechanisms must satisfy the need for regular and continuous resource flow, as well as the requirements of policy makers for higher-quality research and accountability. The most frequently used mechanisms for the mobilisation of financial resources include grants, levies, endowments, trusts and cost-sharing. The intention, given the different sources of such funds, is to create an enabling and supportive environment that allows individual decision making regarding the funding of research, selection and utilisation of preferred service providers.

5.1 Funding structure for the R&D Strategy

The model for the funding of the implementation of the R&D Strategy is presented in Fig. (3).

5.1.1 *Parliamentary grant*

The parliamentary grant shall be sufficiently motivated to address two main components of the ARC, namely the core mandate, and infrastructure maintenance; and associated costs with respect to the provision of national services.

5.1.1.1 **BLOCK GRANT FOR ARC'S RESEARCH MANDATE**

A significant portion of the parliamentary grant shall be allocated to cover the core mandate of a statutory body within the ASI, notably the ARC. This will also cover all agricultural development institutes with regard to their core staff salaries.

5.1.1.2 **INFRASTRUCTURE RENEWAL, CAPITAL INVESTMENT AND NATIONAL SERVICES**

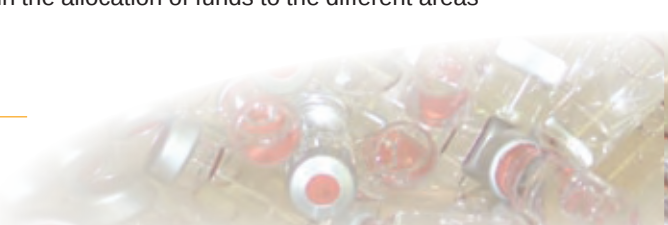
Part of the parliamentary grant to the ARC should be ring-fenced for capital investment and infrastructure renewal. National assets should be expanded to include all agricultural research facilities that are of a public good nature, inclusive of facilities at universities, agricultural development institutes and PDAs and should be audited to determine the minimum level of funding required. The capacity of the research system to maintain high-level national services such as veterinary, diagnostics and regulatory services should be a priority in fund allocation.

5.1.2 *National Agricultural Research and Technology Fund*

Given the level of demand for scientific intervention in agricultural production, the appropriate levels of investment in agriculture should be determined to guide planning and resource allocation. The agricultural research and technology fund should be sufficiently motivated to cover a Matching Grant Fund for research and transfer of technology, Centres and Networks of Excellence Fund, ATHRAP, Fund and Agricultural Extension Services, and Technology Transfer and Adaptive Research Fund. The management of the National Agricultural Research and Technology Fund should be delegated to a competent authority. In Fig. 3, the blocks refer to possible modes in which the government fund can be allocated. In the first two, this is intended to provide adequate core funding for the activities of the ARC (in the areas of core research, national assets, infrastructure and services). There are a number of premises on which funding allocations in the other modes will be determined and these will include principles, drivers, process and clear criteria.

5.1.3 *Principles*

The following principles will be adhered to in the allocation of funds to the different areas of support:



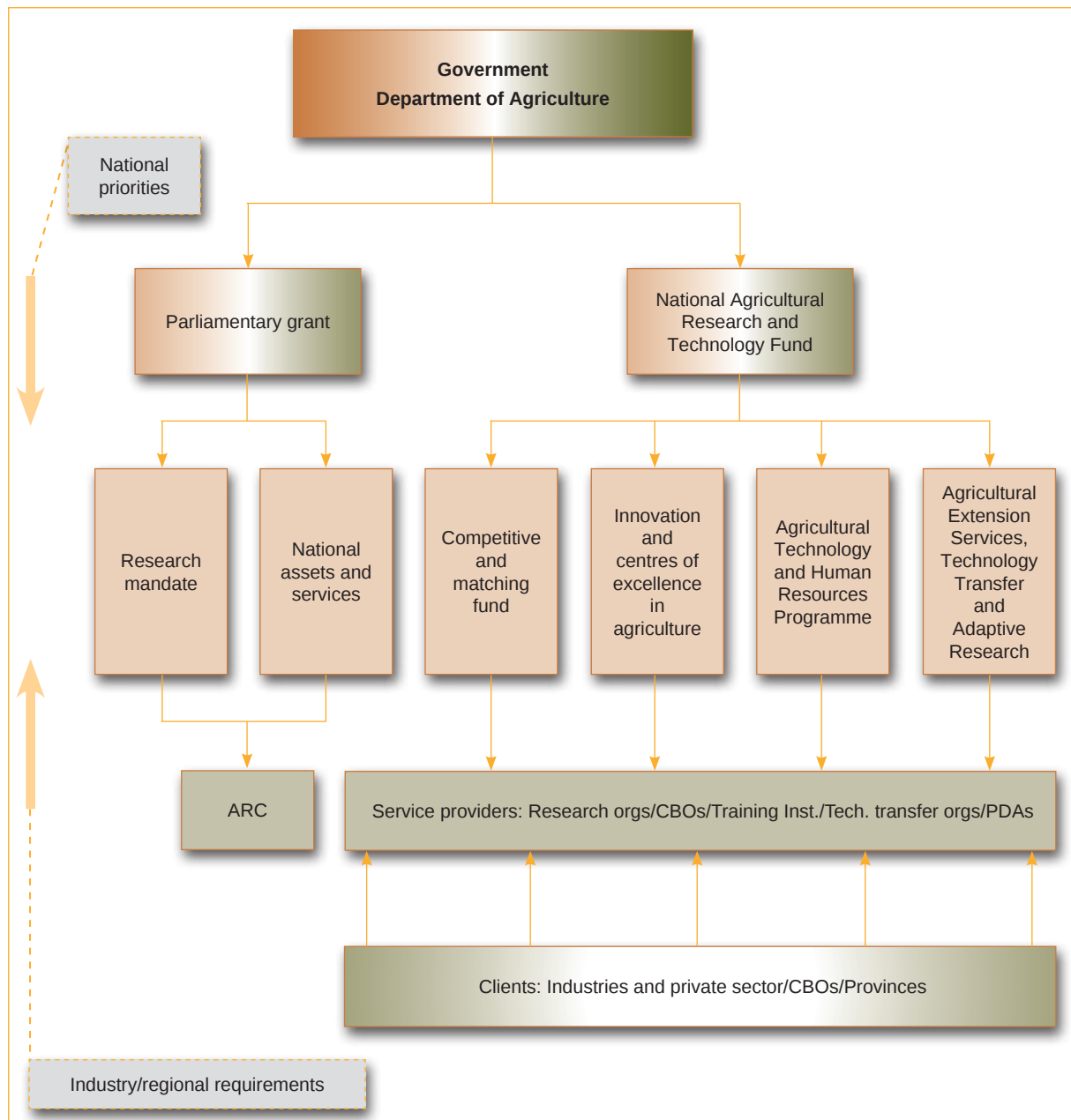


FIG. 3 – Financial flows within the NARS

- Partnerships will be encouraged;
- Sharing of capacity among NARS;
- Development of capacity and human resources;
- Funding will follow actions/programmes;
- Innovation will be encouraged;
- Transfer of technology, to all agricultural producers.

5.1.4 Drivers

It is recognised that the NARS in South Africa will be directed mainly by the following drivers, which have to be balanced at various levels, for the different funds:

- Governance;
- Institutional arrangements;

- Priorities at national, provincial and regional levels, which have to be industry specific;
- Availability of funding;
- Innovation.

5.1.5 *Process*

The realisation of full and effective implementation of the National Agricultural R&D Strategy will depend on establishing the following:

- Priority setting at various levels to inform the national agenda;
- Building budgets at various levels;
- Communication (bottom up and top down).

5.1.6 *Pillars for the National Agricultural R&T Fund*

The following provide broad guidelines for the development of specific criteria for allocation of funds in the different categories:

5.1.6.1 **COMPETITIVE AND MATCHING FUND FOR AGRICULTURAL RESEARCH AND TECHNOLOGY GENERATION**

A component of the Agricultural R&T Fund will be allocated on a matching and competitive basis in order to broaden participation in research, avoid duplication, promote collaborative research, ensure that research is directed at client needs and provide incentives to industries and other private sector parties to fund research. Competition is one of the effective approaches to deliver national priority needs by competent service providers. The aim is to improve the scientific and technical quality of research proposals, and ensure a greater level of networking and collaboration among the national research institutions.

All research institutions (public and private) should have equal access to these funds. Research institutions should qualify for access to the Matching Grant Funds proportional to the research and transfer of technology funds they are able to attract from other sources, including industries and the private sector. This provides a mechanism of ensuring that the research institutions meet the needs of the clients and it provides an incentive to industries and private enterprises to fund research. The involvement of the private sector is to ensure that research projects and contracts entered into by the competitive funding programme will support relevant research addressing their needs. The rationale is that relevance will, in turn, promote financial investment and therefore ease the burden on public funding for agricultural research. Allocations of funds should ensure that:

- Projects have a lead agency, with fully integrated subcomponents from other institution(s) within the NARS;
- Research topics address any of the priority areas defined by a national planning/priority-setting process;
- As an incentive in the fund, there should be the availability of 'start-up' grants for project preparation and an 'initial grant' covering the planning stage for project proposals;
- The matching funds should be allocated on a sliding scale to be determined, normally on a 1:2 ratio between Government and industry.

Given South Africa's experience with the peer-review system of the NRF and the Innovation Fund, the competitive fund for agricultural research will be managed under the existing institutional arrangements. The implementation of a competitive funding mechanism should not undermine the long-term ability of national agricultural research institutes (NARIs) to develop and maintain viable capacity and infrastructural renewal. The regulatory environment for



intellectual property and plant breeders' rights, as an inducement to encourage private sector investment, will have to be strengthened.

5.1.6.2 INNOVATION AND CENTRES OF EXCELLENCE IN AGRICULTURE

A sectoral analysis of the kinds of innovative approaches and requirements for new or improved institutions and/or centres of repute and excellence in key strategic areas has to be conducted. A call for expression of interest should be made to encourage existing institutions to realign their mandates and focus towards national priorities. Specific criteria for designation of centres of excellence and promotion of innovation should complement the efforts of the DST. Funding will be allocated on a competitive basis, to ensure:

- Sustainability of an institution, with a long-term vision;
- Clearly articulated and identified strategic niche for the institution within the agricultural research domain;
- Comparative advantage relating to human resource and infrastructural capacities.

5.1.6.3 AGRICULTURAL TECHNOLOGY AND HUMAN RESOURCES PROGRAMME

The current THRIP model sponsored by the dti and managed by the NRF has successfully demonstrated the partnership principle between government, industry, HEIs and SETIs. It is evident, however, that the THRIP model does not fit the exact requirements of agriculture. It is therefore necessary to introduce an Agricultural Technology and Human Resources Programme (ATHRP) to be administered by DoA as part of the National Agricultural Research and Technology Fund. The aim of the ATHRP will be to:

- Provide the South African agricultural industry (large and small) with solutions to technology and transfer of technology needs.
- Produce a flow of highly skilled researchers and technology managers who understand research, technology development and transfer.
- Foster collaboration between the agricultural industry, HEIs, SETIs and other players in the research arena.

The key objective of ATHRP will therefore be to increase the overall competitiveness of the South African agricultural sector by supporting R&D activities and enhancing the quantity and quality of appropriately skilled people in agriculture. Funding from Government will be competitive and should attract matching funds from industry and private partners for activities and programmes addressing the national R&D agenda and priorities. Competitive bursaries, scholarships and fellowships will be made available to outstanding nationals on merit. All projects funded by ATHRP must include a human resource development (Honours, MSc, PhD/and post-doctoral levels).

5.1.6.4 AGRICULTURAL EXTENSION SERVICES, TECHNOLOGY TRANSFER AND ADAPTIVE RESEARCH

The long-term impact of this strategy will be measured, amongst others, by the extent and level at which farmers and farming communities realise efficiencies and improvement in their production systems. Agricultural extension services and transfer of technology will include the packaging and further development of existing technologies and commercialisation of products. The Government will fund partnerships with other role players. These and related activities will improve production and increase income generation in the sector. Financial support will be made available to service providers, on a competitive basis, to institutions to strengthen their capacities to facilitate transfer of technology, undertake adaptive research and provide advisory services.

6. Legal framework for implementation

The policy and institutional contexts in which agricultural research and innovation occurs have changed dramatically in South Africa. The current Agricultural Research Act (86, 1990) should be reviewed to provide a basis for the implementation of this strategy and to provide for the establishment of a board of governance for agricultural research in the NARS. The revised Act should also recognise the existence and role of the NARF as a body to enhance coordination and efficient research management, priority setting and development of a national agricultural research agenda.



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