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SOUTH AFRICA

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This country brief reviews the major investment and institutional trends in South African agricultural research since the early 1970s, including a new set of survey data for the 1990s collected through the Agricultural Science and Technology Indicators (ASTI) initiative (IFPRI–ISNAR 2001–02).¹

INSTITUTIONAL DEVELOPMENTS

South Africa is relatively wealthier compared to most other African countries, however more than half of the country's population lives in poverty, and about one-third of the labor force is unemployed. In contrast to the rest of Sub-Saharan Africa, the South African economy is based on manufacturing and services, and the agricultural sector is small. In 2000, for example, it accounted for only 3 percent of total gross domestic product (GDP) and merchandise exports, and less than 10 percent of the labor force (FAO 2003; World Bank 2003). The most important earners of foreign exchange in the agricultural sector are sugar, wine, citrus, and deciduous and

Table 1—Composition of agricultural research expenditures and total researchers, 2000

Type of agency	Spending		Researchers ^a	Share		Agencies in sample ^b
	1999 rands	1993 international dollars		Spending	Researchers	
	(millions)		(fte ^c)	(percent)		(number)
<i>Public agencies</i>						
Government						
ARC	429.3	217.9	634.3	57.2	58.9	14
Other national ^c	75.9	38.5	98.3	10.1	9.1	4
Provincial ^c	47.4	24.1	70.1	6.3	6.5	8
Nonprofit ^c	60.7	30.8	68.0	8.1	6.3	4
Higher education ^{c,d}	106.9	54.3	158.0	14.2	14.7	12
<i>Subtotal</i>	<i>720.3</i>	<i>365.6</i>	<i>1,028.6</i>	<i>95.9</i>	<i>95.5</i>	<i>42</i>
Business enterprises ^e	20.5	10.4	32.5	2.7	3.0	8
Estimated omitted business enterprises ^f	10.3	5.2	16.3	1.4	1.5	<i>n.a.</i>
Total	751.1	391.6	1109.9	100	100	50

Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR 2002) and ARC data (ARC 2002a and b).

^aInclude national and expatriate staff.

^bSee note 2 for a list of the 50 agencies included in the sample. A number of smaller, higher-education agencies involved in agricultural research, such as the Faculty of Agriculture of the University of North West, the 10.3 Faculty of Applied Natural Sciences, School of Agriculture at the University of Zululand, were excluded from this table and further data analysis in this brief because data were unavailable.

^cExpenditures for SFRI, the provincial government agencies, two nonprofit institutions, and the higher-education agencies are estimates based on the average expenditure per researcher of ARC.

^dThe 533 faculty staff employed in the 12 higher-education agencies spent between 10 and 40 percent of their time on research, resulting in the 158 fte researchers.

^eExpenditures for three business enterprises are estimates based on average expenditures per researcher for the business enterprises for which data were available.

^fWe estimate that our sample included about two-thirds of the fte research staff and spending performed in the private for-business sector.

KEY TRENDS

- Agricultural research in South Africa is far better funded than most—if not all—Sub-Saharan African countries, given it reports one of the highest spending per scientist and intensity ratios in the region.
- The Agricultural Research Council (ARC) is by far the largest provider of agricultural research in South Africa, being responsible for more than 60 percent of the country's agricultural research expenditure and staff.
- Since 1997, government funding to ARC has begun to contract, and total research staff numbers have decreased by one-third.
- Although private-sector involvement in agricultural R&D is minimal, its share of 3 percent of South African total agricultural research expenditure and staff is high compared to other African countries.

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) Initiative consists of a network of national, regional, and international agricultural R&D agencies managed by IFPRI and ISNAR. The initiative compiles, processes, and makes available internationally comparable data on institutional developments and investments in public and private agricultural R&D worldwide, and analyses and reports on these trends in the form of occasional policy digests for research policy formulation and priority setting purposes.

Primary funding for the ASTI initiative was provided by the CGIAR Finance Committee/World Bank with additional support from the Australian Center for International Agricultural Research (ACIAR), the European Union, and the U.S. Agency for International Development (USAID).

subtropical fruits. The “agrofood complex,” comprising primary production and the input and agroprocessing sectors, accounts for around 14 percent of GDP. In 2000, the agrofood complex exported about R16 billion in primary and processed food products, representing nearly 9 percent of South Africa’s total exports.

Our late-1990s survey (IFPRI-ISNAR 2001–02) included 53 agencies ranging from public sector agricultural research service providers to private companies in South Africa, 50 of which were included in our sample (Table 1).² Together these 50 agencies employed 1,077 full-time equivalent (fte) researchers and spent 751 million 1999 rand on agricultural research and development (R&D)—equivalent to \$381 million in 1993 international prices.³ In terms of fte researchers, South Africa is the second-largest country in the region after Nigeria, whose agricultural research agencies employed over 1,300 fte researchers in 2000. For the same year, however, R&D spending in South African was three times Nigeria’s level, indicating South Africa’s much higher funding of agricultural R&D (Beintema and Ayoola 2004).

The Agricultural Research Council (ARC) was established in 1992 from the commodity and specialist research institutes of the Department of Agricultural Development. It remains the largest agricultural research entity in South Africa, accounting for nearly 60 percent of the country’s agricultural research expenditure and researchers in 2000. In terms of operations, ARC resides within the Ministry of Agriculture and Land Affairs, but receives science research direction from the Department of Science and Technology (DST) within the National System of Innovation. DST, in turn, is advised by the National Advisory Council on Innovation.

As of 2000, ARC consisted of 14 agricultural research agencies and units. The Grain Crops Institute (CGI), Small Grains Institute (SGI), and Institute for Industrial Crops (IIC) focus on crop research; the Vegetable and Ornamental Plant Institute (VOPI), Institute for Tropical and Subtropical Crops (ITSC), and Infruitech-Nietvoorbij (NIETV) primarily conduct horticultural research; and the Rangeland Forage Institute (RFI), Animal Improvement Institute (AII), Animal Nutrition and Products Institute (ANPI), and Onderstepoort Veterinary Institute (OVI) focus on animal production and health. The remaining, specialist agencies are the Plant Protection Research Institute (PPRI), the Institute for Agricultural Engineering (IAE), the Institute for Soil, Climate, and Water (ICSW), and Central Office, which is the overall administrative function of the ARC, but also include the Biometrics Unit and the Group for Development Impact Analysis. The capacity of ARC institutes varied in 2000 from around \$7 to \$25 million in total spending and about 20 to 75 fte researchers; IIC and IAE fall at the low end of that scale, while OVI and NIETV fall at the high end.

Following revisions to national science and technology policy in 1996 and a review of ARC in 1997, ARC’s structure and management were modified. A number of research institutes were merged, and a more entrepreneurial managerial style was adopted. Commercialization of research outputs was emphasized through cost recovery initiatives for all research and services with a view to improving research relevance and performance. Addressing the reviews in particular, research was refocused toward small-scale black farmers, and a separate program—with a totally separate funding line—was created to deal with the issues and needs of poor farmers in “disadvantaged communities”.⁴ Through successive policy changes coupled

A Short History of Government-Based Agricultural Research

The Department of Agriculture (DOA) was created with the establishment of the Union of South Africa in 1910 from the 18 divisions of the two Boer Republics and two English colonies that made up the Republic of South Africa before that time. The period 1910 till 1958 saw the considerable expansion of these divisions with the transfer of four agricultural colleges and three faculties of agriculture from the Department of Education to the Department of Agriculture, as well as the establishment of new divisions, agricultural colleges and faculties of agriculture. In 1958, DOA was divided into the Department of Agricultural and Technical Services (DATS) and the Department of Agricultural Economics and Marketing (DAEM). DATS was again restructured in 1962, when two directorates—the Directorate of Agricultural Research and the Directorate of Field Services—were emerged and took on the responsibility for 10 research institutes, later to become directorates, and 3 service divisions.

Additional reorganizations took place during the 1970s and 1980s. In 1970 the administrative responsibilities of the faculties of agricultural and veterinary services were transferred to the Ministry of Education, though DATS continued to finance research at the universities. In 1980, the directorates of agricultural research and field services were merged to form the Department of Agriculture and Fisheries, which was renamed Department of Agriculture and Water Supplies in 1982. With the introduction of the tri-cameral parliamentary system in 1984, the department was again split into the Department of Agricultural Development (DAD), largely incorporating the branches of the old DATS, dealing with “own affairs” (each of the whites, Indians and coloureds represented in parliament each had its own Department of Agriculture) and the Department of Agriculture, for “general affairs” (responsible for agricultural issues and services such as regulatory measures that were deemed to span racial barriers). Almost all the public sector agricultural research services formed part of the “white” DAD.

In an effort to make the strategic basic agricultural research services of DAD available to other racial groups and as a result of extensive de-regulation and efforts to privatize publicly provided services, most of DAD’s research activities were transferred to ARC in April 1992, following the passing of the Agricultural Research Act in 1990. The process of transferring the Institutes and smaller research units to the ARC was not completed until 1995. ARC is now the primary agricultural research entity in South Africa.

Forestry research began in 1912, largely through the Department of Forestry. The Forestry Product Institute was created in 1919, was merged with the Department of Forestry to form the Forestry Research Division in 1956, and became the Directorate of Forestry under the newly created Department of Water Affairs, Forestry, and Environmental Affairs in 1980. The directorate was reorganized and renamed the South African Forestry Research Institute (SAFRI) in 1984, was incorporated into the Council of Scientific and Industrial Research (CSIR) in 1990, forming the Division of Forestry Science and Technology, and in 1997 was merged to form the current Division of Water, Environment, and Forestry (Environmentek).

Fishery research began in 1912, but it was not until 1929 that the Division of Sea Fisheries (DSF) was created under the Department of Mines and Industries (later the Department of Industries). DSF became the Sea Fisheries Branch in 1972, then the Sea Fisheries Institute (SFI) under the Department of Agriculture and Fisheries in 1980. In 1997 SFI was transferred to the Directorate of Marine and Coastal Management.

Sources: Roseboom et al. (1995).

with changes in leadership after 1999, ARC became increasingly isolated from its stakeholders, so a series of meetings was arranged with provincial departments of agriculture and representative agricultural bodies. Insights gained from this exercise enabled ARC to initiate strategic workshops on its research agenda and funding, which resulted in the May 2002 establishment of a National Agricultural Research Forum (NARF) to investigate solutions to the numerous policy constraints facing the national agricultural research system (NARS). Since its establishment, however, NARF has failed thus far to initiate any meaningful activities to harmonize research activities or formulate proposals to address policy constraints.

Four other national government research agencies conduct agricultural research. The Council for Scientific and Industrial Research (CSIR), established by government in 1945, is the country's central and largest scientific R&D institution. In 2002, it accounted for about 10 percent of South Africa's total R&D budget and employed 3,000 fte research staff (CSIR 2002). Agricultural research is carried out at two of CSIR's divisions—the Division of Water, Environment, and Forestry (Environmentek), and the Division of Food Biological and Chemical Technologies (Bio/Chemtek). The national mandate for sea fisheries research lies with the Directorate of Marine and Coastal Management of the Department of Environmental Affairs and Tourism. Forestry research has declined rapidly since 1997, when the South African Forestry Research Institute (SAFRI) was merged with CSIR's water and environment units to form Environmentek Division.⁵

Nine provincial departments of agriculture undertake mostly adaptive agricultural research within the specific provinces. The provincial departments were created in 1994 from the former agroecological focused Agricultural Development Institutes (ADIs) and the agricultural administrations of the former homelands and independent states. The most affected provinces in this regard were Eastern Cape, Limpopo, North West and Mpumalanga. The homelands had very little research capacity at the time of amalgamation. Agriculture also became the joint responsibility of the national and provincial governments under the new constitution. Grootfontein Agricultural Development Institute (GADI) (having briefly been attached to the Northern Cape Department of Agriculture) was transferred to the National Department of Agriculture in April 2000 because its location and agroecological focus cut across several provincial boundaries. GADI is very small with only 3.5 fte researchers in 2000. (See *A Short History of Government-Based Agricultural Research* on page 2).

Four nonprofit institutions conduct agricultural research. Two of these, the South African Sugar Association's Experiment Station (SASEX) and the Sugar Milling Research Institute (SMRI), conduct sugarcane research including varietal improvement, pest and disease control, processing, and postharvest. The Institute for Commercial Forestry Research (ICFR), which is located at the University of Natal, conducts forestry research for various companies and forestry organizations.⁶ The Oceanographic Research Institute (ORI) of the South African Association for Marine Biological Research (SAAMBR) focuses on marine fisheries research.

Since the late 1990s the universities have become more involved in applied research as a result of the dwindling

research capacity in the public sector. In 2000, the 12 higher-education agencies in our sample accounted for about 15 percent of total financial and human resources in agricultural research. The University of Pretoria's Faculty of Natural and Agricultural Sciences and Faculty of Veterinary Science were responsible for 45 percent of these activities, employing 218 faculty staff or—adjusted to reflect time spent on research—71 fte research staff. The University of Stellenbosch's Faculty of Agriculture and Forestry Sciences and the University of the Free State's Faculty of Natural and Agricultural Sciences employed 28 and 19 fte researchers in 2000, respectively. The remaining 8 higher-education agencies in our sample had only a limited research role in 2000, employing less than 10 fte agricultural researchers each.

To integrate and coordinate the public agricultural system, given the joint responsibility for agriculture between national and provincial governments, an interministerial committee—MINMEC—was established, along with an Inter-Departmental Technical Committee on Agriculture (ITCA). ITCA initially had several subsidiary technical/advisory committees, most of which were disbanded for lack of effectiveness. In early 2003, ITCA reintroduced the Agricultural Economics Working Group. The latter was established to discuss issues related to agricultural economic matters of common concern to all institutions.

HUMAN AND FINANCIAL RESOURCES IN PUBLIC AGRICULTURAL R&D

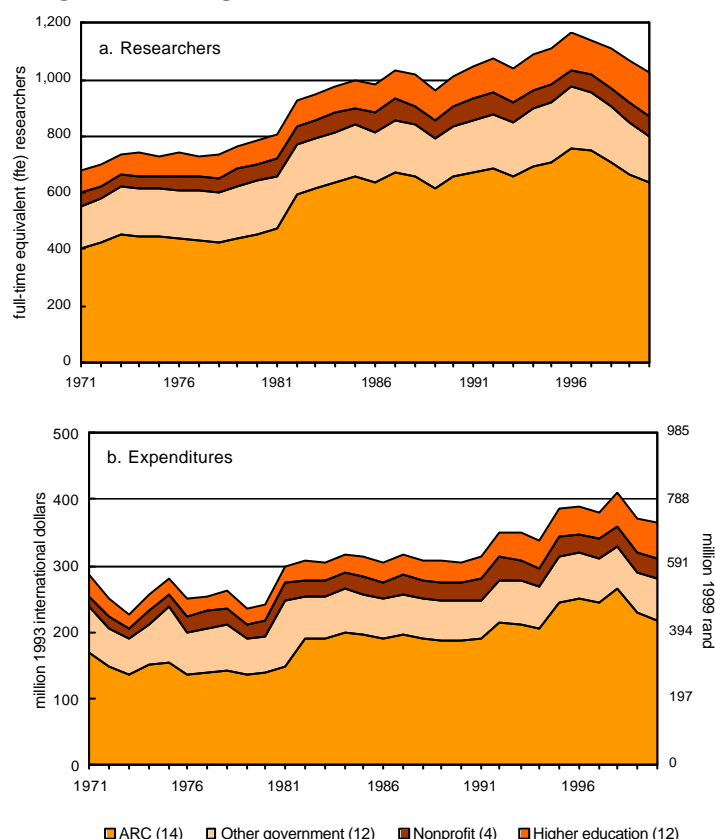
Overall Trends

During 1971–96, the total number of public agricultural researchers increased by 2.2 percent per year, though an average negative growth rate of 3.1 percent persisted from 1996 to 2000 (Figure 1a).⁷ This decline was the result of a contraction in total fte researcher numbers in the national and provincial government sectors. Total research staff at the ARC institutes declined from 761 in 1996 to 634 fte researchers in 2000, and then to 400 by April 2003. This one-third decline in ARC staff has serious implications for ARC's capacity to maintain past performance, since it was estimated at its establishment that ARC would require a base capacity of 750 researchers to fulfill its functions and that it were the most qualified and mobile researchers that have left. The other national and provincial government agencies experienced a stronger decline. In 2000, total fte researchers employed at the 12 agencies were about 20 percent less than in 1996, caused mainly by a strong decline in forestry researchers with the establishment of Environmentek in 1997 (as described earlier). Total fte researchers at the nonprofit institutions increased during 1971–2000 at 1.4 percent per year, but this growth was erratic. Total fte researcher numbers in the higher-education sector doubled over the past three decades, increasing the sector's share in total fte researchers from 12 percent in 1971 to 16 percent in 2000.

Total public agricultural R&D spending increased during 1971–96 by 1.6 percent per year on average, then decreased in the second half of the 1990s by an average of 1.5 percent per year. The decline in total spending occurred mostly in the government sector (Figure 1b). ARC's total spending declined from \$251 million in 1996 to \$217 million in 2000; an average decline of 3.4 percent per year. The other national and provincial government agencies saw their combined total

spending fall by an annual rate of 2.6 percent over the same period.

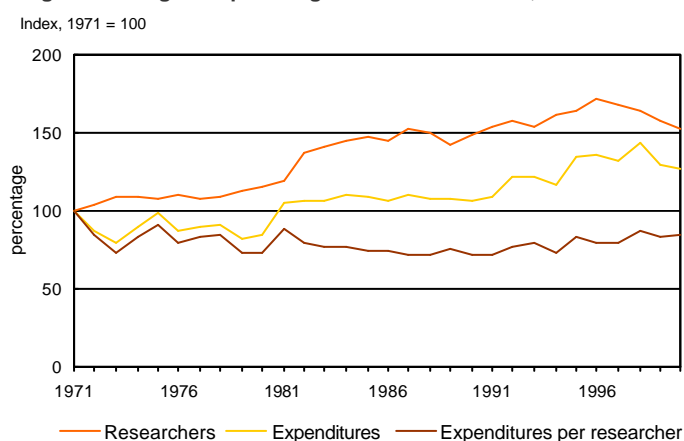
Figure 1 $\frac{3}{4}$ Public agricultural R&D trends, 1971–2000



Sources: Compiled by authors from ARC data (ARC 2002a and b), ASTI survey data (IFPRI–ISNAR 2001–02), and Roseboom et al. (1995).
Notes: See Table 1. Figures in parentheses indicate the number of agencies in each category. Underlying data are available at the ASTI website (www.asti.cgiar.org).

During most of the 1971–2000 period, spending-per-scientist levels remained fairly stable (Figure 2). In 2000, spending per scientist was \$366,000 on average, which was considerably higher than the corresponding levels in most, if not all, other Sub-Saharan African countries.

Figure 2 $\frac{3}{4}$ Long-term public agricultural R&D trends, 1971–2000

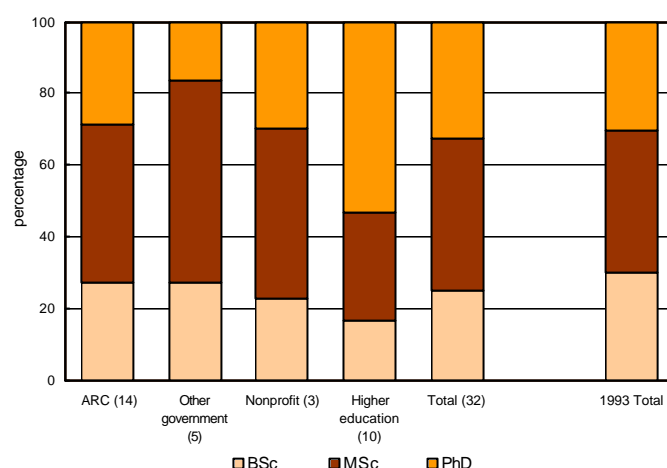


Source: Figure 1.

Human Resources

In 2000, 75 percent of the 900 fte researchers in a 32-agency sample had postgraduate-level training, with more than one-third holding doctorate degrees (Figure 3). Together the higher-education agencies employed a higher proportion of researchers with postgraduate degrees compared with other agencies, which is in line with other African countries (Beintema 2003). Of note, more than half the fte researchers in the 10 higher-education agencies in our sample held doctoral degrees.

Figure 3 $\frac{3}{4}$ Educational attainment of researchers, 2000



Source: Compiled by authors from ARC data (ARC 2002b) and ASTI survey data (IFPRI–ISNAR 2001–02).

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff.

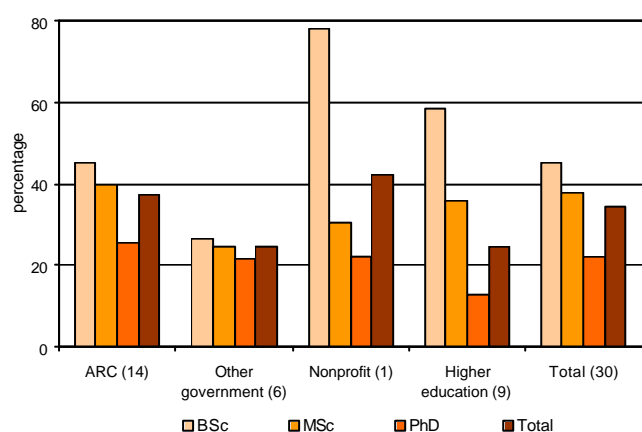
The overall quality of staff—measured as the share of researchers with PhD and MSc degrees—remained fairly constant throughout 1993–2000. ARC and the other government agencies reported a combined increase of 5 percent in the share of researchers holding PhD degrees; however, these shares mask the large decline in absolute research staff numbers. As mentioned, total staff numbers at ARC and the other government research agencies fell considerably in recent years, and the greater proportion of these departing staff held BSc degrees. Nevertheless, ARC researchers with doctorate degrees declined from 206 in 1997 to only 144 in April 2003. Many PhD-holders left ARC for early retirement or for better opportunities in the private sector or abroad. ARC researchers holding MSc degrees also declined during the same period, though at a slower rate.

Prior to 1997 the state provided scholarships for most students interested in a career in agriculture or agricultural research for undergraduate and postgraduate training from the ARC and the national Department of Agriculture. Most ARC researchers took advantage of this opportunity, completing masters and PhD degrees under projects funded by the research institutes and supervised by academics at the major South African universities. In the pre-sanction years (before 1976) many researchers were also trained in Europe, the United Kingdom, and United States, thus providing the research establishment in South Africa with valuable human capital. This partly explains the leading research at institutes such as OVI during this time.

Funding for university scholarships from DOA and ARC ceased in 1997, since the responsibility for granting these scholarships was transferred to the National Research Foundation. In 2003 the national Department of Agriculture in collaboration with the ARC launched a new program to fund training in agricultural sciences, mainly at South African universities in order to address the capacity constraints that have arisen.

In 2000, about one-third of the total fte researchers in a 30-agency sample were female, including 22 percent of all researchers holding doctorate degrees, 38 percent of all researchers with MSc degrees, and 45 percent of BSc-trained researchers (Figure 4). Although the share of women in ARC's total research staff is slightly higher than the sample average, the proportion has apparently not changed since ARC's establishment in 1992 (Roseboom et al 1995). At the higher-education agencies, a much lower share of higher degree holders were female, with only about 13 percent of researchers holding PhD degrees. This contrasts with the relatively high share of female research staff employed in the higher-education sector in many other African countries (Beintema 2003).

Figure 4 Share of female researchers, 2000

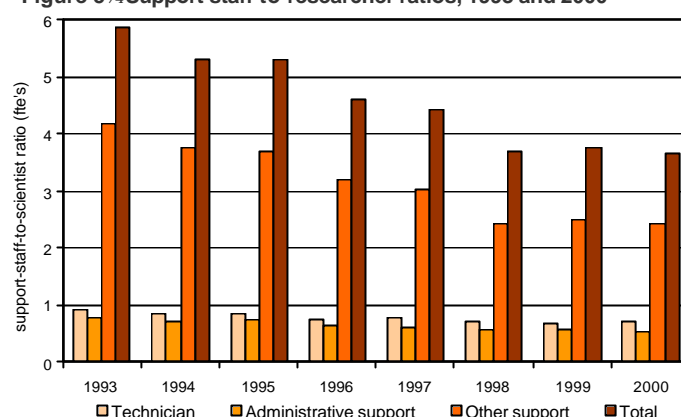


Source: Compiled by authors from ARC data (ARC 2002b) and ASTI survey data (IFPRI-ISNAR 2001–02).

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff.

In 2000, the average number of support staff per scientist at ARC was 3.7—comprising 0.7 technicians, 0.5 administrative personnel, and 2.4 other support staff such as laborers, guards, and drivers (Figure 5). In 2000, ARC employed 2,328 fte support staff compared with 3,846 seven years earlier. The largest drop occurred in the other-support-staff category (42 percent), and given that this decline exceeded the decline in ARC research staff, the support-staff-to-researcher ratio dropped by one-third during the 1993–2000 period.

Figure 5 Support-staff-to-researcher ratios, 1993 and 2000



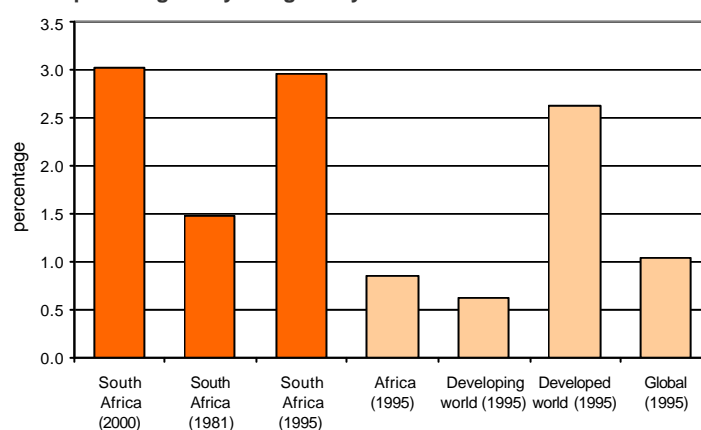
Source: Compiled by authors from ARC data (ARC 2002b) and ASTI survey data (IFPRI-ISNAR 2001–02).

Note: Number of agencies in sample shown in brackets. Figure excludes expatriate staff.

Spending

Total public spending as a percent of agricultural output (AgGDP) is a common research investment indicator that helps to place a country's agricultural R&D spending in an internationally comparable context. South Africa has the second-highest intensity ratio in Sub-Saharan Africa after Mauritius (Beintema et al 2003).⁸ In 2000, South Africa invested \$3.04 for every \$100 of agricultural output (Figure 6). Despite declining total agricultural R&D spending, the intensity ratio increased slightly during 1995–2000 because of a stronger decline in real AgGDP during this period. The 1995 ratio was higher than the average ratio for the developed world that same year (Figure 6). This was also considerably higher than the country's ratio in 1971 (\$1.68) but represents declining real AgGDP, not increased investment.

Figure 6 South Africa's public agricultural research intensity compared regionally and globally

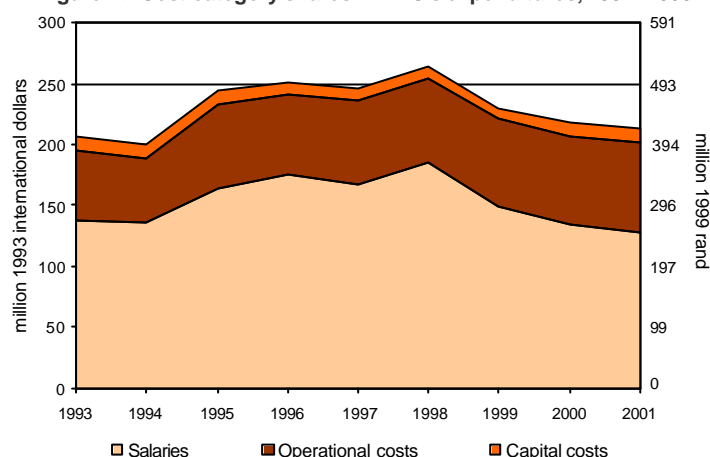


Sources: South Africa compiled from Figure 1b; AgGDP from World Bank (2003); other intensity ratios from Pardey and Beintema (2001).

During the period 1993–2000, ARC spent almost two-thirds of its total expenditure on salaries, and 35 percent on operational costs (Figure 7). Only 5 percent of ARC's total spending was allocated to capital investments, reflecting the already well established research facilities transferred to ARC institutes as

well as the budget pressure since 1998. Annual cost shares remained fairly constant, although since 1998 total spending (adjusted for inflation) decreased as a result of declining government contributions to ARC. The share of salary expenditures dropped from a high of 70 percent in 1998 to 60 percent in 2000, whereas operational expenditure increased from 26 percent to 35 percent during the same period.

Figure 7¾ Cost-category shares in ARC's expenditures, 1991–2000



Source: Compiled by authors from ARC data (ARC 2002a).

Notes: Data include estimated salaries for expatriate staff (see Methodology on page 9).

FINANCING PUBLIC AGRICULTURAL R&D

Systemwide, the funds allocated within the South African NARS come primarily from four sources. At the central-government level, the science vote is allocated by DST through various national government departments. Further national revenue sources include commodity trusts and levies from producer organizations, and research funding from private-sector enterprises. The increasingly prominent role of private enterprises in terms of research funding along with the use of research services and the very limited level of donor funding distinguish South Africa from other African countries.

Apart from the structural changes in the South Africa NARS mentioned earlier, competitive bidding with other science councils for parliamentary grants was introduced in the 1997/98 financial year. Furthermore, from that point, all external research contracts of science councils were based on full cost recovery. This principle was not readily accepted by the various commodity organizations that fund ARC research, so as a compromise a 50:50 cost-sharing arrangement was negotiated between the relevant institute and commodity organizations. This implies that the industry pays only marginal costs but at the same time get a substantial say in research programs and agendas.

Other major funding providers to agricultural research over the past five years have been various commodity trusts that were established when market deregulation led to the abolition of marketing boards. The assets of these boards were transferred to trusts (such as the Maize Trust, the Wool Trust, and the Red Meat Trust), and the returns from these assets are used to fund the activities of the producer organizations, as well as agricultural research. Table 2 indicates the extent of research funding provided by the commodity trusts as well as statutory

and voluntary levies managed by producer organizations since 1999.

Table 2¾ Annual contributions by commodity organizations to agricultural research, 1999–2001

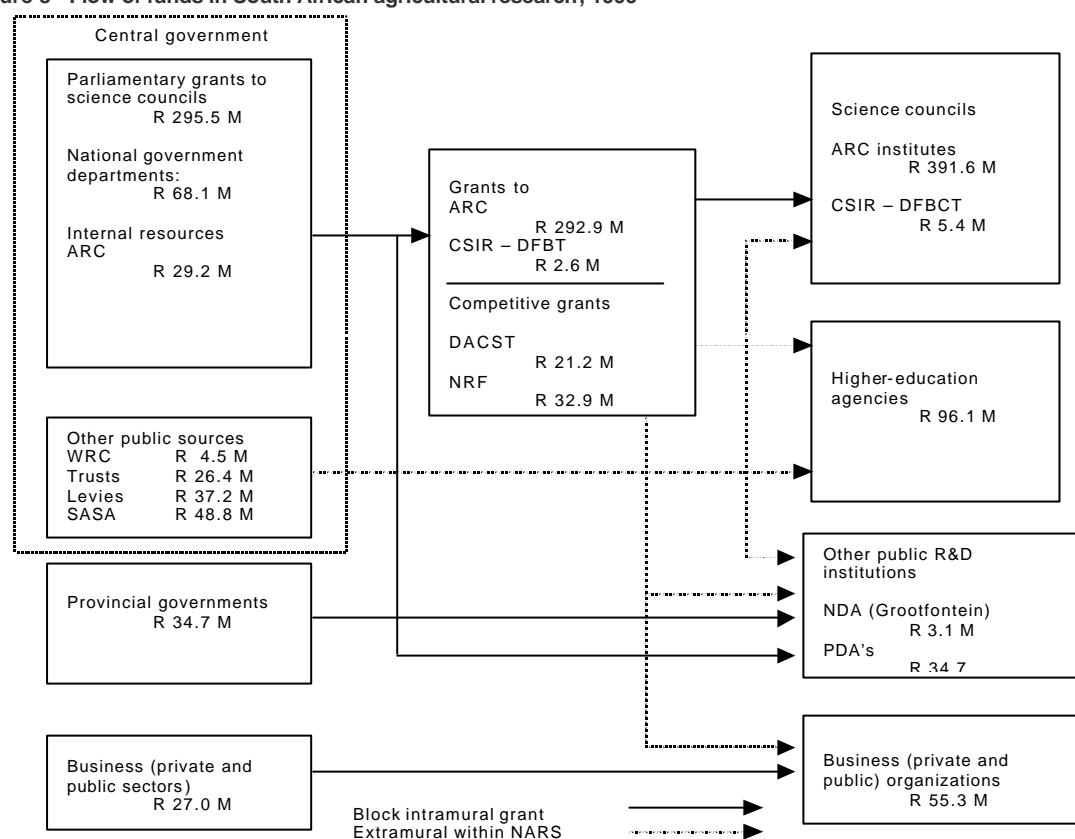
	1999	2000	2001
	(million rand)		
Trust contributions			
Animal	3.6	3.5	7.2
Crops	13.1	18.7	21.3
Horticultural	5.3	4.2	3.7
Subtotal	21.9	26.4	32.2
Levy income			
Crops	11.2	11.5	12.3
Horticultural	19.2	25.7	27.5
Subtotal	30.4	37.2	39.9
Total contributions by commodity organizations			
Animal	3.6	3.5	7.2
Crops	24.3	30.2	33.7
Horticultural	24.4	29.9	31.2
Total	52.3	63.6	72.1

Source: Information provided by various trusts and commodity organizations. (personal communication).

Figure 8 shows the flow of funds for South African agricultural R&D for 1999/2000. At the central-government level, the parliamentary grant from the science vote totaled R295.5 million, R292.9 million of which was allocated to ARC and the remainder to CSIR's Bio/Chemtek. The various national departments allocated a further R68.1 million to agricultural research through performance and service contracts and competitive bidding funds. The bidding funds were allocated mainly through the Technology and Human Development Research for Industry Program (THRIP), the innovation fund administered by the National Research Foundation, and the lead programs (specific competitive bidding funds available to Science Councils for interventions in areas such as poverty alleviation) of DST. An amount of R29.2 million is internally generated by ARC from its own resources (sales of ARC developed diagnostic kits, books, diagnostic services, training workshops, farm produce, etc.) (Figure 9). Figure 9 shows the aforementioned dwindling government funding. This has diminished ARC's capacity substantially and thus making it very difficult for the ARC to fulfill its research function.

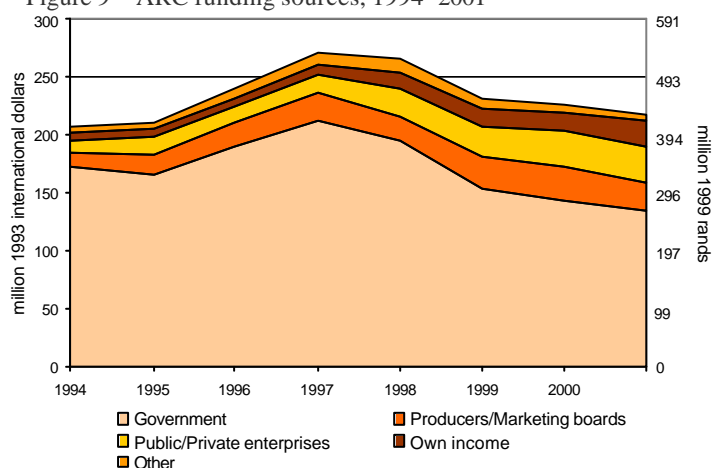
Other public funding sources include R4.5 million allocated to agricultural research by the Water Research Commission, representing 9.1 percent of its total research budget, which is derived from a levy paid by all Water Use Associations. Commodity and producer organizations support research, providing R26.4 million in 1999/2000; in the same year, levy income generated R39.2 million for research into commodities other than the sugar industry which generated R48.8 million for sugar-related research through a consumer level levy collected on the wholesale price at sugar mills. Funding from private enterprises stems mainly from input suppliers and agroprocessors, who outsource some research on technology development and evaluation to science councils and universities on a contract basis and do some research (mainly technology evaluation) in-house. Monies allocated from these sources amounted to R27.0 million in 1999/2000.

Figure 8—Flow of funds in South African agricultural research, 1999



Source: Compiled by authors.

Figure 9—ARC funding sources, 1994–2001



Source: Compiled by authors from ARC data (ARC 2002a).

Since 1995 the funding for the provincial departments of agriculture began to deviate from the pre-1995 levels as the newly established provincial legislatures began to allocate funding according to their priorities. As a result, provincial R&D capacity has dwindled, especially in provinces such as the Eastern Cape and Limpopo. A reasonable degree of research competence exists in only two provinces, the Western Cape (Elsenburg) and Kwazulu-Natal (Cedara). Most of the provinces had to rely on donor funding (funneled through collaborative projects with research and development service providers), the

operations of nongovernmental organizations (NGOs), producer/commodity organizations, and technical support from ARC.

Agricultural research at the different faculties of agriculture is funded by a variety of sources. Commodity organizations and private companies generally support the major, longer term projects, while funds are also supplied to successful bidders under the innovation fund and the National Research Foundation (mentioned above). In addition, donor agencies (mainly GTZ, USAID, AUSAID) and DFID have recently provided some support for research and postgraduate training initiatives at certain universities.

The nonprofit institutions are all funded through private-sector contributions. ICFR receives its funding from forestry companies and organizations that contract research to the institute (ICFR 2003). SMRI is funded through a levy on sugar production at the 15 sugar factories and 3 Swaziland mills that form part of its membership. The institute receives additional funding through contract research and technical services for individual mills (SMRI 2003).

PRIVATE AGRICULTURAL R&D

Agricultural research conducted by private companies is still very limited throughout Africa. Although in absolute terms, South Africa invests more in private agricultural R&D relative to the remainder of Sub-Saharan Africa, the private share of total agricultural R&D spending is still small. We identified eight business enterprises that conducted research in South

Africa, accounting for 3 percent of the country's agricultural R&D spending in 2000. Some private companies were reluctant to provide information on their financial and human resources investments into agricultural research and we estimated that we missed about one-third of total agricultural R&D spending in the private sector. Scaling up the private sector total will increase the private sector share to 5 percent of total 2000 spending (see Table 1 on page 1). In addition, since 2000 private expenditure in agricultural R&D appears to have gained momentum in line with the dwindling capacity and the perceived institutional problems in public sector agricultural research and development services.

Of the eight private companies that participated in our survey, Capespan, Hortec, and Grain South Africa are the larger three companies, investing \$2 to \$3 million in their research activities in 2000. CAPESPAN is an exporter of deciduous and citrus fruits, and the four fte researchers in the company's technology development unit conducted food processing research on these fruits in 2000. Research at Hortec also focused on deciduous and citrus fruits. The 5 fte researchers employed at Grain South Africa in 2000 focused on wheat, barley, sorghum, corn, soybeans, grains, and oilseeds. The other five businesses combined (Intervet, Kynoch Fertilizer, Dow Agrosiences Southern Africa, EPOL, and Forestwood) spent \$3 million on agricultural research in 2000. A number of private companies outsource research activities to ARC, the universities, and other agencies and hence did not participate in the survey - their expenditures are captured in the expenditure of the research service providers.

RESEARCH ORIENTATION

Commodity Focus

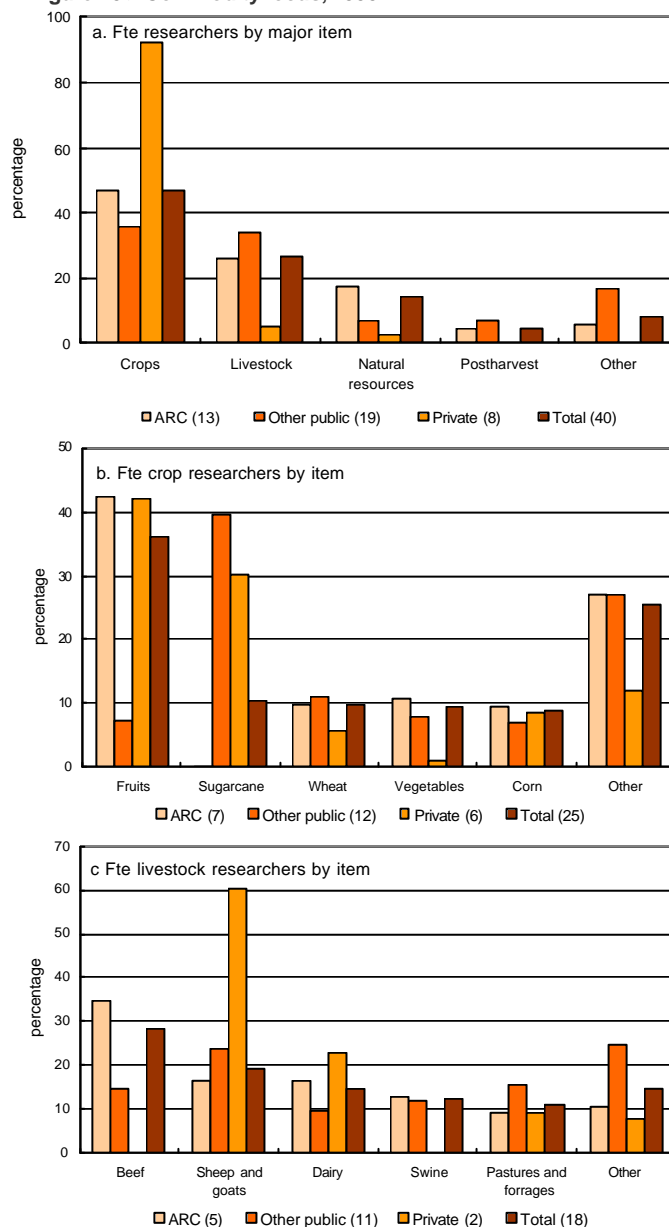
The allocation of resources across various lines of research is a significant policy decision; hence detailed survey information was collected on the number of fte-researchers working in specific commodity and thematic areas.

In 2000, close to half of more than 800 fte researchers in a 40-agency sample conducted crop research (Figure 10a). More than one-quarter of the researchers focused on livestock, while natural resources and postharvest research accounted for 14 and 5 percent, respectively. The remaining 8 percent of fte researchers conducted research across a wide variety of other areas including forestry and fisheries. The fte researchers at the 8 business enterprises for which data were available focused almost completely on crop research, while researchers at the 19 public agencies (excluding ARC) spent slightly more time on livestock research than the sample average. Fruits were the focus of 36 percent of the total fte crop researchers in our sample. Other major crops were sugarcane, wheat, vegetables, and corn, each of which accounted for 9 to 10 percent of the total fte crop researchers in our sample (Figure 10b). Fruits were relatively more important for the 7 ARC institutes involved in crop research than they were at the other agencies conducting crop research. Both the other public agencies and the private sector conducted relatively more sugarcane research. This reflects the large share of research conducted by SASEX and SMRI, accounting for close to half the 67 fte crop researchers in the 12 other public agencies.

Only 18 agencies in our 40-agency sample conducted

livestock research; 28 percent of the total fte livestock researchers were working on beef and about 20 percent were working on sheep and goats (Figure 10c). Other important livestock items were dairy, (14 percent), swine (12 percent), and pastures and forages (11 percent).

Figure 10^{3/4} Commodity focus, 2000



Sources: Compiled by authors from ASTI survey data (IFPRI-ISNAR 2001-02).

Note: Figures in parentheses indicate the number of agencies in each category. Figure 10b only includes agencies involved in crop research; Figure 10c only includes agencies involved in livestock research.

Thematic Focus

Of the total fte researchers employed at the 14 ARC agencies in 2000, 14 percent was working on crop research, 12 percent on livestock pest and disease control, 9 percent on crop genetic improvement, 17 percent on other crop areas, and 17 percent on various postharvest research areas (Table 3). More than 20 percent of the fte researchers at the 24 other government

agencies in our sample focused on other livestock areas (excluding genetic improvement and pest and disease control) and 12 percent conducted postharvest research. The remaining researchers focused on a wide variety of themes.

Table 3¾ Thematic focus, 2000

	Numbers of researchers		Shares	
	ARC (14)	Other (24) ^a	ARC (14)	Other (24) ^a
	<i>(in fte's)</i>		<i>(percent)</i>	
Crop genetic improvement	57.4	18.6	8.9	6.3
Crop pest and disease control	87.5	19.2	13.6	6.5
Other crop	105.6	21.6	16.5	7.3
Livestock genetic improvement	38.7	5.9	6.0	2.0
Livestock pest and disease control	79.5	14.6	12.4	4.9
Other livestock	57.3	66.1	8.9	22.3
Soil	14.4	5.9	2.2	2.0
Water	17.0	7.6	2.6	2.6
Other natural resources	82.3	22.8	12.8	7.7
Postharvest	19.2	35.7	3.0	12.1
Other	83.1	77.7	12.9	26.3
Total	641.9	295.7	100	100

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR 2001–02).

Note: Figures in parentheses indicate the number of agencies in each category.

^a This category includes six other government agencies, two nonprofit institutions, eight higher-education agencies, and eight private companies.

CONCLUSION

Public-sector financing remains the dominant source of funding, but—as in many countries—public funding has come under severe pressure in recent years. In the past five years, contributions to agricultural research funding by producer organizations and international donors have increased, and universities play a much greater role as research providers. Declining core government funding and changes in leadership and management styles have led to the departure of large numbers of the most highly qualified and mobile researchers from South Africa's primary agricultural research provider, ARC. The prospect of the demise of the agricultural research system led to an initiative to coordinate the funding and provision of agricultural research in South Africa through a National Agricultural Research Forum, but the forum has yet to initiate any meaningful steps toward the harmonization of research activities.

NOTES

1. The authors are grateful to Randy Randela and numerous other colleagues in South Africa for their time and assistance with data collection; Eduardo Castelo-Magalhaes and Olympia Icochea for their assistance with data processing; and Nick Vink and Johan van Zyl for useful comments on drafts of this brief.

2. The 50-agency sample consisted of:

- Fourteen agencies under the Agricultural Research Council (ARC): the Grain Crops Institute (GCI), the Small Grains Institute (SGI), the Institute for Industrial Crops (IIC), the Vegetable and Ornamental Plant Institute (VOPI), the Institute for Tropical and Subtropical Crops (ITSC), the Infruitech-Nietvoorbij (NIETV), the Rangeland Forage Institute (RFI), the Animal Improvement Institute (AII), the Animal Nutrition and Products Institute (ANPI), the Onderstepoort Veterinary Institute (OVI), the Plant Protection Research Institute (PPRI), the Institute for Agricultural Engineering (IAE), the Institute for Soil Climate and Water (ICSW), and the Central Office;
- Four national government agencies: the Grootfontein Agricultural Development Institute (GADI); the Sea Fisheries Research Institute (SFRI) under the Directorate of Marine and Coastal Management; and the divisions of Water, Environment, and Forestry (Environmentek), and Food Biological and Chemical Technologies (Bio/Chemtek), under the Council for Scientific and Industrial Research (CSIR);
- Eight provincial government departments of agriculture in Dohne (Eastern Caperegon), Glen (Free State), Potchefstroom (North West), Cedara (Kwazulu-Natal), Nelspruit (Mpumalanga), Elsenburg (Western Cape), and Upington (Northern Cape)
- Four nonprofit institutions: the South African Sugar Association Experimental Station (SASEX), the Sugar Milling Research Institute (SMRI), the Institute for Commercial Forestry Research (ICFR) at the University of Natal, and the Oceanographic Research Institute at the South African Association for Marine Biological Research (SAAMBR);
- Twelve higher-education agencies: the School of Economics of the University of Cape Town; the Faculty of Agriculture of the University of Fort Hare; the Faculty of Natural and Agricultural Sciences of the

University of the Free State; the School of Agriculture Sciences and Agribusiness, and the School Applied Environmental Sciences, at the University of Natal; the Faculty of Sciences, Health, and Agriculture at the University of the North's Technikon South Africa; the Department of Agriculture within the Faculty of Civil Engineering at Port Elizabeth Technikon; the Faculty of Natural and Agricultural Sciences, and Faculty of Veterinary Science, at the University of Pretoria; the Faculty of Agriculture and Forestry Sciences at the University of Stellenbosch; and the School of Agriculture, Rural Development, and Forestry at the University of Venda; and

- Eight private enterprises: Capespan Technology Development; Intervet's Melelane Research Unit; Deciduous Fruit Producer Trust (DFPT)/Hortech; Kynoch Agronomy Research; Grain South Africa's R&D Unit; Dow Agrosiences South Africa; Epol's Technical Department; and Forestwood.

This agency sample excludes a number of smaller, higher-education agencies involved in agricultural research such as the Faculty of Agriculture of the University of North West, the Faculty of Applied Natural Sciences, School of Agriculture at the University of Zululand.

3. Unless otherwise stated, all data on research expenditures are reported in 1993 international dollars.
4. "disadvantaged communities" refer to those communities, or racial groups that were discriminated against under the former apartheid dispensation.
5. Unlike the ARC, the CSIR is structured according to divisions, which essentially reflect clusters of related research activities amongst the various units and former institutes.
6. ICFR was established in 1984, evolving out of the Wattle Research Institute, which was established in 1947.
7. Data are calculated as least squares growth rates.
8. The latter reflects the relatively high level of investment by Mauritius in sugar research.

METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI, ISNAR, and ASARECA 2001-02) and ARC data (ARC 2002a and b).
- The data were compiled using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1994; UNESCO 1984). We grouped estimates using three major institutional categories—government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and nonprofit institutions. We defined public agricultural research to include government agencies, higher-education agencies, and nonprofit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre, on, and postfarm technologies related to agriculture.
- Agricultural research includes crops, livestock, forestry, and fisheries research plus agriculturally related natural resources research, all measured on a performer basis.
- Financial data were converted to 1993 international dollars by deflating current local currency units with a South African GDP deflator of base year 1993 and then converting to U.S. dollars with a 1993 purchasing power parity (ppp) index, both taken from World Bank (2003). Ppp's are synthetic exchange rates used to reflect the purchasing power of currencies, typically comparing prices among a broader range of goods and services than conventional exchange rates.
- The salaries and living expenses of many expatriate researchers working on donor-supported projects are paid directly by the donor agency and are often excluded in the financial reports of the agricultural R&D agencies. These *implicit* costs have been estimated using the average cost per researcher in 1985 to be \$160,000 1993 international dollars and backcasting this figure using the rate of change in real personnel costs per full-time researcher in the US state agricultural experiment station system. This extrapolation procedure has the assumption that the personnel-cost trend for US researchers is a reasonable proxy of the trend in real costs of internationally recruited staff in the agricultural R&D agencies.

See the ASTI website (<http://www.ASTI.cgiar.org>) for more details on methodology.

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