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Access and participation of women and girls in education, training, science and technology, including for the promotion of women's equal access to full employment and decent work

Report of the Secretary-General

Summary

The present report examines women's and girls' access to and participation in science and technology, including with regard to the acquisition of knowledge and skills, and science and technology production. It also assesses the content of science and technology from a gender perspective, and provides recommendations for consideration by the Commission on the Status of Women.

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I. Introduction

1. In accordance with Economic and Social Council resolution 2009/15, the Commission on the Status of Women will consider at its fifty-fifth session, as its priority theme, "Access and participation of women and girls to education, training, science and technology, including for the promotion of women's equal access to full employment and decent work". In order to allow for an in-depth analysis of the theme, the present report covers gender-equality issues in science and technology, including science and technology education and employment. The linkages between women's access to education and training and employment are addressed in the second report of the Secretary-General on the priority theme (E/CN.6/2011/5), which also reviews progress in mainstreaming a gender perspective in national policies and programmes, and responds to the decision contained in Council resolution 2006/9. Both reports serve as inputs for the Commission's consideration of the priority theme.

2. The present report builds on, among other sources, an Expert Group Meeting on the priority theme organized by the Division for the Advancement of Women of the United Nations Secretariat, now part of UN-Women, in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO). It also incorporates analysis and examples provided by Member States,[1] and concludes with recommendations for future action for consideration by the Commission on the Status of Women.

3. In its broadest sense, the term "science and technology" covers all fields of scientific endeavour, including the natural sciences, the biomedical and engineering sciences, and the social and human sciences. The term "science and technology" is commonly used to refer more narrowly to academic and professional disciplines related to the natural sciences, engineering, mathematics and computing, as well as to the knowledge, artefacts and processes that result from those activities. This report uses the term in the latter sense.

4. Science and technology are often discussed together with innovation, which encompasses both technological advances represented, for example, by products and processes, and non-technological improvements through, for instance, marketing and organizational solutions. Science, technology and innovation improve productivity and competitiveness, and therefore contribute to economic growth. Various determinants, such as people, institutions, infrastructure and the policy environment, define the ability of a country to produce and use new knowledge, and to acquire, adopt, adapt and diffuse existing knowledge. These elements and the linkages between them constitute the national system of innovation.[2]

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[1] Contributions were received from the Governments of Argentina, Belarus, Belgium, Bolivia (Plurinational State of), Burkina Faso, Cambodia, Canada, China, Cyprus, Denmark, Djibouti, Ecuador, El Salvador, Germany, Greece, Grenada, Jamaica, Japan, Lebanon, Luxembourg, Malta, Montenegro, the Netherlands, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, the Philippines, Poland, Slovakia, Spain, Sweden, Switzerland, Turkey and Zambia.

[2] See the report of the Secretary-General on science, technology and engineering for innovation and capacity-building in education and research (E/CN.16/2009/3); and Organization for Economic Cooperation and Development, *OECD Science, Technology and Industry Outlook 2008* (Paris).

5. Science, technology and innovation can be a tool with which to accelerate the achievement of the internationally agreed development goals, including the Millennium Development Goals.[3] Technology can, for instance, facilitate efforts to eradicate poverty, achieve food security, fight diseases, improve education and respond to the challenges of climate change. Installing solar water heating technology in rural clinics, for example, can help prevent infections and contribute to reducing maternal and child mortality.

6. There have been efforts at the intergovernmental level to examine how science, technology and innovation intersect with gender-equality issues. Global policy on gender equality — as set, for instance, in the Beijing Platform for Action,[4] the outcome documents of the twenty-third special session of the General Assembly,[5] and the agreed conclusions of the Commission on the Status of Women — include several references to science and technology. Gender-equality issues are mentioned in the outcome documents of the World Conference on Science convened by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council for Science, in cooperation with other partners, and the World Summit on the Information Society, as well as in resolutions of the Commission on Science and Technology for Development, which is the sole functional commission of the Economic and Social Council to have a Gender Advisory Board, established in 1995.[6] Civil society groups, such as the Organization for Women in Science for the Developing World, have also made significant contributions to bridging the divide between these two topics.

7. Despite these efforts, gender equality and science and technology too often continue to be seen as distinct issues. This report argues that policymakers have a key role to play in integrating a gender perspective in science, technology and innovation. To harness the full potential of science and technology for development, Governments must ensure that women have equal access to science and technology knowledge and skills, that they participate equally in developing and applying knowledge, and that research content and technology development and deployment respond to the needs of both women and men.

II. Participation in science and technology education[7]

A. Benefits of science and technology education

8. Women's equal access to scientific and technological knowledge and skills is first and foremost a rights issue, inasmuch as education is a basic human right. An essential part of education, science education contributes to human development by

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[3] See UN Millennium Project, Task Force on Science, Technology and Innovation, *Innovation: Applying Knowledge in Development* (London, Earthscan, 2005).

[4] *Report of the Fourth World Conference on Women, Beijing, 4-15 September 1995* (United Nations publication, Sales No. E.96.IV.13), chap. I, resolution 1, annex II.

[5] General Assembly resolution S-23/2, annex, and resolution S-23/3, annex.

[6] See the note by the Bureau of the Commission on the Status of Women on the discussion guide for the high-level round table on access and participation of women and girls in education, training, science and technology, including for the promotion of women's equal access to full employment and decent work (E/CN.6/2011/4) for a more extensive discussion.

[7] Unless otherwise indicated, the information provided comprises inputs to the report received from Member States.

providing tools with which to make sense of the world and empowers individuals to make informed decisions related to critical aspects of their lives, including their health. On a societal level, it can enhance democratic participation: in an age where many societal debates are linked to the risks and benefits of technological developments, women must be scientifically and technologically literate if they are to fully participate as citizens.

9. Ensuring that women acquire scientific and technical knowledge and skills is also an economic imperative. As the world economy is increasingly driven by knowledge, countries need a large base of workers who can apply technology, as well as scientists and engineers who can carry out further research and development. Developing women's competencies will widen the pool of human resources available to perform these tasks. This is all the more important as many countries are facing a shortage of science and technology professionals, coupled with a growing disinterest in science among youth.[8] Moreover, environmental concerns are leading to a growth in so-called green jobs, many of which will demand a solid educational background in science or technology.

10. Women are generally responsible for a wide variety of tasks, ranging from productive work and household responsibilities to community management activities. Building their scientific and technical capacity can help them achieve a better and more efficient performance of these tasks. For example, the fact that women's traditional role is that of the primary caregiver makes it particularly important that they understand the scientific basis for diseases, as such knowledge is key to preventing and curbing the spread of infectious diseases. Technology training can help women use computers and operate labour-saving equipment such as that utilized in agroprocessing.

B. Progress made and gaps remaining

11. Much progress has been made in the past decades in expanding access to basic education for girls. Attending school is a prerequisite for acquiring literacy and numeracy skills, basic scientific knowledge and technological competencies. Increasing girls' participation in primary and secondary schooling is thus the first step towards ensuring equal access to science education. In addition, because many children leave school lacking basic literacy and numeracy skills,[9] growing attention is now given to improving the quality of education, including through teacher training. It may be particularly important to better train primary schoolteachers in science, as they are the first to introduce science to children but may have limited knowledge of scientific subjects and how to teach them.[10]

12. While at the primary and lower secondary levels, mathematics and science are compulsory subjects, higher secondary school often introduces specialized tracks or optional courses, which may steer girls and boys in different directions. According to the Relevance of Science Education (ROSE) project, 15-year-old girls like their

[8] See Peter J. Fensham, "Science education policy-making: eleven emerging issues" (Paris, UNESCO, 2008); and S. Sjøberg and C. Schreiner, "The ROSE project: overview and key findings" (Oslo, University of Oslo, March 2010).

[9] *EFA Global Monitoring Report 2010: Reaching the Marginalized* (Paris, UNESCO; and Oxford, Oxford University Press, 2010).

[10] Fensham, "Science education policy-making".

science classes less than boys do, particularly in developed countries. At that age, girls are less likely than boys to wish for a career as a scientist, and are markedly less likely to wish for a job in technology. Girls from developing countries, however, display more enthusiasm for entry into such professions than their counterparts in developed nations.[11]

13. At the tertiary level, progress has been made in advancing women's participation in science and technology fields. As evidenced in the table below, women now dominate in some sub-fields of science, particularly life sciences. However, they generally continue to be underrepresented in computing. In addition, women have not made the same inroads in engineering as they have made in science. In 2007, the global median share of female students was 21 per cent in engineering, manufacturing and construction.[12] Further, global and regional data can hide wide variations across countries. In respect of engineering, for example, women constitute 49 per cent of students in Uruguay and 46 per cent in Mongolia, compared with 12 per cent in Japan and Uzbekistan, and 5 per cent in Cambodia.[13]

Proportion of women university graduates in the field of science in 76 countries, by region, 2008

(Percentage)

		Sub-field			
Region	*Science*	*Life sciences*	*Physical sciences*	*Mathematics and statistics*	*Computing*
Arab States	51	73	61	59	33
Central and Eastern Europe	47	70	54	53	29
Central Asia	53	68	44	60	39
East Asia and the Pacific	48	60	58	62	29
Latin America and the Caribbean	41	67	51	53	31
North America and Western Europe	40	60	43	48	21
South and West Asia	[a]	[a]	[a]	[a]	[a]
Sub-Saharan Africa	[a]	[a]	[a]	[a]	[a]

Source: UNESCO Institute for Statistics database, cited in *Global Education Digest 2010: Comparing Education Statistics Across the World.*

[a] Regional averages not available owing to low response rates.

14. The lack of sex-disaggregated data on technical and vocational education and training makes it difficult to assess the extent to which they provide the opportunity for women to acquire scientific competencies. Nevertheless, available evidence suggests that vocational education, in both formal and non-formal settings, is generally marked by strong gender segregation, with women underrepresented in

[11] Based on data collected in 33 countries and subnational regions between 2004 and 2007 (see Sjøberg and Schreiner, "The ROSE project").

[12] *EFA Global Monitoring Report 2010.*

[13] UNESCO Institute for Statistics; *Global Education Digest 2010: Comparing Education Statistics Across the World* (Montreal, Canada, 2010).

technical subject areas.[14] The situation may be changing slowly in some countries. In Canada, for instance, while only 1 in 10 apprentices is a woman, female participation in trades such as building construction and motor vehicle and heavy equipment repair has increased in the last decade.

C. Making science and technology attractive to girls

15. The underrepresentation of women in science and technology fields is a matter of concern for many stakeholders, including Governments, academia, the private sector and non-governmental organizations, and much has been done to understand its causes and identify solutions. A number of countries have adopted comprehensive national strategies, such as the National Pact for Women in Mathematics, Informatics, Natural Science and Technology Careers in Germany, which involves more than 70 partners. The All China Women's Federation worked with 10 ministries and commissions to translate the findings of a study on the difficulties faced by women in science and technology, into feasible policy measures. Recognizing the need for a holistic approach, the Netherlands established a Science and Technology Platform which carries out programmes at all levels of education designed to increase the share of students in scientific and technical education. Four projects focus specifically on girls, and the programme pays attention to the choices and attitudes of both girls and boys.

16. Educational and career choices are shaped by a range of factors, including students' performance and interest in and enjoyment of given subject areas. There appears to be little basis for the widespread belief that girls lack ability in mathematics and science. International tests showed, on average, no gender difference in performance in science, while evidence on mathematics is mixed.[15] In many countries, however, people continue to associate men with mathematics and science, and women with the humanities and care-oriented fields. This belief, referred to as the gender-science stereotype, is sometimes unconscious, and may prevail even in people who support gender equality in science and technology.

17. Extensive research has established that members of a group to which a negative stereotype is attached tend to both underperform and under-assess their performance — a phenomenon known as "stereotype threat". In mathematics and science, stereotypes are thus likely to decrease girls' and increase boys' performance and self-assessment, and consequently to impact their interest in these disciplines.[16] Research has shown that the prevalence of the gender-science stereotype in a given

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[14] M. Harlt, "Technical and vocational education and training (TVET) and skills development for poverty reduction — do rural women benefit?" (2009), paper presented at the Food and Agriculture Organization of the United Nations (FAO)-International Fund for Agricultural Development (IFAD)-International Labour Organization (ILO) Workshop on Gaps, trends and current research in gender dimensions of agricultural and rural employment: differentiated pathways out of poverty, Rome, 31 March-2 April 2009.

[15] Organization for Economic Cooperation and Development, *Equally Prepared for Life? How 15-year-old Boys and Girls Perform in School* (Paris, 2009).

[16] Catherine Hill, Christianne Corbett and Andresse St. Rose, *Why so Few? Women in Science, Technology, Engineering and Mathematics* (Washington, D.C., AAUW, 2010).

country is correlated with gender differences in performance in eighth grade science and mathematics.[17]

18. Gender stereotypes permeate society. They are imposed in many ways, for instance, through family expectations or the media, and can be perpetuated by the education system. Curricula and textbooks may overlook the contribution of women scientists, neglect gender issues or utilize examples and images that confirm students' opinion that science is a male domain. Teachers can be biased, as evidenced by many experiments in developed and developing countries. For example, of 153 science teachers in China who were given the same description of a student but associated in one case with a boy's name and in the other with a girl's name, 71 per cent considered the "boy" a good student but only 20 per cent perceived the "girl" to be so.[18]

19. The persistence of such stereotypes highlights the need to sensitize education personnel to gender issues, an undertaking which is not yet systematic. A study of teacher education textbooks published in the United States of America between 1998 and 2001 found that they devoted about 3 per cent of content to gender issues, including in mathematics and science teaching methods.[19] There have been efforts, however, throughout the world to combat gender stereotypes in the education system. In Sweden, where local governments are responsible for the provision of primary and secondary education, some municipalities have hired "gender educationalists" to ensure that school activities incorporate a gender perspective and prevent gender segregation in subject choice. Belgium recently developed a publication to sensitize teachers and train them to promote girls' participation in science tracks.

20. Women tend to express a preference for professions that directly benefit society or individuals. The ROSE project found that 15-year-old girls were particularly interested in working with people rather than with things, and in helping other people. It was also more important for them than for boys to work in a field that was consonant with their personal values and attitudes.[20] However, scientific fields, with the exception of life sciences, are often viewed as lacking a clear social purpose, a perception that can be reinforced by curricula and pedagogic practices that are often biased towards boys' interests.[21] Emphasizing the broader societal applications of a discipline, rather than its technical aspect, can help engage girls and women.[22]

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[17] Brian A. Nosek and others, "National differences in gender-science stereotypes predict national sex differences in science and math achievement", *Proceedings of the National Academy of Sciences*, vol. 106, No. 26 (30 June 2009), pp. 10593-10597.

[18] H. Song, "Who is a good student? an exploration and analysis of stereotyped gender impressions among junior middle school teachers of science subjects", *Chinese Education and Society*, vol. 36, No. 3 (May/June 2003), pp. 43-54.

[19] Such content included experiences and contributions of women as well as strategies to eliminate gender stereotyping; see K. Zittleman and D. Sadker, "Teacher education textbooks: the unfinished gender revolution" (n.d.). Available from http://www.sadker.org/textbooks.html.

[20] Sjøberg and Schreiner, "The ROSE project".

[21] Fensham, "Science education policy-making".

[22] Hill, Corbett and St. Rose, *Why so Few?*.

21. Girls also tend to prefer hands-on experimentations and collaborative work.[23] Introducing computers and the Internet in classrooms can help familiarize girls with information and communications technology (ICT) and increase their interest in technology. Accessing computers at school can be particularly important for girls, who in some countries may not have the same freedom as boys to enter cybercafes. Activities outside schools can also help raise girls' interest in science and technology. A number of countries, such as Zambia, organize science camps for girls. Some tertiary institutions, for instance, polytechnic schools in Switzerland, offer science discovery workshops and lectures that target girls specifically.

22. A survey of over 1,000 male and female scientists in the United Kingdom of Great Britain and Northern Ireland highlighted the importance of role models: a family member working in science and technology or an inspiring teacher were the factors most often cited, after ability, as having contributed to their career choice.[24] Exposing girls to female role models can be particularly beneficial. However, while teaching has become increasingly feminized in many countries, this is not always the case in scientific disciplines. A study of 10 sub-Saharan African countries, for instance, showed that women constituted a small share of such teachers, particularly in senior secondary schools.[25] It is thus important to attract more women to these positions. Pakistan plans to increase by 30 per cent the share of female teachers in technical vocational institutes in the hope that this will help increase female enrolment in non-traditional courses.

23. Female scientists and engineers can also act as role models for girls. Canada funds Chairs for Women in Science and Engineering to increase the visibility of women in these fields, while in Malta, female scientists visit secondary schools to share their experience. University students can also inspire their younger peers. In Norway's ENT3R initiative, science undergraduates are paired with high school students; although this mentoring programme includes both female and male students, its aim is to recruit more girls.

24. Career counsellors, once sensitized to the topic, can play a key role by highlighting opportunities in scientific and technical careers for girls. In addition, "girls' days" exist in a number of countries to help girls explore opportunities for technical, scientific and information technology careers as well as careers in skilled trades. In Belgium, this day also integrates a focus on teachers, who participate in a short training course on gender stereotypes in education and receive information on technology and technical careers.

25. Universities can also contribute in this regard by actively reaching out to girls and young women, who may not have considered a scientific career and may be less well prepared than boys with respect to studying scientific subjects at an advanced level. The University of Dar es Salaam in the United Republic of Tanzania increased women's enrolment in engineering from 7 per cent in 2003-2004 to 27 per cent in 2007-2008 by modifying its admission criteria and offering borderline female

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[23] InterAcademy Council, *Women for Science: An Advisory Report* (Amsterdam, 2006).

[24] The Royal Society, "Taking a leading role: scientists survey" (2004). Available from http://royalsociety.org.

[25] W. Ottevanger, J. van den Akker and L. de Feiter, *Developing Science, Mathematics, and ICT Education in Sub-Saharan Africa: Patterns and Promising Practices*, *World Bank Working Paper*, No. 101 (Washington, D.C., World Bank, 2007).

applicants a six-week remedial course followed by an entrance exam.[26] Scholarships can also serve as an incentive for women to enrol in traditionally male-dominated domains. The provision of bursaries by Zambia, for example, encouraged female students to pursue engineering and architecture education. Once women have joined, however, they may find it difficult to fit within a male-dominated environment.[27] Mentoring programmes are frequently put in place in universities to remedy the isolation of female students.

26. The strong cultural association between men and technology must also be taken into account in non-formal training. For example, Fundación Solar, in Guatemala, in its community energy projects, found that training women separately from men in the area of equipment maintenance gave them the confidence to practice and ask their own questions, which resulted in better cared for and thus longer-lasting photovoltaic systems.[28] The results achieved by the Barefoot College, which in a period of six months trains illiterate women to install, repair and maintain solar lighting units, likewise owes much to the conducive environment offered by its campus in Tilonia, India.[29] This model is increasingly being recognized in Africa. Djibouti, for example, sent five rural women to the Barefoot College; upon their return, they installed solar panels and lanterns for 250 families.

III. Participation in science and technology employment and production

27. While ensuring that women acquire basic and advanced knowledge and skills in science and technology is important, national systems of innovation require more than a well-qualified human resource base to function well. A private sector that develops and uses technology, strong linkages between the various stakeholders, and a good infrastructure network, for example, constitute other important elements. The present section argues that addressing the barriers that female scientists and engineers face, facilitating the creation and growth of female-owned businesses, and tapping into women's local knowledge and innovation could help heighten the impact of innovation systems and thus accelerate development.

A. Women in science and technology employment

28. Scientists and engineers play a key role in the science and technology infrastructure. They conduct research and develop applications, either producing original knowledge or adapting and refining existing technology. Research and development is a strategic sector: it creates knowledge that can enhance societal

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[26] G. Bunyi, "Negotiating the interface between upper secondary and higher education in sub-Saharan Africa: the gender dimensions" (2008), paper prepared for the Biennale on Education in Africa of the Association for the Development of Education in Africa, Maputo, 5-9 May 2008.

[27] K. Lynch and M. Feeley, *Gender and Education (and Employment): Gendered Imperatives and Their Implications for Women and Men — Lessons from Research for Policy Makers* (Brussels, European Commission; 2009).

[28] Quoted in United Nations Development Programme, "Energy and gender for sustainable development: a toolkit and resource guide" (New York, 2004).

[29] See http://www.barefootcollege.org/sol_approach.asp.

well-being and spur economic growth, which may in turn result in job creation in various sectors of the economy. In addition, the research and development field itself provides attractive employment opportunities. Ensuring women's equal participation in this sector can help increase their access to decent work and reduce occupational segregation and the related gender pay gap.

29. Despite some achievements, women remain underrepresented in the field of research and development, be it in academia, the public sector or private companies. On average, across 121 countries with available data, women account for 29 per cent of researchers, and only 15 per cent of countries have achieved gender parity.[30] These statistics, however, encompass not only science and technology in its narrow sense, but all fields, including social sciences and humanities. There is a relative lack of official cross-comparable data broken down by sex on science and technology careers. Further development of statistics and indicators is crucial to enabling countries to design evidence-based policies and to monitor and evaluate implementation.[31]

30. Women's participation in science and technology has been likened to a "leaky pipeline", with a continuous attrition in the number of women at various stages of their lives. A certain number of graduates may not enter science and technology employment, in some cases because it would be culturally unacceptable to do so. Others may opt to migrate, while yet other scientists may leave the field after a short or a long career. Recognizing the multiple barriers that women face, Governments and other stakeholders have put in place a range of policies and programmes to address the issues of recruitment, retention, promotion and recognition of women in science and technology employment.

31. Recruitment constitutes a first hurdle, as employers may rely on their predominantly male networks to identify candidates, and may — often unconsciously — discriminate against female applicants. Women may also be offered positions that are less favourable in terms of compensation and benefits than those offered to equally qualified men. Recruiters therefore need to be sensitized to gender biases if they are to change this situation. Through the programme offered by the Committee on Strategies and Tactics for Recruiting to Improve Diversity and Excellence (STRIDE) at the University of Michigan, a number of professors were educated on the issue of unexamined biases; those professors in turn conducted workshops for other faculty members. The initiative is credited with having raised the proportion of female hires in science and engineering from 14 per cent in 2001 to 34 per cent in 2005.[32]

32. Once hired, women scientists and engineers face obstacles in the workplace that have an impact on their retention in the industry. The time-intensive nature of research work and the need for geographical mobility, combined with unequal sharing of caregiving responsibilities in the household, make it particularly difficult for women to balance their professional and personal lives. Providing flexible, affordable childcare close to the workplace can help alleviate the pressure of

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[30] United Nations Educational, Scientific and Cultural Organization (UNESCO) and UNESCO Institute for Statistics, "A global perspective on research and development", UIS Fact Sheet, No. 2 (Montreal, October 2009).

[31] United Nations Educational, Scientific and Cultural Organization, *Science, Technology and Gender: An International Report* (Paris, 2007).

[32] See http://sitemaker.umich.edu/advance/recruitment_stride.

parenthood, and benefit both female and male employees. In the Republic of Korea, for instance, the Daedeok research complex integrates a subsidized 300-slot childcare centre which is open from 7.30 a.m. to 10.30 p.m.[33]

33. Caregiving responsibilities may lead women to take career breaks. In this respect, provisions for paid leave as well as time extension of research grants can help equalize the playing field for female researchers. Enabling male scientists and engineers to assume their caregiving responsibilities can also contribute to changing the workplace culture. A number of mechanisms can be put into place to encourage women to reintegrate work after a break, such as the offer of discounted journal subscriptions and special conference rates during the break,[34] and dedicated grants after the break. India's Department of Science and Technology provides such funds to help women scientists and technologists return to research.[35]

34. Whether in academia, the public or private sector, women scientists and engineers face difficulty in gaining recognition for their work and progressing in their career. It has been highlighted that the measurement of performance and scientific excellence may not be fair to women.[36] In addition, women employed in traditionally "male" sectors find themselves in a double bind, as they tend to be viewed as either less competent than men or, when their competency cannot be challenged, less likeable than men. The combination of competency and likeability, however, is key to obtaining promotions.[37] Measures taken by some States include setting time-bound targets as well as providing financial incentives, such as funding for extra professorships and bonuses, to encourage universities to appoint more women to such positions. Universities are increasingly putting into place "stop the tenure clock" policies to minimize the impact of career breaks on women's career advancement.

35. Women's isolation in a predominantly male environment may exclude them from accessing the information and advice that male colleagues routinely exchange. Female workers may also have less of a connection to wider social networks, which in turn can limit their career opportunities.[38] Formal networking programmes can help palliate this situation. Mentoring is also frequently used to help women advance in their careers. For example, the African Women in Agricultural Research and Development (AWARD) programme of the Consultative Group on International Agricultural Research (CGIAR) pairs female scientists in Africa with senior professional mentors of either sex. Mentors are in return offered access to special events such as leadership or research proposal writing courses.[39]

36. The various obstacles that women face may also impact their access to research funding. Data from the European Union on all fields of study — not solely science and technology — show that fewer women than men apply for research,

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[33] K. Lee, "Effective policies for supporting education and employment of women in science and technology" ((2010) EGM/ST/2010/EP.6), expert paper prepared for the Expert Group Meeting: Gender, Science and Technology, Paris, 28 September-1 October 2010.

[34] *Women for Science: An Advisory Report*.

[35] See http://dst.gov.in/scientific-programme/women-scientists.htm.

[36] *Science, Technology and Gender*.

[37] Hill, Corbett and St. Rose, *Why So Few*.

[38] C. Buré, "Gender in/and science, technology and innovation policy: an overview of current literature and findings", International Development Research Centre (IDRC) Innovation, Policy and Science Program Area (IPS) Strategic Commissioned Paper (Ottawa, December 2007).

[39] See http://awardfellowships.org/.

relative to the pool of potential female and male applicants, and that men have a higher success rate in obtaining funding in a majority of countries.[40]

37. Actions put into place to increase female researchers' access to funding include soliciting funding applications from women researchers, which is done in South Africa,[41] as well as setting a target for the proportion of women funded or introducing funding programmes open to women only.[42] Targeted awards and fellowships, such as those awarded by L'Oréal and UNESCO, can also help make visible the contributions of women scientists.

38. Few women are leaders at scientific institutions, head large technology companies or become members of scientific boards. Female membership of national academies in science and technology disciplines is estimated at about 5 per cent globally.[43] Acknowledging the issue, some academies have created a young-member category in order to widen the nomination pool of women, while some Governments have established quotas or gender-balance targets for the boards of national research funding organizations. The Slovenian Research Agency, for instance, adopted a 30 per cent target for women in its expert bodies.[44] Countries have also been active in redressing the situation in academia. Austria, for instance, enforces a 40 per cent quota of women in all leadership bodies at universities.[45]

B. Women entrepreneurs: innovation and job creation

39. Small and medium-sized enterprises are increasingly recognized as crucial actors within innovation systems. Firms in research and development create breakthrough technology, while companies in other sectors innovate through practice, as the problems they face in their everyday work as well as their interaction with suppliers and clients prompt them to find new solutions.[46] These different types of innovation help companies grow and therefore lead to job creation. In addition, technology can enhance business operations and spur productivity.

40. Women constitute a significant share of business owners, especially in developing countries. Female-owned enterprises are often micro- and small-scale businesses, and many operate in the informal economy. The extent to which these enterprises are able to develop, acquire or apply technology depends on a number of factors, including the availability of skilled human resources and good infrastructure, and the overall regulatory environment. It is important that science, technology and innovation policies, which States use as an instrument for developing national innovative capacity, take into account and address the specific

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[40] European Commission, *She Figures 2009: Statistics and Indicators on Gender Equality in Science* (Luxembourg, Publications Office of the European Communities, 2009).

[41] See http://wir.nrf.ac.za/.

[42] European Commission, *The Gender Challenge in Research Funding: Assessing the European National Scenes* (Brussels, 2009).

[43] *Women for Science*.

[44] *The Gender Challenge in Research Funding*.

[45] See http://bmwf.gv.at/startseite/hochschulen/universitaeten/gesetze/organisationsrecht/ug_2002/.

[46] Organization for Economic Cooperation and Development, *SMEs, Entrepreneurship and Innovation* (Paris, 2010).

constraints that women entrepreneurs face, and actively support their contributions to national development.

41. Limited access to credit remains a significant barrier to enterprise creation and growth, particularly for those wishing to invest in technology. Women can find themselves at a disadvantage owing to discriminatory laws, lesser availability of collateral, and a general distrust of women's entrepreneurial capacities. Microfinance, often hailed as the solution to women's exclusion from credit, may be ill equipped to respond to this challenge, as technology-based enterprises require larger loans with longer repayment periods.[47]

42. While it is important to mainstream a gender perspective into all science, technology and innovation policies, targeted initiatives can also help address the specific issues faced by women entrepreneurs. Building on the common State practice of supporting the creation and growth of technology-based enterprises with technology parks and business incubators, the Government of India, in collaboration with the M. S. Swaminathan Research Foundation and the Tamilnadu Industrial Development Corporation, established a biotechnology park for women. The park brings together women entrepreneurs, scientists, financial institutions and industry, and includes a technical resource centre which assists with quality testing, technology development and training.[48]

C. Women's local knowledge and innovation

43. The role that communities themselves can play in solving local problems is being increasingly recognized. Often, in resource-poor households, developing new techniques and products, and adapting existing ones to specific needs, are a matter of survival. Local knowledge, technology and innovation can be particularly important in rural and urban areas that are underserved by infrastructure and government services and can ease the work burden of women who engage in time-consuming, labour-intensive household and productive activities.

44. Over time, rural communities have developed a vast repertory of knowledge and skills. Owing to social divisions of labour, women often have considerable expertise in respect of medicinal plants utilization, seed development, livestock rearing and soil conditions assessment. This traditional knowledge can usefully complement and contribute to modern science and technology. The birth of the contraceptive pill, for instance, can be traced back to one scientist's chance discovery of how some Mexican women used a variety of wild yam, which became the basis for producing synthetic progesterone.[49]

45. Indigenous knowledge, however, is at risk of being lost, as it relies on oral tradition and is often undervalued. A number of initiatives have been put into place to document indigenous technical knowledge. India's National Innovation Foundation, for instance, scouts for outstanding local knowledge, after which a team

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[47] See report of the Secretary-General on the World Survey on the Role of Women in Development (A/64/93).

[48] See http://www.biotechpark.co.in/.

[49] M. Claxton, "Indigenous knowledge and sustainable development", Third Distinguished Lecture, the Cropper Foundation, University of the West Indies, St. Augustine, Trinidad and Tobago, 1 September 2010.

of researchers test and validate practices, and refine them further, if need be. The knowledge is protected before the technology is promoted and disseminated, including through commercial channels.[50]

46. Actors at the local level, in particular Governments and non-governmental organizations, can encourage communities to revitalize and manage such knowledge — a need made all the more pressing within the current context of climate change and biodiversity loss. In the Bolivian Altiplano, a project carried out by the Swiss foundation Intercooperation helped 10 female and 50 male farmers strengthen and refine their knowledge of local best agricultural practices. These *yapuchiris* (sowers) then provided agricultural research and extension services to the community. The project tapped into women's expertise in respect of seed variety and encouraged gradual change, with a view to overcoming the male farmers' initial resistance to being assisted by women *yapuchiris*.[51]

47. It is important to recognize and support women's potential as innovators. Doing so can help foster, and diffuse, a greater number of innovations. In addition, women tend to be more likely than men to design solutions that require low external input. Their products may have a greater chance to be taken up by low-income households. One example of such low-cost innovation can be found in South Africa, where a group of women developed nesting boxes, made from a local plant, to protect chickens from predators and insulate them against heat and cold. Research on rural innovators further suggests that women are more open than men to sharing their ideas.[52]

48. Women's innovation potential often remains overlooked. A contributing factor is the fact that in some cases, women must rely on male artisans to turn their ideas into products, owing to their lack of the technical training and equipment required to do so themselves.[53] Prolinnova, a multi-stakeholder international network engaged in participatory innovation development, is piloting a support mechanism that provides male and female inventors with both grant funding for materials and equipment and access to technical expertise. Women farmers are part of the screening committee and can thus influence the direction of local research and development.[54]

IV. Access to gender-responsive science and technology

49. While it is important that women participate equally in the development of science, technology and innovation, be it as scientists and engineers, as entrepreneurs or as individuals contributing local knowledge and inventions, policymakers must also focus their efforts on the content of science and its applications. It is critical that research, development and deployment take into

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[50] S. Shenoy, "Gender issues and indigenous technical knowledge (ITK) for sustainable agriculture" (PowerPoint presentation, n.d.). See http://www.nif.org.in.

[51] International Strategy for Disaster Reduction, "Gender perspectives: integrating disaster risk reduction into climate change adaptation — good practices and lessons learned" (Geneva, 2008).

[52] L. Letty and A. Waters-Bayer, "Recognising local innovation in livestock-keeping: a path to empowering women", *Rural Development News*, No. 1/2010 (Lausanne, Switzerland, Swiss Centre for Developing Agriculture and Rural Areas).

[53] M. Carr, "Women, innovation and poverty reduction" (2007), unpublished paper.

[54] Letty and Waters-Bayer, "Recognising local innovation".

account women's needs and situation, and that national and international research priorities benefit both women and men.

A. Content of research and development

50. Critics have questioned whether the content of research and the development of technology adequately take into account women's needs and interests. While science is often seen as objective, research and development is carried out by human beings, who are prone to making subjective judgements. Scientists and engineers, whether male or female, may not be free of gender biases and may overlook the need to factor sex and gender considerations into their research and product design.

51. Biomedical research is a case in point. Much progress has been made since the 1980s, when the safety and efficacy of medications had been tested only on men from the fear of hurting the foetus that women of childbearing age could potentially be carrying. In the 1990s, the United States, for instance, mandated that research funded by the National Institutes of Health include both women and men in clinical trials.[55] However, inequalities remain. Despite well-recognized differences between female and male physiology, preclinical experiments tend to be conducted mostly on male animals. As shown in the figure, even research on diseases that affect primarily women is carried out disproportionately on male animals.[56] In addition, the majority of participants in early-stage clinical trials tend to be men, and studies too often fail to analyse results by sex or to report the sex of research subjects. These practices potentially skew results, with serious implications for women's health.[57]

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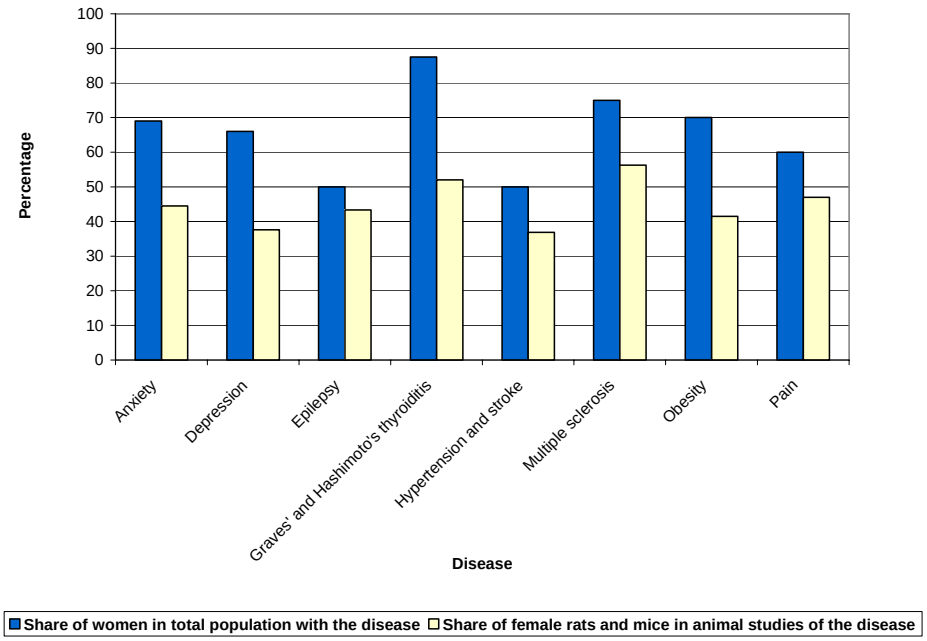
[55] A. Lippman, *The Inclusion of Women in Clinical Trials: Are We Asking the Right Questions?* (Toronto, Canada, Women and Health Protection, 2006).

[56] Analysis based on the Thomson Reuters Web of Science database for 2009. See also I. Zucker and A. Beery, "Males still dominate animal studies", *Nature*, vol. 465, No. 7299 (10 June 2010), p. 690.

[57] See "Putting gender on the agenda" (editorial), *Nature*, vol. 465, No. 7299 (10 June 2010), p. 665; Allison M. Kim, Candace M. Tingen and Teresa K. Woodruff, "Sex bias in trials and treatment must end", *Nature*, vol. 465, No. 7299 (10 June 2010), pp. 688-689; and Zucker and Beery, "Males still dominate".

Use of females animal models in biomedical studies



52. While the extra cost incurred through the need to control for the female hormonal cycle is often advanced as a justification for using male research subjects, the practice of using males has its own economic consequences. For example, 4 of the 10 drugs that were withdrawn from the market in the United States between 1997 and 2000 and had been prescribed to both women and men posed greater health risks for women.[58] In addition, gender biases impact men, too: research on osteoporosis has historically excluded men, leading to diagnostic criteria relevant for the female body and resulting in under-diagnosis and higher mortality from osteoporotic hip fractures among men.[59]

53. Regulatory and funding agencies can contribute to addressing these shortcomings by strengthening regulation and monitoring compliance.[60] In this regard, a review of the practices of research ethics committees in five European countries concluded that these bodies, which evaluate drug study protocols, paid

[58] United States General Accounting Office, “Drug safety: most drugs withdrawn in recent years had greater health risks for women” (Washington, D.C., U.S. Government Publishing Office, 2001).

[59] See L. Schiebinger, “Gender, science and technology” (October 2010) (EGM/ST/2010/BP.1), background paper prepared for the Expert Group Meeting: Gender, Science and Technology, Paris, 28 September-1 October 2010.

[60] See Lippman, *The Inclusion of Women*; and M. Ruiz Cantero and M. Angeles Pardo, “European Medicines Agency policies for clinical trials leave women unprotected”, *Journal of Epidemiology and Community Health*, vol. 60, No. 11 (November 2006), pp. 911-913.

limited attention to gender equality.[61] In addition, scholarly journals should require authors to document the sex of research subjects in their papers.[62]

54. Greater attention to gender issues is needed in all research and development fields. In many cases, women and men have different needs and preferences. Seat belts, for instance, do not conform well to the anatomy of pregnant women. In the event of a car accident, seat belts placed over the belly would apply heavy pressure to the uterus, which could cause foetal death.[63] Integrating gender-based analysis in research and development — that is to say, examining the relevance to each project of possible biological (sex) and socially constructed (gender) differences between women and men — can help produce better science and more useful applications. For example, after finding a high incidence of lower back pain in rural villages of the Tibet Autonomous Region of China, an Australian-funded project identified water collection as an important risk factor for women. It developed a "back-happy" tap stand, whose high tap and bench eliminate the need for women to bend in order to lift heavy water containers onto their backs.[64]

55. A focus on gender issues is relevant at all stages of research and development, and must be included starting with the initial problem identification until the final evaluation. Funding institutions can help drive this process forward by asking grantees to take gender issues into account. Pursuant to having mainstreamed a gender-equality perspective in its agricultural support strategy, the Gates Foundation reviewed its grant proposal and proposal review template to ensure that projects would empower women.[65] The current European Union research programme requires grantees to submit an end-of-project report on the wider societal implication of their research, including its gender-related aspects.[66]

56. Recognizing that researchers may be ill equipped to undertake gender-based analysis, these two institutions have developed capacity-building tools such as training toolkits and gender checklists. In the realm of product development, a project supported by the Government of Denmark, Female Interaction, is currently under way. Its aim is to develop guidelines on designing gender-responsive electronic products.[67] In addition, training tertiary-level students on gender issues could help sensitize future scientists and engineers, and prepare them to use gender-sensitive methodologies.

57. To be truly gender-responsive, the development of technology must be informed by consultation with the target user population. The development of the energy-efficient Upesi cook stove in Kenya, for example, included women in the design and testing of prototypes, an approach in marked contrast to that of earlier,

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[61] C. Moerman and others, "Gender equality in the work of local research ethics committees in Europe: a study of practice in five countries", *Journal of Medical Ethics*, vol. 33, No. 2 (February 2007), pp. 107-112.

[62] "Putting gender on the agenda".

[63] Schiebinger, "Gender, science and technology".

[64] D. Hoy and others, "The back happy tap-stand", *Journal of Water Supply, Research and Technology — AQUA*, vol. 54, No. 4 (2005), pp. 261-263.

[65] See http://www.gatesfoundation.org/learning/Pages/2008-gender-impact-strategy-report-summary.aspx.

[66] See http://www.yellowwindow.be/genderinresearch/.

[67] See http://www.femaleinteraction.com/.

unsuccessful stove development projects.[68] In areas where women have little influence over public matters, participatory methods can be particularly helpful in ensuring that women's needs, preferences and constraints are not neglected, and in identifying the possible adverse impacts that a new technology can have on some groups.

B. Technology deployment

58. Deployment is a crucial process within the technology life cycle. Technology is often disseminated through market channels, but Governments and other stakeholders also have a role to play, particularly in countries that have a small private sector or insufficiently developed distribution networks. Within countries, some regions, for instance, rural and remote areas, may require greater attention.

59. A number of obstacles may prevent the large-scale adoption of technology by women. Cost is a major barrier for both women and men living in poverty, but the former are likely to face cumulative disadvantages, such as a limited say in household spending decisions and lack of access to credit. Governments, donors and non-governmental organizations can make a product more affordable by subsidizing its cost. For example, the United Nations Development Programme (UNDP) financed about half the cost of the multifunctional platforms (diesel engines that can power tools and produce electricity) acquired by rural women's associations in Mali.[69]

60. Engaging women in roles other than that of user — enabling them to work, for example, as potters developing energy-efficient clay stoves, technicians maintaining solar panels or trainers in an ICT access centre — can also help them generate the income needed to acquire or use the technology and can also serve as a means of enlisting their support for the diffusion of the technology.

61. Deployment strategies must also address women's lack of access to information. In many countries, women have higher illiteracy rates than men. They may also have more limited social networks and lesser access to ICT. This combination of factors may in turn limit their awareness of the range of existing products. Governments, particularly at the local level, can contribute to technology uptake with communications campaigns highlighting particular products, coupled with training on using the new technology. In India, for example, a two-day fair was recently organized by the Directorate of Research on Women in Agriculture, in collaboration with public organizations, scientists and manufacturers, to showcase women-friendly farm tools and equipment.[70]

C. Research priorities

62. While Governments can promote the use of gender-based analysis in research and development and help improve women's access to technology, they also have a responsibility to ensure that national and international research and innovation

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[68] Kirrin Gill and others, "Bridging the gender divide: how technology can advance women economically" (Washington, D.C., International Center for Research on Women, 2010).

[69] Ibid.

[70] See http://www.icar.org.in/node/2092.

priorities benefit women and men equally. Questions have been raised about the gender-responsiveness of the research agenda, particularly in view of the overrepresentation of men in science decision-making. It is difficult to tell whether gender parity among decision makers would lead to a substantial redirection of research funding. However, adopting gender-responsive budgeting practices: (a) can help Governments to assess whether their support provided to research and development activities serves both women and men and (b) provides an opportunity for donors to examine their programmes, particularly those related to infrastructure or technology, in order to determine whether their policy commitment to gender equality translates into a fair use of resources.

63. Concern has been expressed that in a number of countries, particularly in Africa, fields where research would be most beneficial for the poor and could greatly benefit women, such as agricultural production, environmental management and public health, are often underfunded (see E/CN.16/2009/3). In addition, there may be an emphasis on basic research, even though poor linkages between universities and industry, and the overall small size of the private sector, prevent its use for applied research and practical and commercial applications. Governments, through their funding mechanisms, can gear universities towards engaging in more applied research and ensure that they provide incentives for researchers to be in line with the needs of local communities. Argentina, for instance, granted 30,000 scholarships for degrees in applied sciences.

64. The international community can help stimulate innovation for underserved populations — for instance, with partnerships such as HarvestPlus, a multi-stakeholder initiative funding research on crop biofortification, and TDR, a programme of the United Nations system for research and training in tropical diseases. Both these initiatives are sensitive to gender issues. Competitions, such as the Changemakers women, tools and technology contest, organized by the social entrepreneurship association Ashoka and supported by ExxonMobil, the oil and gas company, can also focus attention on women's needs.[71] In addition, greater collaboration between stakeholders, including South-South cooperation, can help countries learn from each other's experiences and pool funds in order to invest in pro-poor, gender-responsive research and development activities.

V. Recommendations

65. **Greater attention must be paid to gender-equality issues in science, technology and innovation. Promoting women's participation in science and technology education, ensuring that they contribute fully to producing and applying science, technology and innovation, and increasing their access to scientific knowledge and technology that fully meet their needs can contribute to accelerating development.**

66. **The Commission on the Status of Women may wish to call on Governments, the United Nations system, international and regional organizations, academia, research institutions, the private sector, non-governmental organizations, civil society and other relevant actors, as appropriate, to:**

[71] See http://www.changemakers.com/node/70652.

(a) **Mainstream a gender perspective in, and monitor and evaluate the impact on women and men of, all science, technology and innovation policies and programmes, including those related to infrastructure and enterprise development;**

(b) **Take into account in policies and programmes the many factors that intersect with gender, including social class, age, ethnicity and disability;**

(c) **Develop comprehensive national strategies with clearly defined targets, time frames and resources, in collaboration with all stakeholders, to increase the participation of women and girls in science and technology education and training and employment;**

(d) **Improve the collection, compilation and dissemination of sex- and age-disaggregated data on all aspects of women's access to and participation in science and technology, including in the realm of formal and non-formal education, employment and decision-making;**

(e) **Increase the quality of science education, including by developing teaching methodologies that engage and investing in the professional development of teachers, and revising science and technology curricula so as to ensure that they emphasize the broad societal applications of science and appeal to women's and girls' interests;**

(f) **Promote a positive image of careers in science and technology for women, including through sensitizing parents, students, teachers, career counsellors and curriculum developers;**

(g) **Expose girls and boys and women and men to female role models in science and technology, including by recruiting female science teachers and professors, and increasing the visibility of female scientists and engineers;**

(h) **Provide incentives for institutions undertaking educational and training activities in science and technology, including universities and professional associations, to develop gender action plans;**

(i) **Develop networking and mentoring programmes to support the retention of female students and workers in science and technology fields;**

(j) **Increase transparency and fairness in science and technology employment and decision-making by setting clear criteria for recruitment, promotion and awards, and sensitizing staff, in particular recruiters, human resources personnel and supervisors, to gender-equality issues;**

(k) **Ensure that flexible work policies are available to both female and male employees so as to promote a greater work-life balance, including with provisions for paid maternity, paternity and parental leave;**

(l) **Also ensure gender parity in decision-making positions in science academies, funding institutions, academia and the public and private sector, including through setting time-bound targets and instituting quotas;**

(m) **Remove barriers to the creation and growth of female-owned enterprises, including discriminatory laws on access to land and property, and limited access to credit, training and information, and ensure that business incubators and technology parks cater to the needs of women entrepreneurs;**

(n) **Recognize, support, promote and protect women's traditional knowledge and innovation, including by facilitating access to skills and equipment;**

(o) **Promote the deployment of existing technology through increased access to information by women, including expanded access to ICT;**

(p) **Ensure that research, development and deployment respond to the needs and interests of both women and men, including through strengthening and expanding the use of gender-based analysis;**

(q) **Train scientists and engineers as well as all other personnel involved with research and development on gender-based analysis, including by mainstreaming a gender perspective in the curricula in tertiary education and continuous learning;**

(r) **Engage women as partners in technology development and deployment, including through the use of participatory methods;**

(s) **Prioritize research and development aimed at poverty eradication that would benefit both women and men;**

(t) **Adopt gender-responsive budgeting and auditing practices in all areas related to science, technology and innovation, including infrastructure development and agricultural support.**