

RESEARCH AND DEVELOPMENT IN THE SOUTH AFRICAN PUBLIC SECTOR

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Since 2012, the public sector has consistently outperformed the private sector when it comes to expenditure on research and experimental development (R&D). Continued investment, by both sectors, in R&D personnel and infrastructure will help to ensure South Africa advances the frontiers of knowledge as well as tackles its most pressing development problems.

This Research Brief highlights the public sector as a *performer* of research. It focuses on expenditure amounts and categories, types and fields of research performed, and human resources devoted to R&D. It also evaluates the public sector as a *funder* of research, highlighting its potential to play a catalytic role in strengthening the national innovation system.

***Note:** The South African National Survey of Research and Experimental Development ('R&D Survey') is performed by the Centre for Science and Technology Innovation Indicators (CeSTII) on behalf of the Department of Science and Technology (DST). Data showcased in this Brief is drawn from the R&D Survey's 2015/16 reference period.

Why is R&D in the public sector vital to South Africa's future growth and development?

South Africa's gross domestic expenditure on R&D (GERD) amounted to R32.337 billion in 2015/16, reflecting a research intensity ratio of 0.80% (measured by GERD as a percentage of GDP). The current 0.80% falls significantly below the stated target of 1.5%, signalling a national investment shortfall. Nevertheless, in 2015/16 R&D performance in the public sector accounted for more than half (54.5%) of total R&D expenditure in South Africa, or R17.630 billion (Box 1), reflecting government's commitment to foster R&D capability within the national system of innovation. Indeed, expanding R&D investment in the South African public sector can help to ignite economic growth, societal transformation and inclusive development — whether through the creation and application of knowledge in the immediate public interest, or through so-called 'blue skies' research.

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Box 1. Defining R&D within the public sector

South Africa's R&D Survey collects data in accordance with the guidelines recommended by the OECD in the *Frascati Manual* (OECD, 2002, 2015). Its scope includes all entities performing R&D, and covering the four main institutional 'sectors': business enterprise, government, private not-for-profit, and higher education sectors. The overarching 'private sector', as defined within the R&D Survey, therefore includes for-profit businesses, state-owned enterprises, and not-for profit organisations; while the overarching 'public sector' comprises government departments, higher education institutions, and science councils.

Sampling methods per institutional type vary: for businesses and not-for profit organisations, the R&D Survey follows a purposive sampling method of all known or 'most-likely-to-perform-R&D' organisations. Government departments, higher education institutions and science councils are surveyed using a census approach. Data inputs collected include R&D expenditure and human resources devoted to R&D, and money amounts are expressed in current ZAR.

Statistics on R&D employees are headcounts by researchers (includes postdoctoral fellows and doctoral students), technicians and other support personnel directly supporting R&D. A unit is considered as a response if it completed and returned a questionnaire with non-zero in-house R&D expenditure. Only aggregated data is published to ensure confidentiality of an organisation's information, as required by the Statistics Act (No. 6 of 1999). To access the South African National Survey of Research and Experimental Development 2015/16, go to <https://qoo.gl/TjGaqi>.

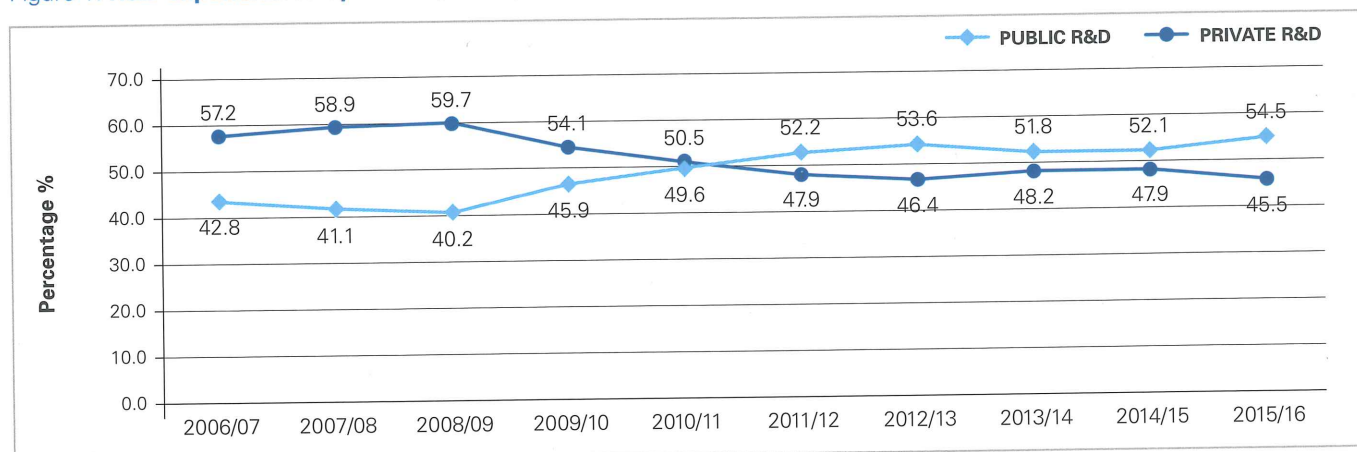
Historically, the private sector has been the largest R&D performer in South Africa, though from 2011/12 onwards the public sector exceeded the private sector in this regard; a pattern that is expected to continue (Figure 1). Indeed, South Africa's most recent R&D Survey data shows that R&D performance in the public sector has increased steadily over time, with expenditure reaching a sum value of R17.630 billion in 2015/16. This reflects a 15.4% increase from the R15.275 billion public sector R&D expenditure total reported in 2014/15 (Table 1).

Table 1. R&D expenditures by sector (R'000), South Africa, 2006/07 to 2015/16

YEAR	GERD R'000	PUBLIC SECTOR R'000	PRIVATE SECTOR R'000
2006/07	16 520 584	7 064 881	9 455 703
2007/08	18 624 013	7 662 355	10 961 658
2008/09	21 041 046	8 468 385	12 572 661
2009/10	20 954 677	9 626 600	11 328 077
2010/11	20 253 805	10 031 965	10 221 840
2011/12	22 209 192	11 574 565	10 634 627
2012/13	23 871 219	12 796 660	11 074 559
2013/14	25 660 573	13 294 560	12 366 013
2014/15	29 344 977	15 275 254	14 069 723
2015/16	32 336 679	17 630 542	14 706 138

Source: SA R&D Survey, 2015/16

Figure 1. R&D expenditures by sector (R'000), South Africa, 2006/07 to 2015/16



Source: SA R&D Survey, 2015/16



Policy Implication: While the increase in public sector R&D is a sign of government's commitment to knowledge-intensive growth in South Africa, deepening this commitment through continued investment is needed to ensure that the knowledge-intensive growth goal is coupled with inclusive development objectives. Investment in R&D in the private sector also remains essential to stimulate economic growth through advancement of a more competitive environment by encouraging local firms to develop their own capabilities and rely less on imported technologies.

What are the key expenditure trends in public sector R&D?

The overall sectoral breakdown of 2015/16 public sector R&D expenditure reflects R9.877 billion (56.0%) spent in higher education institutions, R5.741 billion (32.6%) in science councils, and R2.013 billion (11.4%) in government. Patterns of R&D investment by accounting category provide a useful basis for review and forward planning of capital expenditure in critical R&D infrastructure. For example, in 2015/16 the public sector spent R2.376 billion (7.4%) on capital assets and R15.253 billion (47.2%) on current expenditure items.² Overall, R&D costs are largely driven by costs related to human resources; and this is evident in the labour cost data reported in 2015/16 (Table 2) — in both the public (R8.417 billion) and private (R8.291 billion) sectors. Notably, the proportion of labour costs has been increasing at a faster rate than capital and other current expenditures.³ Also notable is that while total labour cost in the public and private sectors remains on par, the number of people employed in the two sectors differs significantly (see personnel data in Table 5).

Table 2. R&D expenditures by expense categories (R'000), South Africa, 2015/16

TYPE OF EXPENDITURE	CAPITAL EXPENDITURE			CURRENT EXPENDITURE			TOTAL R&D EXPENDITURE
	Total Capex	Land: buildings and other structures	Vehicles, plant, machinery, equipment	Total current costs	Labour costs	Other current expenditure	
Expenditures R'000							
Private sector	1 343 029	204 787	1 138 242	13 363 109	8 290 748	5 072 361	14 706 138
Public sector	2 377 594	506 844	1 870 750	15 252 948	8 417 101	6 835 848	17 630 542
National	3 720 622	711 631	3 008 992	28 616 057	16 707 849	11 908 208	32 336 679
Proportional R&D expenditure (%)							
Private sector	4.2	0.6	3.5	41.3	25.6	15.7	45.5
Public sector	7.4	1.6	5.8	47.2	26.0	21.1	54.5
National	11.5	2.2	9.3	88.5	51.7	36.8	100.0

Source: SA R&D Survey, 2015/16

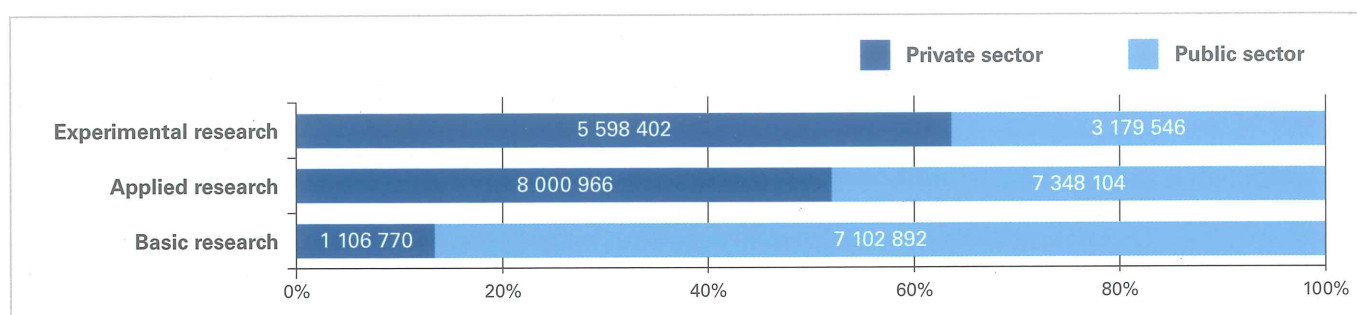
In 2015/16, the proportional split of South Africa's national R&D expenditure by research type appears as follows: basic research (25.4%); applied research (47.5%); and experimental development (27.1%). Figure 2 demonstrates that the majority of basic research was performed in the public sector (R7.103 billion), while the more technology intensive, applied and experimental development research was performed in the private sector (R13.599 billion). Sectorally, the science councils and government sector devoted more funds to applied and experimental development research, a total of R 6.047 billion (Figure 3). This is perhaps encouraging, considering the primary mandates of science councils to conduct research intended to tackle major developmental issues such as poverty, energy, disease, and food security.

In the public sector, higher education represented the largest performer of basic research (Figure 3), reinforcing its role as the knowledge generator in the national system of innovation. While certain investment or policy horizons may favour applied research for its direct links to technological or economic gain, it is essential that basic research receive adequate support due to its fundamental purpose as generating the building blocks for the creation of knowledge.

² Includes labour costs and the associated expenses to perform R&D.

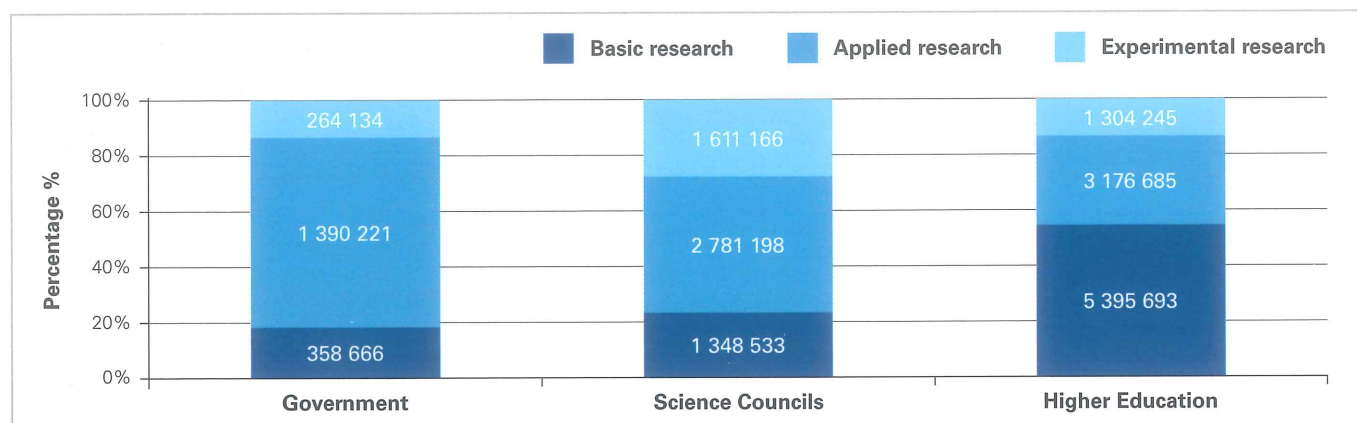
³ Full data set available in the South African National Survey of Research and Experimental Development: Statistical Report 2015/16 (CeSTII, 2017a). Available from: <https://goo.gl/TjGagj>

Figure 2. R&D expenditures by type of research performed (R'000), South Africa, 2015/16



Source: SA R&D Survey, 2015/16

Figure 3. R&D expenditures by type of research performed (R'000) in the public sector, South Africa, 2015/16



Source: SA R&D Survey, 2015/16

In terms of expenditure within research fields, the largest share of GERD was devoted to the Natural Sciences, Technology and Engineering division (79.1%), while Social Sciences and Humanities division attracted 20.9% of total R&D expenditure in 2015/16 (Table 3). In the 2015/16 reference period, the specific research fields attracting the highest proportion of R&D funding in the public sector were natural sciences (16.1%), medical and health sciences (10.7%) and social sciences (11.0%); while the private sector performed more R&D in the engineering and technology sciences (13.7%). Notably, the public sector reported a relatively high proportion of GERD within the social sciences category (11.0%) in the 2015/16 reference period, of which the bulk was performed in the higher education sector. It is perhaps concerning to note a low level of investment in the agricultural sciences in both the public (5.7%) and private (2.3%) sectors, considering the South African and global challenges associated with food security (Labadarios et al, 2011).

Table 3. Classification and distribution by Fields of Research and Development (FORD), South Africa, 2015/16

Fields of Research and Development (FORD)	R&D investment (R000's)			Percentage contribution (%)		
	Public sector	Private sector	Total GERD	Public sector	Private sector	Total
1. Natural Sciences ⁴	5 203 905	4 126 371	9 330 276	16.1	12.8	28.9
2. Engineering and Technology	2 829 173	4 440 282	7 269 454	8.7	13.7	22.5
3. Medical and Health Sciences	3 473 979	2 915 476	6 389 455	10.7	9.0	19.8
4. Agricultural Sciences	1 841 588	731 921	2 573 509	5.7	2.3	8.0
Sub-Total: Natural Sciences, Technology and Engineering	13 348 646	12 214 049	25 562 695	41.3	37.8	79.1
5. Social Sciences	3 558 955	2 484 851	6 043 806	11.0	7.7	18.7
6. Humanities	722 941	7 238	730 179	2.2	0.0	2.3
Sub-Total: Social Sciences and Humanities	4 281 896	2 492 089	6 773 985	13.2	7.7	20.9
Total R&D	17 630 542	14 706 137	32 336 679	54.5	45.5	100.0

Source: SA R&D Survey, 2015/16

⁴ Natural sciences include: Mathematics, Computer and information sciences, Physical sciences, Chemical sciences, Earth and related environmental sciences, Biological sciences, Other natural sciences



Policy Implication: Overall levels of investment in R&D activities could be enhanced by means of increased investment in public research infrastructures. Over the longer-term, this can strengthen institutions to deliver on their mandates more efficiently and effectively. It can also contribute to placing South Africa in a favourable position to attract more domestic and international investment in R&D, potentially leading to increased R&D capacity and positively impacting the human resources linked to R&D.

Where does public sector funding for R&D go?

The largest funder of R&D nationally, the South African government, funded 44.6% of the country's R&D in 2015/16 (R14.425 billion), and higher education institutions and science councils continued to be the largest recipients of government funding. The business sector (excluding NPOs) was the second-largest funder of R&D, contributing 38.9% (R12.578 billion) towards total R&D funding (Table 4), with the balance composed of foreign funds (13.0%) and other SA sources (3.5%) (Figure 4). It is also evident that the business sector largely funds itself, given the increasing awareness of the economic benefits of companies investing in R&D.

Box 2. To what extent should the public sector fund private sector R&D?

Public funding of R&D in the private sector is important to creating the conditions that foster investment in R&D and innovation. The South African government has implemented a variety of instruments, such as the Support Programmes for Industrial Innovation (SPII), which drive the development of enhanced products and process, as well as human resource development through the Technology and Human Development Programme (THRIP). The introduction of a tax incentive programme for investment in R&D by firms was also introduced with an explicit aim to stimulate innovation in the private sector. Learn more: <https://goo.gl/S9zzag>

The third-largest source of funding for R&D in 2015/16 was from abroad (R4.210 billion) (Table 4). R&D funding from abroad shows fluctuations across the institutional sectors over the years, but reflects increases across all sectors in 2015/16. The largest share of foreign funding was received by the business (36.4%) and higher education (28.7%) sectors.

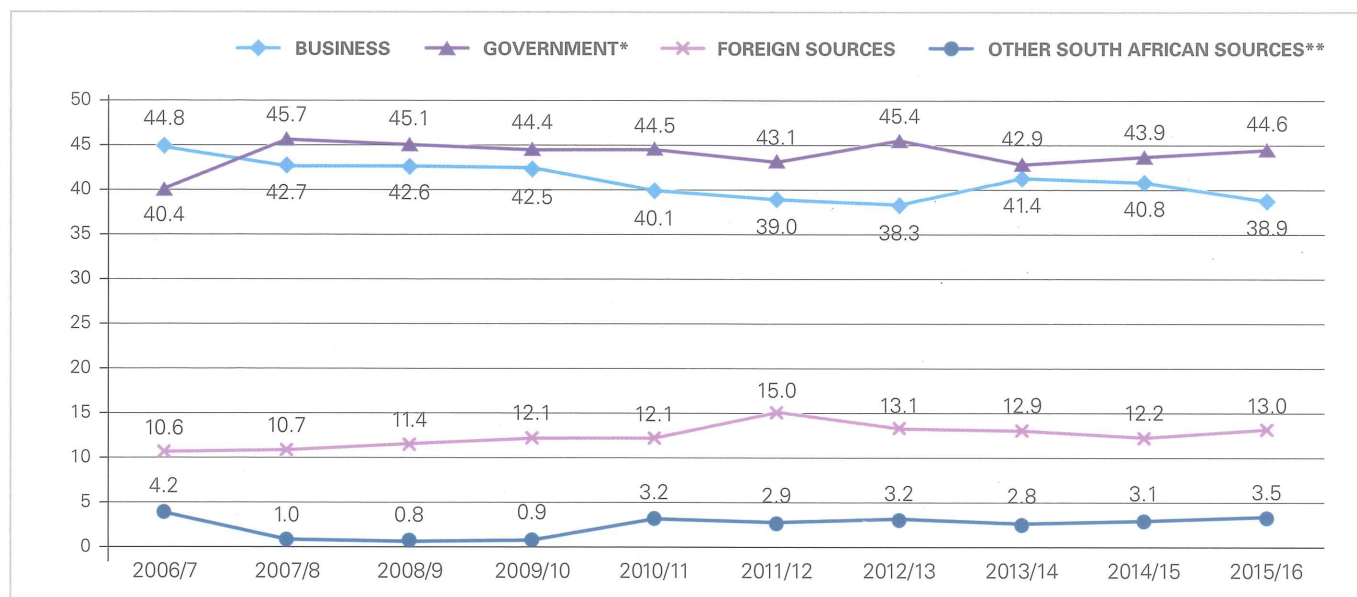
Table 4. Funding for R&D by source (R'000), South Africa, 2006/07 to 2015/16

YEAR	TOTAL FUNDS	GOVERNMENT*	BUSINESS	FOREIGN SOURCES	OTHER SOUTH AFRICAN SOURCES**
	R'000	R'000	R'000	R'000	R'000
2006/07	16 520 570	6 672 138	7 399 660	1 746 865	701 907
2007/08	18 624 059	8 510 101	7 945 949	1 987 082	180 927
2008/09	21 041 046	9 497 510	8 973 490	2 394 827	175 219
2009/10	20 954 676	9 313 028	8 907 527	2 538 439	195 682
2010/11	20 253 805	9 018 874	8 128 246	2 445 009	661 676
2011/12	22 209 192	9 561 917	8 663 105	3 330 496	653 674
2012/13	23 871 219	10 831 893	9 152 042	3 116 984	770 300
2013/14	25 660 573	11 007 083	10 615 902	3 315 227	722 361
2014/15	29 344 977	12 873 458	11 981 974	3 566 015	923 530
2015/16	32 336 679	14 425 992	12 578 499	4 209 861	1 122 328

* Includes science council and university own funds.
 ** Includes funds from higher education institutions, not-for-profit organisations and individual donations disbursed to all sectors.

Source: SA R&D Survey, 2015/16

Figure 4. Proportional funding for R&D by source, South Africa, 2006/07 to 2015/16



Source: SA R&D Survey, 2015/16

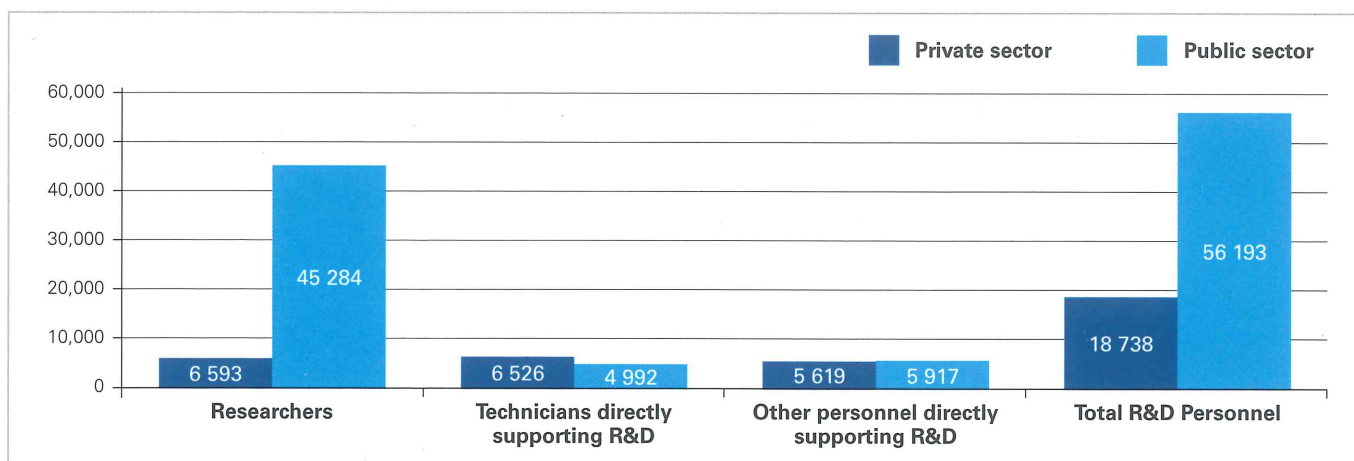


Policy Implication: The public sector has become a major performer and the major funder of R&D in South Africa. Only through a combination of significant increases to private sector investment in R&D, international cooperation, as well as by National Treasury committing to prioritise STI investment across the government, can the national target of 1.5% of GDP spent on R&D be considered as realistic and achievable.

What is the breakdown of the R&D workforce in the public sector?

Statistics on science and technology personnel can provide insight into the nature of the highly skilled workforce that is required to perform R&D within a national system of innovation. The headcount of national R&D personnel in 2015/16 was 74 931, a 3.5% increase from the 72 400 headcounts in 2014/15. In 2015/16, the majority of South Africa's R&D workforce (75.0%) were employed in the public sector: of a total of 51 877 researchers, 45 284 (87.3%) researchers (including students) were located in the public sector, with the highest concentration to be found in higher education institutions (Figure 5). R&D Survey data trends suggest that the growth of R&D personnel is primarily influenced by increases in the number of researchers in the public sector, particularly at the level of postgraduate students.

Figure 5. Total R&D personnel, South Africa, 2015/16



Source: SA R&D Survey, 2015/16

Gender analysis of R&D personnel reveals that the combined share of women in R&D in both the public and private sector comprises just under half of the total R&D personnel. Female personnel accounted for 35.3% and 9.1% of the total R&D workforce in the public and private sectors respectively (Table 5). The R&D Survey's *Main Analysis Report* reported a total 23 334 female researchers in 2015/16 (CeSTII, 2017b).

The majority of female researchers in South Africa were employed in the public sector. When compared to the full quantum of researchers, females accounted for 40.3% in the public sector, while the private sector only accounted for a low 4.7% of total researchers.

In the same reference period, a total of 13 269 researchers had a PhD qualification, of which 24.1% were employed in the public sector and only 1.4% in the private sector. Only 9.4 % and 0.4% of female researchers holding a doctoral degree were accounted for in the public and private sectors.⁵ African researchers holding a PhD totalled 4 865 in 2015/16. This reflects a low percentage of 9.1% in the public and 0.3% in the private sector, as a proportion of the total researchers in the country.

Table 5. **R&D Personnel categories in the public & private sectors, South Africa, 2015/16**

R&D Personnel categories	Sector			Percentage contribution (%)	
	Public	Private	Total	Public	Private
R&D personnel	56 193	18 738	74 931	75.0	25.0
Total female R&D personnel	26 463	6 832	33 295	35.3*	9.1*
R&D researchers	45 283	6 593	51 877	87.3	12.7
Total female researchers	20 892	2 442	23 334	40.3**	4.7**
	Public	Private	Total	As percentage of total researchers (%)	
Researchers with a PhD	12 528	741	13 269	24.1	1.4
Female researchers with a PhD	4 883	224	5 130	9.4	0.4
African researchers with a PhD	4 715	150	4 865	9.1	0.3

* Percentage of total R&D personnel (%)
 ** Percentage of total Researchers (%)

Source: SA R&D Survey, 2015/16



Policy Implication: South Africa's human resource capacity in the domain of R&D has grown since 2001/02. The growth of R&D personnel is influenced by increases in the number of researchers in the public sector, specifically postgraduate students. The ability of the national system of innovation to absorb these researchers is a critical issue to ensure the system performs robustly over the longer run. South Africa has invested significantly in addressing imbalances in equity in the scientific labour force, and transformation of human resources is increasingly evident in the R&D landscape. However, more intense efforts are required to ensure the attainment of transformation goals and to combat the slow pace of transformation visible in both the public and private sectors. This slow transformation is specifically noticeable in the relatively low number of African females with a PhD.

⁵ Female researchers with a PhD includes postdoctoral fellows but excludes doctoral students. A total 20 154 of the R&D workforce are in the process of obtaining a doctoral degree, of which 11 055 are male and 9 099 female.

Ideas for policy

1

Expanding investment in public research institutions, including universities and science councils, can help to ensure greater coherence and alignment between societal challenges and the knowledge-based solutions required to address these challenges.

2

Growing public expenditure in research infrastructures and personnel specifically can help to gear South Africa's national system of innovation to attract expertise and R&D investment.

3

Diverse but complementary resource pools are required for South Africa to reach its goal of spending 1.5% of its GDP on R&D. To expand these resources pools within the public sector requires mobilisation of both national and international cooperation, resources and networks.

4

To the extent that the vast majority of R&D personnel is employed in the public sector, transformation is a pressing national priority. Also pressing is the need for the national system of innovation to expand its absorptive capacity for trained R&D personnel at different levels, particularly in a global context of rapid technological change.

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The Centre for Science, Technology and Innovation Indicators (CeSTII) is a statistical and policy research institute based at South Africa's Human Sciences Research Council (HSRC). CeSTII performs national surveys that underpin benchmarking, planning and reporting on R&D, innovation and technology transfer in South Africa. Our Research Briefs are concise papers based on our ongoing work. Their goal? To provide empirical evidence and informed opinion that policy- and decision-makers can use to strengthen the quality of their thinking and action.

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