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Department of Agricultural Research

BOTSWANA

RECENT DEVELOPMENTS IN PUBLIC AGRICULTURAL RESEARCH

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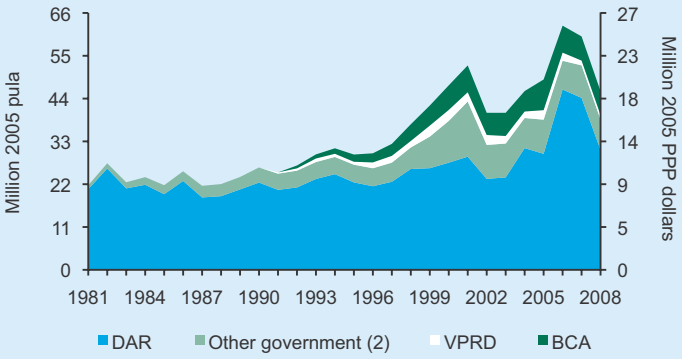
LONG-TERM INVESTMENT AND CAPACITY PATTERNS IN PUBLIC AGRICULTURAL R&D

Agriculture's contribution to Botswana's gross domestic product (GDP) fell dramatically from 44 percent at independence in 1966 to less than 2 percent in 2008, mainly due the increased economic importance of mining, tourism, manufacturing, and the services industry (World Bank 2010). Despite Botswana's arid climate and the sector's declining contribution to formal employment, agriculture remains important as a source of food, income, and employment for a large proportion of the population, particularly in rural areas. Given that productivity gains are critical to maintaining and enhancing competitiveness of Botswana's commodities and advancing the status of the rural poor, agricultural research and development (R&D) should remain a top priority in national development planning. For most of the 1990s, agricultural R&D investments in Botswana increased steadily (Beintema, Modiakgotla, and Mazhani 2004). This trend continued until 2007, albeit more erratically, but in 2008 investments plunged suddenly. That year, the country as a whole spent 46 million Botswanan pulas or 19 million purchasing power parity (PPP) dollars on agricultural research, both in 2005 constant prices (Figure 1, Table 1). Note that, unless otherwise stated, all dollar values quoted

Key Trends Since 2000

- Overall, agricultural research and development (R&D) spending rose rapidly in Botswana until 2007, after which it fell in response to spiraling inflation levels, which prompted the government to cut funding to many public-sector agencies.
- Agricultural R&D capacity levels followed a similar trend. The Department of Agricultural Research (DAR) has serious difficulties attracting and retaining well-qualified staff because of its low salary levels compared with parastatals such as the Botswana College of Agriculture (BCA) and the National Food Technology Research Centre (NFTRC).
- Compared with R&D staff in many other countries in the region, Botswana's pool of agricultural researchers is younger and less qualified in terms of postgraduate degrees.
- The country's agricultural R&D is almost entirely funded by the government. Donor funding plays a negligible role.

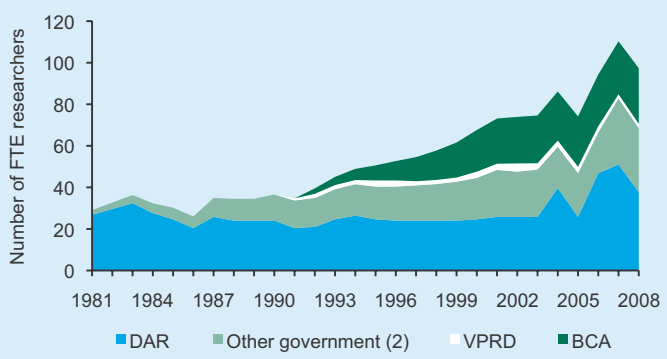
Figure 1—Public agricultural R&D spending adjusted for inflation, 1981–2008



Sources: ASTI–DAR 2009–10; Beintema, Modiakgotla, and Mazhani 2004.

Notes: The figure in parentheses indicates the number of other government agencies. For more information on coverage and estimation procedures, see the Botswana country page on ASTI's website at www.asti.cgiar.org/botswana.

Figure 2—Public agricultural research staff in full-time equivalents, 1981–2008



Sources: ASTI–DAR 2009–10 and Beintema, Modiakgotla, and Mazhani 2004.

Notes: The figure in parentheses indicates the number of other government agencies. Given the large share of time DAR spends on seed multiplication and range management, its share of FTE scientists has been revised downward to 60 percent. Hence, overall R&D staff numbers in this note differ from those previously published by Beintema, Modiakgotla, and Mazhani (2004).

Table 1—Overview of public agricultural R&D spending and research staff levels, 2008

Type of agency	Total spending			Total staffing	
	Botswanan pulas	PPP dollars	Shares	Number	Shares
	(million 2005 prices)		(%)	(FTEs)	(%)
DAR	30.8	12.7	67.2	37.8	39
Other government (2)	7.8	3.2	16.9	30.8	32
VPRD	1.2	0.5	2.5	2.0	2
BCA	6.1	2.5	13.4	26.8	27
Total (5)	**45.9**	**19.0**	**100**	**97.4**	**100**

Source: ASTI–DAR 2009–10.

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

herein are based on PPP exchange rates, which reflect the purchasing power of currencies more effectively than standard exchange rates because they compare the prices of a broader range of local—as opposed to internationally traded—goods and services.[1] Agricultural R&D capacity levels in Botswana also rose considerably during 2000–07, falling somewhat in 2008. The country employed 97 full-time equivalent (FTE) researchers in 2008, up from 68 FTEs in 2000 (Figure 2).

The Department of Agricultural Research (DAR), under the Ministry of Agriculture, is Botswana's principal agricultural research agency, accounting for close to 40 percent of the country's agricultural R&D staff and two-thirds of its agricultural R&D expenditures in 2008. DAR is headquartered in Gaborone and comprises three divisions: the Arable Research Division, the Animal Production and Range Research Division, and the Support Services Division. Research activities encompass crops (including cereal crop improvement, horticulture, oil seeds, grain legumes, crop pest and disease management, and water and soil management) and livestock management (including work on animal breeding, dairy, small livestock, feed, and sustainable deployment of range resources). In addition, DAR provides research support services in seed production and certification; soil, plant, and feed analysis; and genetic resources conservation (DAR 2009). DAR is also endowed with experiment stations in a number of locations dispersed across the country. In addition, DAR is the country's National Biosafety Authority, fulfilling the mandate of ensuring the safe use, handling, and transboundary distribution of living modified organisms for sustainable conservation of biodiversity.

Although research is DAR's primary mandate, a large part of the department's overall spending is allocated to seed production and the management of rangelands. It was estimated that DAR's scientists spend 60 percent of their time on research and the balance on other activities. DAR has had difficulties attracting and keeping qualified research staff and has lost a large number of staff to parastatals that are able to offer higher salaries.[2] In order to redress these staff resignations, large-scale recruiting, mostly of junior scientists who are recent university graduates, has occurred since the turn of the millennium. DAR's total agricultural researcher capacity doubled from 23 FTEs in 2002 to 46 FTEs in 2006, but by 2008 numbers had once again fallen to 38 FTEs. Similarly, DAR's overall spending decreased by more than 20 percent during 2007–08. As a result of the country's spiraling inflation levels in 2008, the Government of Botswana reduced its yearly budget allocations to many public-sector agencies, including DAR.

Two other government agencies are involved in agricultural R&D in Botswana: The National Veterinary Laboratory (NVL) and the National Food Technology Research Centre (NFTRC). NVL falls under the Ministry of Agriculture's Department of Animal Health and Production. In 2008, the laboratory employed 29 FTEs in agricultural R&D to focus on livestock disease diagnosis and control; applied research designed to maintain the health, welfare, and production of farm animals; and the preservation of high meat hygiene standards. All of NVL's R&D activities are conducted at a laboratory in Gaborone. NFTRC, a parastatal, has the most modern R&D facilities in the country. Based in Kanye, its mission is to generate food technologies that enhance economic diversification, food security, and quality through sustained R&D focused on end users. In 2008, 2 FTE researchers were involved in agricultural research; the majority of NFTRC's remaining researchers conducted related—but not strictly agricultural—research (including biochemistry, microbiology, and nutrition and dietetics research), and are therefore not included in further analysis in this note.

One nonprofit agency was identified as conducting agricultural R&D in Botswana: Veld Products Research and Development (VPRD), which specializes in nontimber forest products and is located in Gabane west of Gaborone.[3] In 2008, the agency accounted for just 2 percent of the country's agricultural R&D expenditures and capacity. VPRD carries out nursery-based research and field activities, develops a wide range of veld products, and investigates suitable management systems for natural resources in order to ensure sustainable utilization.

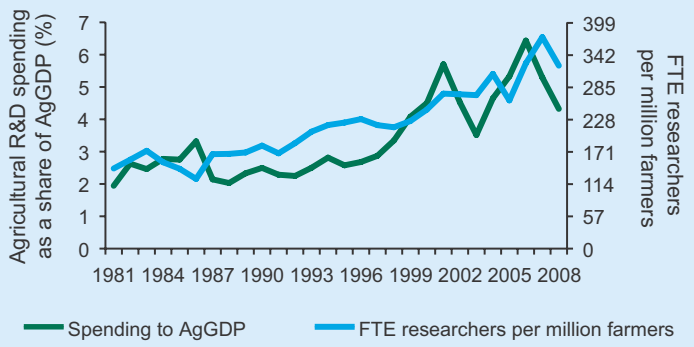
The Botswana College of Agriculture (BCA), established in 1966, is a parastatal under the Ministry of Agriculture and associated with the University of Botswana. Although BCA has always maintained close links with DAR (and is located adjacent to DAR's headquarters in Gaborone), the college's agricultural R&D activities only began in 1992. Activities have been expanded significantly since then, and in 2008, BCA accounted for more than a quarter of Botswana's total agricultural R&D capacity. BCA's

ASTI Website Interaction

- More details on institutional developments in agricultural research on Botswana are available in the 2004 country brief at asti.cgiar.org/pdf/Botswana_CB_19.pdf.
- Underlying datasets can be downloaded using ASTI's data tool at asti.cgiar.org/data.
- A list of the 3 government, 1 nonprofit, and 1 higher education agencies included in this brief is available at asti.cgiar.org/botswana/agencies.

www.asti.cgiar.org/botswana

Figure 3—Intensity of agricultural research spending and capacity, 1981–2008



Sources: Calculated by authors from Beintema, Modiakgotla, and Mazhani 2004; FAO 2009; ASTI–DAR 2009–10; and World Bank 2010.

27 FTE agricultural researchers focused on a variety of areas including crops, livestock, forestry, environmental sciences, and socio-economics. In 2007, research at BCA was consolidated under three streams relating to crops, livestock, and socioeconomics. Drought is the main research theme under crop research, and crop marketing strategies is an important focus of socioeconomic research.

Private companies play a limited role in agricultural R&D in Botswana, but the Centre for Applied Research (CAR) is an important exception. CAR was established in 2000 in response to the growing demand for high-quality contract-based research. Unfortunately, lack of available data precludes CAR's inclusion in the analysis in this note.

In 2008, 32 percent of Botswana's agricultural researchers were female (ASTI–AWARD 2009), which was well above the African average (Beintema and Stads 2011). NVL employed comparatively more female researchers (50 percent) than DAR (27 percent) or BCA (28 percent). Botswana's 2008 support-staff-per-researcher ratio averaged 1.3, consisting of 0.6 technicians, 0.1 administrative support staff, and 0.6 other support staff per scientist (ASTI–DAR 2009–10).

Total public agricultural R&D spending as a percentage of agricultural output (AgGDP)—a commonly used indicator of comparative agricultural R&D spending across countries—increased rapidly during 1996–2001 but followed a highly volatile trend thereafter. In 2008, the country invested $4.32 on agricultural research for every $100 of agricultural output (Figure 3), which is among the highest shares in Africa and the developing world. In comparison, the 2008 average for Sub-Saharan Africa as a whole was 0.61 (Beintema and Stads 2011). The cause for Botswana's exceptionally high agricultural research intensity has little to do with high investment levels, but rather reflects the small size of the country's agricultural sector and hence its AgGDP. Research intensity ratios are often higher in countries with small populations and high per capita income levels. This is logical when you consider that human and capital investments have a fixed base component, regardless of population size, especially when facilities and services are spread across the country (Pardey, Roseboom, and Anderson 1991). The number of agricultural FTE researchers per million farmers increased steadily until 2007, after which the ratio fell somewhat. In 2008, Botswana employed 323 FTE agricultural researchers for every million farmers, which again is well above corresponding ratios in most other African countries.

ASTI Website Interaction

- Detailed definitions of PPPs, FTEs, and other methodologies employed by ASTI are available at asti.cgiar.org/methodology.
- The data in this note are predominantly derived from surveys. Some data are from secondary sources or were estimated. More information on data coverage is available at asti.cgiar.org/botswana/datacoverage.
- More relevant resources on agricultural R&D in Botswana are available at asti.cgiar.org/botswana.

www.asti.cgiar.org/botswana

INSTITUTIONAL STRUCTURE AND POLICY ENVIRONMENT

The institutional structure of agricultural R&D in Botswana has changed little since the turn of the millennium. Some important changes have occurred at the ministerial level, however. The Department of Research, Science, and Technology (DRST) was established in 2004 under the Ministry of Infrastructure, Science, and Technology (MIST). DRTST's mandate is to coordinate and provide an enabling environment for science and technology (S&T) in Botswana. A key responsibility has been to define and justify the research products and services being funded by the ministry. Another has been to create a planning and reporting system for the research institutions to assure the government that institutions will be scientifically and financially viable long term (SADC 2008). Nevertheless, despite some high-level consultative meetings and the establishment of MIST, Botswana still lacks a national S&T policy. Most agricultural R&D agencies are organized under separate administrative units with little or no interagency coordination, and this has led to a duplication of research efforts and wastage of scarce resources (SADC 2008).

DAR's effectiveness is constrained by inefficient and bureaucratic government procedures and systems. Some believe that DAR would be better able to prioritize and focus its activities as a parastatal body, with less government intervention, including the ability to set higher salary levels. A recent proposal to remove DAR from the Ministry of Agriculture was rejected by the Ministry, and another submission proposing a merger with BCA to eliminate duplication of activities has yet to move beyond the discussion phase. The recent absorption of NFTRC into the Ministry of Agriculture has also fueled talk of a potential merger between DAR and NFTRC, but no change is foreseeable for the time being.

DEGREE LEVELS AND TRAINING OF RESEARCH STAFF

In 2008, 59 percent of agricultural researchers employed in Botswana were trained to the postgraduate level, with 24 percent holding PhD degrees and 35 percent holding MSc degrees (Figure 4). Consistent with developing countries around the world, the higher education sector reported a much higher share of researchers with PhD degrees (47 percent) compared with DAR (17 percent) and the two other government agencies combined (12 percent). Despite an overall drop in the share of postgraduate scientists in Botswana's agricultural R&D agencies, the absolute number of MSc- and PhD-qualified researchers increased during 2001–08. In 2008, 24 FTE researchers held PhD degrees and 34 held MSc degrees compared with 13 and 27 FTE researchers, respectively, in 2001. In addition, the total number of BSc-qualified researchers almost doubled during this period, from 21 to 40 FTEs. As already established, since the turn of the millennium, DAR has recruited a large number of young college graduates, holding only BSc degrees, who receive on-the-job training from their more senior and experienced colleagues.

Until 2007, BCA only offered BSc-level training, so scientists who wanted to pursue training beyond this level had to go abroad (mostly to South Africa, but also to Kenya, Zambia, Australia, the United Kingdom, and the United States). This ceased to be the case, at least for MSc training, with the introduction of 6 new MSc programs in agricultural sciences at BCA in 2007.

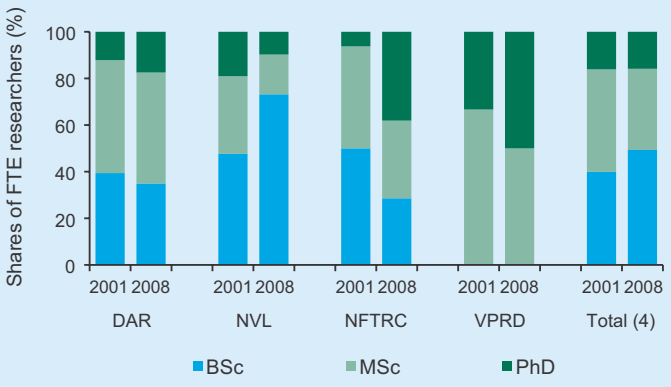
Being an upper middle-income country, Botswana is not a priority when it comes to donor funding. Unlike many of its African counterparts, the Government of Botswana funds the vast majority of postgraduate training for agricultural scientists, and the number of PhD-qualified scientists at DAR grew from 4 to 11 during 2001–04 as a result. Nevertheless, with the general decline in government funding to DAR, support for training has also decreased somewhat in recent years. As of 2010, five of DAR's researchers were pursuing PhD degrees in plant breeding at foreign universities, and one researcher had recently returned to DAR. In addition, since September 2008, the United Kingdom's Department for International Development (DFID) has provided funding for 8 DAR researchers to pursue MSc training through the Southern African Development Community (SADC). SADC and the International Atomic Energy Agency (IAEA) also fund training for NVL scientists.

NFTRC has taken important steps to build its capacity in recent years. Since 2000, a large number of NFTRC scientists have undertaken PhD training (mostly in South Africa). As a result, the number of PhD-qualified researchers at NFTRC rose from 1 to 10 (individuals, not FTEs) during 2001–09, although the extended leave of absence required for the training had a negative impact on research in the early 2000s. Most of the researchers that completed foreign training are relatively young and inexperienced. Attracting experienced staff able to conduct high-level research, monitor younger scientists, and secure future R&D funding has proved to be a challenge. NFTRC and BCA often compete for qualified staff. In addition, even though salary levels are higher at parastatals like NFTRC and BCA compared with DAR, they are still too low to attract experienced foreign scientists from countries like South Africa. In recent years, however, NFTRC has successfully recruited nutritionists from Jamaica to address some of its pressing capacity challenges.

BCA's yearly training budget, provided by the Government of Botswana, is roughly 5 million pula (in current prices). In 2009, about 40 research and technical staff from BCA were undertaking (mostly PhD) training at foreign universities. The W.K. Kellogg Foundation has also provided funding toward training for BCA staff. BCA is currently having difficulty recruiting professors, so many positions remain vacant. The situation is expected to improve somewhat as scientists begin to return from training abroad.

As previously indicated, unlike many other countries in Sub-Saharan Africa, Botswana is not afflicted with the challenge of an aging pool of agricultural scientists approaching retirement age. The average age of scientists at DAR and NFTRC is currently around 35 and 40 years, respectively. All DAR researchers are paid according to a civil servant pay scale, which explains the discrepancy in salaries between DAR and the parastatal agencies (including BCA), and the difficulty DAR faces in attracting and keeping well-qualified senior staff. To redress this situation, the government introduced the scarce skill allowance for senior civil servants in May 2008, offering specialized scientists with unique skills salaries of up to 40 percent above their scale. As of September 2010, however, this allowance was suspended until further notice due to implementation issues. Only MSc-qualified scientists were eligible for the allowance at DAR, and it acted as a disincentive for many staff members given the seemingly arbitrary definition of "scarce skills," which many scientists could not claim to possess. Capacity will continue to remain a challenge at DAR in the coming years without appropriate restructuring to enable the Department to compete for staff alongside the country's parastatal agencies.

Figure 4—Degree level of researchers by institutional category, 2001 and 2008



Source: ASTI–DAR 2009–10.
Note: The figure in parentheses indicates the total number of agencies.

INVESTMENT TRENDS

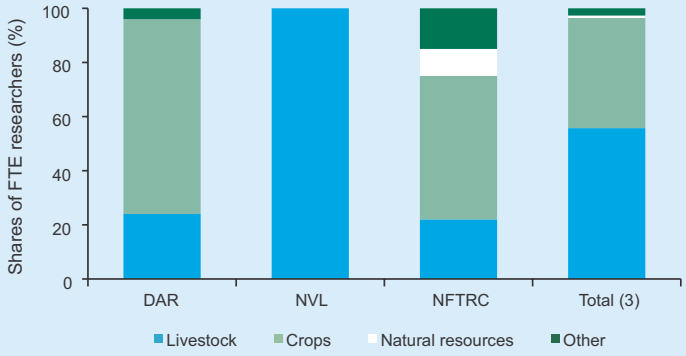
Cost Categories

The allocation of research budgets across salaries, operating costs, and capital investments affects the efficiency of agricultural R&D, so detailed cost category data were collected from the government agencies as part of this study. During 2001–08, salaries at DAR accounted for 49 percent of total expenditures, operating costs for 45 percent, and capital investments for 6 percent (Figure 5). The overall decline in spending during 2007–08 explains the increase in the share of salaries. Around the turn of the millennium, DAR invested considerably in its infrastructure, including offices, housing, farmhouses, and equipment, largely

Figure 5— DAR's cost category shares, 2001–08

Source: ASTI–DAR 2009–10.

Figure 6—Research focus by major commodity area, 2008



Source: ASTI–DAR 2009–10.

Notes: The figure in parentheses indicates the total number of agencies. BCA was excluded from the sample because of data unavailability.

because of the construction of three regional stations. The overall share of capital investments also increased during 2007–08.

Funding Sources

Agricultural R&D funding in Botswana is primarily financed by the national government. During 2005–08, the government accounted for 97 percent of DAR's total funding, with the private sector (including producers) and foreign donors contributing the remaining 3 percent. This situation sharply contrasts with other African countries that are highly dependent on donor funding for agricultural R&D, as well as and DAR's situation in the 1980s, when donor contributions represented one-third of the Department's total funding (Beintema, Modiakgotla, and Mazhani 2004). As previously mentioned, as an upper middle-income country, Botswana is not a priority country many foreign donors. A small component of DAR's program costs, however, is funded by donors such as the United Nations Environment Programme (UNEP). SADC has financed some training in recent years. DAR also raises a small amount of funding internally through the sale of products like vegetables, fruit, milk, and cattle.

More than 90 percent of NFTRC's budget is also funded by the government. An increasing share of the Centre's funding, however, is generated internally through commercialization trials for the private sector. Donor funding plays a limited role. Some donors, including Secure the Future, the Food and Agriculture Organization of the United Nations (FAO), and IAEA, have provided funding for specific projects in recent years. During 2003–09, VPRD received the bulk of its funding through England's Kew Gardens as part of a Kalahari plants, livelihoods, and community conservation project. The completion of the project in 2009 led to a severe drop in overall funding, resulting in the loss of staff jobs. In addition, Unilever South Africa financed a small two-year R&D program on the indigenous hoodia plant.

Research at BCA is funded by the national government and donor organizations. In 2008, the college received a total of 37.8 million (current) pula, 26.7 million of which was funded by the government and the remainder of which was funded through collaborative projects with the European Union and foreign (mainly British and Danish) universities. Just 1 million pula of the government budget was specifically allocated to research programs; the bulk of the funding supported salaries, training, and operating costs. BCA's overall research budget has increased in recent years now that more PhD-qualified scientists are returning to Botswana.

RESEARCH ALLOCATION

The allocation of resources across various lines of research is a significant policy decision, so detailed survey information was collected on the number of FTE researchers working in specific commodity and thematic areas. Livestock dominates Botswana's agricultural sector, accounting for 80 percent of agricultural output (SADC 2008). It is therefore not surprising that livestock research also dominates, forming the focus of 56 percent of the country's agricultural researchers in 2008 (Figure 6). That year crop research accounted for 41 percent of all FTE researchers, while the remaining researchers focused on natural resources, forestry, postharvest, and socioeconomic research.

Sorghum is the most researched crop in Botswana, accounting for 36 percent of the country's crop research (Table 2). Fruits and vegetables each accounted for 14 percent of all crop research, and groundnuts accounted for 13 percent. Other important crops include maize, millet, and wheat. The country's livestock researchers concentrated primarily on beef, dairy, and swine.

Table 2—Research focus by major crop, 2008

	DAR	NFTRC	VPRD	Total (3)
	Shares of FTE researchers (%)			
Sorghum	37.5	28.6	—	35.8
Vegetables	13.9	19.1	—	13.6
Fruits	13.9	19.1	—	13.6
Groundnuts	13.9	9.5	—	13.2
Maize	6.9	9.5	—	6.8
Millet	6.9	—	—	6.4
Wheat	6.9	—	—	6.4
Other crops	—	14.1	100	4.3
Total	**100**	**100**	**100**	**100**

Source: ASTI–DAR 2009–10.

Notes: The figure in parentheses indicates the total number of agencies. BCA was excluded from the sample because of data unavailability.

CONCLUSION

Botswana's agricultural R&D capacity and investments rose rapidly during 1995–2007. However, inflationary pressures and a considerable exodus of R&D staff from DAR, the country's principal public agricultural R&D agency, caused overall R&D investments and capacity levels to fall in 2008. That year, the country as a whole employed 97 FTE research staff and spent 46 million pula or 19 million dollars on agricultural R&D (both in 2005 PPP prices). Botswana has one of the highest agricultural R&D intensity ratios in Africa and the developing world, but this is not uncommon for a country with a small population and a relatively high per capita income.

Notwithstanding important government-funded training initiatives for DAR scientists leading to an overall increase in the number of PhD-qualified scientists since the turn of the millennium, the Department has serious difficulties attracting and retaining well-qualified staff because of its comparatively low government salaries. Many scientists have left DAR in favor of better-paying positions at parastatals, and DAR has been forced to fill most of these vacancies with recent university graduates. Advanced training for this relatively inexperienced pool of scientists should be a high priority in the coming years, as a critical mass of highly qualified research staff is crucial to producing high-level research and to securing future R&D funding, whether through regional competitive funds or other channels.

Parastatals, including BCA and NFTRC, are able to offer much higher salaries compared with DAR and therefore more easily attract well-qualified staff. The government will have to reconsider measures to increase DAR's competitiveness and to clearly identify its long-term R&D priorities and translate them into relevant, focused, and coherent R&D programs. Though talks of merging DAR with BCA or NFTRC have been ongoing, no firm plans have been made. For the time being, the Department will continue to face these fundamental challenges.

NOTES

[1] Financial data are also available in current local currencies or constant 2005 U.S. dollars via ASTI's Data Tool, available at www.asti.cgiar.org/data.

[2] A parastatal is an institution or organization in which the state holds a share; it is an independent company limited by guarantee.

[3] The term "veld" refers to large tracts of open rural land in southern Africa and, in particular, to certain flatter areas or districts covered in grass or low scrub.

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IFPRI is one of 15 agricultural research centers that receive their principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (www.cgiar.org).

DAR is Botswana's principal agricultural R&D agency. It was established in the late 1960s and falls under the administrative coordination of the country's Ministry of Agriculture. The institute holds a broad mandate covering crop and livestock management research. In addition, it provides research support services in seed production and certification; soil, plant, and feed analysis; and genetic resources conservation. To learn more about DAR visit http://www.dar.gov.bw.

The Agricultural Science and Technology Indicators (ASTI) initiative compiles, analyzes, and publishes data on institutional developments, investments, and human resources in agricultural R&D in low- and middle-income countries. The ASTI initiative is managed by the International Food Policy Research Institute (IFPRI) and involves collaborative alliances with many national and regional R&D agencies, as well as international institutions. The initiative, which is funded by the Bill & Melinda Gates Foundation with additional support from IFPRI, is widely recognized as the most authoritative source of information on the support for and structure of agricultural R&D worldwide. To learn more about the ASTI initiative visit www.asti.cgiar.org.

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