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Female Participation in African Agricultural Research and Higher Education: New Insights

Synthesis of the ASTI–Award Benchmarking Survey on Gender-Disaggregated Capacity Indicators

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ABSTRACT

Female farmers play a vital role in African agriculture, accounting for the majority of the agricultural workforce. However, agricultural research and higher education are disproportionately led by men. There is an urgent need for greater representation of women in the field of agricultural science and technology (S&T) in Sub-Saharan Africa. Female scientists, professors, and senior managers offer different insights and perspectives to help research institutes to more fully address the unique and pressing challenges of both female and male farmers in the region.

Gender-disaggregated data on S&T capacity are scarce, often lack sufficient detail, and focus more generally on S&T rather than on agriculture specifically. Data are not always comparable due to different methodologies and coverage. The Agricultural Science and Technology Indicators (ASTI) initiative and the CGIAR Gender & Diversity (G&D) Program partnered together to address this information gap. This report presents the results of an in-depth benchmarking survey on gender-disaggregated capacity indicators, covering 125 agricultural research and higher education agencies in 15 countries in Sub-Saharan Africa. This is the first study of its kind to present detailed human resources data on female participation in agricultural science, the main findings of which include the following:

- Total capacity in terms of the professional staff employed at the agricultural research and higher education agencies included in this study increased by 20 percent between 2000/01 and 2007/08, and women constituted almost half of this capacity increase. The female population of professional staff grew by eight percent per year on average, which is four times higher than the comparable rate of increase for the male population, indicating that the gender gap in African agricultural sciences is closing.
- The proportion of female professional staff employed at the sample agricultural research and higher education agencies increased from 18 percent in 2000/01 to 24 percent in 2007/08, but fewer women have advanced degrees compared to their male colleagues. In 2007/08, for example, 27 percent of the sample's professional women held PhD degrees compared with 37 percent of the sample's professional men.
- Of concern, about two-thirds of the overall (female and male) capacity increase comprised staff holding only BSc degrees, indicating that the overall quality of capacity in agricultural research and higher education is declining in some Sub-Saharan African countries. Notably, the total number of male professional staff trained to the MSc level declined between 2000/01 and 2007/08; however, more in-depth analysis is needed to explain the underlying causes of these shifts and to what degree they represent structural changes.
- Levels of female participation in agricultural research and higher education among the sample agencies were particularly low in Ethiopia (6 percent), Togo (9 percent), Niger (10 percent), and BurkinaFaso (12 percent). Shares of female professional staff were much higher in South Africa, Mozambique, and Botswana (32, 35, and 41 percent, respectively).
- The female share of students enrolled in higher agricultural education was higher than the female shares of professional staff employed at the agricultural research and higher education agencies in most cases, but a significant proportion of the female students concerned were undertaking only BSc-level studies (83 percent).
- Only 14 percent of the management positions were held by women, which is considerably lower than the share of female professional staff employed at the sample's agricultural research and higher education agencies (24 percent).
- The pool of female staff is much younger on average than the pool of male staff.
- The prevalence of female professional staff is comparatively higher in fields related to life and social sciences, and comparatively lower in fields involving areas traditionally thought of as "hard science", such as engineering.

Keywords: agricultural R&D, Sub-Saharan Africa, female participation, S&T capacity, agricultural higher education

ABBREVIATIONS AND ACRONYMS

ASTII	African Science, Technology, and Innovation Indicators
AWARD	African Women in Agricultural Research and Development
AgGDP	Agricultural Gross Domestic Product
ASTI	Agricultural Science and Technology Indicators
CGIAR	Consultative Group on International Agricultural Research
EC	European Commission
EU	European Union
FARA	Forum for Agricultural Research in Africa
FTEs	Full-time equivalents
G&D	Gender and Diversity
HCs	Headcounts
IAC	InterAcademy Council
IFPRI	International Food Policy Research Institute
KCI	Knowledge, Capacity, and Innovation
NEPAD	New Partnership for Africa's Development
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
S&T	Science and Technology
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific, and Cultural Organization

1. INTRODUCTION

The emergence of knowledge-based, technologically advanced societies has led to greater recognition of the importance of science and technology (S&T) and a greater need for human, institutional, and infrastructural capacity in these disciplines. This is especially true in developing countries, which are shifting from simply being consumers of developed-country technologies to actually adapting those technologies and even developing their own. Ultimately, countries that lack appropriate S&T capacity will fall behind (IAC 2004a; Huyer and Westholm 2007), and, unfortunately, capacity in many developing countries is limited due to lack of training and other opportunities. In addition, student enrollments in the fields of science and engineering have declined in a number of countries since the early 1990s. This situation has been exacerbated by high levels of human resource mobility from developing to developed countries, or from science to non-science and technical sectors. Attracting more women into science and engineering would be a highly beneficial way of reducing these shortages (Huyer and Westholm 2007). The important role of women in S&T—not only as participants and implementers, but also as beneficiaries—has been increasingly recognized in recent years (Huyer and Westholm 2007). The InterAcademy Council (IAC) report on Women in Science (2004a) points out that greater participation in S&T by women will provide more diverse skills, experiences, perspectives, and working styles within the workforce. Higher rates of female participation in S&T systems can enhance the quality and competitiveness of research and innovation (EC 2008). The participation of women in S&T has in fact increased since the mid-1990s (including the numbers of girls being educated in S&T fields), but such increases have mostly occurred at the lower levels of S&T systems (Huyer and Westholm 2007; IAC 2004a).

Female participation is known to diminish with career advancement in S&T systems—a phenomenon known as "the leaking pipeline."[1] Huyer and Westholm (2007) point out that women entering the S&T system encounter two levels of segregation. First, *horizontal segregation* involves the considerably higher concentration of women in "softer" fields of science, such as biology, other life sciences, and social sciences rather than "harder" fields like engineering and physics. Second, *vertical segregation* involves the overrepresentation of women at lower levels of the professional hierarchy, and this is true in industry and education, as well as in S&T. Hence, women are less represented in high-level research and management positions compared with their male colleagues. As a result, women have less influence in policy- and decisionmaking processes.

International Efforts to Measure Female Participation in S&T

Gender-disaggregated data on participation in S&T—both over time and across countries—are extremely important for national and international decisionmakers, including research and human resources managers. Such data remain scarce, however. Even where available, such information is often unusable due to inconsistent approaches, methodologies, samples, and timeframes (Huyer and Westholm 2007; Otchet 2007). A number of international organizations have emphasized the need for gender-disintegrated data on capacity and have increased their own collection efforts. To facilitate cohesion in the collection of such statistics, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) developed a toolkit on gender indicators in science, engineering, and technology, which outlines the issues and provides theoretical and methodological frameworks and guidelines, including a number of case studies (Huyer and Westholm 2007)[2].

UNESCO. The UNESCO Institute for Statistics (UIS) was established in 1999 to fulfill the increasing need of member states for reliable and policy-relevant data on education, S&T, culture, and

[1] Huyer and Westholm (2007) identify four major points where leaks in the pipeline are evident: (1) access to education, (2) participation by women, (3) participation in the S&T workforce, and (4) S&T for social development. Additional barriers include social and cultural expectations and roles, institutional barriers, and barriers based on qualifications.

[2] The toolkit is available online at http://gstgateway.wigsat.org/toolkit/toolkit.html.

communications. Prior to UIS' establishment, UNESCO published statistics on education, science, and culture in annual yearbooks, but not all the data series were disaggregated by gender. UIS emphasizes systematic data collection by gender and in 2006 published the report, *Women in Science* (UIS 2006). About half the world's countries were missing, however, including Australia, Canada, China, Mexico, the United Kingdom, and the United States—all of which have sizeable S&T capacity in global terms. Although gender-disaggregated data are available for the United Kingdom and the United States, such data were collected using different definitions from those used by UIS[3]. Furthermore, many low-income countries do not collect gender-disaggregated data on education and S&T (Otchet 2007)[4].

The UNESCO report shows that, in the 89 countries for which data were available, women account for an average of 27 percent of the total number of scientists (in headcounts). Only in 17 countries (18 percent) was the percentage of female scientists between 45 and 55 percent, therefore reaching gender parity (UIS 2006). The study found the proportion of female scientists in the private sector to be lower than in the government and higher education sectors. This is true for high-income countries, but the correlation does not appear to hold in low- and middle-income countries. The UIS report also analyzes the share of women participating in higher education because these women form the origins of the future pool of female scientists. Female participation in higher education has increased but remains low for advanced degrees, such as PhDs. The report concludes that further analysis of other barriers to women's access to and retention in research positions is urgently needed (UIS 2006).

European Union/Eurostat. The Women and Science Group of the European Union (EU), in collaboration with Eurostat and the national representatives of the *Helsinki Group*[5], developed a system of internationally comparable, gender-disaggregated science indicators. The group has published a series of reports under the title *She Figures*, which covers data for EU member states, as well as associated non-EU countries (some which have become EU member states in recent years). The latest report with gender data for 2006/07 waspublished in the fall of 2009. A leaflet containing preliminary results shows that the overall share of women in scientific research averaged 30 percent in 2006, and that the pool of female researchers grew more quickly than the pool of male scientists (4.4 versus 2.8 percent during 2002–06). The share of women graduating with PhD degrees in scientific fields grew by an annual average of 7.3 percent per year during the same period. The proportion of female scientists is still poor in technology and engineering, whereas the female share is considerable higher in social and agricultural sciences, medical sciences and humanities. Although these are very positive trends, male scientists still far outnumber their female counterparts in most countries (EC 2009a).

The *She Figures* reports also give a number of innovative tools for use in presenting gender data. One example is the *Glass Ceiling Index* (see Appendix C), which assesses women's chances of reaching senior S&T positions compared with their male colleagues. For the first time, information on the age structure of women in senior positions was collected (EC 2009a).

Measuring Female Participation in Agricultural Sciences

As mentioned, women's participation in research systems is important for two major reasons: the need to reach gender balance and hence more equal representation in research and policy, and the opportunity to attract additional, much-needed human resource capacity. Lack of capacity has been a particular problem

[3] The UIS and a number of other international/national organizations present the scientist data in headcounts, whereas the United States and many other developed countries present their data in full-time equivalents (Otchet 2007). See more on this in Section 3 of this report.

[4] Many low-income countries do not even collect S&T indicators. For example, until recently South Africa was the only country in Sub-Saharan Africa with an ongoing system of S&T data collection. Since 2003, the African ministers responsible for S&T have called for the development of a harmonized system of science, technology, and innovation indicators. The New Partnership for Africa's Development (NEPAD) created the African Science, Technology, and Innovation Indicators (ASTII) initiative to address this demand (NEPAD 2009).

[5] The *Helsinki Group*—named after the location of its first meeting and created by the European Commission—was established to promote the participation and equality of women in science within the EU. The group meets twice a year, consists of representatives of EU member states, and provides an important forum for policy dialogue (EC 2009b).

in agricultural research and higher education in Sub-Saharan Africa, where appropriate capacity is a necessary foundation for economic growth and to ensure food security (IAC 2004b; World Bank 2007). But strengthening Africa's agricultural research capacity requires more than just increasing the number of women participating in absolute terms; it requires more women in senior, decisionmaking roles. Female farmers play an important role in African agriculture , producing the majority of the region's crops. Addressing the needs of these farmers requires increased participation by female scientists, professors, and senior managers. Women also have different insights, which will support research institutes in more fully addressing the unique and pressing challenges of both female and male farmers in Africa (Goh et al. 2008). The Consultative Group on International Agricultural Research (CGIAR) collects gender-specific human resources information for the agricultural sector through two of its programs.

CGIAR Gender & Diversity Program. The CGIAR aims to achieve sustainable food security and reduce poverty in developing countries through scientific research and related activities in the fields of agriculture, forestry, fisheries, policy, and the environment. Nearly 8,000 scientists and staff are employed at 15 CGIAR centers, 13 of which are headquartered in developing countries. The CGIAR Gender & Diversity Program periodically conducts human resource surveys to document the composition of staff at the 15 centers in terms of job function, gender, diversity, and so on. The most recent (2008) survey found that women constituted 26 percent of the 1,026 employees in the scientist category, representing a marked increase over the 2003 result of 20 percent. During this period, the number of female scientists increased by 49 percent (from 182 to 271), while the number of male scientists—though much higher in absolute numbers—rose by only 2 percent (from 740 to 755). Notably, the proportion of female scientists increased within every grade of the scientist category. Notwithstanding these increases, the survey confirmed a consistent pattern of lower proportions of women in higher positions. In the scientist category, for example, 44 percent of the associate scientists were women, decreasing to 27 percent at the scientist grade, 19 percent at senior scientist grade; and 11 percent at the principal scientist grade[6].

Agricultural S&T Indicators initiative. The Agricultural Science and Technology Indicators (ASTI) initiative, which is managed by the International Food Policy Research Institute (IFPRI), collects, analyzes, and publishes data on agricultural research and development (R&D) investments and capacities in low- and middle-income countries. Since the early 1990s, ASTI has collected gender-disaggregated data on professional agricultural scientists by highest degree and institute type for about 60 countries (Stads and Beintema 2006; Beintema 2006). While to date this information has provided new and interesting insights into the pool of female agricultural scientists in the developing world, many other important questions—such as the exact share of female graduates that drop out after completing their degree or during their career, and the relative number of female scientists that attain leadership positions—have been overlooked. To address these omissions, the G&D Program and the ASTI initiative in partnership collected gender-disaggregated capacity data through a benchmarking survey in key Sub-Saharan African countries. This report presents the results of this survey round, which will also provide baseline data for monitoring and evaluating the African Women in Agricultural Research and Development (AWARD) fellowship program, which is managed by the G&D program. The AWARD program offers two-year fellowships intended to build capacity in science, mentoring, and leadership among high-performing female African scientists at one the three critical career junctures: completion of their BSc, MSc, or PhD degrees.

This report presents the results of this benchmarking study for 125 agricultural research and higher education agencies in 15 Sub-Saharan African countries for which detailed quantitative information was obtained on female participation in agricultural research and higher education. These new insights will provide key information to national policymakers, human resource specialists, research managers, and national and regional bodies responsible for capacity strengthening activities in African agricultural R&D.

[6] For more information, visit the CGIAR Gender & Diversity website at http://www.genderdiversity.cgiar.org.

2. BENCHMARKING FEMALE PARTICIPATION IN AGRICULTURAL RESEARCH AND HIGHER EDUCATION

The ASTI–AWARD benchmarking survey focused on the largest agricultural research and higher education agencies in 19 African countries. Table 1 shows the 155 agencies identified—encompassing government agencies, nonprofit institutions, and higher education agencies (see Appendix A). Requests to participate in the survey were sent either directly by the ASTI team or through national coordinators for countries with numerous target agencies (Ethiopia, Ghana, Nigeria, South Africa) and Zambia. Such agencies were selected based on their size in terms their share of national research staff in full-time equivalents (FTEs) based on ASTI datasets for 2000/01. Coverage ranged from 62 percent of total 2000/01 research staff for Nigeria, to more than 90 percent for Malawi, Mali, Mauritania, Niger, and Uganda. Data were collected for professional staff only, defined as staff with a minimum qualification of a BSc degree. This definition may differ somewhat across agencies, however, in that some include tertiary-qualified staff members acting in technical support positions, whereas others do not.

The first step of the ASTI–AWARD benchmarking study was the development of the survey forms, drafts of which were shared with experts who provided valuable feedback for improvement. The forms consisted of a set of questions about both male and female professional staff in order to develop indicators (i) by age group; (ii) by discipline; (iii) by seniority (to address leadership); (iv) by years of service (to address experience); (v) by recent departures (to address retention); (vi) by recent promotions (to address career advancement); (vii) by long- and short-term training undertaken; and (viii) by vacant positions. The survey form for the higher education agencies included additional questions to obtain information on tertiary degree levels and on male and female students enrolled and graduating in agricultural science.

In total, 87 percent of the agencies—that is, 135 of the 155 targeted agencies—returned surveys. For 15 of the sample countries the coverage was sufficient to allow the preparation of a country fact sheet and to contribute to the data analysis in this report. The fact sheets, which form the foundation of this report, were published in late 2008 and are available at http://www.asti.cgiar.org/gender-capacity. Survey returns for Mali, Mauritania, Rwanda, and Tanzania were missing key agencies and consequently were excluded from the data analysis in this report.

Table 1. ASTI–AWARD benchmarking survey: Details of agency sample

Countries	Surveys returned by institutional category: Government agencies	Nonprofit institutions	Higher education agencies	Total agencies	Coverage (% of 2000/01 researchers)[a]	Agencies failing to respond
Included in this report						
Botswana	2	—	1	3	80	—
Burkina Faso	2	—	1	3	77	—
Burundi	1	—	2	3	79	1
Ethiopia[b]	17	—	2	19	84	5
Ghana[c]	11	—	4	15	89	—
Kenya	1	1	3	5	70	2
Malawi	1	—	1	2	59	1
Mozambique	2	—	2	4	na	—
Niger	1	—	1	2	84	—
Nigeria	15	—	7	22	60	1
Senegal	2	—	1	3	87	—
South Africa[d]	14	1	6	21	78	—
Togo	1	—	1	2	82	—
Uganda[e]	14	—	3	17	93	—
Zambia	1	1	2	4	76	—
Subtotal (15)	*85*	*3*	*37*	*125*	*77*	*10*
Excluded from this report						
Mali	0	—	1	1	na	1
Mauritania	1	—	1	2	na	1
Rwanda	1	—	—	1	na	1
Tanzania	—	1	—	1	na	7
Subtotal (4)	*2*	*1*	*2*	*5*	*na*	*10*
Total (19)	**89**	**5**	**41**	**135**	**na**	**20**

Source: Calculated by authors based on survey responses.
Notes: Appendix Table A.1 lists all agencies, their institutional category; and where available gender-disaggregated data for 2000/01 and 2007/08.
[a] Agency coverage based on various ASTI country briefs published during 2002–04 (see http://www.asti.cgiar.org /pubs-africa.aspx). The 15-country subtotal excludes Mozambique for which no 2000/01 data were available.
[b] Includes 12 of the 15 institutes and units of the Ethiopian Institute of Agricultural Research (EIAR).
[c] Includes 10 institutes under the Council for Scientific and Industrial Research (CSIR).
[d] Include 14 institutes and other units of the National Agricultural Research Organisation (NARO).
[e] Includes 14 institutes and other units of the Agricultural Research Council (ARC).

The methodology and definitions used for the benchmarking study generally follow those used by ASTI, which are based on the guidelines provided in the *Frascati Manual* developed by the Organisation for Economic Co-operation and Development (OECD). The manual, which has been revised numerous times since its original 1963 publication, was developed as a standard for R&D studies in OECD countries, but has since become the global standard for both national and international organizations. The manual, along with others in "the Frascati Family," is a key tool in understanding the role of S&T in economic development (OECD 2002). The *Canberra Manual*, which focuses on human resources related to S&T, provided additional insights drawn on in the preparation of this report (OECD 1995).

Two approaches are used in the international literature to measure the activities of S&T professionals—headcounts (HCs) and full-time equivalents (FTEs). FTEs take into account the proportion of time actually spent on R&D activities. Professional staff at universities, for example, spend a considerable proportion of their time on nonresearch activities, such as teaching, administration, or

student guidance. These nonresearch activities should be excluded in R&D resource calculations.[7] Following the *Frascati Manual*, the FTE approach is preferred when measuring the volume of human (and financial) R&D resources because HCs would considerably overstate actual R&D capacity. Nevertheless, data on the total number of personnel engaged in R&D activities at a given point in time—whether on a full- or part-time basis—are relevant when it comes to measuring the stocks and flows of researchers and other R&D personnel. HC data series also allow overall linkages to be made in terms of employment, education, and other relevant statistics (OECD 2002). The *Frascati and Canberra Manuals* also recommend HCs when measuring additional human resources data such as gender, age, ethnicity, or national origin (OECD 1995, 2002).

Following these guidelines, ASTI uses FTEs to present its regular time-series data on human and financial resources in agricultural R&D. This report, however, does not deal with the overall volume of R&D capacity, but rather with its stocks and flows. Hence, where possible, the data is presented in HCs. The agencies that participated in the ASTI–AWARD survey were still asked to provide an estimate of the time their professional staff spend on research. For example, it was estimated that professional staff at the College of Agriculture and Veterinary Sciences at the University of Nairobi spend 35 percent of their time on research, 60 percent of their time teaching, and their remaining time on extension/training. This information was collected so that the gender-disaggregated capacity data would be comparable with ASTI's overall data series on agricultural R&D staffing, both for the sample countries and for other low- and middle-income countries for which ASTI has collected quantitative information. This also enables this new data set to be compared with ASTI datasets collected in 2000/01.

Table 2 compares the stock and volume (in HCs and FTEs, respectively) of professional staff in the 125 agricultural research and higher education agencies covered in the 15-country sample included in this study. Together these agencies employed 8,258 professional staff, representing 5,899 FTEs. On average, professional staff at the 37 higher education agencies spent almost three-quarters of their time teaching or conducting other activities unrelated to research in 2007/08. In contrast, on average, professional staff at the government agencies only spent 2.5 percent of their time on nonresearch activities.[8]

[7] For example, when a university professor spends an average of 30 percent of his time on research, he or she is given an FTE researcher value of 0.3. Similarly, if a full-time researcher is employed for 9 months of a given year, he or she is given an FTE researcher value of 0.9. Nevertheless, calculating professional staff in FTEs can be a subjective and arbitrary process, especially in the university sector where it can difficult to accurately access time spent on research.

[8] Note that, for agencies with a full research mandate, 100 percent of staff time was allocated to research activities because any management or technology transfer activities are considered to be research-supporting.

Table 2. Agricultural research and higher education capacity in headcounts and full-time equivalents, 2007/08

Country/institutional category	Institutional coverage	Professional staff		FTEs as a share of HCs
		Headcounts (HCs)	Full-time equivalent researchers (FTEs)	
By country		(*number*)		(*percentage*)
Botswana	3	235	148	63.0
Burkina Faso	3	184	170	92.4
Burundi	3	96	77	80.2
Ethiopia	19	1,366	1,197	87.8
Ghana	15	698	449	64.3
Kenya	5	967	660	68.3
Malawi	2	178	85	47.8
Mozambique	4	360	271	75.3
Niger	2	101	87	86.1
Nigeria	22	1,800	1,268	70.4
Senegal	3	200	159	79.5
South Africa	21	1,307	800	61.2
Togo	2	98	78	79.6
Uganda	17	465	303	65.2
Zambia	4	203	147	72.4
Total (15 countries)	**125**	**8,258**	**5,899**	**71.5**
By institutional category				
Government	85	5,081	4,953	97.5
Higher education	37	3,085	878	28.5
Nonprofit	3	90	68	75.6

Source: Calculated by authors based on survey responses.

The Pool of Female Professional Staff by Degree Level

Table 3 provides a country-level overview of professional staff employed at the 125 sample agencies included in the study by gender. Of the total number of staff employed in 2007/08, 1,942 were female and 6,316 were male. About two-thirds of the female staff were employed in only three countries: Kenya, Nigeria, and South Africa. All three countries employed relatively higher shares of female researchers, with the result that these three countries strongly influence the 15-country averages presented in the remainder of this report. Notably, Ethiopia employed the second-largest number of professional staff overall but ranked seventh in terms of numbers of female staff (representing only 4 percent of the female staff in the 15-country sample).

Eight countries each accounted for only 1 to 2 percent of the female staff in the sample (Botswana, Burkina Faso, Burundi, Malawi, Niger, Senegal, Togo, and Zambia). Close to two-thirds of the female professional staff in agricultural sciences were employed in the government sector, 39 percent were employed in the higher education sector, and only 1 percent were employed in the nonprofit sector. The corresponding shares of male professional staff were very similar, at 62, 37, and 1 percent, respectively.[9]

[9] When converted to FTEs, the share of women employed at the government sector increases to 83 percent, while the share of those employed in the higher education sector decreases to 16 percent.

Table 3. Female and male professional staff for 15 sample countries, 2007/08

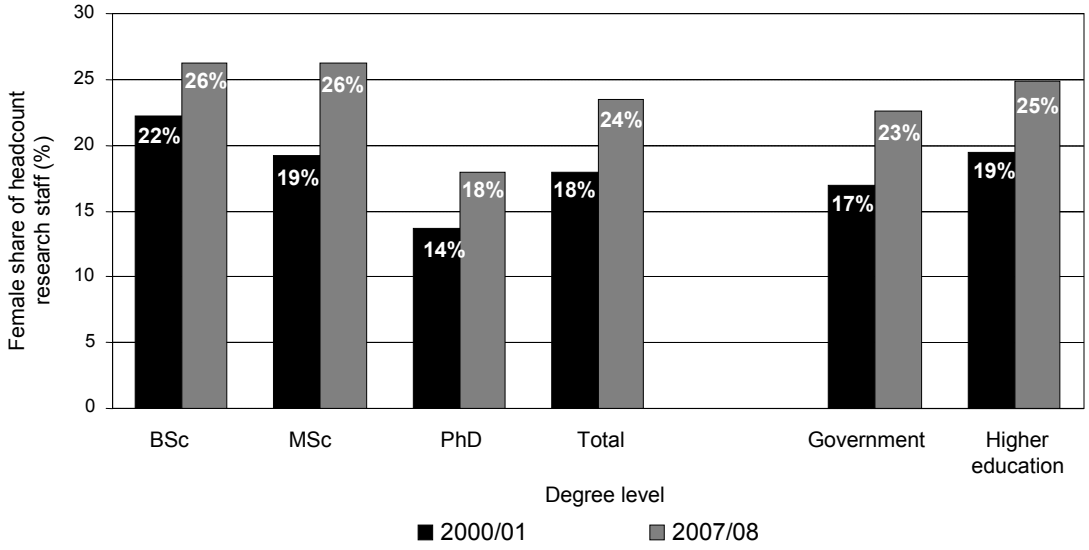
Country/ institutional categories	Professional staff (headcounts)			Share of country/ institutional category		
	Female	Male	Total	Female	Male	Total
By country		(*number*)			(*percentage*)	
Botswana	75	160	235	4	3	3
Burkina Faso	22	162	184	1	3	2
Burundi	19	77	96	1	1	1
Ethiopia	83	1,283	1,366	4	20	17
Ghana	115	583	698	6	9	8
Kenya	253	714	967	13	11	12
Malawi	30	148	178	2	2	2
Mozambique	127	233	360	7	4	4
Niger	10	91	101	1	1	1
Nigeria	462	1,338	1,800	24	21	22
Senegal	36	164	200	2	3	2
South Africa	537	770	1,307	28	12	16
Togo	9	89	98	0	1	1
Uganda	121	344	465	6	5	6
Zambia	43	160	203	2	3	2
Total (15 countries)	1,942	6,316	8,258	100	100	100
By institutional category						
Government	1,152	3,931	5,083	59	62	62
Higher education	765	2,320	3,085	39	37	37
Nonprofit	25	65	90	1	1	1

Source: Calculated by authors based on survey responses.

Figure 1 shows that, on average, women constituted 24 percent of the professional staff employed in agricultural research and higher education in the 15-country sample in 2007/08. Omitting Mozambique due to lack of data for 2000/01, the share contracts to 23 percent, which is a considerable increase over the equivalent 2000/01 share of 18 percent.[10] The share of female professional staff at the government and higher education agencies was similar (23 versus 25 percent, respectively).

[10] The average share of female professional staff remains 23 percent when Mozambique, for which 2000/01 data were unavailable, is excluded.

Figure 1. Female shares of professional staff by degree and institutional category, 2000/01 and 2007/08



Source: Calculated by authors based on survey responses.

Note: 2000/01 shares exclude Mozambique due to lack of available data. Because only three nonprofit institutions were covered in the survey, this institutional category is not listed separately.

Figure 2 further illustrates the increased capacity in absolute terms and as annual growth rates. Overall, the number of professional agricultural research and higher education staff increased by 20 percent, from about 6,600 headcounts in 2000/01 to 7,900 in 2007/08 (Figure 2a). Nigeria and Ethiopia accounted for the vast majority of this increase (39 and 35 percent, respectively), followed by South Africa (14 percent).

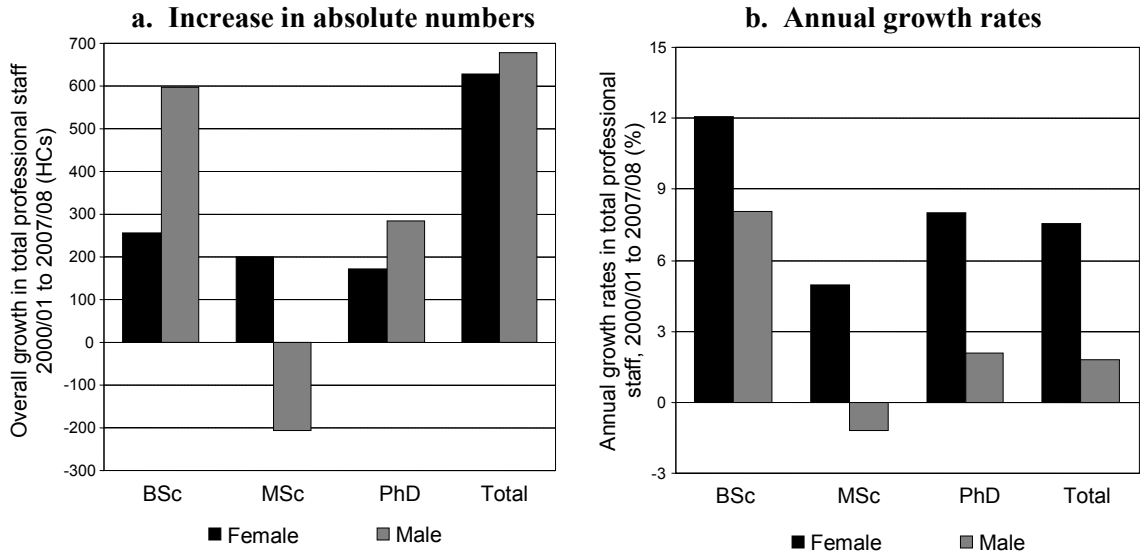
Close to half of the additional 1,304 professional staff were female, and this increase occurred in all 14 sample countries—even in Burkina Faso, Kenya, Niger, Togo, and Zambia where the total number of agricultural professional staff actually declined during the seven-year period. The pool of female professional staff at least doubled in Botswana, Nigeria, Senegal, and Zambia.

At the same time, almost half of the additional 1,304 professional staff were men trained to the BSc level—a significant increase. Offsetting this increase somewhat, the number of men qualified to the MSc level declined by more than 200 between 2000/01 and 2007/08. This decline occurred in 12 of the 14 sample countries, but its size varied from less than 10 percent in Ghana, South Africa, and Uganda, to more than 50 percent in Burundi and Senegal. Some, though not all, of this decline can be attributed to male staff obtaining PhD degrees or leaving their organizations.

The increased number of female professional staff was more equally distributed across the three qualification categories, although it was slightly higher in the BSc category. The decline in the number of male staff holding MSc degrees combined with an increase in the number of women holding MSc degrees gave rise to the aforementioned higher increase in the share of women in this category.

The female population in the overall pool of agricultural research and higher education staff increased by 8 percent per year from 2000/01 to 2007/08 (Figure 2b)—four-times higher than the annual rate for the male population (2 percent). The annual growth rates also illustrate the relatively higher increase in professional staff qualified to the BSc level compared with those qualified to the MSc or PhD levels.

Figure 2. Gender-disaggregated growth in the pool of professional staff, 2000/01–2007/08



Source: Calculated by authors based on survey responses.

Note: Excludes Mozambique due to lack of available data for 2000/01.

Table 4 presents annual, country-level growth rates by gender. Growth in female professional staff capacity was particularly high in Burkina Faso, Burundi, Botswana, Nigeria, and Zambia, ranging from 12 to 15 percent per year. Although the number of female professional staff in Senegal increased by 22 percent per year, this growth was from a small base of 14 women. Despite this growth, Senegal continues to have one of the lowest shares in the region.

Overall, the growth rates in female professional staff are impressive, but because they were measured at only two points in time, they do not provide annual trend data. It is therefore important that the composition of professional staff in agricultural research and higher education be monitored on an on-going basis.[11]

[11] The ASTI initiative is currently conducting its overall human and financial resources survey in about 35 African countries. This data will provide an update of the gender-disaggregated capacity numbers for 2008/09.

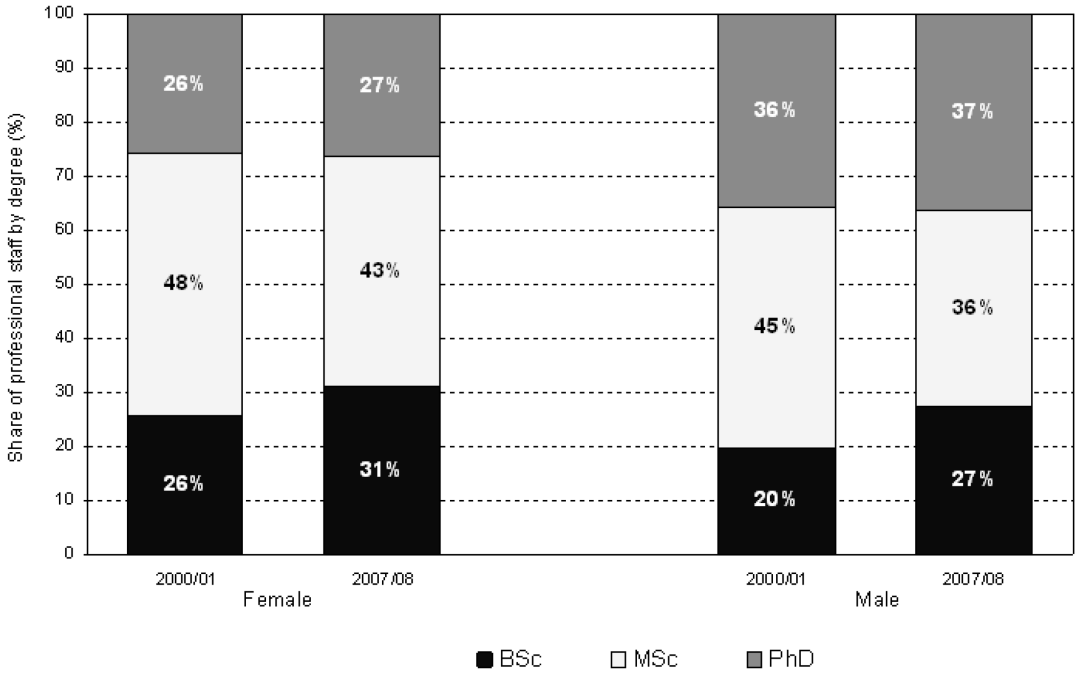
Table 4. Annual growth rates of female and male professional staff by country, 2000/01 to 2007/08

	Female	Male	Total
		(*percentage*)	
Botswana	15	8	10
Burkina Faso	12	–3	–2
Burundi	13	1	2
Ethiopia	5	7	7
Ghana	3	1	1
Kenya	2	–2	–1
Malawi	4	4	4
Niger	6	–1	–1
Nigeria	15	4	6
Senegal	22	–1	1
South Africa	6	0	2
Togo	7	–5	–4
Uganda	7	3	4
Zambia	15	–3	–2
Total (14 countries)	8	2	3

Source: Calculated by authors based on survey responses.

Figure 3 presents the distribution of female and male professional staff by level of qualification. Female professional staff members are consistently less likely to have advanced degrees than their male counterparts. For example, in 2007/08 fewer women than men held PhD degrees on average (27 compared with 37 percent). The high influx of professional staff with BSc degrees resulted in an overall increase in this category, from 26 to 31 percent for women and from 20 to 27 percent for men. Interestingly, the shares of female and male staff with PhD degrees remained fairly stable over the seven-year period.

Figure 3. Overall degree level shares by gender, 2000/01–2007/08



Source: Calculated by authors based on survey responses.

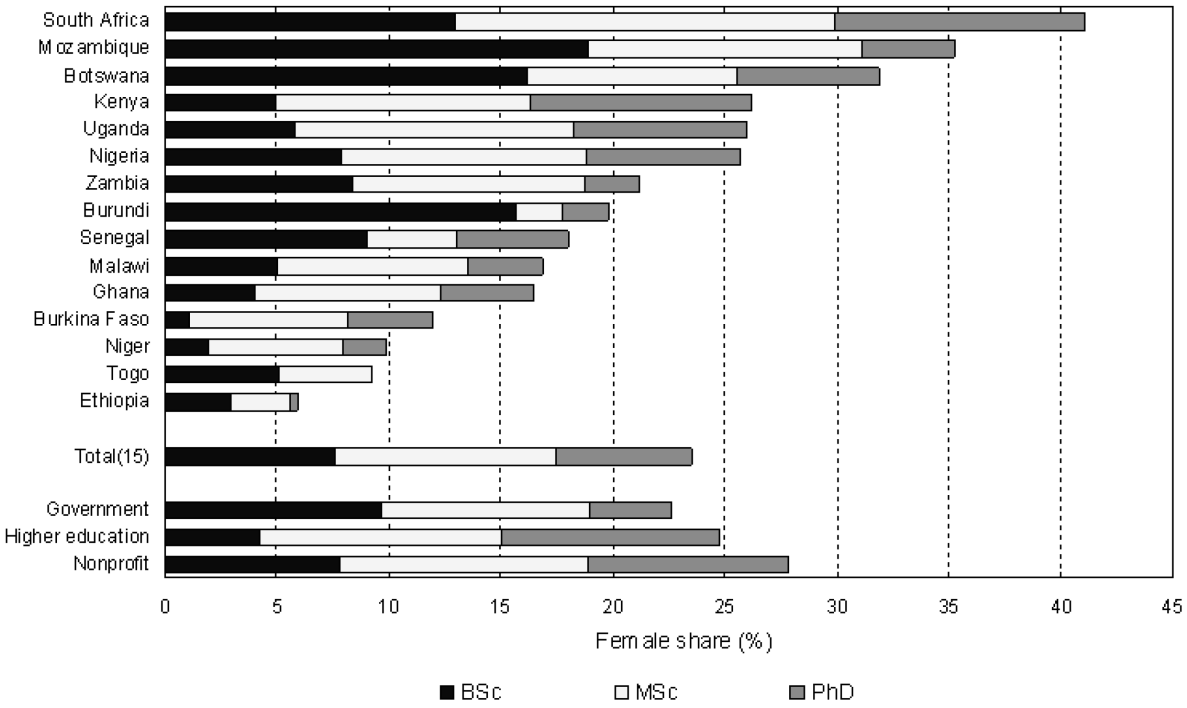
The data presented in preceding figures indicates that, despite the increase in overall professional agricultural staff numbers from 2000/01 to 2007/08, qualification levels were eroded. This is a worrisome trend in light of existing capacity constraints in many African countries. Various organizations and publications have expressed concern in this regard. For example, an assessment of the national agricultural research and extension systems in Africa, which was conducted for the Forum for Agricultural Research in Africa (FARA), found that many agencies experience professional staff shortages, many positions remained vacant, and in a number of countries the pool of professional research staff is aging (FARA 2006). Although the number of agricultural universities and faculties has grown substantially during the past three decades, many suffer from staff shortages, insufficient funding, declining student enrollments, outdated curricula, and a continuing focus on undergraduate studies (Beintema, Pardey, and Roseboom 1998; IAC 2004b; World Bank 2007).

In the first two decades after attaining their independence, many African countries made great strides in building their agricultural research and higher education systems, both in terms of absolute numbers and quality. A large number of African scientists were sent abroad to obtain postgraduate degrees, many of which were funded through grants from a wide number of donor organizations. But donor support for agricultural research and related training programs waned in the 1990s, and African governments have been largely unable to fund training themselves (Beintema, Pardey, and Roseboom 1998). A number of countries have more recently established postgraduate training programs, but they are generally small in terms of student enrollments. The evidence of an increasing share of BSc-qualified agricultural research and higher education staff—in combination with the increasing costs of postgraduate training abroad, and the diminishing relevance of such training programs to Africa—indicates that the need to strengthen and expand local postgraduate training may be even more urgent than previously thought.

Figure 4 presents the breakdown of female agricultural professional staff for our 15-country sample. Female participation is particularly low in Ethiopia and a number of Francophone countries. Of the professional staff employed at the sample agencies in Ethiopia, only 6 percent were female and, of

those, only a very small proportion of these were trained to PhD level (6 percent). Female staff accounted for 9, 10, and 12 percent of the professional agricultural staff in Togo, Niger, and Burkina Faso, respectively. Female participation in southern Africa appears to be much higher than in other subregions. The percentage of female professional staff in South Africa, Mozambique, and Botswana was 41, 35, and 32 percent, respectively. In Nigeria, 26 percent of the professional staff were female, which is slightly higher than the 15-country average. About one-fifth of these female researchers were trained to PhD level, and about 42 percent held MSc degrees. The qualifications of the pool of female staff in Uganda and Kenya were relatively higher (30 and 38 percent, respectively, held PhD degrees).

Figure 4. Shares of female agricultural professional staff by degree, institutional category, and country, 2007/08



Source: Calculated by authors based on survey responses.

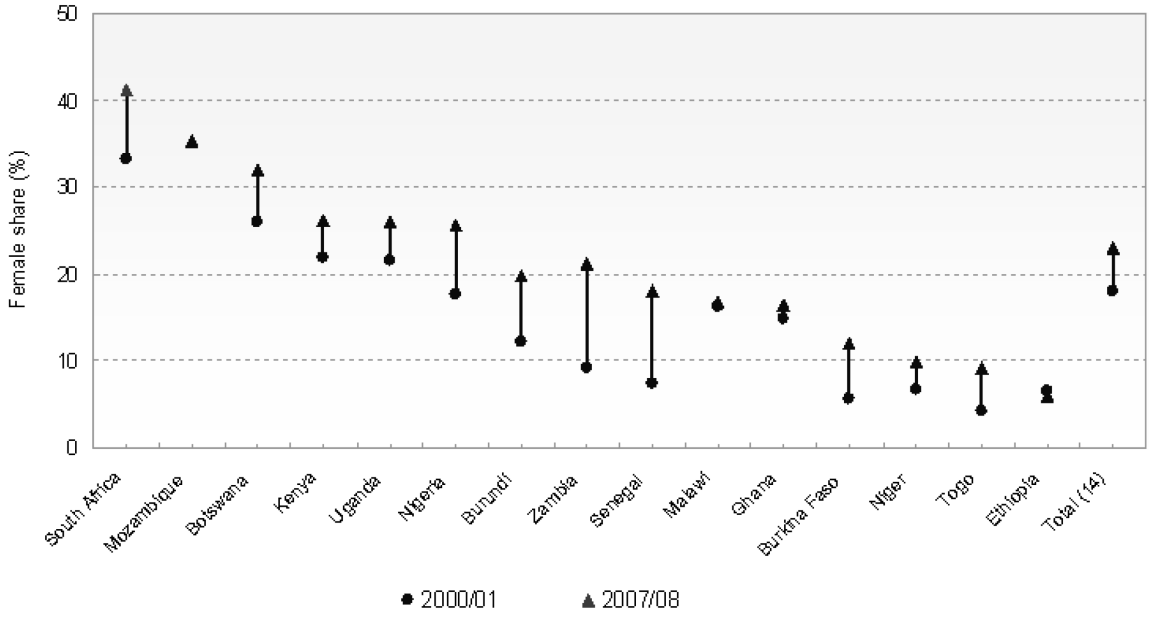
Professional staff members employed in higher education agencies are traditionally more highly qualified than their counterparts at government agencies, and this trend also holds for women. Of the female professional staff employed in higher education agencies in our 15-country sample, 39 percent held PhD degrees—far higher than the 16 percent average share for the government agencies.[12]

Figure 5 compares the proportion of female professional staff in each country in 2007/08 with the corresponding figures for 2000/01. The share of female professional staff increased substantially more in some countries than in others. For instance, the percentage of female professionals increased by 11 and 12 percent respectively in Senegal and Zambia during the seven-year period. In Zambia this was the result of a large decrease in the number of—mostly male—professional staff at the largest agricultural research agency, the Zambian Agricultural Research Institute (ZARI). At the same time, the number of female, BSc-qualified staff at ZARI rose from 1 to 15. In addition, the number of female staff at the University of Zambia almost doubled (from 11 to 20), whereas male staff numbers grew only moderately (from 44 to

[12] The corresponding share for nonprofit institutions was high, at 32 percent, but this was partly because of the small sample of three institutions.

51). In Senegal, the number of professional staff at the two government agencies, the Agricultural Research Institute of Senegal (ISRA) and the Food Technology Institute (ITA), increased substantially during 2000/01 –2007/08, whereas the number of staff at the National School of Agriculture (ENSA)[13] declined. The increase in the number of female professional staff at ISRA and ITA (from 13 to 33) increased proportionately more than the number of male staff during this period (from 107 to 133), explaining the large increase in female participation in Senegal. The proportion of female professional staff also increased substantially in three of the four countries that employ the highest numbers of agricultural professional staff. Female shares in Nigeria and South Africa both increased by 8 percent, and in Kenya increased by 4 percent. The increase in South Africa is particularly striking given that its 2000/01 shares for female staff were already the highest in the 27 countries for which data were available (Stads and Beintema 2006). On the other hand, despite a large increase in the total number of professional staff in Ethiopia during the seven-year period, the proportion of female professional staff actually declined by 1 percent.

Figure 5. Increase in female professional staff by country from 2000/01 to 2007/08



Source: Calculated by authors based on survey responses.

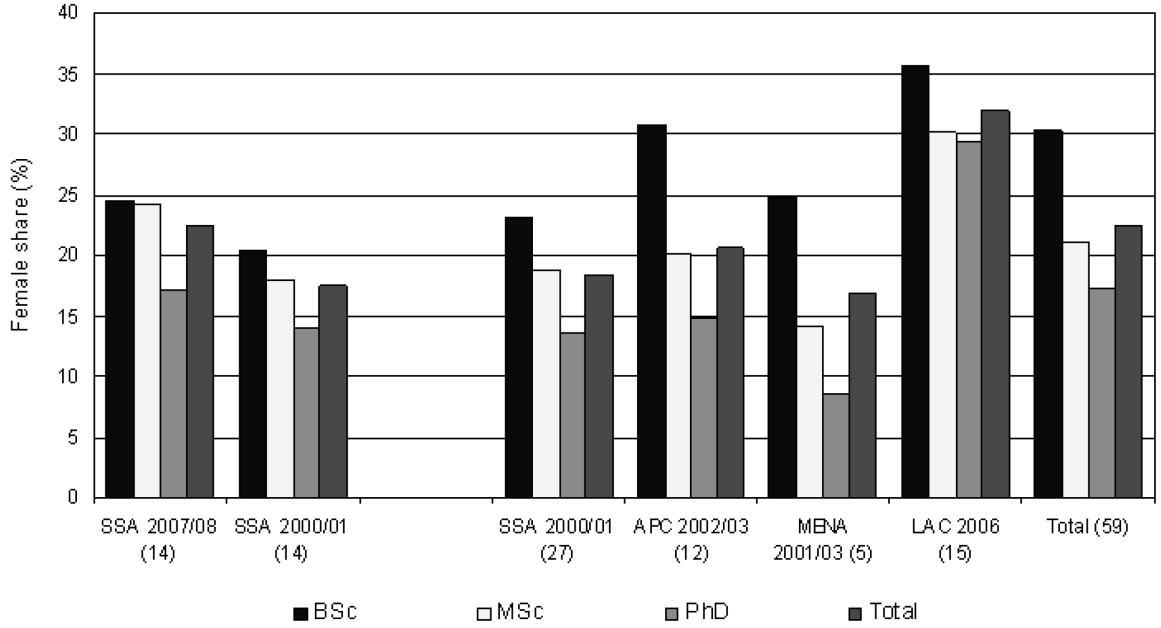
Note: Only 2007/08 data were available for Mozambique.

Comparison with Other Developing Regions

Figure 6 compares the average proportion for the 14-country sample (excluding Mozambique) with quantitative evidence for the remainder of the Sub-Saharan African region and other developing regions of the world. Note that FTE data are used to allow comparability with ASTI's broader database. The 2000/01 shares for female participation for the 14-country sample were similar to those for a fuller set of Sub-Saharan African countries because both studies include most of the large countries. On average, more female agricultural scientists are employed in Africa than in the Middle East and North Africa, whereas more women on average are employed in the Asia-Pacific region and Latin America and the Caribbean compared with Africa.

[13] The official French agency names are Institut sénégalais de recherches agricoles (ISRA), Institut de technologie alimentaire (ITA), and École nationale supérieure d'agriculture (ENSA).

Figure 6. Share of female professional agricultural staff in Sub-Saharan Africa compared with in other developing regions, 2000–06

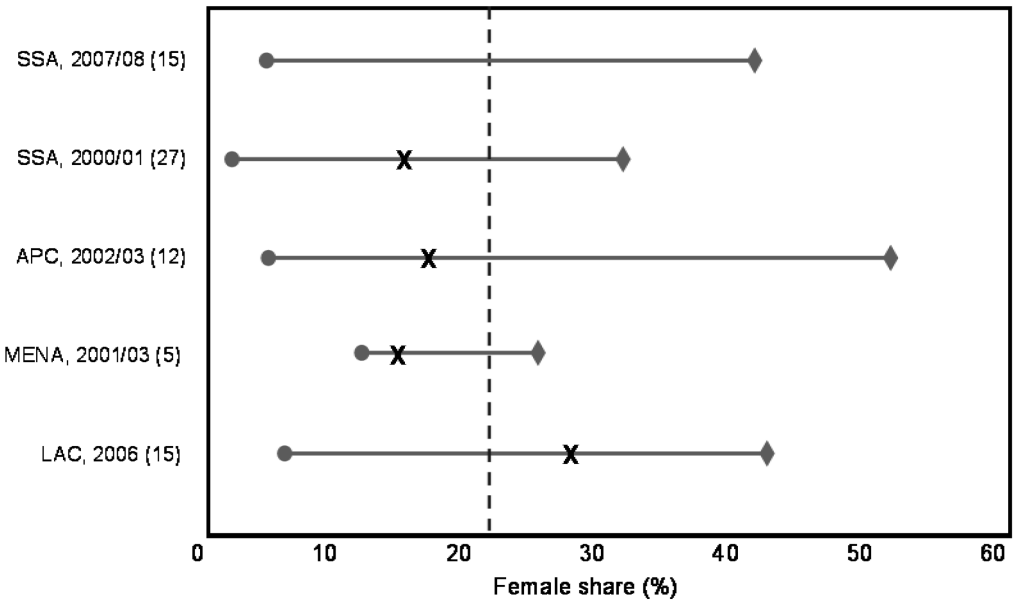


Sources: Table 1; regional totals are calculated by the authors based on Beintema (2006), Beintema and Stads (2008), and Stads and Beintema (2009).

Notes: The number of countries included in the regional totals is shown in parentheses. SSA indicates Sub-Saharan Africa; APC, the Asia–Pacific region (here excluding China); MENA, the Middle East and North Africa; and LAC, Latin America and the Caribbean. Data are presented in full-time equivalent (FTE) researchers because (as previously discussed) this is the unit used for ASTI's broader database.

Figure 7 presents national variation within the regional averages. In Asia, for example, fewer than 10 percent of the total research staff in Nepal and Pakistan were female in 2002/03 compared a corresponding figure of 30 percent in the Philippines and 54 percent in Myanmar.

Figure 7. National variation in female shares of agricultural research staff by region (in FTEs), 2000–06

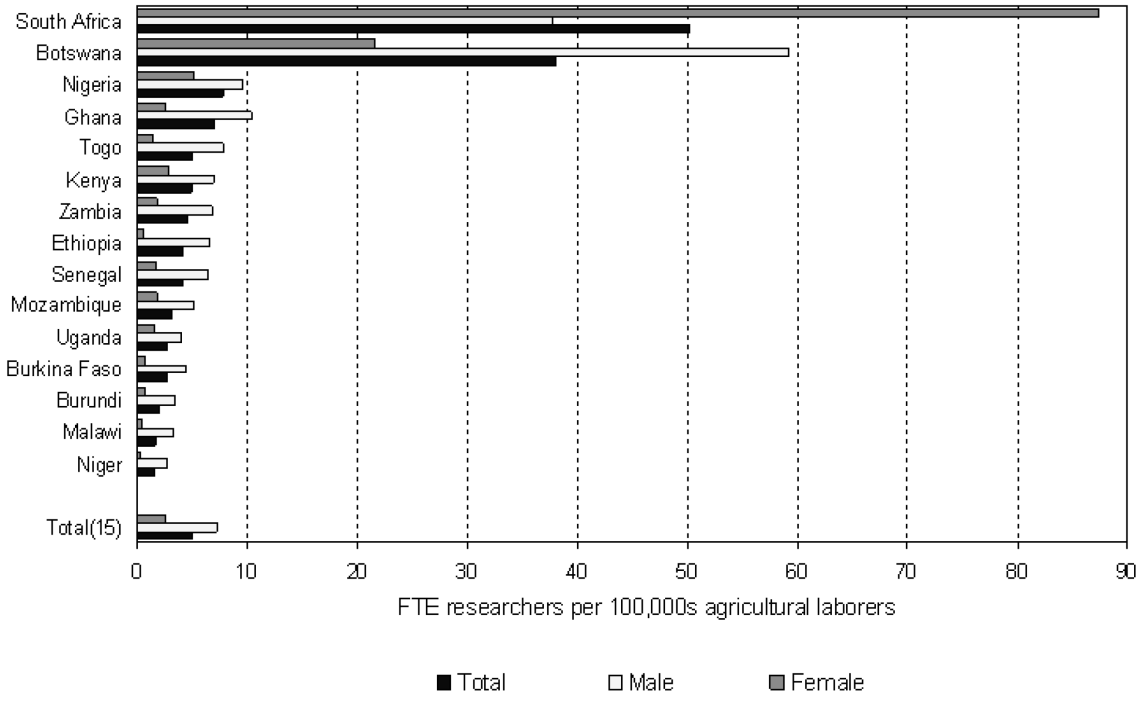


Sources and notes: See Figure 6.

Measuring the Intensity of Female and Male Research Staffing

Research intensity levels place agricultural research capacity in an internationally comparable context by comparing agricultural R&D efforts with the size of a country's or region's agricultural sector. The most common method of calculation is the ratio of public agricultural R&D spending to agricultural gross domestic product (AgGDP). Figure 8 measures agricultural research capacity as a share of the number of people employed in the agricultural sector, which is more relevant for this report. Once again, FTEs rather than headcounts were used to account for nonresearch activities. On average, the 15 sample countries employed 5.1 FTE researchers per 100,000 laborers employed in the agricultural sector. The ratio ranged from 38 and 50 FTE researchers in Botswana and South Africa respectively, to 2.0 or fewer in Burundi, Malawi, and Niger. With the exception of South Africa, the gender-disaggregated intensity ratios show considerable underrepresentation of women. For the 15 countries combined, female scientists as a share of 100,000 female agricultural laborers averaged 2.5, which is close to three times lower than the corresponding ratio of male scientists to male agricultural laborers. South Africa was the only country in our sample where the ratio of female scientists to female agricultural laborers was higher than the male ratio.

Figure 8. Gender-disaggregated FTE researchers per 100,000 agricultural laborers



Source: Table 1 and FAO (2009).

Note: FTE researcher data are for 2007 or 2008; agricultural labor force data are for 2006.

3. TRAINING OF FEMALE PROFESSIONAL STAFFPRIOR TO AND DURING EMPLOYMENT

The current pool of female agricultural scientists in Africa is derived from the female students that have graduated from agricultural higher education agencies in the past four decades (UIS 2006) and the women that have pursued careers and ongoing education in agricultural research and higher education.

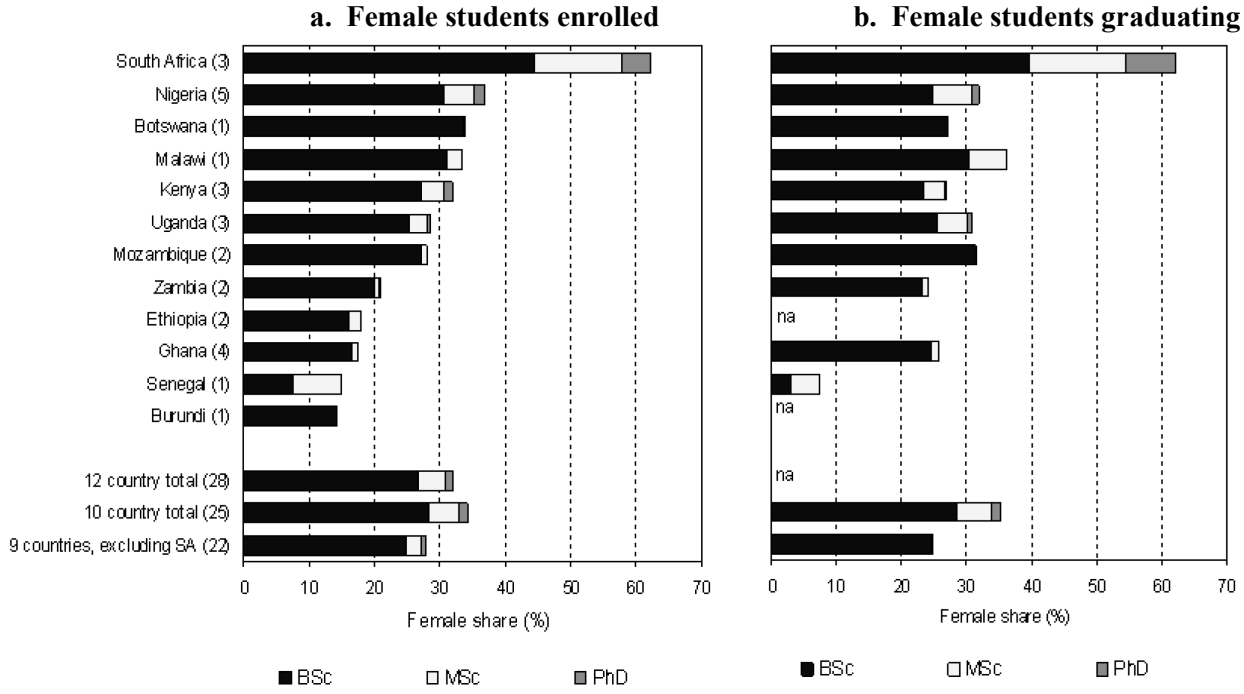
Female Student Participation in Higher Education

Future trends in female participation in agricultural research are influenced by current student enrollment and graduation levels. An increasing number of women have been enrolling in higher education, not only in Sub-Saharan Africa, but also in other regions in the world (UIS 2006). This also appears to be the case in agricultural sciences, but unfortunately no gender-disaggregated trend data is available on student enrollments and graduations in agriculture.

Figure 9 presents data on student enrollments and graduations for 28 of the 36 higher education agencies participating in the ASTI–AWARD survey. On average 34 percent of the students enrolled in agricultural science in 2007 were female (Figure 9a). Most of these women were enrolled in BSc studies (83 percent), whereas only 13 and 4 percent were enrolled in MSc and PhD studies respectively. This distribution was similar for male students and reflects the reality that many faculties and schools lack, or have only small, PhD programs. There were relatively more women enrolled in agricultural sciences in South Africa, where 62 percent of students were female (although enrollment data were only available for three of the six major faculties). In contrast, less than one-fifth of the agricultural student populations in Ethiopia, Ghana, Senegal and Burundi comprised female students. For a 25-agency sample (excluding Burundi and Ethiopia for which data were unavailable), the average share of female students successfully graduating in 2007 was about the same as the average proportion of women in the total student population (35 versus 34 percent) (Figure 9b).

It should be noted, however, that the proportion differ considerably across the sample countries and are strongly influenced by the three South African higher education agencies in the sample, which together accounted for about one-third of all the women enrolled university in the 25-agency sample. If these agencies were excluded, the share of female students graduating with MSc and PhD degrees in 2007 would fall to 30 and 19 percent of the total graduating population, respectively.

Figure 9. Share of female students enrolled in and graduating from agricultural higher education agencies, 2007

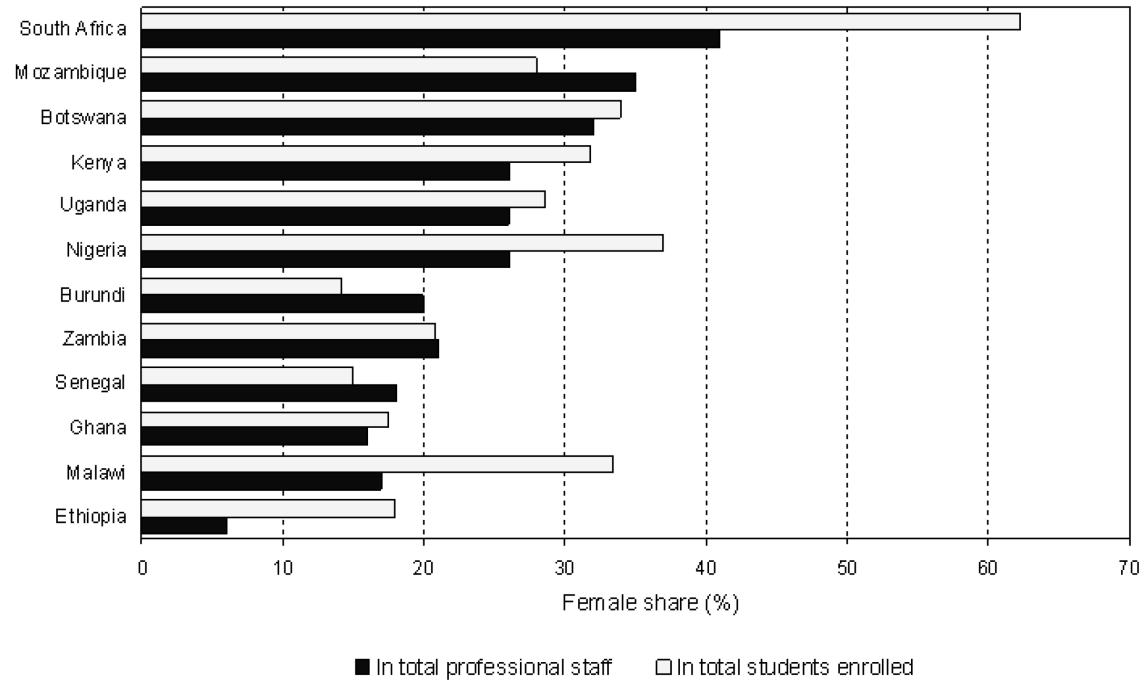


Source: Table 1 and FAO (2009).

Note: The number of higher education agencies included per country is shown in parentheses. For country-level agency coverage, see the ASTI–AWARD Country Fact Sheets available at www.asti.cgiar.org/gender-capacity.

Figure 10 compares the national share of women enrolled in agricultural science courses with those employed in agricultural research and higher education. In Ethiopia, the proportion of women studying agricultural science is three times as high as the proportion of professional women employed in agriculture (18 percent compared with 6 percent), indicating potential for the country to increase its female capacity in the near future, given appropriate incentives to attract new graduates into the workforce. Of course, this also depends on the role of women in the society, as well as the institutional environment for female researchers (see the case studies in Appendix B). In South Africa, Malawi, and Nigeria, the share of female students is also substantially higher than the proportion of professional female employees, but the reverse is the case in Burundi, Mozambique, and Senegal.

Figure 10. Share of female students enrolled in agricultural faculties, compared with female professional staff employed in agriculture



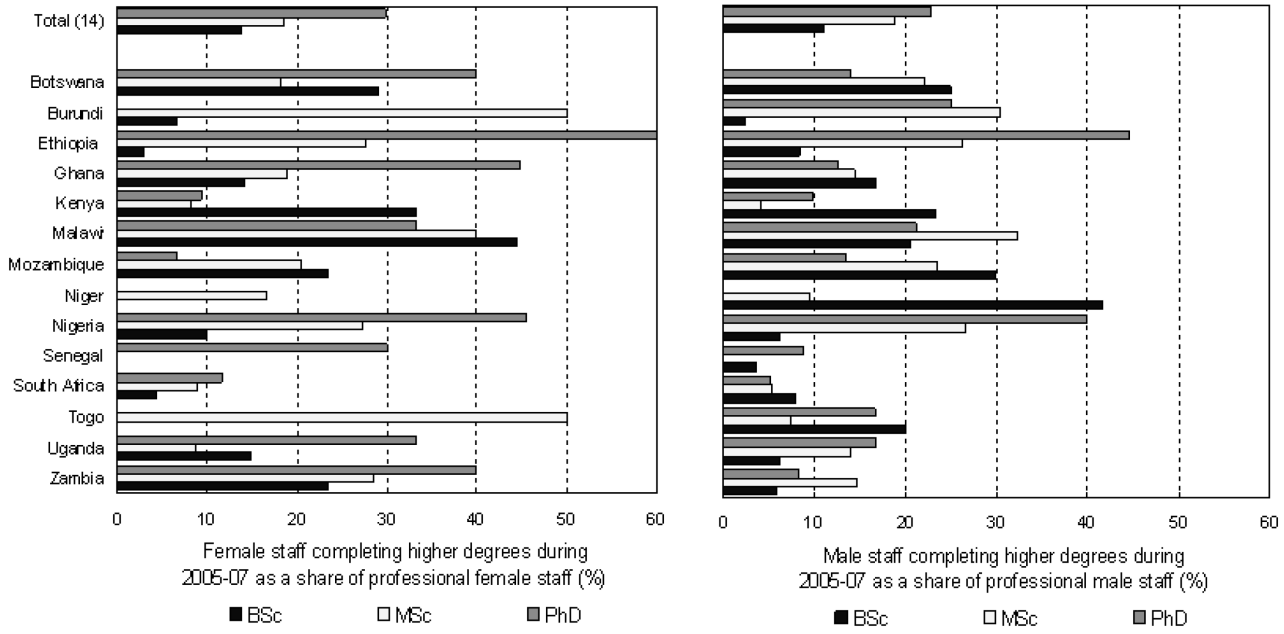
Source: Calculated by authors based on survey responses.

Training of Female Professional Staff

Professional staff often pursue higher degrees while employed in agricultural research or higher education. Given that yearly fluctuations occur in the number of staff completing degrees, information was collected over a three-year period (2005–07).

Figure 11 presents the number of female (Figure 11a) and male (Figure 11b) professional staff successfully completing PhD, MSc, or BSc degree training during 2005–07 as a share of the female and male professional staff employed in agriculture in 2007/08. These figures should be analyzed with some care because the degrees obtained during 2005–07, for example, may actually correlate with staff that have since left their agencies. Furthermore, many organizations do not keep up to date records on staff training. Nevertheless, the data do indicate that a large proportion of women obtained university degrees in recent years compared with their male colleagues. This is particularly so for PhD-level training: 60 percent of the 5 female professional staff holding PhD degrees employed in Ethiopia in 2007 received their degrees in the preceding three years. The corresponding ratios were 46 percent for Nigeria (based on 123 women), 45 percent for Ghana (based on 29 women), 40 percent for Zambia and Botswana (based on 5 and 15 women, respectively), 33 percent for Uganda and Malawi (based on 36 and 6 women, respectively) and 30 percent for Senegal (based on 10 women). This indicates that considerable training efforts are ongoing and, if these trends continue, the share of women qualified at the MSc and PhD levels can be expected to continue to rise.

Figure 11. Professional female and male staff completing degree training during 2005–07 as a share of staff employed in 2007/08



Source: Calculated by authors based on survey responses.

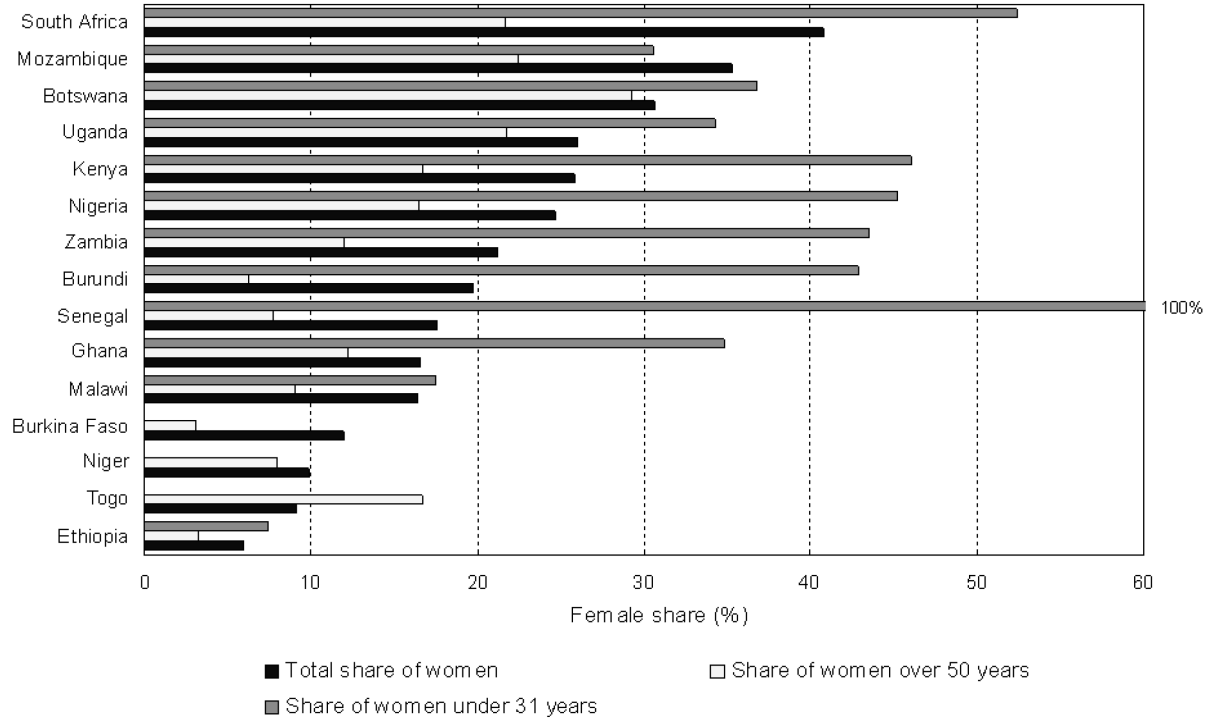
4. AGE STRUCTURE, YEARS OF SERVICE, AND DISCIPLINE MIX

Given the increasing numbers of female staff in agricultural research and higher education reported in most sample countries over the past few years, it is important to obtain more detailed information on their composition in terms of age, years of service, and discipline mix and to analyze these data in comparison with the male population.

Age Structure of Female Professional Staff

Figure 12 presents female professional staff in agricultural research and higher education under 31 years and over 50 years of age as a share of total professional staff (i.e., men and women) in the two age groups. These shares are compared with the proportion of women in total agricultural professional staff as presented in Figure 4. The proportion of women in total professional staff under 31 years of age is 40 percent or higher in about half of the countries. Kenya and South Africa employ particularly large numbers of younger women (46 and 52 percent of total staff, respectively).

Figure 12. Female staff aged 30 years or younger, or over 50 years as a share of total professional staff in the two age groups, 2007/08



Source: Calculated by authors based on survey responses.

It is important to note that the pool of professional staff in some of these age groups is extremely small. For example, the two young staff in Senegal were both female (hence the 100 percent in the graph above). In contrast, neither of the two young staff in Burkina Faso nor the three in Togo were female, and no agricultural staff in Niger were aged 30 years or younger.

The proportion of professional agricultural female staff declines with age in most countries. With the exception of Togo, the share of female professional staff over 50 years of age is lower than the total proportion of female professional staff in all the sample countries.

Figure 13 shows how the above trends compare with the corresponding shares of men in the younger and older age groups. This figure also indicates the relatively higher representation of women in the younger age group, and the underrepresentation of women in the older age group. This is particularly true in Ethiopia where more than half the female professional staff were 30 years or younger. The case is similar for the male staff, although to a slightly lesser extent (44 percent). More than one-fifth of the female professional staff in Botswana, Malawi, Zambia, South Africa, and Uganda were younger than 31 years old. With the exception of Malawi, these proportions were considerably higher than the corresponding figures for men in this age group.

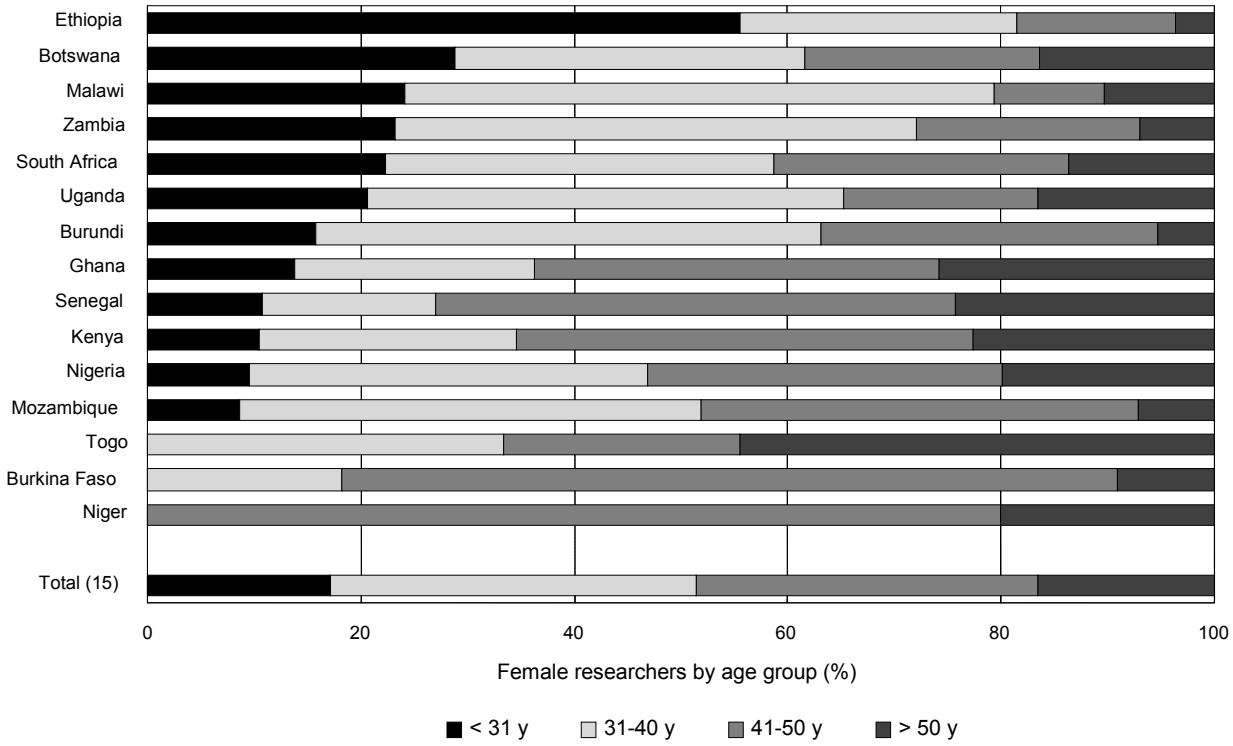
Figure 13. Gender-disaggregated proportions of professional staff aged younger than 31 and older than 50 years, 2007/08



Source: Calculated by authors based on survey responses.

Figure 14 presents the distribution of female professional staff by age group. On average, the majority of women were aged between 31 and 50 years. Less than one-fifth of the female professional staff in the 15-country sample were younger than 31 years. As usual, there is a wide variation across countries. More than half the female staff employed in Ethiopia were 30 years or younger, which is in part due to a comparatively high increase in overall capacity in professional staff in the country's agricultural research and higher education agencies. Botswana, Malawi, and Zambia also had relatively young pools of female professional staff, whereas Burkina Faso and Togo employed no female professional staff younger than 31 years, and Niger employed no female staff younger than 41 years. Of the nine female staff in Togo 44 percent were 51 years or older.

Figure 14. Distribution of female professional staff by age group, 2007/08

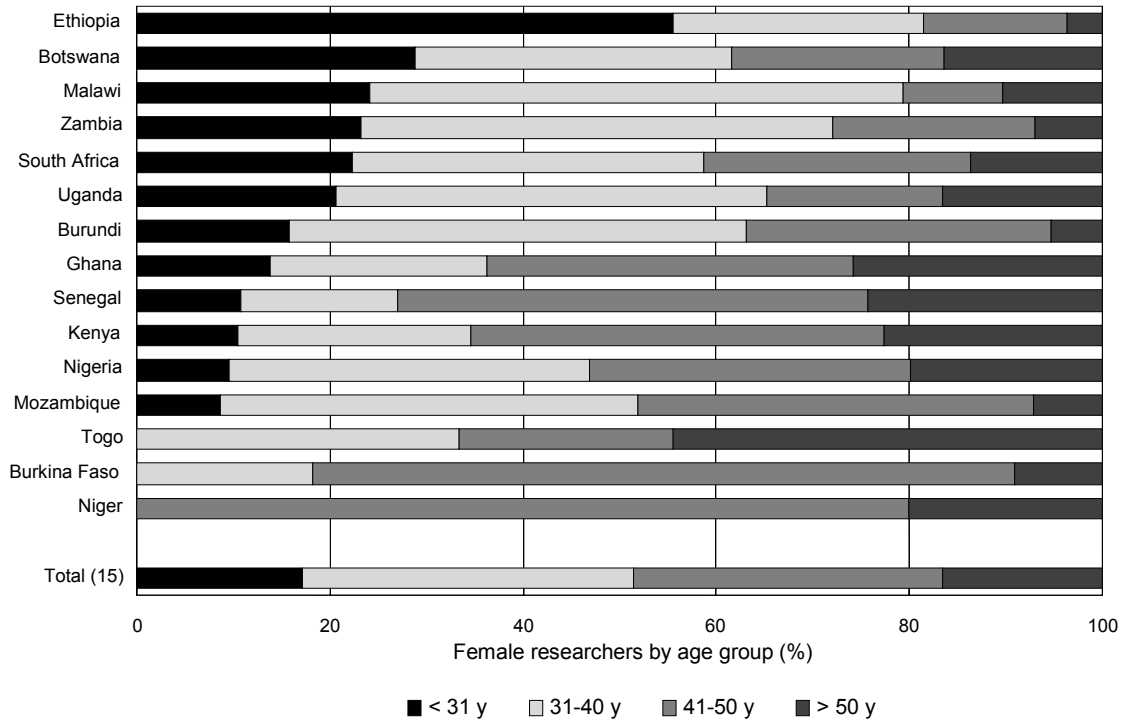


Source: Calculated by authors based on survey responses.

Years of Service of Female Agricultural Scientists

Figure 15 shows the distribution of women by years of service. Unsurprisingly, almost all countries with a large share of young female professional staff (as presented in Figure 20) also have comparatively more female staff employed for less than two years at the respective agencies. Notably, Senegal had a high share of women with more than 20 years of service (54 percent), although the share of male staff with more than 20 years of service was even higher (63 percent). Female (and male) professional staff in Niger were also employed for comparatively longer periods of time, which is also reflected in the age structure of staff in both countries.

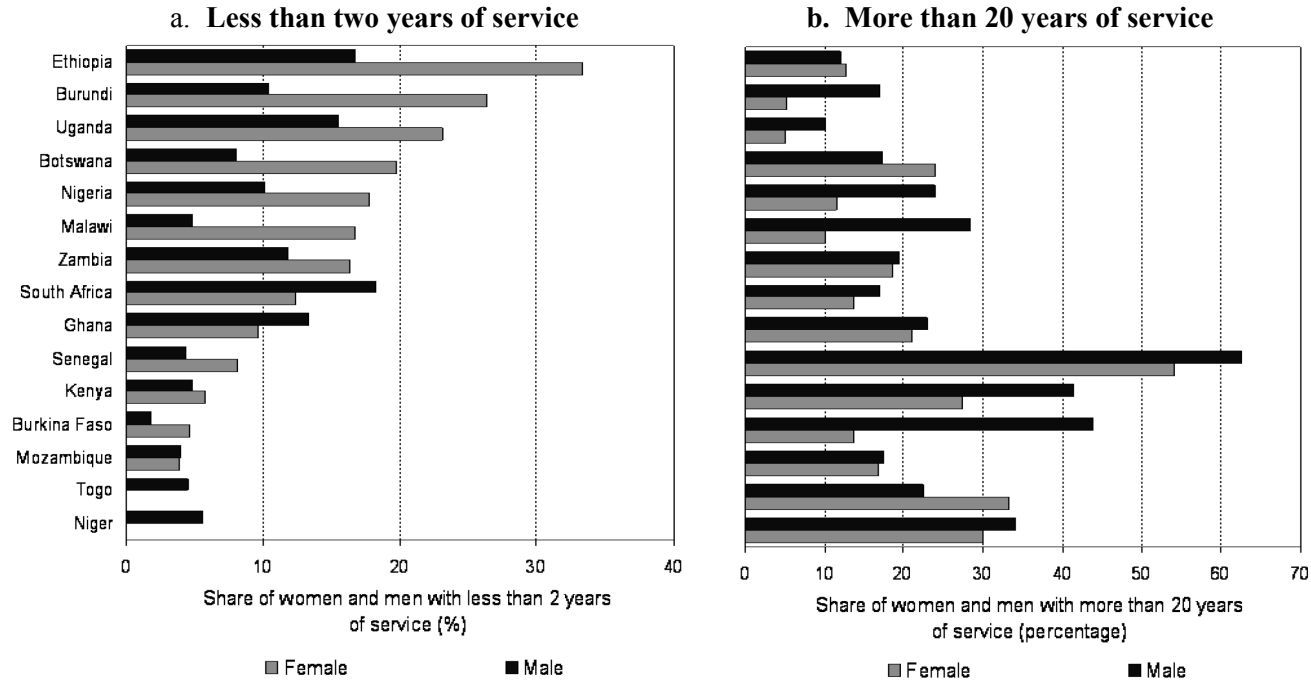
Figure 15. Distribution of female professional staff by years of service, 2007/8



Source: Calculated by authors based on survey responses.

Figure 16 presents the shares of female and male professional staff employed for less than two years (Figure 16a) or more than 20 years (Figure 16b) at their respective agencies. In 2007/08, more than 20 percent of the female professional staff in Ethiopia, Uganda, and Burundi were employed at their agencies for less than two years, which is considerably higher than the corresponding share of male staff. In contrast, a large proportion of women in Togo, Senegal, and Niger have been employed for more than 20 years. The share of professional male staff with service of more than 20 years is also extremely high, indicating the aforementioned aging of professional agricultural staff in this country.

Figure 16. Gender-disaggregated shares of professional staff in service for less than 2 years or more than 20 years, 2007/08



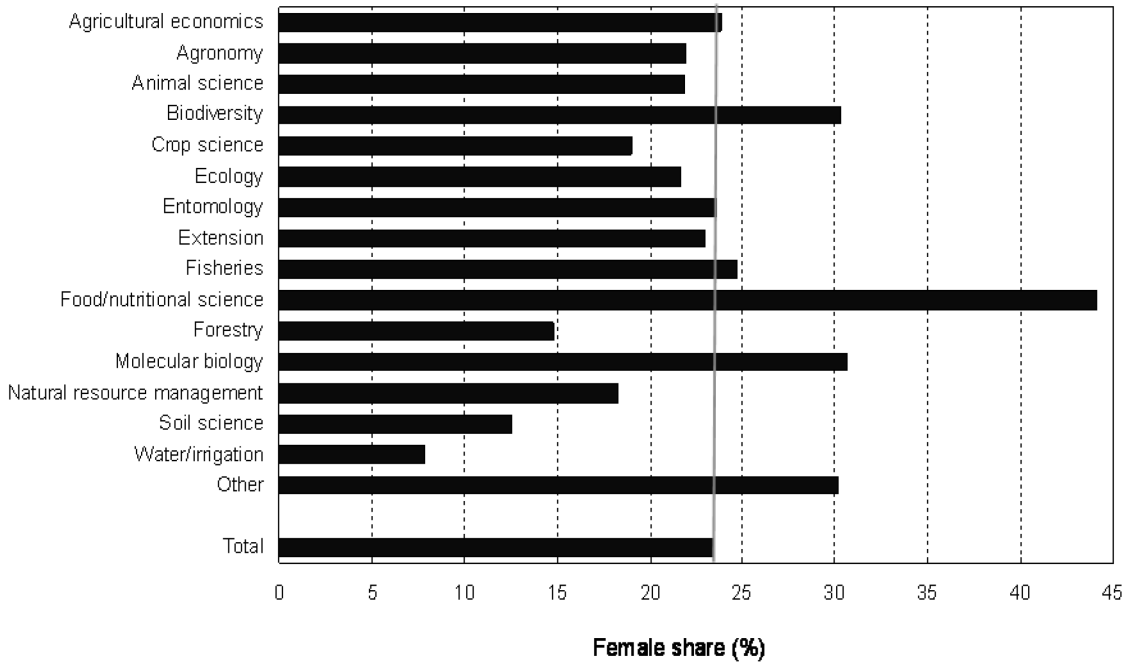
Source: Calculated by authors based on survey responses.

Discipline Mix of Female Agricultural Scientists

As outlined in Section 1, horizontal segregation measures the concentration of women in certain disciplines and sectors. Evidence shows that female participation levels are higher in areas such as biology and other life and social sciences ("soft science") and much lower in areas such as physics and engineering ("hard science"). It is difficult to make a clear distinction between "soft" and "hard" fields of science within agricultural R&D, although some fields are clearly related to engineering and others are clearly related to life or social sciences.

Figure 17 presents the distribution of female professional staff by agricultural discipline. The proportion of women in total agricultural professional staff engaged in food and nutritional science was very high at 44 percent. There were also relatively large numbers of female professional staff trained in biodiversity (30 percent), molecular biology (31 percent), and agricultural economics (24 percent). In contrast female shares were particular low for disciplines such as water and irrigation (8 percent), forestry (15 percent), and soil science (13 percent).

Figure 17. Distribution of female professional staff by discipline mix, 2007/08



Source: Calculated by authors based on survey responses.

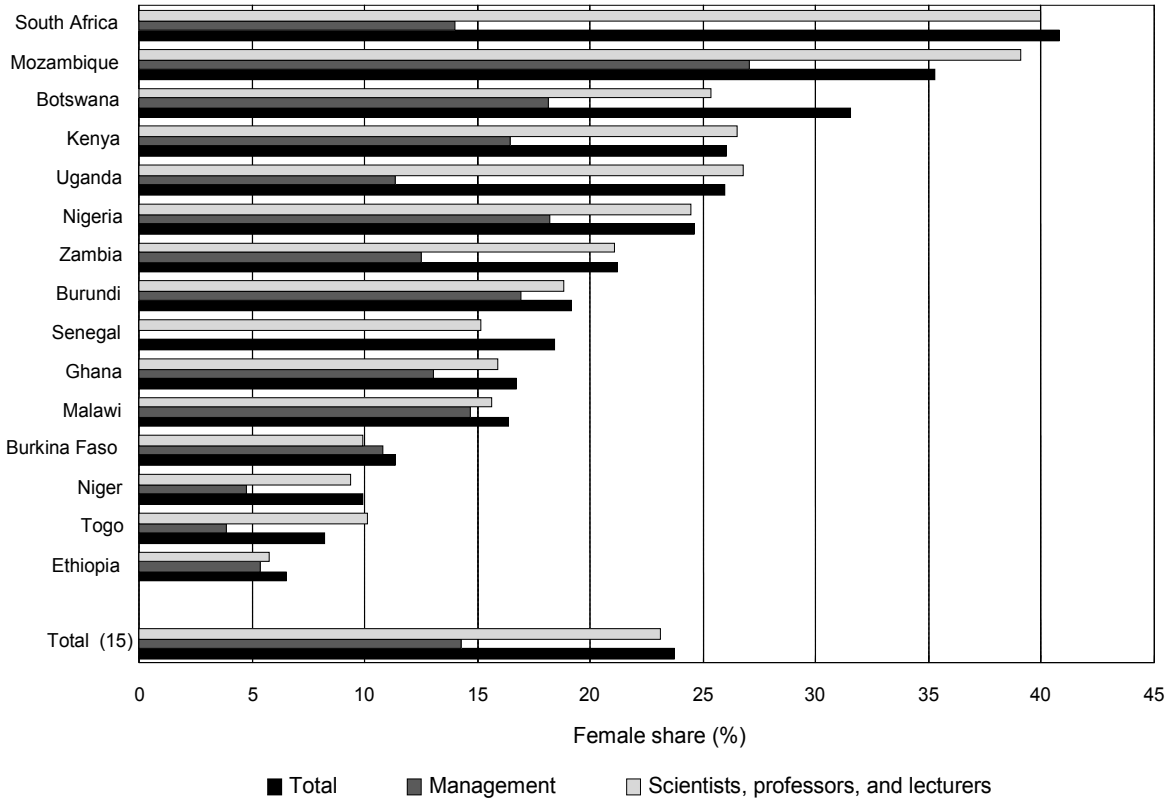
Note: The gray bar indicates the average share of women participating across all fields of agricultural science (24 percent).

5. SENIORITY LEVELS OF FEMALE AGRICULTURAL RESEARCH STAFF

The vertical dimension, or segregation, of agricultural research and higher education capacity is measured by the distribution of female and male professional staff at different levels of seniority. This measurement is important because decisions on the content and the execution of the research and higher education agenda are made at senior levels (EC 2006).

Figure 18 presents the share of female staff in management positions and other senior roles such as scientists at government research agencies and (assistant) professors and lecturers at the higher education agencies. In 2007/08, 14 percent of the total professional staff in management positions were female. This is considerably lower than the overall proportion of women in professional agricultural staff (24 percent) and indicates a high level of vertical segregation in African agricultural research and higher education. This category excludes other professional staff such as research, technical, and support staff holding university degrees.[14] Only in Ethiopia was this share about equal to the share of female professional staff, but as indicated earlier in this report Ethiopia has the lowest share of female professional staff in the 15-country sample. Although South Africa has the highest proportion of female professional staff, the share of female staff in management positions was similar to the 15-country average of 14 percent.

Figure 18. Share of female staff in total staff in management and other senior positions compared with of the overall share of female professional staff, 2007/08

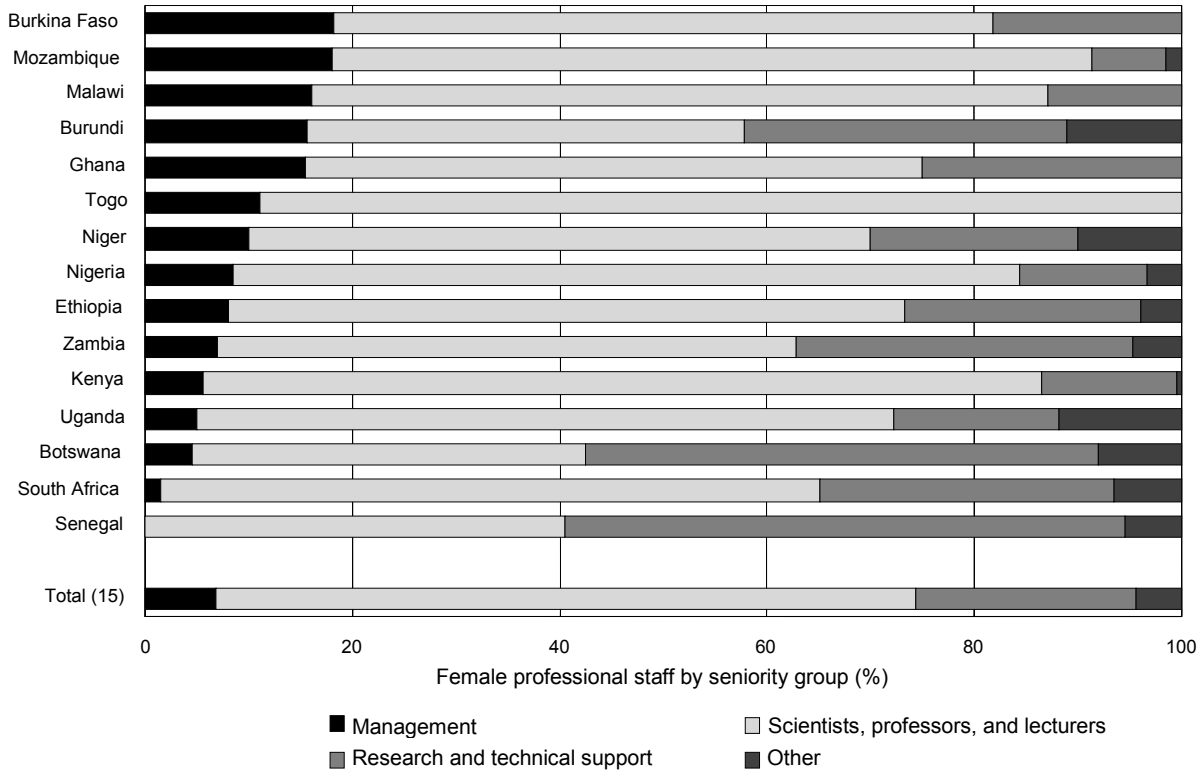


Source: Calculated by authors based on survey responses.

[14] Agencies use different definitions of professional staff. For some it includes research and technical support staff, whereas for others it does not (see Section 3).

Figure 19 presents the distribution of female professional staff by level of seniority. Overall, 7 percent of all female staff employed in agricultural research and higher education in the 15 sample countries held management positions. This ranged from 5 percent or less in Botswana, Senegal, South Africa, and Uganda, to 18 percent in Burkina Faso and Mozambique. Interestingly, despite the relatively large share of female professional staff in research and higher education in Botswana, Kenya, South Africa, and Zambia, a comparatively small proportion of these women held management positions.

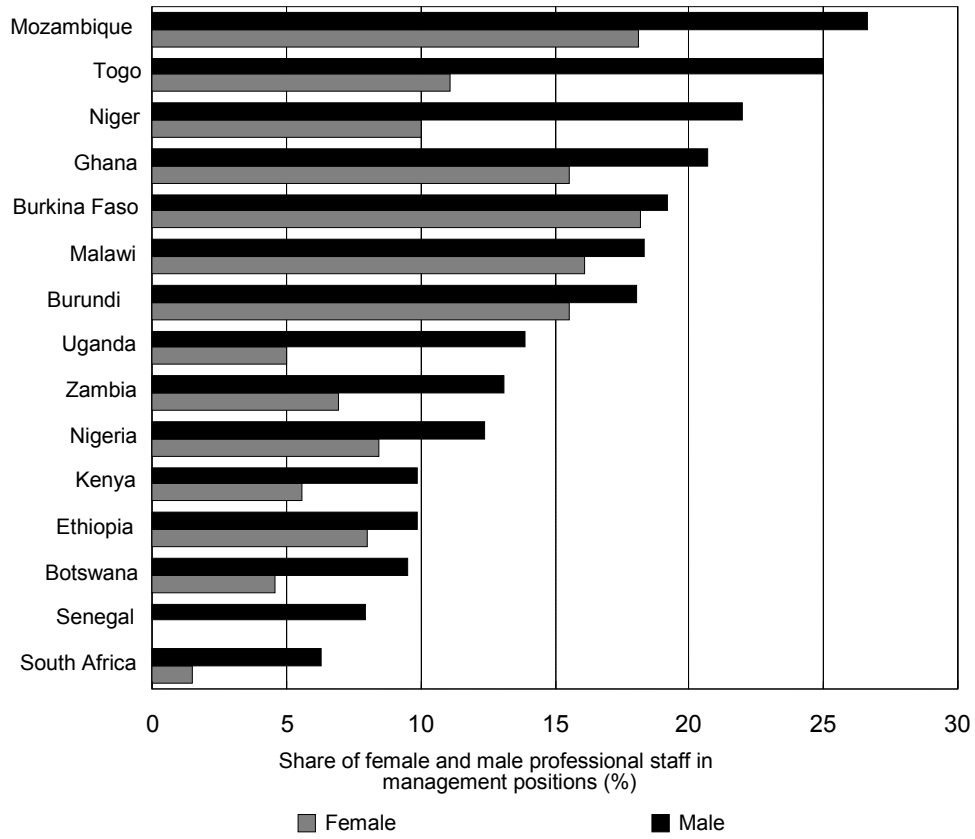
Figure 19. Distribution of female professional staff by seniority, 2007/08



Source: Calculated by authors based on survey responses.

Figure 20 compares the proportion of female professional staff holding management positions with the share of male professional staff in management. The aforementioned 7 percent of women holding management positions was about half the corresponding share for male staff consistently in all 15 countries. This comparison is also important to place the country-level shares for women in senior positions presented in Figures 5.1 and 5.2 in better perspective. For example, the 6 percent share of male staff holding management positions in South Africa was not as low as the corresponding share of women in management positions, but the overall availability of management positions in agricultural research and higher education agencies in South Africa was considerably lower than in countries like Ghana, Malawi, and Mozambique. The difference between women and men was almost negligible in Burkina Faso (18 versus 19 percent), Ethiopia (8 versus 10 percent), and Burundi and Malawi (16 versus 18 percent each).

Figure 20. Share of female and male professional staff in management positions, 2007/08

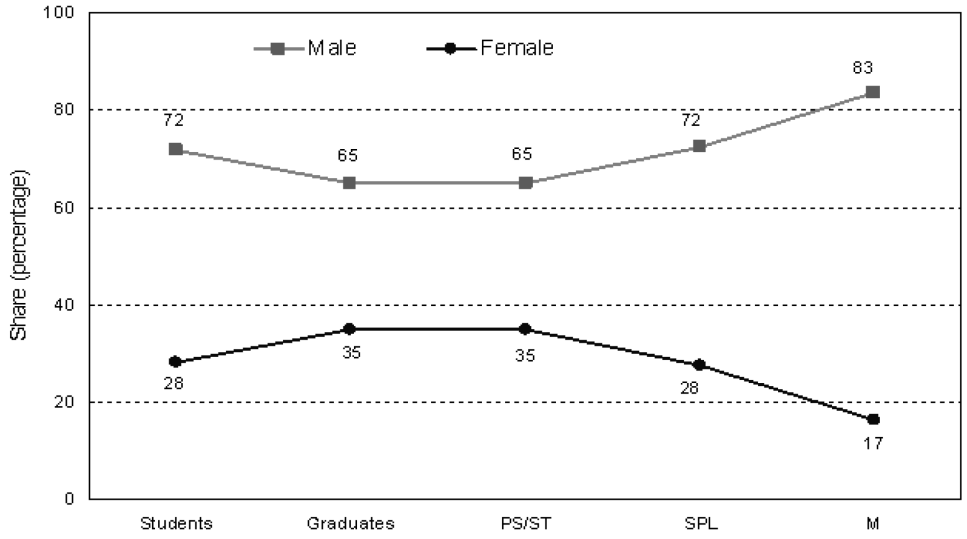


Source: Calculated by authors based on survey responses.

In *She Figures*, the European Commission (EC 2006, 2009) uses a "scissor" diagram to illustrate the way the gender gap progresses along various points of an S&T career path, starting with higher education. This scissor pattern occurs because generally at BSc and MSc levels, more women than men enroll and graduate, but from PhD level onwards, this trend reverses. In the following stages in the career path, the proportion of women further declines, reaching its lowest level in management. These general figures include all academic fields, even when women are underrepresented.

Figure 21 illustrates the way the gender gap changes at different points of an S&T career path using the data collected under the ASTI–AWARD survey. As it happens, the figures presented show much lower proportions of women even at BSc and MSc levels. For example, female participation in BSc and MSc courses at higher education agencies is considerably lower than that of men, with the result that the diagram does not follow the classic scissor trend. Although the proportions of enrolled and graduating women in total student population are higher than in the later stages of their career path, the shares of women are lower than that of men. This is comparable to the European Commission's diagrams for science and engineering.

Figure 21. Shares of women and men at different points along the career path, 2007/08

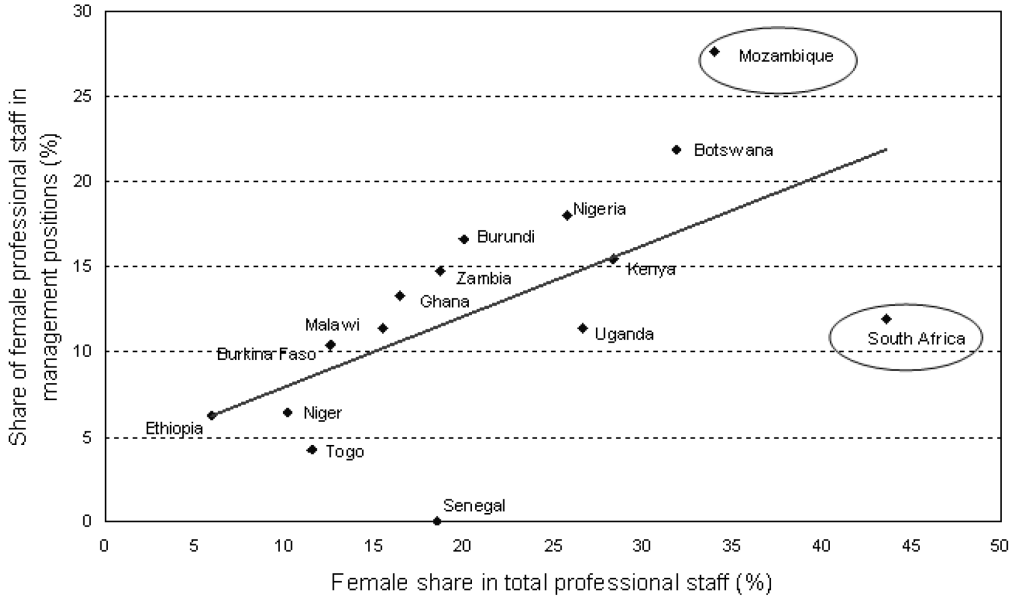


Source: Calculated by authors based on survey responses.

Note: Burkina Faso, Burundi, Ethiopia, Niger, and Togo were excluded because data on student enrollments and graduations were either unavailable or incomplete. PS/TS indicates professional and technical support staff; SPL includes scientists, (assistant) professors, and (senior) lecturers not in management positions; and M indicates management and includes directors, deans, and department heads. When all 15 countries are included, the share of women in management positions falls to 14 percent.

Figure 22 shows a clear correlation between the overall proportion of female staff compared with their representation in management positions. The two outliers are Mozambique and South Africa. In South Africa, due to the aforementioned limited number of management positions overall, the share of women in management is low, similarly for men. In contrast, relatively more management positions are available in the agricultural research and higher education agencies in Mozambique resulting in a relative higher share of women (and men) in management positions.

Figure 22. Share of female professional staff in management positions versus the share of females in overall professional research staff, 2007/8



Source: Calculated by authors based on survey responses.

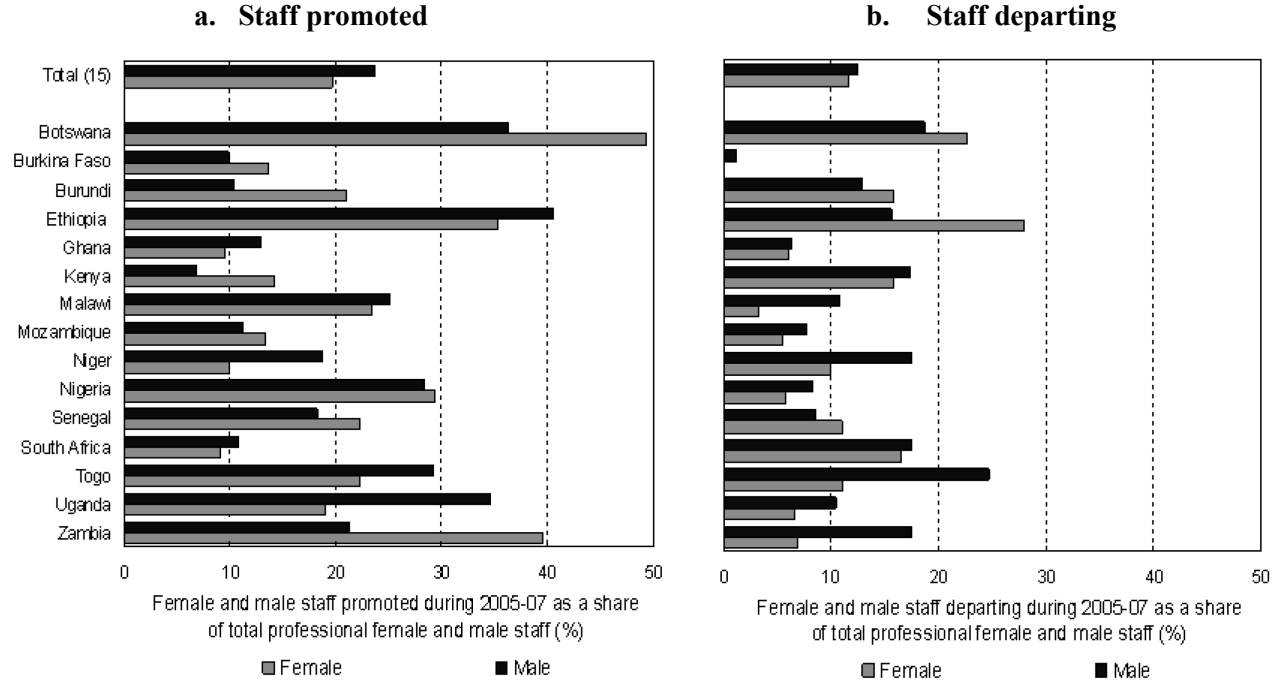
6. DEPARTURES AND PROMOTIONS OF FEMALE RESEARCH STAFF

One aspect of measuring the so-called 'leaking pipeline' is to keep track of the number of women leaving their agency; hence, survey information was collected on how many women and men left their respective agencies during 2005–07. It is also important to measure how many women have been promoted compared with their male counterparts (here during the same three-year period), which is a further means of measuring vertical segregation.

Figure 23a shows the numbers of female and male staff promoted during 2005–07 as a share of total female and male professional staff employed in 2007/08. Overall, a lower proportion of women than men were promoted during this timeframe (20 versus 24 percent), but no detailed information was available regarding the level of the employment hierarchy within which these promotions took place. Furthermore, these average figures hide large variations across countries. Notably, a higher proportion of women were promoted than men in 8 of the 15 sample countries.

Figure 23b shows the number of female and male staff that left their agencies during 2005–07 as a share of total female and male professional staff employed in 2007/08. With the exception of Botswana, Burundi, and Ethiopia, relatively more male professional staff left the agencies over the three-year period. This is somewhat surprising, as attrition among women in scientific fields is generally higher than among men, but there can be various explanations for this. This relatively higher departure rate for men may be a reflection of the aforementioned substantial decline in male professional staff at the MSc level, but more research is needed to indentify the underlying causes of staff mobility.

Figure 23. Gender-disaggregated shares of professional staff that were promoted and departed their agencies during 2005–07 as a share of total professional staff employed in 2007/08



Source: Calculated by authors based on survey responses.

7. CONCLUSION

Participation by women in agricultural research and higher education in Africa has increased in recent years. For a sample of 15 Sub-Saharan African countries, the proportion of female professional staff employed in agricultural research and higher education increased from 18 percent in 2000/01 to 24 percent in 2007/08. Nevertheless, female participation levels varied considerably across countries, with comparatively low shares in Ethiopia and a number of Francophone countries in West Africa, and comparatively high levels in southern Africa.

In absolute numbers, female professional staffing levels increased by 8 percent per year, whereas male professional staff levels increased by only 2 percent per year. About two-thirds of the total increase in capacity comprised staff holding only BSc degrees, indicating that the overall quality of agricultural research and higher education staff declined in Sub-Saharan Africa over the seven-year period studied, at least in some of the countries. This is a particularly worrisome trend in light of significant concerns about agricultural research capacity in Africa.

Because of the growing representation of women in entry-level positions, women in agricultural research and higher education are typically younger, currently have lower degrees, and are by definition overrepresented in lower positions and underrepresented in management positions compared with men.

The proportion of women studying agricultural sciences is actually larger than the share of female professional staff employed in agriculture, which is a positive indicator for the future, assuming appropriate incentives can be provided to encourage these students to pursue careers in agricultural research, undertake higher degrees, and ultimately attain positions of seniority. Given that a large proportion of the current pool of students is only enrolled in BSc degrees, it is extremely important that MSc and PhD training programs be provided to ensure the quality of the future pool of researchers.

Women's participation is clearly more prevalent in agricultural disciplines related to life and social sciences (for example, food nutrition sciences, molecular biology, and agricultural economics), whereas women are particularly underrepresented in areas related to engineering (such as irrigation and water management, natural resource management, and soil science).

Although this report provides new insights into existing female and male capacity in African agricultural research and higher education, more research is needed to improve our understanding of underlying factors such as staff mobility, career paths and the relationship between age distribution and professional levels of women and men. Furthermore, the gender-disaggregated capacity indicators collected for this study only reflect a certain point in time and are subject to fluctuations. Ongoing survey rounds, at least every two to three years, are necessary to maintain an accurate picture not only of women's participation in agricultural research and higher education in Africa, but also of the region's overall capacity.

APPENDIX A: SUPPLEMENTARY TABLE

Table A.1. List of agencies targeted

		Number of professional staff (headcounts)					
		2000/01			2007/08		
Country/agency name	**Agency type**	**Female staff**	**Male staff**	**Total**	**Female staff**	**Male staff**	**Total**
Botswana							
Department of Agricultural Research (DAR)	Government	12	21	33	23	63	86
Department of Animal Production and Health, National Veterinary Laboratory (NVL)	Government	10	11	21	21	21	42
Botswana College of Agriculture (BCA)	Higher education	na	na	na	31	76	107
Burkina Faso							
Institut National de l'Environnement et de la Recherche Agricole (INERA)	Government	8	145	153	12	106	118
Institut de Recherche en Sciences Appliquées et de Technologie (IRSAT)	Government	na	na	na	9	34	43
Institut du Développement Rural (IDR)	Higher education	2	22	24	1	22	23
Burundi							
Institut des Sciences Agronomiques du Burundi (ISABU)	Government	5	41	46	13	52	65
Université du Burundi (UB) - Institut Supérieur d'Agriculture (ISA)	Higher education	2	10	12	2	10	12
Université du Burundi (UB) - Faculté d'Agronomie (FACAGRO)	Higher education	3	21	24	4	15	19
Centre National de Technologies Alimentaires (CNTA)[a]	Government	na	na	na	na	na	na
Ethiopia							
EIAR sum		35	394	429	36	479	515
EIAR - Headquarters (HQ)	Government (national)				4	18	22
EIAR - Debre Zeit Agricultural Research Center (DZARC)	Government (national)				14	69	83
EIAR - Holetta Agricultural Research Center (HRC)	Government (national)				7	65	72
EIAR - Jimma Agricultural Research Center (JARC)	Government (national)				0	58	58
EIAR - Ambo Agricultural Research Center (AmRC)	Government (national)				1	25	26
EIAR - Assosa Agricultural Research Center (AsARC)	Government (national)				0	12	12
EIAR - Melkassa Agricultural Research Center (MARC)	Government (national)				4	75	79
EIAR - Worer Agricultural Research Center (WARC)	Government (national)				2	40	42
EIAR - Forestry Research Center (FRC)	Government (national)				2	49	51
EIAR - Kulumsa Research Center (KRC)	Government (national)				0	34	34

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
Ethiopia (Continued)							
EIAR-Powe Agricultural Research Center (PARC)	Government (national)				0	31	31
EIAR- Hwassa/Awassa National Maize Research Program (HNMRP)	Government (national)	4	0	4	2	3	5
Oromia Agricultural Research Institute (OARI)	Government (national)	3	82	85	6	219	225
Amhara Regional Agricultural Research Institute (ARARI)	Government (regional)	6	98	104	12	199	211
Amhara Regional Agricultural Research Institute (APARI)	Government (regional)				2	27	29
Somali Pastoralist and Agro-pastoralist Research Institute (SPARI)	Government (regional)				2	56	58
Southern Nations Agricultural Research Institute (SNARI)	Government (regional)				na	na	na
Tigray Agricultural Research Institute (TARI)	Government (regional)				10	105	115
Gambela Agricultural Research Center (GARI)	Government (regional)				na	na	na
Haramaya University (HAU) - College of Agriculture (CA)	Higher education	3	140	143	13	164	177
Addis Ababa University (AAU) - Faculty of Veterinary Medicine (FVM)	Higher education	3	33	36	2	34	36
Ghana							
CSIR Animal Research Institute (ARI)	Government	6	15	21	9	25	34
CSIR Crops Research Institute (CRI)	Government	9	75	84	14	73	87
CSIR Soil Research Institute (SRI)	Government	2	29	31	1	27	28
CSIR Oil Palm Research Institute (OPRI)	Government	3	15	18	1	23	24
CSIR Food Research Institute (FRI)	Government	16	22	38	14	24	38
CSIR Forestry Research Institute of Ghana (FORIG)	Government	12	35	47	10	40	50
CSIR Institute for Industrial Research (IIR)	Government	na	na	na	3	18	21
CSIR Plant Genetic Resources Centre (PGRC)	Government	1	10	11	2	15	17
CSIR Savanna Agricultural Research Institute (SARI)	Government	2	41	43	2	28	30
CSIR Water Research Institute (WRI).	Government	7	52	59	10	43	53
University of Ghana (UG) - College of Agriculture and Consumer Sciences (CACS)	Higher education	9	60	69	18	43	61
Kwame Nkrumah University of Science and Technology (KNUST) - College of Agriculture and Natural Sciences (CANS)	Higher education	9	51	60	18	90	108
University of Development Studies (UDS) - Faculty of Agriculture (FA)	Higher education	8	50	58	8	64	72

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
Ghana (Continued)							
University of Cape Coast (UCC) - School of Agriculture (SA)	Higher education	3	38	41	2	40	42
Cocoa Research Institute of Ghana (CRIG)	Nonprofit	4	31	35	3	30	33
Kenya							
Kenyan Agricultural Research Institute (KARI)	Government	97	336	463	153	350	503
University of Nairobi (UN) - Faculty of Agriculture (FA)	Higher education	45	90	135	20	59	79
University of Nairobi (UN) - Faculty of Veterinary Sciences (FVS)	Higher education	14	123	137	12	100	112
Jomo Kenyatta University of Agriculture and Technology (JKUAT)	Higher education	na	na	na	63	190	253
Egerton University (EU) - Faculty of Agriculture (FA)	Higher education	na	na	na	na	na	na
Coffee Research Foundation (CRF)	Nonprofit	4	30	34	5	15	20
Tea Research Foundation of Kenya(TRF)	Nonprofit	na	na	na	na	na	na
Malawi							
Department of Agricultural Research (DARS)	Government	6	64	70	9	53	62
Forestry Research Institute of Malawi (FRIM)	Government	na	na	na	na	na	na
Bunda College of Agriculture (BCA)	Higher education	17	54	71	21	95	116
Mali							
Rural Economy Institute (IER)	Government	27	213	240	23	230	253
Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA)	Higher education	na	na	na	na	na	na
Mauritania							
Centre National de Recherche Agronomique et de Développement Agricole (CNRADA)	Government	2	39	41	na	na	na
Centre National de l'Élevage et de Recherches Vétérinaires (CNERV)	Government	3	15	18	3	8	11
Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP)	Government	2	35	37	4	62	66
Mozambique							
Instituto de Investigação Agrária de Moçambique (IIAM)	Government	na	na	na	65	129	194
Instituto de Investigação Pesquira (IIIP)	Government	na	na	na	15	32	47
Universidade Eduardo Mondlane (UEM) FVET	Higher education	na	na	na	28	37	65
(UEM) FA	Higher education	na	na	na	19	35	54

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
Niger							
Institut National de la Recherche Agronomique du Niger (INRAN)	Government	6	76	82	8	69	77
Direction des Centres de Multiplication du Bétail et Stations d'Elevage (CMB-SE)	Government	na	na	na	na	na	na
Université Abdou Moumouni de Niamey (UAMN) - Faculté d'Agronomie (FA)	Higher education	1	22	23	2	22	24
Nigeria							
National Veterinary Research Institute (NVRI)	Government	15	89	104	71	218	289
Nigerian Institute for Oil Palm Research (NIFOR)	Government	9	55	64	6	46	52
Rubber Research Institute of Nigeria (RRIN)	Government	4	54	58	10	41	51
National Cereals Research Institute (NCRI)	Government	5	50	55	5	35	40
Nigerian Institute for Oceanography and Marine Research (NIOMR)	Government	16	32	48	32	61	93
Institute of Agricultural Research (IAR)	Government	na	na	na	5	28	33
National Root Crops Research Institute (NRCRI)	Government	4	51	55	16	55	71
National Horticultural Research Institute (NIHORT)	Government	8	32	40	29	35	64
Forestry Research Institute of Nigeria (FRIN)	Government	4	41	45	31	58	89
Cocoa Research Institute of Nigeria (CRIN)	Government	7	31	38	14	57	71
Institute of Agriculture Research and Training (IAR&T)	Government	17	43	60	20	31	51
National Animal Production Research Institute (NAPRI)	Government	4	42	46	9	32	41
National Agricultural Extension–Research Liaison Service (NAERLS)	Government	2	46	48	7	39	46
National Stored Products Research Institute (NSPRI)	Government	10	21	31	15	22	37
National Institute for Freshwater Fisheries Research (NIFFR)	Government	na	na	na	9	46	55
Lake Chad Research Institute (LCRI)	Government	na	na	na			
University of Ibadan (UI) - Faculty of Agriculture and Forestry (FAF)	Higher education	23	105	128	47	124	171
University of Ibadan (UI) - Faculty of Veterinary Medicine (FVM)	Higher education	22		22	15	94	109
Ahmadu Bello University (ABU) - Faculty of Agriculture (FA)	Higher education	na	na	na	na	na	na
Ahmadus Bello University (ABU) - Faculty of Veterinary Medicine (FVM)	Higher education	na	na	na	42	44	86

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
Nigeria (Continued)							
University of Nigeria (UN) - Faculty of Agriculture (FA)	Higher education	18	57	75	31	60	91
University of Nigeria (UN) - Faculty of Veterinary Medicine (FVM)	Higher education	na	na	na	11	62	73
Obafemi Awolowo University (OAU) - Faculty of Agriculture (FA)	Higher education	10	56	66	20	52	72
University of Agriculture, Makurdi	Higher education	na	na	na	17	98	115
UAM-CASE		na	na	na	na	na	na
Rwanda							
Institut des Sciences Agronomiques du Rwanda (ISAR)	Government	na	na	na	28	98	126
Université Nationale du Rwanda (UNR) - Faculté d'Agronomie (FA)	Higher education	na	na	na	na	na	na
Senegal							
Institut Sénégalais de Recherches Agricoles (ISRA)	Government	10	94	104	24	107	131
Institut de Technologie Alimentaire (ITA)	Government	3	13	16	9	26	35
Ecole Nationale Supérieure d'Agriculture (ENSA)	Higher education	1	66	67	3	31	34
South Africa							
ARC - Central Office (CO)	Government	na	na	na	14	14	28
ARC - Grain Crops Institute (GCI)	Government	11	26	37	22	30	52
ARC - Small Grains Institute (SGI)	Government	12	15	27	16	23	39
ARC - Institute for Industrial Crops (IIC)	Government	9	8	17	5	13	18
ARC - Vegetable and Ornamental Plant Institute (VOPI)	Government	15	23	38	23	19	42
ARC - Institute for Tropical and Subtropical Crops (ITSC)	Government	11	26	37	14	20	34
ARC - Infruitech-Nietvoorbij (NIETV)	Government	27	50	77	32	32	64
ARC - Rangeland Forage Institute (RFI)	Government	14	18	32	10	17	27
ARC - Animal Improvement Institute (AII)	Government	14	29	43	12	31	43
ARC - Animal Nutrition and Products Institute (ANPI)	Government	13	17	30	20	14	34
ARC - Onderstepoort Veterinary Institute (OVI)	Government	31	30	61	56	39	95
ARC - Plant Protection Research Institute (PPRI)	Government	35	68	103	38	32	70
ARC - Institute for Agricultural Engineering (IAE)	Government	1	19	20	1	13	14
ARC - Institute for Soil Climate and Water (ICSW)	Government	14	62	76	20	40	60
University of Pretoria (UP) - Faculty of Natural and Agricultural Sciences (FNAS)	Higher education	34	72	106	100	117	217

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
South Africa (Continued)							
University of Pretoria (UP) - Faculty of Veterinary Science (FVS)	Higher education	51	60	111	28	73	101
University of Stellenbosch (US) - Faculty of Agriculture and Forestry Sciences (FAFS)	Higher education	17	77	94	51	61	112
University of KwaZulu Natal (UKZN) - School of Agricultural Sciences and Agribusiness (SASA)	Higher education	11	51	62	27	51	78
University of Fort Hare (UFH) – School of Agricultural and Agribusiness (SAA)	Higher education	10	16	26	8	20	28
University of the Free State (UFS) - Faculty of Natural and Agricultural Sciences (FNAS)	Higher education	15	39	54	22	74	96
South African Sugar Association Experimental Station (SASA)	Nonprofit	13	18	31	18	37	55
Tanzania							
Division of Research & Development (DRD)	Government	6	20	26	na	na	na
Sokoine University of Agriculture (SUA) SUA-FA	Higher education	na	na	na	na	na	na
Tea Research Institute of Tanzania (TRIT)	Nonprofit	na	na	na	na	na	na
Tanzania Coffee Research Institute (TACRI)	Nonprofit	0	10	10	1	14	15
Togo							
Institut Togolais de Recherche Agronomique (ITRA)	Government	5	55	60	9	61	70
Université de Lomé: École Supérieure d'Agronomie (ESA)	Higher education	1	80	81	0	28	28
Uganda							
National Agricultural Research Organization (NARO) sum		39	145	184	60	160	220
NARO-Secretariat (NAROSEC)	Government				3	7	10
NARO- Semi-Arid (NaSARRI)	Government				1	16	17
NARO-Ngetta (KAZARDI)	Government				2	4	6
NARO-ABIZARDI (ABI)	Government				0	10	10
NARO-Bulindi	Government				2	7	9
NARO-Kachwekano	Government				1	9	10
NARO-KAWANDA (NARL-Kawanda)	Government				6	26	32
NARO-Nabuin (NABUZARDI)	Government				2	5	7
NARO-Mukono (MUZARDI	Government				9	4	13
NARO- National Livestock Resources Research Institute (NaLIRRI)	Government				9	16	25

Table A.1. Continued

Country/agency name	Agency type	Number of professional staff (headcounts)					
		2000/01			2007/08		
		Female staff	Male staff	Total	Female staff	Male staff	Total
Uganda (Continued)							
NARO- National Forestry Resources Research Institute (NaFORRI)	Government				3	9	12
NARO-National Fisheries Resources Research Institute (NaFIRRI)	Government				8	17	25
NARO- National Crops Resources Research Institute (NaCRRI)	Government				8	25	33
NARO-Mbarara (KAZARDI	Government				6	5	11
Makerere University (MU) - Faculty of Agriculture (FA)	Higher education	21	72	93	30	85	115
Makerere University (MU) - Faculty of Forestry and Natural Conservation (FFNC)	Higher education	6	18	24	8	34	42
Makerere University (MU) - Faculty of Veterinary Medicine (FVM)	Higher education	14	55	69	23	65	88
Zambia							
Soils and Crops Research Branch (SCRB)	Government	8	159	167	21	96	117
University of Zambia (UZ) - School of Agricultural Sciences (SAS)	Higher education	8	22	30	14	30	44
University of Zambia (UZ) - School of Veterinary Medicine (SVM)	Higher education	3	22	25	6	21	27
Golden Valley Agricultural Research Trust (GART)	Nonprofit	2	6	8	2	13	15

Note: na indicates that data were not available.
[a] Agency did not return the survey form.

APPENDIX B: INSTITUTIONAL AND POLICY ENVIRONMENTS FOR FEMALE RESEARCHERS

Ghana[15]

Agriculture plays a dominant role in Ghana's economy, contributing about 40 percent of gross domestic product (GDP). The Food and Agriculture Sector Development Policy (FASDEP), which outlines agricultural policy directions for Ghana, defines the national agricultural vision as a modernized agricultural sector that will cumulate into a structurally transformed economy with food security, employment opportunities, and reduced poverty. The role of women in achieving this vision is paramount, given their high visibility in the country's food and agricultural production.

In Ghana, the socioeconomic roles of women appear to be well defined. Women dominate several areas of economic activity related to agriculture, such as subsistence food-crop farming, fish-mongering, the marketing of produce, and the micro-processing of *gari* (a grain-like food product made from cassava), corn dough, palm oil, bread, and local dishes. The performance of agricultural research and higher education is generally male-dominated, however. Women are only beginning to make their presence felt, yet their participation is fundamental to modernization and to the application of S&T to address women's needs.

Ghana has recognized the challenge of the lack of equal opportunities for women and is committed to achieving the Millennium Development Goal target of equality and improved circumstances for women. In the specific area of S&T, schemes have been established to enhance access to knowledge-intensive professions for women. For example, affirmative action is in place for women's admission to universities, improving their access to scientific studies, and an important innovation to facilitate girls' access to scientific education is the availability of high school–level science and mathematics clinics.

The concern to address women's issues in national development has led to the establishment of key institutions, such as the Ministry of Women's and Children's Affairs, which was established in 2001 to address policy gaps in order to create a level playing field for women. In addition, the National Council for Women and Development was established as a statutory body in 1975 to advise the government on all issues relevant to women. The council commissions research projects and initiates and funds programs to enhance the role of women in the national economy. Specific to the challenges in the agricultural sector, the program Women in Agricultural Development was established under the Ministry of Food and Agriculture to improve women's productivity in the sector through research and improved technologies.

Despite these efforts, deeper insights are needed into the nature of the specific policy interventions required. The ASTI-AWARD benchmarking study makes a significant contribution is in this regard.

Nigeria[16]

Agriculture in Nigeria provides significant employment for both men and women in the formal and informal sectors. Yet despite women's diverse role in agriculture—which includes planting, weeding, and harvesting crops; transporting, processing, and marketing produce; raising livestock, particularly poultry and small ruminants such as sheep and goats; and undertaking fisheries and acquaculture activities, especially fish processing and marketing—women's participation in agricultural research and higher education agencies is low. Achieving the Millennium Development Goals poses quite a challenge to the Government in Nigeria and particularly for its male-dominated agricultural sector. A number of agencies focus attention on women's issues, including the Ministry of Women's Affairs (established in 1985), the Ministry of Millennium Development Goals (established in 2001), and the National Council of Women's Societies (established in 1960).

[15] Prepared by George Essegeby.
[16] Prepared by Gbolagade Ayoola and Stella Williams.

In 1985, Maryam Babangida—the wife of the then Military ruler—was proactive in establishing a program to facilitate women's agricultural and economic contributions. The program, called "A Better Life for Rural Women," encouraged the development of cooperative societies for women, whereby they could initiate product cooperatives and access funds from rural community banks. This one action gave women access to much-needed financial credit. Maryam Babangida also facilitated the establishment of a national blueprint for the education of women and girls, which in turn led to the creation of the National Association of Women in Science, Technology, Engineering, and Mathematics (NAWSTEM) under the Ministry of Education's Women in Science and Technology Division. Other initiatives to promote gender equality followed, including national and international competitions and Junior Engineers, Technicians, and Scientists Clubs.

The country's primary policy to promote gender equality is through gender mainstreaming, under which most public authorities pursue ways to maximize women's roles in the development process. In Nigeria, gender mainstreaming has featured in numerous federal, state, and local intervention programs, including:

- The establishment of a Ministry of Women's Affairs at federal and state levels;
- The establishment of desk officers in other ministries to facilitate gender mainstreaming, particularly women's participation in development;
- The overt inclusion of gender issues in interventions such as the Women in Agriculture program under agricultural development projects, the National Program on Food Security, the National Food Production Program, and the National Poverty Alleviation Program; and
- The establishment of Centres for Gender and Policy Studies in a number of state universities.

In addition, Nigeria has benefitted from the input of international organizations and programs focusing on women, including United Nations Development Fund for Women (NIFEM) and the World Bank–assisted Fadama Development Program.

South Africa[17]

South Africa's definition of and goals toward achieving gender equality are guided by a vision of human rights that incorporates acceptance of the equal and inalienable rights of all women and men. This ideal is a fundamental tenet under the Bill of Rights of The Constitution of the Republic of South Africa, 1996 (Act 108 of 1996). South Africa has one of the most progressive constitutions in the world in which Section 9 (1) "affirms the right of everyone to be equal before the law and to the equal protection and benefit of the law." This ideal emerged from a people whose history is steeped in institutional racism, where rights, opportunities, and the distribution of goods and services were predicated on racial lines. More importantly, respect for the dignity of individuals was determined by skin color and by their gender. In most interpersonal relationships, in both public and private life, men had more power. This has had a marked impact at the workplace where women were less likely to have managerial and decisionmaking roles.

More recently South Africa has signed a number of international treaties committing to the promotion of gender equality. These include the Convention to End All Forms of Discrimination against Women (1979) and the Beijing Platform for Action (1995). Since 1994 the South African government has put in place a number of important policies and legislative frameworks to promote gender equality:

- The National Policy Framework for Women's Empowerment and Gender Equality was approved by Cabinet in 2002 and defines roles and responsibilities related to gender for government representatives at all levels. The Framework establishes national guidelines for action to facilitate equal access to goods and services.

[17] Prepared by Frikkie Liebenberg and Johann Kirsten.

- The Commission on Gender Equality is one of six state institutions established to promote democracy and a culture of human rights by "exposing gender discrimination in laws, policies, and practices; advocating changes in sexist attitudes and gender stereotypes; and instilling respect for women's rights as human rights."
- Affirmative action laws have been in place in South Africa since the Employment Equity Act came into effect in 1998.
- The Broad-Based Black Economic Empowerment Act 53 of 2003 aims to promote economic transformation to enable meaningful participation of black people in the economy.
- The Preferential Procurement Policy framework Act 5 of 2000 includes specific provisions favoring women in the codes of good practice under which the legislation is enacted. Agriculture the Land Reform initiatives also make provision for the protection of women's interests as beneficiaries of land claims and within the farmer support programs that underpin farmer settlement projects.
- Reward and recognition schemes promoting women's participation in various endeavors have been implemented, including the Female Farmer of the Year Award and the Female Scientist of the Year Award. Bursary schemes targeting female scientists have also been created to increase the participation of woman in science.

Since 1994, South Africa has made significant progress in promoting gender equality and currently ranks 20th of the 128 countries included in the Gender Equality Index survey of the World Economic Forum. Nevertheless, South Africa's ranking is largely influenced by its achievements in the field of political empowerment. Female participation in the labor force is still only 49 percent compared with 82 percent for men, and female wages are typically about half those of men, largely because women are not well represented in management. The female share of researchers nationally has increased only marginally in recent years, from 35.3 percent in 2001/02 to 39.7 in 2006/07.

In its report to the United Nations on the Status of Women, South Africa admits that gender inequality continues to undermine democracy, impede development, and dramatically compromise people's lives. Consequently, government and civil society organizations have begun to implement a range of initiatives intended to increase men's involvement in the achievement of gender equality.

Zambia[18]

In terms of government action, gender equality and women's empowerment have been most succinctly articulated in Zambia through its two most recent national plans: the Poverty Reduction Strategy Paper of 2002–04 and the Fifth National Development Plan, 2006–10. These two documents provide the basis for resource allocation to the national development programs, and it is through this channel that the government has continued to allocate resources for gender and development.

The government has also developed the National Gender Support Program as a way of effectively providing coordination of resource mobilization and effective implementation of gender mainstreaming. The government has also established policies to promote the education of girls. For example, low cutoff points at secondary level, encourage girls to remain in school. Even at higher learning institutions, measures are in place to ensure female participation. At the University of Zambia, 30 percent of places are reserved solely for women, with the remainder open to both men and women based on merit. Zambia now has female professors, a higher number of female doctors, and increased numbers of women pursuing careers in engineering, agriculture, and mining.

In Zambia, agriculture accounts for 18–20 percent of GDP, and the sector employs about 67 percent of the country's total labor force. Women contribute not less than 65 percent of agricultural labor and have responsibility for domestic food production and household food security. Women account for 51

[18] Prepared by Ngoma Hambulo, Simukondo Coilard, and Mick Mwala.

percent of the population, but they still lack decisionmaking power. To this end, in 2000 the Zambian government approved a National Gender Policy to ensure the mainstreaming of gender activities into economic growth and development programs and policies. Issues covered under the National Gender policy include:

- Women's empowerment in the domestic, community, and public domains;
- Gender issues related to poverty, particularly in terms of women's limited access to and control over productive resources, remunerative employment opportunities, and the minimal participation in public life; and
- Disparities in opportunities, including in education, science and technology, and skills development training.

Zambia has adopted a number of international treaties and conventions to mainstream gender issues, and a variety of institutional frameworks have been established. These include:

- Convention on the Political Rights of Women (1953),
- SADC Declaration on Gender and Development Protocol (1997),
- African Charter on Human and People's Rights (1981),
- United Nations Charter on the Rights of the Child (1989), and
- Chapter 24 of Agenda 21: Global Action for Women towards Sustainable and Equitable Development (1992).

Zambia has also adopted key international labor conventions protecting the status of women in employment, including:

- Convention 100, promoting the principle of equal remuneration for men and women for equal work of equal values;
- Convention 103, providing maternity protection to women, includes compulsory leave, medical benefits, and many worker's rights including breastfeeding;
- Convention 105, concerning the abolition of forced labor and stating that ratifying countries undertake to declare and pursue a national policy to promote equal opportunity and treatment in respect of employment and occupation, and to eliminate discrimination;

Additionally, the Government of Zambia has established the following mechanisms to mainstream gender issues:

- The Gender in Development Division, under the Ministry of Gender of Women's Development, is mandated is to coordinate, monitor, and evaluate the implementation of the National Gender Policy in order to achieve gender responsive development.
- Gender Focal Points 5 appoints both men and women in each line ministry and at the provincial level for the purpose of implementing the Gender in Development Division's mandate.
- Gender subcommittees have been established in all line ministries and provincial and district administrations to address the observed gaps in gender mainstreaming and to function as a link between the Gender Development Division and the various institutions.
- Gender sensitization activities have been established to increase gender sensitivity among key officials within line ministries and key institutions. Due to limited resources, however, most ministries have not been able to hold sensitization workshops to create gender awareness and the basic analytical skills and tools needed to mainstream gender in the planning and implementation of programs.
- A Gender Consultative Forum has been established to guide and advise government, via the Gender in Development Division, on emerging issues. The main functions of the

Forum are to (a) advise the Gender Development Division on emerging gender issues, (b) ensure that policies being implemented are gender sensitive, and (c) advise on incidental or related issues of relevance to gender and development.

- The Gender Management Team was established to provide leadership in the implementation of gender activities; to lobby for resources; to lobby ministries, provinces, and parastatals on gender implementation; to monitor and evaluate gender implementation activities; and to develop implementation strategies.
- The Nongovernmental Coordinating Committee, which is an umbrella organization responsible for coordinating the activities of affiliate nongovernmental organizations involved in the implementation of gender and development initiatives. The Committee has established provincial chapters in all nine provinces of Zambia to ensure effective coordination at provincial and district levels.

These strategies broadly apply to all women, but the field of science is especially affected by gender barriers. For this reason, the integration of women into research agencies traditionally staffed by men poses significant challenges, and changes in Zambia and slowly evolving such that it is now not uncommon to find women in fields once dominated by men. A forum for female scientists was created in the Ministry of Science Technology and vocational training has been provided to address the specific challenges facing the country's female scientists.

Ongoing gender challenges identified in Zambia's Strategic Plan for the Advancement of Women include:

- The persistent and growing burden of poverty on women, their unequal access to resources, and exclusion from economic policy and institutions;
- Women's unequal access to health-related services;
- Women's lack of decisionmaking power; and
- Inequality in the rights of female children.

Overall, female scientists still face a number of challenges. In particular, they must deal with male management structures that reflect the norms and values of the wider feudal society. Sexual harassment remains an issue, along with favoritism and nepotism, and the general working conditions often undermine women's performance and job satisfaction. Nevertheless, progress is being made based on the institutional frameworks outlined above.

APPENDIX C: ADDITIONAL INNOVATIVE TOOLS FOR PRESENTING GENDER DATA

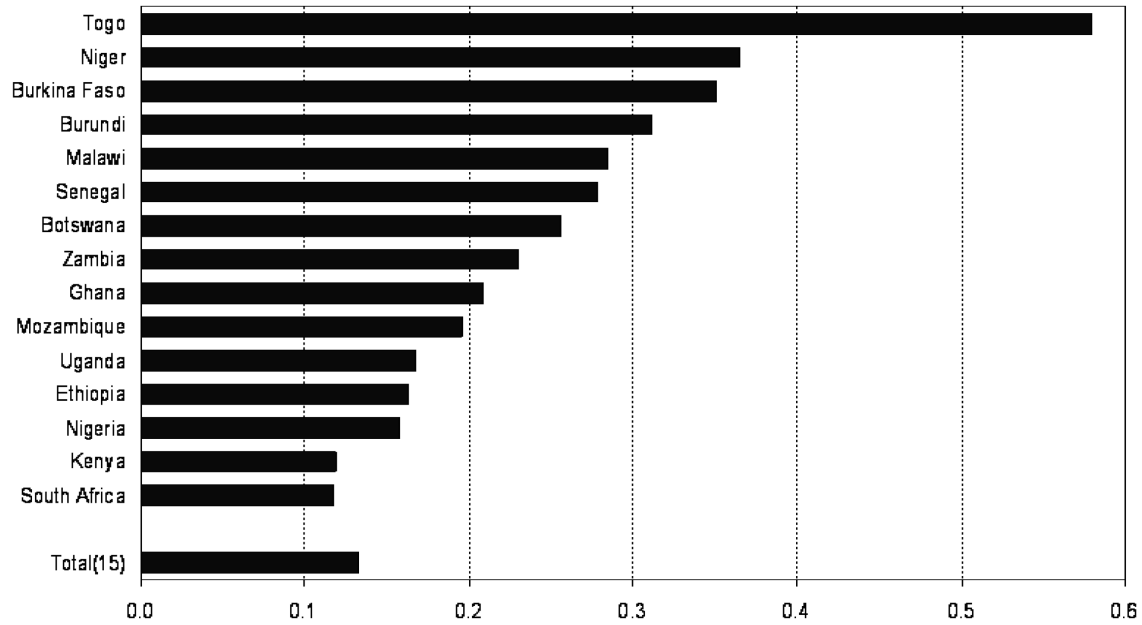
The *She Figures* series from the EU provides some additional innovative tools to present gender data. These tools, however, are perhaps more relevant for overall S&T capacity in high-income countries than for agricultural S&T capacity in Africa, but this appendix uses two of these measurements, the *Dissimilarity Index* and the *Glass Ceiling Index*.

Dissimilarity Index

The European Commission (EC 2006) calculates a *Dissimilarity Index* to measure the differences in the level of horizontal segregation across countries. This dissimilarity index is a theoretical measurement that indicates the percentage of female and male scientists that have to move to another occupation (or in this report, train in another discipline), to ensure that the share of women are equal across occupational groupings, or as in this case, disciplines. An index of 0 indicates equal distribution of a country's female and male professional staff across all disciplines. An index value of 1 indicates that only women or men are employed in all disciplines. Index values between 0 and 1 indicate the level of the gender imbalance within the range of disciplines. It is important to note that the outcomes of the index calculations also depend on the number of categories, in that, the greater the number of categories, the larger the variability in the distribution and hence the higher the level of segregation. For this purpose, we grouped the 16 disciplines shown in Figure 16 into nine categories: (1) Animal science (including fisheries), (2) Crop science (including agronomy and entomology), (3) forestry, (4) agricultural economics, (5) extension, (6) molecular biology, (7) food and nutritional science, (8) natural resources (including biodiversity, soil science, natural resource management, water/irrigation, and ecology) and (9) other.

Figure C.1 shows the *Dissimilarity Index* for each country, along with the sample average of 0.13—indicating that 13 percent of all professional staff have to change their occupation to ensure that the average share of female professional in each discipline is similar as the overall average of 24 percent. Although the *Dissimilarity Index* is a theoretical measurement, the European Commission (2006, 37) states that "the calculation that lies behind the *Dissimilarity Index* is a means of producing a consistent indicator of difference, which allows for systematic comparisons across sectors and countries." But the index is not very useful for countries with a small pool of (female) professional staff as this may result in a high dissimilarity index. For example, of the nine female professional staff in Togo, 4 were employed in food and nutrition sciences and 3 in crops sciences, resulting in an index of 0.58.

Figure C.1. Dissimilarity Index



Source: Calculated by authors based on survey responses.

Glass Ceiling Index

One way to compare the proportion of female professional staff in management positions relative to their presence in the number of professional staff employed in agricultural research and higher education, is to calculate the so-called *Glass Ceiling Index* (EC 2006). The term Glass Ceiling has been used for more than two decades to describe the constraints women face in attempting to reach top levels of management (Falk and Voigt 2006, Wikipedia 2009). The *Glass Ceiling Index* measures the actual "thickness of the ceiling" and has been applied in different ways. The European Commission (2006), for example, measures the share of women in full professorships or equivalent positions compared with the share of women in academia. Falk and Voigt (2006) defined the *Glass Ceiling Index* in more detailed terms and interviewed 590 female and male executives in five OECD countries and the Philippines in order to collect information on the factors that affected women's ability to advance in their career across three dimensions: individually, within a company, and within the country's societal environment. The *Glass Ceiling Index* in this report measures the proportion of female agricultural professional staff in management positions compared with the overall share of women in agricultural research and higher education.

Table C.1 ranks the indexes by country. The value can run from zero to infinity, with an index of 1 indicating that there is no difference in the ability of female and male professional staff to obtain a promotion. A score of less than 1.0 indicates that women are overrepresented in management positions. Unsurprisingly all 15 countries have scores above 1.0, which indicates that women are underrepresented in management positions. It is important to note, however, that the *Glass Ceiling Index* measures seniority levels of women relative to their presence in the workforce. It does not address women's underrepresentation in relation to their male colleagues in the overall labor force. Clear examples are Burkina Faso and Ethiopia, where the index signals that the share of female staff in management positions is close to be proportionate with their presence in agricultural professional staff. But the index overlooks the reality that the share of female professional staff in agricultural research and higher education is very low in both countries.

A score of more than 1.0 indicates that female professional staff are underrepresented in management positions, and the higher the score, the thicker the glass ceiling. Indexes for Niger, Uganda, Togo, South Africa, and, Senegal, were all above 2 percent.

Table C.1. The Glass Ceiling Index, 2007/8

Ranking of countries	Female shares in HC		Glass ceiling index (=PS/SP_i)
	Total professional staff (PS)	Management position (PS_i)	
	(*percentage*)		
Burkina Faso	12	11	1.11
Ethiopia	6	5	1.13
Malawi	17	15	1.15
Burundi	20	17	1.17
Ghana	16	13	1.26
Mozambique	35	27	1.30
Nigeria	26	18	1.41
Kenya	26	16	1.59
Zambia	21	13	1.69
Botswana	32	18	1.76
Niger	10	5	2.08
Uganda	26	11	2.30
Togo	9	4	2.39
South Africa	41	14	2.93
Senegal	18	0	∞
Total (15)	23	18	1.34

Source: Calculated by authors based on survey responses.

REFERENCES

Beintema, N. M. 2006. *Participation of female agricultural scientists in developing countries.* Brief prepared for the meeting, "*Women in Science: Meeting the Challenge*," an adjunct to the CGIAR Annual General Meeting, Washington, D.C., December 4, 2006.

Beintema, N. M., P. G. Pardey, and J. Roseboom. 1998. *Educating agricultural researchers: A review of the role of African universities.* EPTD Discussion Paper No. 36. Washington, D.C.: International Food Policy Research Institute.

Beintema, N. M., and G. J. Stads. 2008. *Diversity in agricultural R&D resource in the Asia-Pacific region.* Washington, D.C. and Bangkok: International Food Policy Research Institute and Asia-Pacific Association of Agricultural Research Institutions.

EC (European Commission). 2006. *She figures 2006: Women and science, statistics and indicators*. Brussels.

_____. 2008. *Mapping the maze: Getting more women to the top in research.* Brussels.

_____. 2009a. *She figures 2009: General information.* Brussels.

_____. 2009b. *Women and science: Gender difference, gender equality*. http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=27 (Accessed May 2009).

Falk, S., and A. Voigt. 2006. *The anatomy of the glass ceiling:* Barriers to women's professional advancement. Accenture.

FAO (Food and Agriculture Organization of the United Nations). 2009 FAOSTAT – POPSTAT. <http://faostat.fao.org/ site/550/default.aspx#ancor > (accessed April 2009).

FARA (Forum for Agricultural Research in Africa). 2006. *Agricultural research delivery in Africa: An assessment of the requirements for efficient, effective and productive national agricultural research systems in Africa: Main report and strategic recommendations*. Accra: FARA.

Goh, A., H. Recke, D. Hahn-Rollins, and L. Guyer-Miller. 2008. *Successful women, successful science*. Gender & Diversity Working Paper 48. Nairobi: CGIAR Gender & Diversity Program.

Huyer, S. and G. Westholm. 2007. *Gender indicators in science, engineering, and technology: An information. Science and Technology for Development Series*. Paris: United Nations Educational, Scientific and Cultural Organization.

IAC (InterAcademy Council). 2004a. *Inventing a better future: A strategy for building worldwide capacities in science and technology*. Amsterdam.

_____. 2004b. *Realizing the promise and potential of African agriculture. Science and technology strategies for improving agricultural productivity and food security in Africa*. Amsterdam.

_____. 2006. *Women for Science: An advisory report*. Amsterdam.

OECD (Organisation for Economic Co-operation and Development). 1995. *Manual on the measurement of human resources devoted to S&T: Canberra Manual*. Paris.

_____. 2002. *Frascati manual: Proposed standard practice for surveys on research and experimental development*. Paris.

UIS (UNESCO Institute of Statistics). 2006. *Women in science: Under-represented and under-measured*. UIS Bulletin on Science and Technology Statistics Issue No. 3 (November).

UNESCO (United Nations Educational, Scientific and Cultural Organization), *Division of Statistics on Science and Technology*. 1984. Manual for statistics on scientific and technological activities. Paris.

Stads, G. J. and N. M. Beintema. 2009. *Public agricultural research in Latin America and the Caribbean: Investment and capacity trends*. Washington, D.C.: International Food Policy Research Institute and Inter-American Development Bank.

Wikipedia. 2009. *Glass Ceiling*. <http://en.wikipedia.org/wiki/ Glass_ceiling> (Accessed May 2009).

World Bank. 2007. *Cultivating Knowledge and Skills to Grow African Agriculture*. Washington, D.C.).

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