European Journal of Soil Science, Volume 76, Issue 1, January-February 2025, Article number e70039
DOI:10.1111/ejss.70039

Where are we with gender parity in academia and professional societies? A multinational look at women in soil science

Running Title: A multinational look at gender parity

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Abstract

Issues of diversity, equity, and inclusion (DEI), including gender equity, have gained increasing recognition at the beginning of the 21st century. As an academic discipline soil science has been late in addressing gender equity, but several peer-reviewed studies have been published in the last five years. This study investigated gender equity in the soil science university faculty/academic staff (f/as) and soil professional societies in Canada, Egypt, Mexico, Nigeria, the United Kingdom, and the United States of America using data publicly available on the Internet and anonymized data from soil science professional societies. We found that women still lag behind men among our soil science f/as by considerable margins (69.2% men vs. 30.8% women for pooled data for all six countries in this study), and that the percentage of women in soil science f/as positions are similar to those for f/as women in many other scientific fields. There are differences in gender equity by soil science subdiscipline that vary by country. In countries where data is available to make comparisons, over the last 6-8 years the gender gap has closed to some degree, both overall and for sub-disciplines. Women also often hold leadership positions in numbers that are lower than their representation among the f/as and membership in professional societies. In addition, women are recognized with awards such as society Fellowship in numbers lower than their overall representation would suggest. This study concluded that progress has been made on several fronts in the last 6-8 years, but there is still much work to be done to achieve gender equity in soil science academia and professional societies. It is recommended that soil science societies collect, analyze, and compare data on gender in the discipline so that progress can be evidenced, tracked, and encouraged.

Highlights

- Soil science as a discipline has been slow to address gender equity issues
- Gender equity in soil science has gained increasing attention since the late 2010s
- Women are still underrepresented particularly in higher level positions and awards
- Data collection and studies by national soil science societies are needed

Keywords: Diversity, equity, and inclusion; soil science faculty; soil science professional societies; professional society officers; career recognition; career advancement

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The final published version (version of record) is available online at DOI:10.1111/ejss.70039. Please refer to any applicable publisher terms of use.

1. Introduction

Gender equity is a goal that has achieved wide-spread recognition and acceptance in the 21st century. In September 2000 world leaders met at the United Nations headquarters to commit to a series of eight goals to be achieved by 2015, goals that came to be known as the Millennium Development Goals (MDGs). Goal 3 was "Promote gender equality and empower women" (United Nations, n.d.). In September 2015 world leaders came together again and adopted 17 Sustainable Development Goals (SDGs) to be achieved by 2030. SDG 5 was "Achieve gender equality and empower all women and girls" (United Nations, 2015). Some aspects of the SDGs and the discipline of soil science were discussed in a paper by Lal et al. (2021). Unfortunately, despite goals such as the MDGs and SDGs and initiatives such as those of the Soil Science Society of America (SSSA) and International Union of Soil Sciences (IUSS), the world is not currently on track to meet most of the gender equality indicators established under SDG 5 by 2030 (United Nations, 2023).

It is worth noting that the terms "gender equity" and "gender equality" are often used interchangeably in the literature (Smith-Doerr, 2004), even though "equity" and "equality" have different meanings. "Equity" considers the circumstances of a person or group and provides what is needed for that person or group to be successful, while "equality" provides the same to all regardless of circumstance (International Union of Soil Science, 2022; Annie E. Casey Foundation, 2023). We have focused on the concept and use of "gender equity" in this paper, only using "gender equality" in places where it is a direct quote from materials being referenced.

Many institutions of higher education and professional societies have adopted diversity, equity, and inclusion (DEI) platforms. For example, the SSSA Board of Directors passed a DEI statement in 2021 (Soil Science Society of America, 2021). The IUSS also produced a DEI policy as part of its 2021-2030 Strategic Plan that was approved by its Council in 2022 (IUSS, 2022). With this plan IUSS joined the Standing Committee for Gender Equality in Science (SCGES) where it collaborates with 27 other International

Science Unions and the International Science Council (ISC). Initiatives such as these represent a major step forward, but more efforts are still needed.

Studies have demonstrated that achieving gender equity is important on several fronts, including but not limited to increased economic growth and reduced fertility, child mortality, and undernutrition rates (Abu-Ghaida and Klasen, 2004), and of course simple fairness to half the world's population. Increasing gender equity brings different life experiences and broader perspectives to human undertakings and builds social trust and capital among women (Sahu and Yadav, 2018; Reyes-Sánchez and Irazoque, 2022), all outcomes that improve conditions for society as a whole.

A Google Scholar search revealed that discussion of gender equity issues increased substantially in the 1990s (Table 1). Soil science has lagged other disciplines based on publications on the topic. The first peer-reviewed paper on gender equity in soil science appeared in 2019 (Vaughan et al., 2019) and investigated soil science gender equity issues in the United States of America (USA) (Table 1). Since that time, several additional studies have been conducted. For example, Dawson et al. (2021) investigated measures of international gender equity in soil science. They found that men exceeded women overall by 68.3% to 31.7%, with more men than women in 37 out of 44 individual national soil science societies that reported data, and advocated for more in-depth studies to be carried out at the national level. Gender equity issues in Indonesian soil science have been explored by Fiantis et al. (2022) and Hairiah et al. (2022), who concluded that women made up about 30% of the soil science faculty and 35% of the Indonesian Soil Science Society membership even though 55% of soil science students were women. They also concluded that women in Indonesia had fewer opportunities than men to achieve PhD degrees and obtain leadership positions in academia. Adamo et al. (2022) investigated gender equity in public research institutions and universities as well as those affiliated with soil science societies in Italy, concluding there were no statistical differences between men and women by career level. However, there was a lack of women in top leadership roles, including research center leadership. The

participation of women in relevant professional societies varied by society. Díaz-Raviña and Caruncho (2022) explored soil science gender equity issues in Spain. They found that men and women represented about 50% each in postdoctoral research positions with the Spanish Research Council in 2020, but in each succeeding career step women made up a smaller percent and represented only 27% of research professors. These percentages had not seen any major changes since 2009. Díaz-Raviña and Caruncho (2022) also reviewed women in Russian/Soviet soil science history and concluded that these women made major contributions to the discipline. Reichert et al. (2022) looked at gender equity in agronomic research in Brazil, a dataset that included soil science. They found that there were fewer opportunities for women to advance their careers, which impeded gender equity. Grunwald and Daroub (2023) reviewed barriers to gender equity in soil science. They concluded that women have fewer leadership and advancement opportunities, need mentoring networks to help them connect with others in the discipline, and highlighted the importance of forming professional workgroups to support women in soil science. Reyes-Sánchez and Irazoque (2022) focused on an in-depth discussion of why gender equity is important to the health and vitality of soil science as a discipline. They argued that science can only be as good as the sum of the individuals engaged in it, and maximizing discovery science requires the inclusion of diverse experiences, skills, and perspectives, including those of women.

While it is encouraging that multiple peer-reviewed papers focused on gender equity in soil science have emerged since 2019, there are still many topics that have not been addressed and many countries that have not received detailed investigation. Therefore, the objectives of this study were to:

1. Explore the current status of women soil scientists primarily in academia in Canada, Egypt, Mexico, Nigeria, the United Kingdom, and the United States of America. This study includes several countries that have not previously had a gender equity analysis at any depth reported in the peer-reviewed literature.
2. Investigate leadership opportunities for women in soil science.

3. Evaluate trends in gender equity over time for countries where the relevant data could be obtained.

Table 1. Google Scholar search results for "gender equity" as well as "gender equity" plus "soil science" by decade. Google Scholar reports results from the 1990s and after as "about (value)", so the results are estimates.

Time period	Gender equity	Gender equity plus soil science	Notes*
1900-1909	5	0	
1910-1919	8	0	
1920-1929	9	0	
1930-1939	6	0	
1940-1949	9	0	
1950-1959	20	0	
1960-1969	61	0	
1970-1979	116	0	
1980-1989	732	4	None focus on gender equity in soil science.
1990-1999	12,300	49	One paper on gender equity in geosciences, another on environmental sciences, some on general agricultural topics. Many of the identified publications focus on sports and recreation topics.
2000-2009	31,700	154	More publications on geosciences, environmental sciences, and general agricultural topics where soil science is mentioned. Most are broad general discussions of the importance of gender equity for the identified topic of interest.
2010-2019	46,100	434	Two publications specifically on gender equity in soil science, Vaughan et al. (2019) and Van Miegroet (2016). The first is a peer-reviewed journal article, the second is a professional newsletter article.
2020-2024	26,100	216	At least eight additional peer-reviewed studies focused on gender equity in soil science have been published, including papers from a special issue "Women in Soil Science" in the Spanish Journal of Soil Science.

* - Notes refer to the papers identified by Google Scholar during the "gender equity" plus "soil science" search.

2. Materials and Methods

Many aspects of this study were based on the use of website data to determine whether the soil scientists on those sites were men or women based on names and physical appearance. While this approach allows a large amount of data to be collected at low cost, these websites typically do not include information on how an individual views themselves from a gender perspective. Also, while some national soil science societies have begun to offer more comprehensive gender identifier options to members, this is a new development, the data is likely to be incomplete, and not all professional societies offer this option. Therefore, this study utilized a binary "men" and "women" analysis.

A crucial point in this study is the use of the word "faculty", which can have different meanings in different countries. In North America, the term "faculty" refers to the people who teach and research at institutions of higher education (colleges and universities). Other parts of the world might use "academic staff" or "academics" to refer to teachers and researchers. For the purposes of this paper the North American use of "faculty" will be implied whenever the word is used.

Another consideration with the web-based approach is the degree to which each institution has kept their websites up to date. This study relied on accurate content regarding faculty affiliation, specialization, academic rank, etc. No information was found during a search for publications on how accurate this type of information tends to be on university websites, but most people who have spent time viewing them are aware that they may not accurately reflect the current status of faculty members. This is a source of uncertainty that must be factored in when considering the ultimate ramifications of this study. The web-based approach has been previously used to study gender equity amongst faculty in the USA by Vaughan et al. (2019). It has also been used to study soil science education issues in the USA and other countries by Brevik and Vaughan (2020), Brevik et al. (2020), Brevik et al. (2023), and Diochon et al. (2017), among others.

Dawson et al. (2021) concluded there was a need to conduct country-by-country evaluations of gender equity in soil science. For every country in this study except the USA, this is the first time a gender equity analysis of any detail has been carried out. The USA was investigated in detail by Vaughan et al. (2019), but this study provides an opportunity to see how academia in the USA has changed since the Vaughan et al. (2019) data was collected. Every country in the world is unique in how soil science programs and national societies are organized and in the availability of quality data sources. Therefore, while we have tried to achieve a reasonable standardization in this study, it was necessary to collect data for each country in the manner and type in which it was available. The subsections below give details for data collection for each country.

2.1. Canada

Information collected in July 2023 builds on the previous study by Diochon et al. (2017) that inventoried undergraduate soil science course offerings at Canadian universities in 2015. In both July 2023 and September 2015, we searched the websites of the faculties, programs, and/or departments (herein termed "units") to identify faculty members who teach soil science courses. This was sometimes supplemented by searching other publicly accessible websites such as LinkedIn and ResearchGate. Comparing ranks of the faculty members in July 2023 to their ranks in September 2015 allowed us to determine who was promoted during that period and also who has been hired since 2015. To supplement the information gathered by the website searches of Canadian postsecondary units, additional information on Presidents and Fellows of the Canadian Society of Soil Science (CSSS) was obtained from the Society's website (https://csss.ca/) and information on gender distribution in CSSS was provided by the Society.

2.2. Egypt

Data on the faculty teaching in soil science degree-granting programs in Egypt was gathered by visiting the relevant university websites or by personally contacting the programs. This was carried out in March 2023. Data on new faculty hires and promotions were determined by comparing the March 2023 data to the data set collected in May and June 2017 (collected from the Soil Science Society of Egypt (SSSE)), which was supplied by SSSE staff. Comparing ranks of the faculty members in 2023 to their ranks in 2017 allowed us to determine who had been promoted during that period.

2.3. Mexico

Information collected in Mexico comes from the three principal institutions at which soil science education is currently offered: the National Autonomous University of Mexico (UNAM), the Autonomous University of Chapingo (UACh), and the Colegio de Posgraduados (Graduate College). Data was obtained from the university web pages and as provided directly by the institution through electronic communications in September 2023. The Mexican Society of Soil Science (MSSS) provided data on gender distribution in the membership, past Presidents, and gender changes in membership over time.

2.4. Nigeria

Data for this study was gathered by visiting websites of Nigerian universities that offer soil science degree programs (Table 2). The data are based on information as of August 2023. A Google search for Nigerian universities that offer soil science programs comes up with many universities, but some of the universities do not have websites or their websites do not have the information required for this study. Thus, a significant amount of information may not be captured by this survey. Another challenge with collecting data this way is that information on tenure and promotion is lacking since that type of information is not usually available on websites. Data from the Soil Science Society of Nigeria (SSSN)

(https://sssn.ng/), whose mission is to promote the understanding of soil science nationally and internationally, did not have information about rank, membership gender, or any diversity initiatives.

Table 2. Sources of information for Nigerian academic soil scientists and professional societies.

University / Institute	Website
University of Nigeria	https://soilscience.unn.edu.ng/staff/
Michael Okpara Univ. of Agriculture	https://ccss.mouau.edu.ng/staff-profile-soil-science-and-meteorology/
Rivers State University	https://www.rsu.edu.ng/department-of-crop-soil-science/
Delta State University	https://delsu.edu.ng/departments.aspx?dept=22
University of Calabar	https://www.unical.edu.ng/department-of-soil-science#
University of Ibadan	https://agric.ui.edu.ng/soil-resources-management
Nasarawa State University	https://nsuk.edu.ng/agriculture/agronomy-crop-and-soil-science/
Dennis Osadebe University	https://www.dou.edu.ng/doustaff/staffprofile/department.aspx?id=5
Bayero University Kano	https://agric.buk.edu.ng/?q=node/13
Federal Univ. of Technology, Owerri	https://futo.edu.ng/soil-science-and-technology/
Nnamdi Azikiwe University	https://agriculture.unizik.edu.ng/departments/soil-science-and-land-resources-management/staff/
Federal Univ. of Agriculture, Abeokuta	https://funaab.edu.ng/section/soil-science-and-land-management/
Federal University Oye-Ekiti	https://ssc.fuoye.edu.ng/staff/
Nigerian Institute of Soil Science	https://niss.gov.ng/#
The Soil Science Society of Nigeria	https://sssn.ng/

2.5. United Kingdom

Data on university faculty and staff teaching in soil science degree-granting programs in the United Kingdom (UK) was gathered initially using the British Society of Soil Science (BSSS) membership record database. It is expected that most faculty teaching soil science at UK universities would be a member of BSSS as it is a membership organization primarily committed to the study of soil. In cases where this did not yield enough data (such as career level), university websites were checked and, where needed, additional information was supplemented from publicly accessible websites such as LinkedIn,

ResearchGate, online press releases, and other related reliable sources. These searches were conducted throughout 2023. Data on change over time was obtained by comparing the 2023 data with data from 2019 published in Dawson et al. (2021) and was collected in the same way.

Data on membership and Fellowships from the BSSS was supplied by BSSS staff (data controller). Because much of the data was provided in confidence to the societies, no names were provided by the BSSS, only composite data. Data on committee membership and presidents was obtained from the BSSS annual reports which can be found at https://soils.org.uk/about-us/governance/annual-reports/ and augmented by the BSSS staff. Data from the BSSS membership record database was used from the last 10 years (2014 to 2023) to identify the gender split of leadership positions within the Society (President, Board of Trustees, and Committee Chairs).

2.6. United States

Data on the faculty teaching in soil science degree-granting programs in the USA was gathered by visiting the relevant university websites. In cases where the information was not enough to gather the desired data, these websites were supplemented by information from publicly accessible websites such as LinkedIn, ResearchGate, online press releases, and similar sources. This was carried out in March 2023. Data on new faculty hires and promotions was determined by comparing the March 2023 data to the data set collected in May and June 2017 and published in Vaughan et al. (2019). Soil science degree-granting programs in the USA were identified using the list from Brevik et al. (2020).

Data on Soil Science Society of America (SSSA) membership and Fellows was supplied by SSSA staff. Information on SSSA Presidents, Board of Directors, and Division Chairs was obtained from SSSA websites as displayed in Table 3. When an individual's gender was not known a web search was used to obtain the information. SSSA membership numbers for 2023 were not finalized until January 2024, after data collection was done, so 2022 was used. Other SSSA data was from 2023.

Table 3. Sources of information for Soil Science Society of America leaders.

Leadership Role	Website
Presidents	https://www.soils.org/membership/committees/view/S001.1/members/history
Board of Directors	https://www.soils.org/membership/committees/view/S003/members/history
Division Chairs	
Forest, Range, and Wildland Soils	https://www.soils.org/membership/committees/view/S011.07/members/history
Nutrient Management and Soil and Plant Analysis	https://www.soils.org/membership/committees/view/s011.08/members/history
Pedology	https://www.soils.org/membership/committees/view/S011.05/members/history
Practicing Professional Soil Scientists	https://www.soils.org/membership/committees/view/S011.12/members/history
Soils and Environmental Quality	https://www.soils.org/membership/committees/view/S011.11/members/history
Soil and Water Management and Conservation	https://www.soils.org/membership/committees/view/S011.06/members/history
Soil Biology and Biochemistry	https://www.soils.org/membership/committees/view/S011.03/members/history
Soil Chemistry	https://www.soils.org/membership/committees/view/S011.02/members/history
Soil Education and Outreach Division	https://www.soils.org/membership/committees/view/S011.14/members/history
Soil Fertility and Plant Nutrition	https://www.soils.org/membership/committees/view/S011.04/members/history
Soil Mineralogy	https://www.soils.org/membership/committees/view/S011.09/members/history
Soil Physics and Hydrology	https://www.soils.org/membership/committees/view/S011.01/members/history
Urban and Anthropogenic Soils	https://www.soils.org/membership/committees/view/S011.13/members/history
Wetland Soils	https://www.soils.org/membership/committees/view/S011.10/members/history

3. Results and Discussion

3.1. Women in academia

All six countries provided data on faculty gender (Figure 1). Men greatly exceeded women in all countries, ranging from a difference of 24.2% (62.1% men and 37.9% women) in Canada to 60.0% in Nigeria (80.0% men and 20.0% women). Career level information was also provided by all six

countries (Figure 2). There was a trend of a decreasing percentage of women with increasing rank. The exceptions to this were a small increase from mid-career to senior positions in Canada, and an increase from introductory to mid-career positions in Nigeria. Positions were classified as introductory, mid-career, and senior because not all countries use the same academic ranking system. Therefore, this three-part career stage ranking allowed comparisons among countries. Another way to look at this data is that in five of the six countries studied, women held the smallest percentage of senior faculty positions and had their greatest representation in the introductory positions. While it is encouraging that more women are being hired overall, based on the increased percentages in the introductory positions, it is discouraging that in 2023 women still only represented 1/3 or less of the soil science faculty in five of these countries.

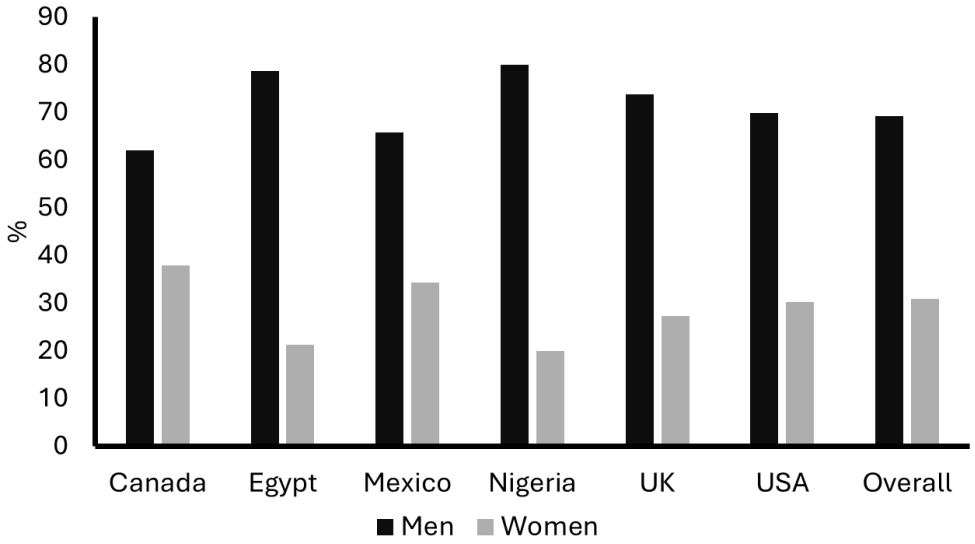


Figure 1. The percentage of men and women serving on the soil science faculty in 2023 at universities in the countries covered by this study. The overall value is based on the sum of values from all six countries.

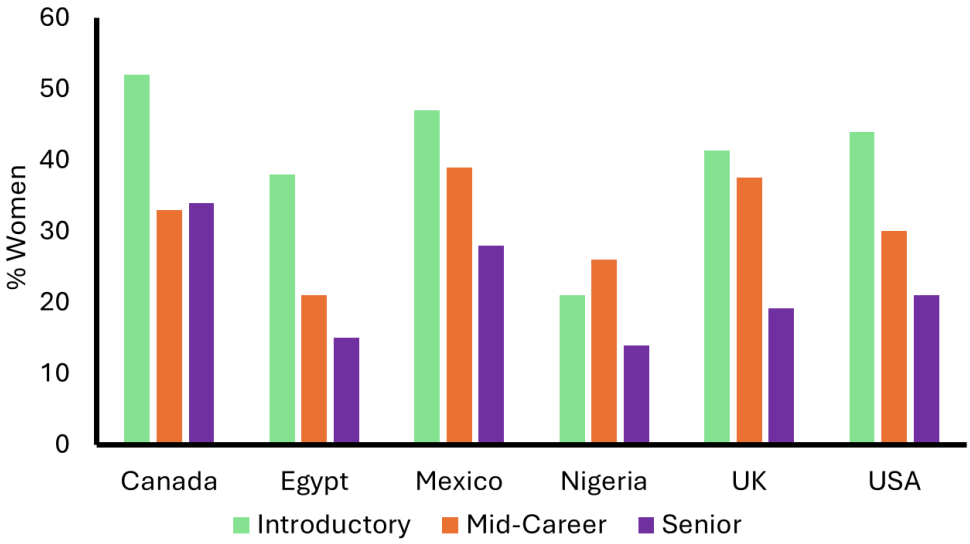


Figure 2. The percent of women by faculty career level in 2023 at universities in the countries covered by this study. The introductory category includes ranks such as instructor, lecturer, assistant professor, and similar. The mid-career category includes associate professor, senior lecturer, and similar. The senior category includes professor and similar.

The percentage of women who served as department chairs for units that offer soil science was also small, 0% in Canada, Egypt, and the UK, and 17.9% in the USA in 2023. Therefore, the data indicates that women lack positions of authority within the soil science academic community, and that their holding of such positions trails their overall employment rate within that community.

Our findings are similar to those in other scientific fields. Ceci et al. (2014) noted that women were strong minorities in tenure-track or tenured faculty positions in the USA in 2010, making up about 25% of geoscience faculty, 10% of physical science faculty, and 25% of life sciences faculty. In 2011 only 20.1% of the Earth science faculty at the leading 106 institutions in the USA were women, and the percentage of women decreased with every step from assistant professor (35.8%) to associate professor (23.6%) to professor (13.4%) (O'Connell, 2014), similar to the soil science situation in our study. In more recent studies, women make up about 23% of the American

Association of Physicists in Medicine (AAPM) (Paradis et al., 2023), 19% of the tenured physics faculty in India, with the percentage being lower at more prestigious institutions and in senior positions (Resmi et al., 2019), and about 25% of university physics faculty in Canada (Rangan et al., 2023). Women held fewer than 30% of tenured or tenure-track chemistry positions in the USA in 2013 (Rovner, 2014) and only 9% of the chemistry professors in the UK were women in 2018, even though 39% of graduate students were women (RSC, 2018). Only 16.8% of the faculty at leading chemistry universities world-wide were women in 2021 (Wu, 2023). Men outnumbered women more than two to one in geography tenure-track faculty jobs in the USA in 2018, and only about 22% of professors were women (Schurr et al., 2020). A common theme found across these studies is that the percentage of women in the science student body is much higher than the percentage of women on faculty (Vaughan et al., 2019), and it is very important that our students have mentors who look like them and share similar life experiences if we are going to get these women to stay in the sciences as their long-term profession (RSC, 2018).

Not all science faculties are severely deficient in women. In 2017, 41% of the faculty at medical schools in the USA were women (Clark and Horton, 2019) and 60.7% of veterinary faculty in the USA (20 universities), Canada (2 universities), and the Caribbean (1 university) were women in 2018 (Morello et al., 2023). In 2016, epidemiology faculty in the USA were 55.0% women, although the percentage was highest for assistant professors (70.1%) and decreased with increasing rank (55.0% associate professors and 41.4% professors) (Schisterman et al., 2017). Note that all these studies address fields within the life sciences, which have been documented to have more women working in them than other scientific fields (National Science Board, 2024). Reasons that have been advanced to explain this include less gender discrimination in the life sciences and women being more emotionally connected to what life scientists do as compared to physical scientists (Ecklund et al., 2012). Eckland et al. (2012) suggest that major pathways to increasing the number of women in

underrepresented scientific fields include addressing discrimination issues and clearly communicating the societal benefits of a given scientific field early in a student's education. They also conclude that it is important that men do this, as these fields are still dominated by men.

Women in soil science faculty positions are not distributed equally across the discipline's subfields (Figure 3). In general, the number of women faculty was relatively high in soil

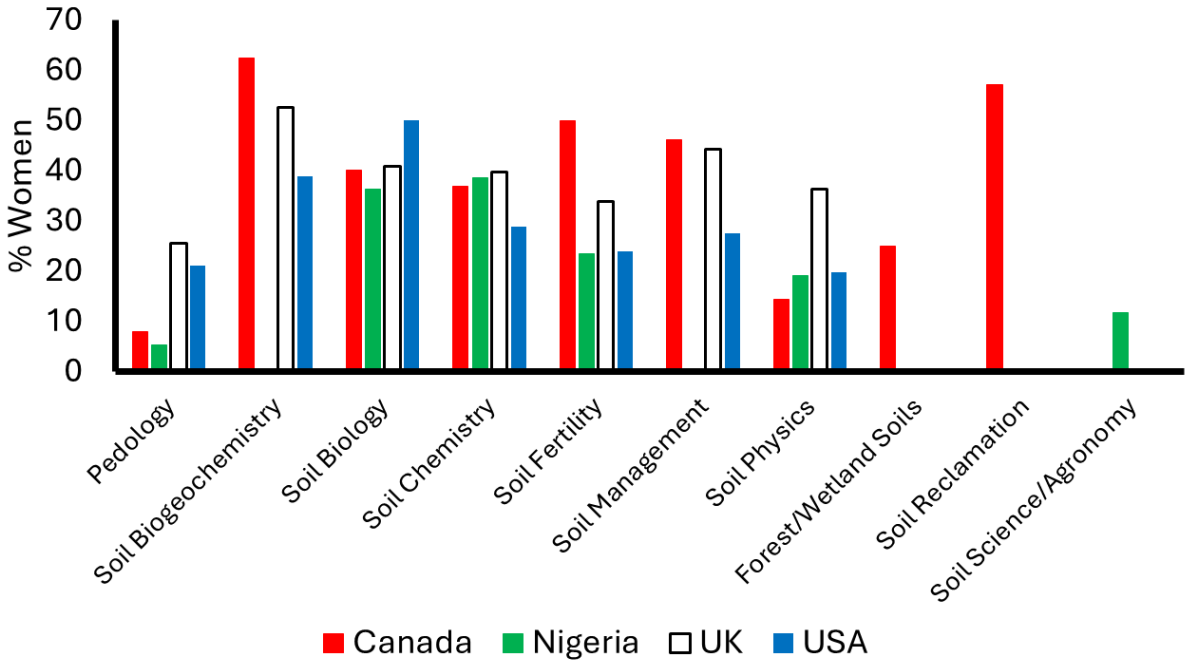


Figure 3. The percent of women faculty in soil science subdisciplines in 2023 by country. Note that Nigeria did not report any faculty (men or women) in soil biogeochemistry, and the final three subdisciplines were only reported by the countries for which data is presented.

biogeochemistry, soil biology, and soil chemistry, and fairly low in pedology and soil physics. Soil biogeochemistry and soil biology showing as the most likely soil science subfields for women to work in aligns with other findings that life science related fields are the most likely science careers for women to enter (National Science Board, 2024).

3.2. Women in professional societies

Men dominated the membership of the soil science professional societies in the four countries that provided data, making up 52.7% of CSSS, 67.4% of MSSS, 65.2% of BSSS, and 66.9% of SSSA membership. This is consistent with the results of Dawson et al. (2021), who found that 37 of the 44 soil science professional societies they surveyed had more men as members than women. Two professional societies provided membership by career status (Figure 4). Similar to the faculty data, the professional society membership data showed the highest percentage of women in the youngest age (earliest career) group and declining percentages of women with advancing experience assuming that early career/student members tend to be young, the full/regular members are within the working years of their lives, and the retired/emeritus members are older.

Studies have indicated that women are often underrepresented in high-level professional awards and leadership positions. To investigate this, we looked at the number of society Fellows that have been awarded to women, women elected as Presidents, and high-level board and committee positions held by women in soil science professional societies. Fellow is the highest honor given by many professional societies. Through its entire history, 8.3% of the Fellows in the CSSS have been women. The first woman Fellow in CSSS was elected in 2007, and since then 34.8% of CSSS Fellows have been women. For the SSSA, only 4.9% of the Fellows have been women. The first woman Fellow was elected in 1985, and since then 8.9% of the Fellows have been women. Note that such

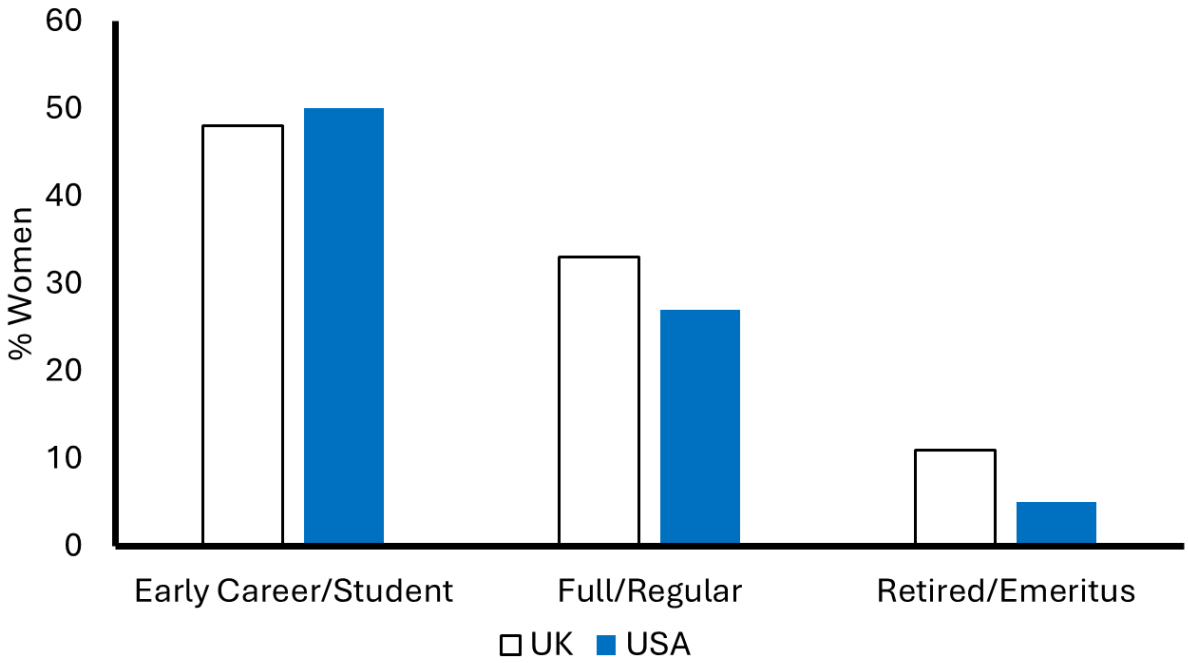


Figure 4. Gender distributions for members of the British Soil Science Society (UK) in 2023 and Soil Science Society of America (USA) in 2022 by membership level. The UK uses the first set of designations (early career, full, and retired) while the USA uses the second (student, regular, and emeritus). Rough equivalents are grouped.

Fellow recognition is low not only all time, but even since the time the first woman was recognized as a Fellow, especially in the SSSA. While the all-time and since first woman elected as Fellow numbers were not available for the BSSS, 13.1% of BSSS Fellows were women in 2023. This did not change much between 2017 and 2023, with a high of 15.2% of BSSS Fellows being women in 2018 and a low of 11.7% in 2020. The relative lack of women receiving high level awards agrees with the findings of Paradis et al. (2023), who reported that 93% of the major AAPM awards have historically gone to men. A lack of mentorship and failure to convert young women members to full

membership were identified as challenges to women receiving more of those awards (Paradis et al., 2023).

Election as the President of a professional society is often seen as an indication of respect from the members of that society for the person elected. It has not been common for women to be elected as the President of soil science professional societies, particularly when looking over the entire history of the society. Only about 13% of CSSS, 2% of MSSS, 8% of BSSS, and 5% of SSSA Presidents over the history of these societies have been women. However, more women have been elected in recent years, and in Canada and the UK they have made up more than 40% of the Presidents elected since the first woman was elected to the office. However, in Mexico only one woman has ever been elected President of MSSS, and about 22% of SSSA Presidents have been women since the first woman was elected. The dates that the first women were elected President



Figure 5. Women who have been elected to serve as President of their soil science professional society. By society: Canadian Society of Soil Science: A – Anne Naeth (President in 2005), B – Cinthia Grant (2010), C – Barbara Cade-Menun (2015), D – Maja Krzic (2016), E – Joann Whalen (2017), F – Noura Ziadi (2018), G – Fran Walley (2019), H – Angela Bedard-Haughn (2021), I – Amanda Diochon (2023), Mexican Society of Soil Science: J - María Edna Álvarez Sánchez (2004-2005), British Society of Soil Science: K – Helaina Black (2011-2012), L – Liz Baggs (2015-2016), M – Jacqueline (Jack) Hannam (2023-2024), Soil Science Society of America: N – Mary Collins (2006), O – Carolyn Olson (2014), P – April Ulery (2021), Q – Carrie Laboski (2023), and R – Samira Daroub (2025).

are 2005 for CSSS, 2004 for MSSS, 2011 for BSSS, and 2006 for SSSA (Figure 5). As of 2019, only 2.9% of the American Society of Agronomy's (ASA), 7.7% of the Geological Society of America's (GSA), and 14.4% of the Ecological Society of America's (ESA) Presidents were women through these society's

histories. Through 2023, only 9.5% of the American Chemical Society's (ACS) Presidents were women (Wu, 2023). Similar to the investigated soil science societies, the situation has improved since 1985 as 8.8% of ASA's, 29.4% of GSA's, and 41.2% of ESA's Presidents have been women (through 2019) (Vaughan et al., 2019), and between 1985 and 2023 38.2% of ACS's Presidents were women (Wu, 2023). The number of women Presidents of national societies of soil science in Latin America is currently 50%, while the number of women Presidents of national societies of soil science that are part of the IUSS is 36.9% (Reyes-Sánchez and Irazoque, 2022). However, only one woman has been elected as President of the IUSS in its 100 years of existence, and only one woman has chaired the Intergovernmental Technical Panel on Soils (ITPS) of the FAO's Global Soil Partnership in the more than ten years of its existence even though 33% of its members are women (Reyes-Sánchez and Irazoque, 2022). This lack of any substantial increase in women as Presidents was also seen in part of our data, as the MSSS has only had one woman President in its history, who served 20 years before our data was collected.

Election or appointment to boards and major committees can also be an indication of professional respect. Women have fared reasonably well in this respect for the three professional societies we have data for, often having 40% to 50% of such positions in 2023 (Figure 6). However, this percent can vary considerably from one individual position to another. For example, overall, the BSSS Committee Chairs were 48.6% women between 2014 and 2023; but the percentage of women Chairs on the individual committees ranged from 0% to 100% over the same period. Likewise, while 42.9% of the SSSA Division Chairs were held by women in 2023, that number ranged from 14.3% (2014) to 57.1% (2022) between 2014 and 2023. In addition, similar to what was observed with the BSSS Committee

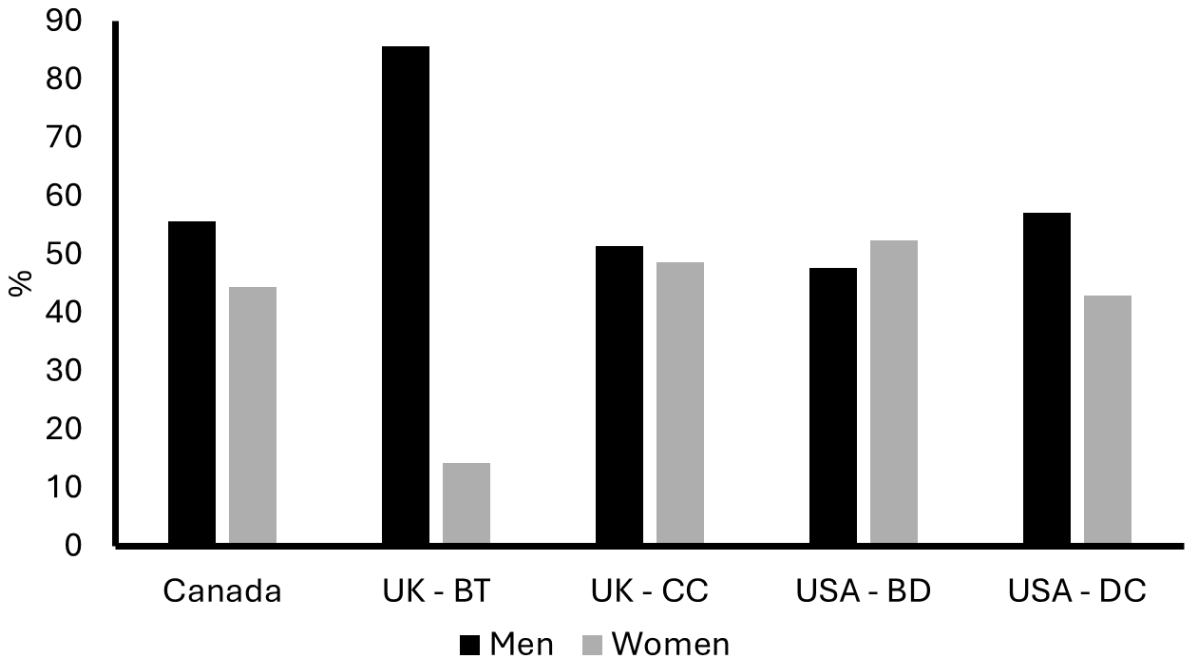


Figure 6. Membership on governing bodies for soil science professional societies. Canada – Canadian Society of Soil Science Council 2023; UK-BT – British Society of Soil Science Board of Trustees 2023; UK-CC – British Society of Soil Science Committee Chairs 2014-2023 (appointment is currently for 3-year terms, prior to 2019 the term was not standardized); USA-BD – Soil Science Society of America Board of Directors 2023; USA-DC – Soil Science Society of America Division Chairs 2023.

Chairs, there was considerable variation between divisions, ranging from a high of 70.0% of Chairs being women for Soil Biology and Biochemistry to a low of 20.0% in 6 of the 14 divisions between 2014 and 2023, with an overall average of 35.0% of the division chairs being women over this time period. There are some different ways to look at this data. From one perspective, even in situations where the broader averages might appear encouraging there is potentially room for improvement once a closer look is taken. There are individual committees and divisions where women are still well below their representation in the membership of the investigated societies. On the other hand, when looking at the

committees and divisions overall, there are a higher percentage of women providing service in these areas than their share of the society memberships. This indicates women are taking on a larger leadership and service load than their membership levels would indicate should be expected. Having said all of that, a major part of what needs to happen is retaining more women in soil science generally and specifically into the subfields of soil science where women are still underrepresented. Divisions such as Soil Physics and Hydrology, Soil and Water Management and Conservation, and Pedology, which are among the six SSSA divisions that had women as Chairs 20% of the time from 2014-2023, also only have about 20-30% women among their membership (Vaughan et al., 2019).

3.3. Changes over time

In some cases we were able to document changes in gender equity standing over time. The percent of women faculty members increased in Canada, Egypt, and the USA between the mid-2010s and 2023, with gains of 4.2%, 7.4%, and 6.7%, respectively, among the overall faculty. This increase was not just true for faculty across the board, it was also true for faculty at all career stages (Figure 7).

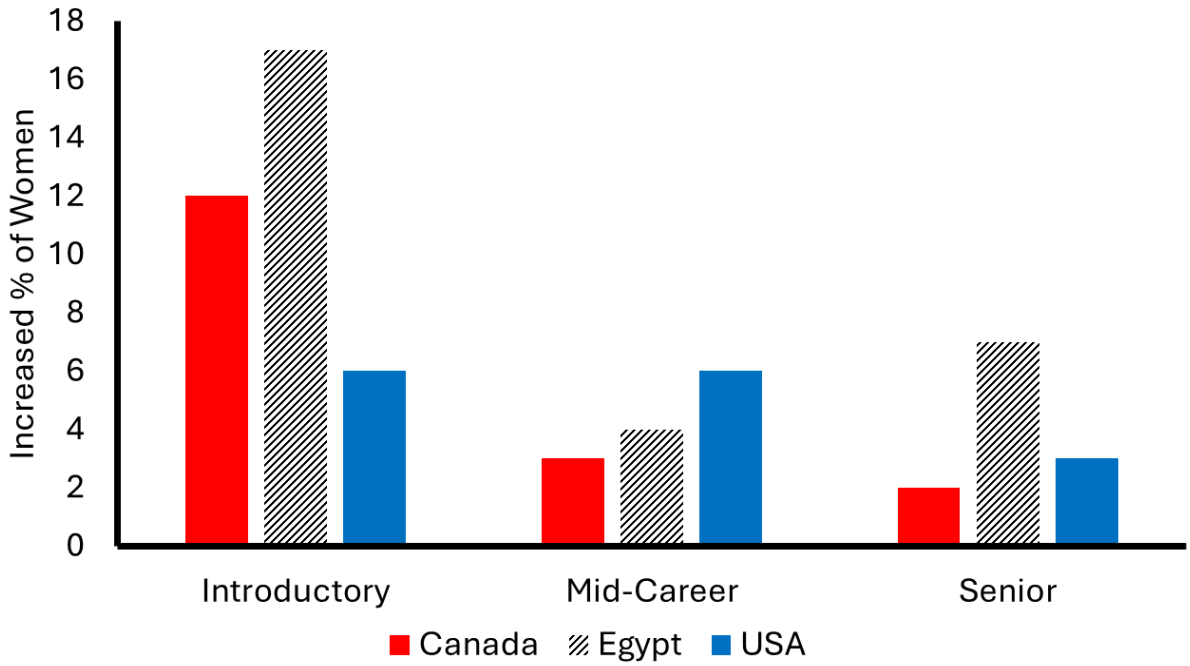


Figure 7. The increase in the percent of women soil science faculty in introductory, mid-career, and senior positions. The time period is 2015-2023 for Canada and 2017-2023 for Egypt and the USA.

This corresponds to data from this study that shows 55.0% of new faculty hired in Canada between 2015 and 2023 and 45.9% of new faculty hires in the USA between 2017 and 2023 were women. It also aligns with the findings of Ceci et al. (2014) who noted that the percentage of women faculty in the sciences increased (doubled or more) between 1973 and 2010 in the USA.

Women were promoted in Canada (time period 2015-2023) and the USA (2017-2023) at similar rates to men, with women slightly more likely to be promoted in Canada (65.8% of eligible men to 70.0% of eligible women) and men slightly more likely to be promoted in the USA (72.2% men to 67.8% women). Women in Egypt (2017-2023) were much more likely to be promoted (75.7%) than men (20.7%). For the purposes of these calculations, any faculty member who had not yet achieved the rank of Professor in 2015/2017 was considered eligible for promotion during the time period of the study. The combination of hiring women at rates greater than their previous percent in faculty

roles and promoting women at rates similar or higher than men combined to increase the percentage of women at each career level over the time of the study (Figure 7).

With the exceptions of pedology in Canada and soil biology in the USA, the percent of women increased for most soil science subdisciplines in those two countries (Figure 8), This was an encouraging finding, as most of these subdisciplines are currently below 50% women faculty in all the countries studied (Figure 3).

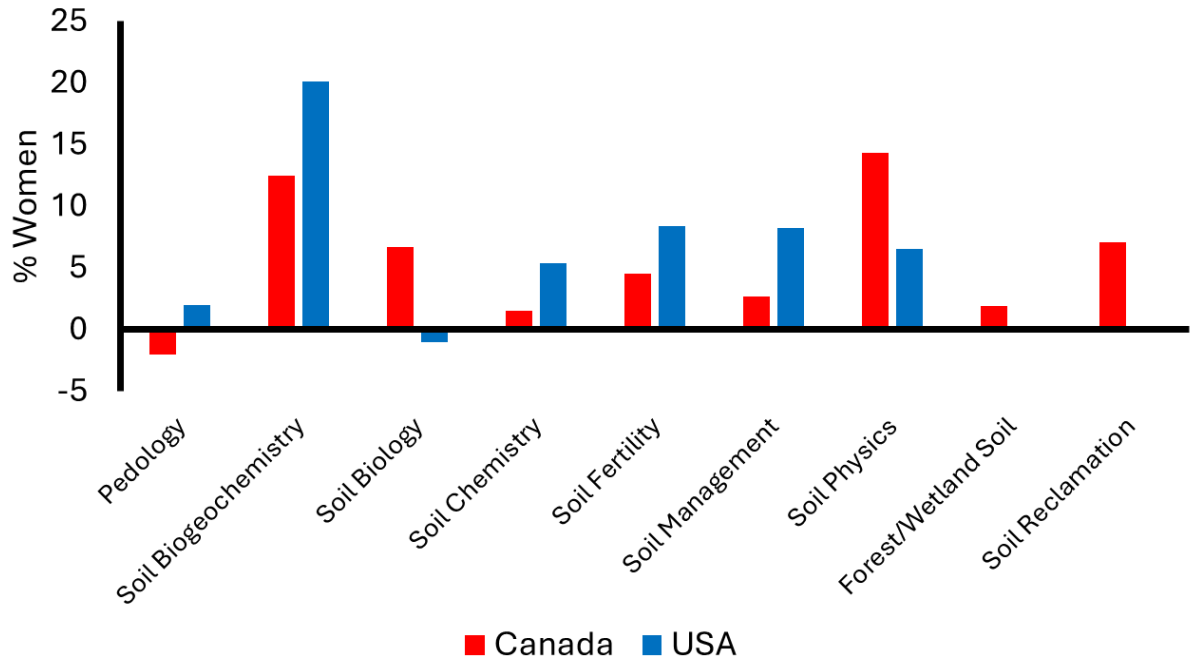


Figure 8. Changes in the percent of women faculty by soil science subdiscipline in Canada and the United States of America (USA). The time period is 2015-2023 for Canada and 2017-2023 for the USA. No data were reported for the final two subdisciplines in the USA.

Three professional societies, in Mexico, the UK, and the USA, provided data on membership changes over time. In each case, the percentage of women in the society increased, from 4.7% in the

USA to 12.6% in Mexico. However, in the case of the MSSS another issue was revealed in the data; MSSS membership declined 77.5% from 2020-2023. The decline in the number of women members was just lower (68.9%) than the decline in men members (81.7%), leading to the percentage increase in women members.

The change in the percent of women members in the BSSS and SSSA was evaluated by membership level. Women represented a greater proportion of the membership in every category except for BSSS retired (Figure 9). The greatest gains for both societies were in the early career/student categories. This aligns with the faculty findings where the greatest gains were in the introductory position jobs, and both findings indicate an influx of young women into soil science in these countries.

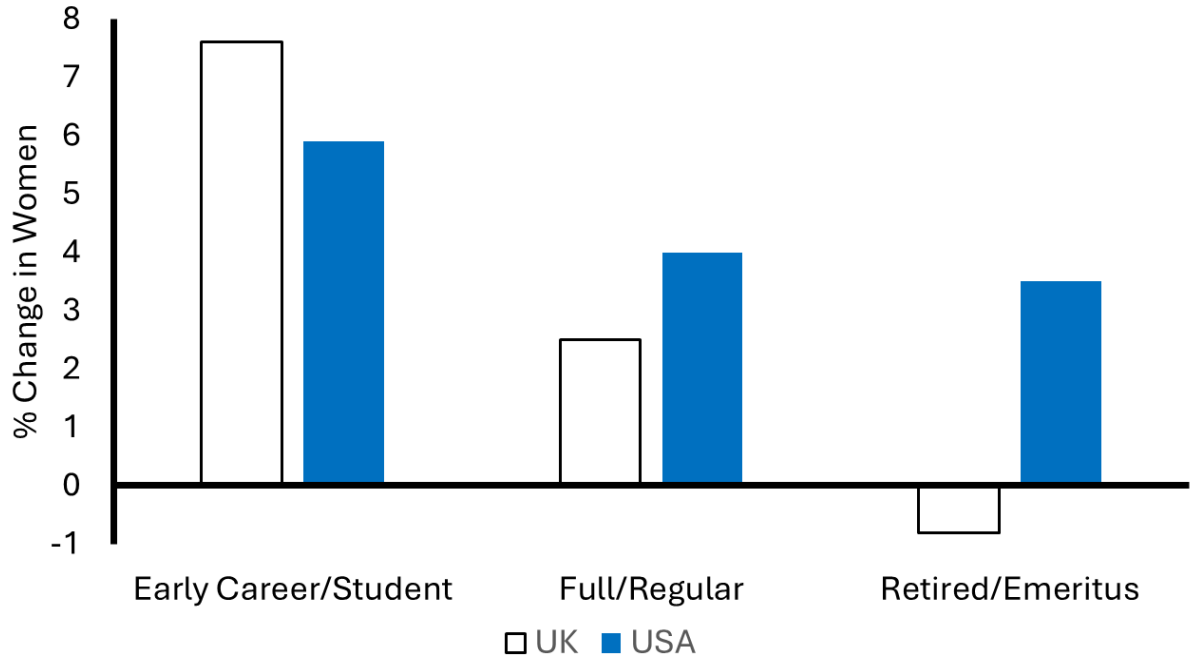


Figure 9. Change in the percent of women members in the British Society of Soil Science (UK) and Soil Science Society of America (USA) by membership level. The UK data is from 2020-2023 and the USA data is from 2017-2022.

The number of women elected as a Fellow of SSSA has increased considerably over time (Figure 10). Nearly complete gender data for SSSA Fellows is available from 1971 to the present, with Internet searches being used in some cases to clarify an unknown gender. From 1960-1970 gender information is available for 86% of the Fellows (all men), but the other 14% are marked as “unknown”. From 1937-1959 only 54% of the Fellows have gender information (all men) with the other 46% marked “unknown”. Internet searches were not helpful in clarifying unknown genders from these earlier times. It was assumed that all the unknown Fellows from 1937-1970 were men, as it is widely accepted that SSSA bestowed Fellow recognition on a woman for the first time in 1985, but there is a small chance that one or more of these unknown Fellows from 1937-1970 was a woman. Overall, 4.9% of SSSA Fellows are women. This increases to 8.9% since 1985, when the first woman was chosen as a Fellow. Only two women were recognized prior to 1995, since then 11.8% of SSSA Fellows have been women with 20.7% being women over the last 10 years (2014-2023). At least two women have been chosen as Fellows every year since 2012, and at least one woman has been chosen in 17 of the last 20 years. The 20.7% of women elected as Fellows over the last 10 years trails the 33.1% overall women’s membership and 27.3% regular women’s membership. This agrees with studies that have found women are underrepresented in receiving top professional awards and recognitions (Vaughan et al., 2019; Dawson et al., 2021; Paradis et al., 2023).

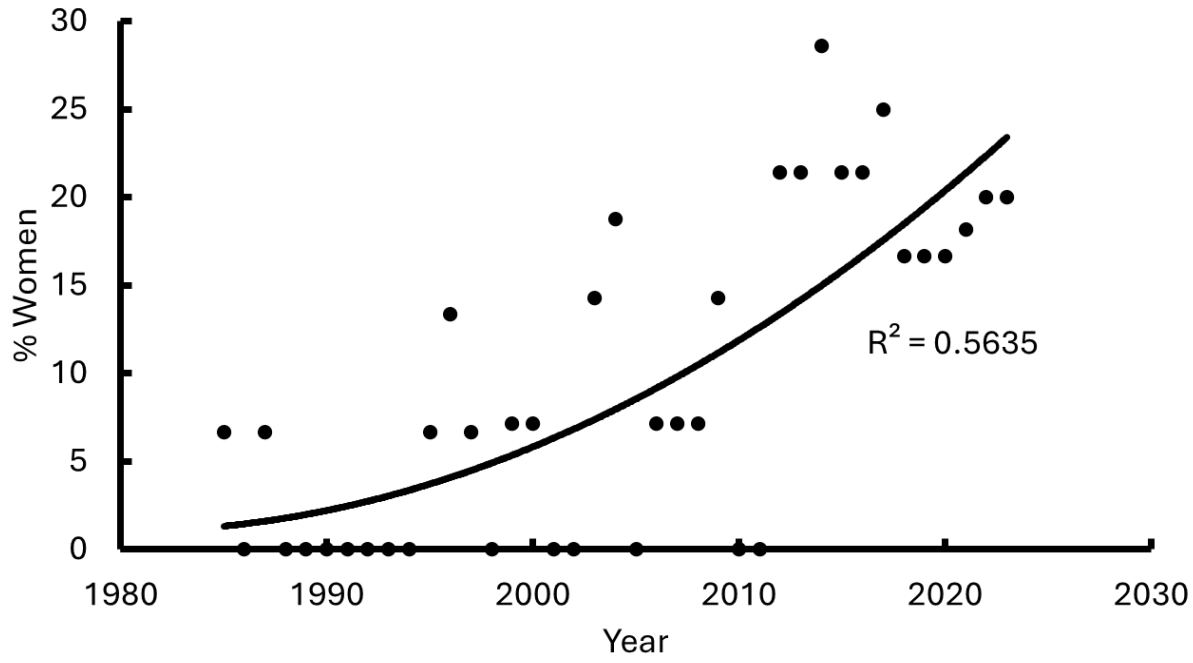


Figure 10. The percent of Soil Science Society of America (SSSA) Fellows who were women by year from 1985 (the first year SSSA elected a woman Fellow) through 2023. The polynomial trend line shows there has been an increasing rate of women elected as SSSA Fellows since 1985. The first SSSA Fellows in society history were elected in 1937.

Data was available over the last 10 years (2014-2023) for the CSSS Council, BSSS Board of Trustees, SSSA Board of Directors, and SSSA Division Chairs (Figure 11). Little change in the gender distribution was seen for CSSS (average of 55.6% women members with a low of 44.4% and high of 66.7%) or BSSS (average 19.5%, low 12.5%, and high 25.0%) over this time period, although much lower numbers for women can be found in the CSSS numbers prior to 2013. The SSSA numbers (average 29.4%, low 15.8%, high 52.4%) showed a steady rise over this time period, starting at a level more in line with the BSSS numbers but ending in 2023 more in line with the CSSS. The CSSS Council exceeded 50% women members for the first time in 2015. For SSSA 2022 was the first year the Board of Directors

reached 50% women members, and 2023 was the first year it exceeded 50%. The SSSA Division Chairs (average 35.0%, low 14.3%, high 57.1%) followed a similar pattern to the Board of Directors, starting off low and generally rising over time. The SSSA Division Chairs exceeded 50% women in 2022.

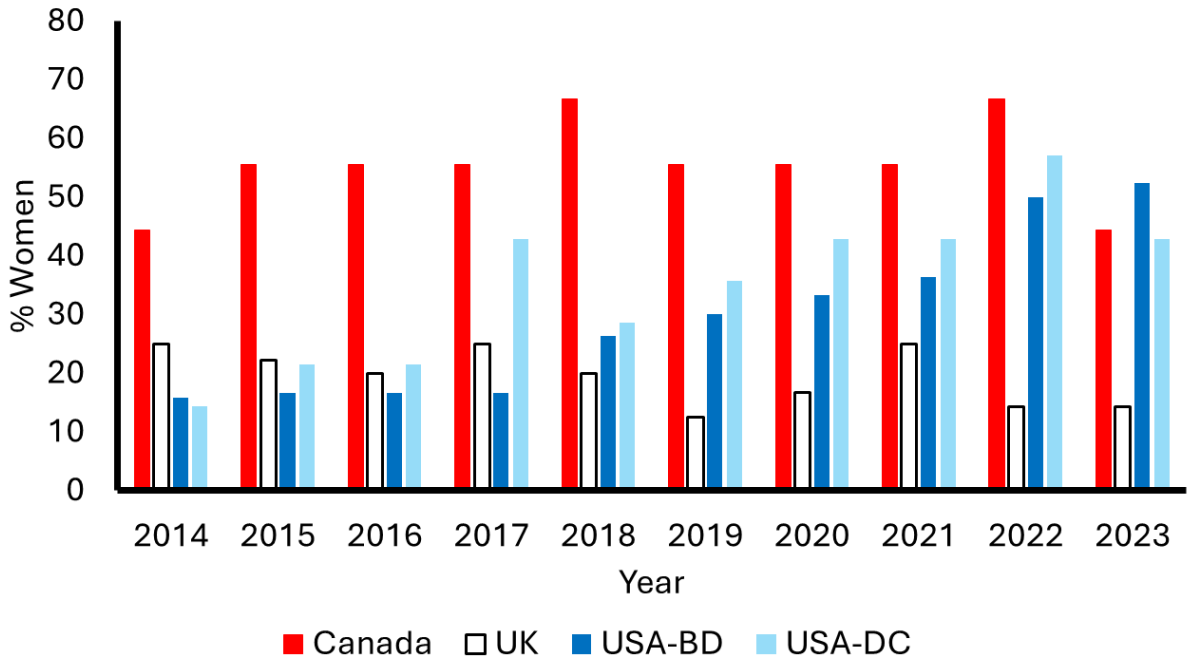


Figure 11. The percent of women serving on the Canadian Soil Science Society Council (Canada), British Society of Soil Science Board of Trustees (UK), Soil Science Society of America (SSSA) Board of Directors (USA-BD), and as SSSA Division Chairs (USA-DC) from 2014-2023.

In most cases, this study is the first time the status of women in soil science has been closely explored for the countries discussed. In these cases, this study serves as a baseline against which future progress in this area can be measured, but for the most part it was not possible to discuss changes over time due to a paucity of robust data. For those countries where we were able to establish some comparisons over time, future studies will be able to investigate longer-term trends. In all cases it is

important that baselines are established and that future studies follow up to investigate how the gender equity status of each country changes with time. This study was also able to identify gaps in the available data that should be obtained to provide more robust future evaluations of gender equity in soil science for these countries. A summary of data availability and the identified gaps is provided in Table 4. In addition to what is shown in Table 4, the availability of robust gender data that extends beyond the binary "men" and "women" approach is needed in all the countries investigated so that gender equity comparisons can be more complete.

Table 4. The types of data that were found for each country included in this study. Places where data was not found indicate areas of need for future research.

	Country					
Type of Data	Canada	Egypt	Mexico	Nigeria	United Kingdom	United States of America
% of women serving on soil science faculty	X	X	X	X	X	X
% of women by career level	X	X	X	X	X	X
% of women by soil science subdiscipline	X			X	X	X
% of women who are department chairs	X	X			X	X
% of women in professional society memberships	X		X		X	X
% women in professional societies by career level					X	X
% of women Fellows in professional societies	X				X	X
Time first women was elected a Fellow	X					X
% of women elected Presidents of professional societies	X		X		X	X
Time first women was elected President	X		X		X	X
% women on major professional society boards and/or committees	X				X	X
Increase in % of women faculty over a given period time	X	X				X

Increase in % of women faculty by career level over a given period of time	X	X				X
% of faculty who received promotions over a given period of time	X	X				X
Change in % of women faculty by subdiscipline over a given period of time	X					X
Changes in % women membership in professional societies over a given time			X		X	X
Change in % women membership in professional societies by career level over time					X	X
% of professional society Fellows who were women by year	X					X

3.4. Improving the place of women in soil science

Previous studies have offered numerous suggestions on how to improve the participation of and opportunities for women in scientific fields. Ecklund et al. (2012) found that women reported discrimination in the sciences at higher rates than men and reported differences between subjects, with for example, more discrimination in physics than in the life sciences. They also found that women appear to connect to scientific fields where they can see benefits to society that arise from the study of that field. Given these findings, Ecklund et al. (2012) suggested that discrimination must be identified and eliminated in science fields. They also suggested that introductory courses be revised to clearly communicate the benefits that society derives from the field. Finally, Ecklund et al. (2012) concluded that men need to be engaged in these changes, as men still make up most of the scientific faculties.

Dawson et al. (2021) suggested that current inequities need to be addressed to attract and retain women in soil science. Major issues that need to be addressed include providing equal pay for the

same job expectations and performance. It is very important to provide the same level of job security for both men and women who desire to have families (Mason et al., 2013). Work expectations should be addressed, as studies have shown women faculty are often expected to do more teaching and/or service, while men have more time for research (Misra et al., 2011). At least in the USA, time spent on research is positively correlated to faculty pay, while time in the classroom is negatively correlated (Fairweather, 2005). Women should have equal opportunity for advancement, which means giving them equal opportunity for research or rewarding them for the work they are often expected to do (teaching and service). However, not all changes required are workplace based and professional societies also have a major role to support an individual's career. Women should have greater opportunities to serve as society leaders, be on editorial boards, and be invited as keynote speakers in a similar way to men. Beyond work and the profession, there should be greater emphasis on shared responsibilities at home, so that women have the time to work on their professional development in an equitable manner (Mason et al., 2005).

Grunwald and Daroub (2023) concluded that women need opportunities for leadership development that break through implicit biases. Funding to allow women to participate in prestigious, and often costly, leadership training programs would facilitate greater uptake of leadership positions. The development of policies by professional societies that ensure diverse participation in keynote lectures and leadership positions would help. The development of mentoring networks that can help women tap into broader opportunities in the field is also important, as mentoring has been shown to lead to more career satisfaction and opportunity. Given the much higher percentage of men in leadership roles, it is important that men serve as effective mentors and support opportunities for leadership that will enable women to enhance and advance their careers (Johnson and Smith, 2019).

4. Conclusions

This study showed an increase in the representation of women across academia and within professional societies in soil science over the last decade in several countries across the world. The percentage of women who are on university soil science faculties has increased in Canada, Egypt, and the USA, but in all six countries included in this study overall numbers of women faculty members are still lower than men, and in most cases much lower. When totaling the faculty numbers reported for all the countries in this study, 69.2% (n=1210) of those faculty were men and 30.8% (n=539) were women. Soil science subdisciplines in Canada and the USA have experienced increases in the percentage of women faculty, apart from pedology in Canada and soil biology in the USA. In Nigeria, on the other hand, all subdisciplines were still strongly dominated by men faculty members, with soil management not having a single documented woman faculty. Women have also recently been elected as Presidents of soil science societies at a higher rate than was true in the past in Canada, the UK, and the USA, and also some improvements in board and committee leadership opportunities have been noted, although this was not true for all countries. However, women still lag behind men in leadership roles, as expressed by senior faculty positions in all the countries investigated and in department Chair positions for countries where data was available. They are also behind in their levels of recognition, such as with high-level awards and service opportunities (recognition as Fellows, election as Presidents and to important committee positions).

Participation in science by diverse groups benefits science through consideration of different experiences, abilities, and perspectives. It is important that the progress made continues and work on improving areas where progress is lacking is increased. To ensure we can monitor progress, gender and other DEI data should be routinely collected and analyzed by national and international soil science societies. One of the issues highlighted by this study is the lack of high-quality DEI data in many countries and professional societies. Addressing gender equity and other DEI issues will require the establishment

of robust baseline data so progress can be tracked and responded to. Finally, it is important to emphasize within the scientific community the difference in the meaning of equity and equality. Equality means each individual or group of people is given the same resources or opportunities. Equity recognizes that each person has different circumstances and allocates the exact resources and opportunities needed to reach an equal outcome. They are not the same, and failing to understand that difference is an underlying part of the current gender gap and a big obstacle to overcome.

CRediT Author Statement

Conceptualization – all authors; Data curation – all authors; Formal analysis – all authors; Investigation – all authors; Methodology – all authors; Project administration – Eric C. Brevik; Validation – all authors; Writing - original draft – all authors; Writing - review & editing – all authors.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplemental files - Where are we with gender parity in academia and professional societies? A multinational look at women in soil science

Data for 3.1 – Women in Academia

Table S1. Faculty gender by academic rank in Canada during 2023 and 2015.

Rank	Men % (#)		Women % (#)		% Women Change
	2023	2015	2023	2015	
Instructor	42.8 (3)	33.3 (2)	57.2 (4)	66.7 (4)	-9.5
Assistant Professor	50.0 (10)	68.4 (13)	50.0 (10)	31.6 (6)	18.4
Associate Professor	66.7 (20)	69.7 (23)	33.3 (10)	30.3 (10)	3.0
Professor	65.7 (44)	67.4 (31)	34.3 (23)	32.6 (15)	1.7

Table S2. Women and men faculty members by academic rank in Egypt during 2023 and 2017.

Rank	Men % (#)		Women % (#)		% Women Change
	2023	2017	2023	2017	
Assistant Lecturer	60.0 (39)	80.3 (49)	40.0 (26)	19.7 (12)	20.3
Lecturer	62.8 (49)	78.3 (47)	37.2 (29)	21.7 (13)	15.5
Associate Professor	78.7 (48)	83.0 (39)	21.3 (13)	17.0 (8)	4.3
Professor	85.3 (64)	92.2 (47)	14.7 (11)	7.8 (4)	6.9
Professor Emeritus	90.7 (152)	91.7 (110)	9.3 (16)	8.3 (10)	1.0

Table S3. Faculty gender by academic rank in Mexico.

Rank	Career Level	Men % (#)	Women % (#)
Subject Teacher	Introductory	53.0 (64)	46.2 (55)
Assistant Researcher	Introductory	0.0 (0)	100.0 (1)
Associate Research Professor	Mid-career	50.0 (2)	50.0 (2)
Associate Researcher	Mid-career	59.1 (39)	40.9 (27)
Associate Career Professor	Mid-career	61.9 (26)	38.1 (16)
Collaborating Researcher Professor	Mid-career	100.0 (4)	0.0 (0)
Senior Research Professor	Senior	77.8 (14)	22.2 (4)
Senior Researcher	Senior	71.7 (160)	28.3 (63)
Tenured Career Professor	Senior	71.8 (51)	28.2 (20)

Table S4. Faculty gender by seniority of position in Mexico.

Career Level	Men % (#)	Women % (#)
Introductory	53.3 (64)	46.7 (56)
Mid-career	61.2 (71)	38.8 (45)
Senior	72.1 (231)	27.9 (93)

Table S5. Gender distribution of soil science faculty by rank at Nigerian universities.

Rank in Nigeria	US Equivalent Rank	Men % (#)	Women % (#)	Gender Gap %
Assistant Lecturer	Instructor	68.4 (13)	31.6 (6)	36.8
Lecturer II	Assistant professor	95.5 (21)	4.5 (1)	67.6
Lecturer I	Assistant professor	66.7 (10)	33.3 (5)	
Senior Lecturer	Associate professor	85.0 (17)	15.0 (3)	48.4
Reader or Associate Professor	Associate Professor	54.5 (6)	45.5 (5)	
Professor	Professor	86.0 (37)	14.0 (6)	72.0

Table S6. Academic and professional ranks for BSSS members in 2023. Members were given gender choices of "male", "female, "something other than male or female" and "prefer not to say", so when the percentages do not equal 100 at least one of the latter two options were selected.

	BSSS Academic and Professional Rank 2023			
	Rank	Men % (#)	Women % (#)	Total (n)
Academic Rank	Assistant Professor	50.0 (3)	50.0 (3)	6
	Associate Professor	70.0 (7)	30.0 (3)	10
	Fellow	75.0 (3)	25.0 (1)	4
	Lecturer	60.9 (14)	39.1 (9)	23
	Master's Student	42.9 (3)	57.1 (4)	7
	PhD Student	36.8 (25)	61.8 (42)	68
	Postdoc Researcher	40.0 (10)	56.0 (14)	25
	Professor	80.8 (59)	19.2 (14)	73
	Reader	100.0 (3)	0.0 (0)	3
	Research Associate	28.6 (4)	71.4 (10)	14
	Research Fellow	50.0 (11)	50.0 (11)	22
	Researcher	40.0 (12)	56.7 (17)	30
	Senior Lecturer	45.5 (5)	54.5 (6)	11
	Student	50.0 (3)	50.0 (3)	6
	Teaching - Other	80.0 (4)	20.0 (1)	5
	Technician	57.1 (4)	14.3 (1)	7
	Vice Chancellor	100.0 (1)	0.0 (0)	1

Professional Rank	Advisor	25.0 (3)	75.0 (9)	12
	Agronomist	71.4 (5)	28.6 (2)	7
	Assistant	50.0 (1)	50.0 (1)	2
	Chair (in industry)	100.0 (3)	0.0 (0)	3
	Chief Executive	80.0 (4)	20.0 (1)	5
	Co-Editor in Chief	100.0 (1)	0.0 (0)	1
	Consultant	62.7 (42)	35.8 (24)	67
	Director	76.7 (33)	23.5 (10)	43
	Ecologist	42.9 (3)	57.1 (4)	7
	Engineer	100.0 (6)	0.0 (0)	6
	Environmental Scientist	20.0 (1)	80.0 (4)	5
	Farmer	100.0 (2)	0.0 (0)	2
	Founder	66.7 (2)	33.3 (1)	3
	Head of Department	70.0 (7)	30.0 (3)	10
	Laboratory Worker	66.7 (2)	33.3 (1)	3
	Manager	50.0 (6)	50.0 (6)	12
	Managing Director	85.7 (6)	14.3 (1)	7
	Officer (non-soil)	36.3 (4)	54.5 (6)	11
	Other (non-soil)	62.5 (10)	37.5 (6)	16
	Partner	100.0 (2)	0.0 (0)	2
	Practitioner	0.0 (0)	100.0 (1)	1
	Principal (non-soil)	75.0 (3)	25.0 (1)	4
	Retired	89.3 (108)	10.7 (13)	121
	Scientific Officer	50.0 (2)	50.0 (2)	4
	Scientist – Other	60.0 (3)	40.0 (2)	5
	Soil Scientist	61.4 (35)	38.6 (22)	57
	Soils Specialist	66.7 (4)	33.3 (2)	6
	Soil Surveyor	100.0 (3)	0.0 (0)	3
	Team Lead	75.0 (6)	25.0 (2)	8

Table S7. Faculty gender by academic rank in the USA between 2023 and 2017.

Rank	Men % (#)		Women % (#)		% Women Change
	2023	2017	2023	2017	
Instructor	47.4 (9)	37.5 (3)	52.6 (10)	62.5 (5)	-9.9
Assistant Professor	57.7 (79)	64.2 (77)	42.3 (58)	35.8 (43)	6.5
Associate Professor	70.1 (82)	76.0 (92)	29.9 (35)	24.0 (29)	5.9
Professor	78.6 (198)	81.8 (220)	21.4 (54)	18.2 (49)	3.2

Table S8. Faculty gender by soil science subdiscipline at Canadian universities during 2023 and 2015.

Subdiscipline	Men % (#)		Women % (#)		% Women Change
	2023	2015	2023	2015	
Pedology	92.0 (11)	90.0 (9)	8.0 (1)	10.0 (1)	-2.0
Soil Biogeochemistry	37.5 (3)	50.0 (3)	62.5 (5)	50.0 (3)	12.5
Soil Biology	60.0 (9)	66.7 (8)	40.0 (6)	33.3 (4)	6.7
Soil Chemistry	63.2 (12)	64.7 (11)	36.8 (7)	35.3 (6)	1.5
Soil Fertility	50.0 (7)	54.5 (6)	50.0 (7)	45.5 (5)	4.5
Soil Management	53.8 (14)	56.5 (13)	46.2 (12)	43.5 (10)	2.7
Soil Physics	85.7 (6)	100.0 (6)	14.3 (1)	0.0 (0)	14.3
Forest/Wetland Soil	75.0 (12)	76.9 (10)	25.0 (4)	23.1 (3)	1.9
Soil Reclamation	42.9 (3)	50.0 (3)	57.1 (4)	50.0 (3)	7.1

Table S9. Distribution of soil science faculty gender by subdiscipline in Nigerian Universities.

Subdiscipline	Men % (#)	Women % (#)	Gender Gap (%)
Pedology	94.7 (18)	5.3 (1)	89.4
Soil Microbiology	63.6 (7)	36.4 (4)	26.8
Soil Chemistry	61.5 (8)	38.5 (5)	23.0
Soil Fertility	76.5 (13)	23.5 (4)	53.0
Soil Management	100.0 (3)	0.0 (0)	100.0
Soil Physics	81.0 (17)	19.0 (4)	62.0
Soil Science/Agronomy	88.2 (30)	11.8 (4)	76.4

Table S10. Subdisciplines of BSSS members in 2023. Members were given gender choices of "male", "female, "something other than male or female" and "prefer not to say", so when the percentages do not equal 100 at least one of the latter two options were selected.

Subdiscipline 2023			
	Men % (#)	Women % (#)	Total (n)
Pedology	70.2 (33)	25.5 (12)	47
Soil Biogeochemistry	45 (18)	52.5 (21)	40
Soil Biology	54.7 (58)	41.5 (44)	106
Soil Chemistry	60.2 (62)	39.8 (41)	103
Soil Fertility	65.4 (89)	33.8 (46)	136
Soil Management	55.8 (86)	44.2 (68)	154
Soil Microbiology	75.0 (3)	25.0 (1)	4
Soil Physics	63.6 (28)	36.4 (16)	44
Retired	89.0 (105)	11.0 (13)	118

Table S11. Faculty gender by soil science subdiscipline in the USA during 2023 and 2017.

Subdiscipline	Men % (#)		Women % (#)		% Women Change
	2023	2017	2023	2017	
Pedology	79.0 (49)	81.0 (51)	21.0 (13)	19.0 (12)	2.0
Soil Biogeochemistry	61.1 (44)	81.3 (52)	38.9 (28)	18.8 (12)	20.1
Soil Biology	50.0 (41)	49.0 (47)	50.0 (41)	51.0 (49)	-1.0
Soil Chemistry	71.2 (47)	76.6 (59)	28.8 (19)	23.4 (18)	5.4
Soil Fertility	76.1 (86)	84.5 (93)	23.9 (27)	15.5 (17)	8.4
Soil Management	72.5 (50)	80.7 (46)	27.5 (19)	19.3 (11)	8.2
Soil Physics	80.3 (53)	86.8 (59)	19.7 (13)	13.2 (9)	6.5

Data for 3.2 – Women in professional societies

Table S12. Gender distribution of the Mexican Soil Science Society members from 2019 to 2024

	Men % (#)	Women % (#)
2019-2020	67.4% (93)	32.6% (45)
2021-2022	84.14% (69)	15.85% (13)
2022-2023	62.5% (25)	37.5% (15)
2023-2024	54.83% (17)	45.16% (14)

Table S13. Membership of BSSS in 2020 and 2023. Members were given gender choices of "male", "female, "something other than male or female" and "prefer not to say", so when the percentages do not equal 100 at least one of the latter two options were selected.

	BSSS Membership 2020			**BSSS Membership 2023**		
Category	Men % (#)	Women % (#)	Total (n)	Men % (#)	Women % (#)	Total (n)
Full	66.3 (207)	32.7 (102)	312	64.5 (185)	35.2 (101)	287
Fellow	88.3 (83)	11.7 (11)	94	86.9 (73)	13.1 (11)	84
Technical	73.9 (17)	26.1 (6)	23	73.3 (22)	26.7 (8)	30
Early Career	48.9 (93)	47.9 (91)	190	41.2 (91)	55.2 (122)	221
Associate	70.4 (19)	22.2 (6)	27	55.0 (44)	42.5 (34)	80
Honorary / Life	94.6 (35)	5.4 (2)	37	90.2 (37)	9.8 (4)	41
Retired	88.6 (78)	11.4 (10)	88	89.4 (93)	10.6 (11)	104
Totals	69.0 (532)	29.6 (228)	771	64.3 (545)	34.4 (291)	847

Table S14. Soil Science Society of America membership by gender in 2022 and 2017.

Subdiscipline	Men % (#)		Women % (#)		% Women Change
	2022	2017	2022	2017	
Undergraduate	43.8 (175)	49.1 (214)	56.3 (225)	50.9 (222)	5.4
Graduate	52.6 (594)	58.6 (751)	47.4 (535)	41.4 (530)	6.0
Regular Member	72.7 (2230)	76.7 (2882)	27.3 (839)	23.3 (875)	4.0
Emeritus	94.7 (266)	98.2 (276)	5.3 (15)	1.8 (5)	3.5

Table S15. Gender distribution of the Canadian Society of Soil Science (CSSS) Presidents and Fellows.

	Men % (#)	Women % (#)	Total #
All Time Presidents (1955-2023)	87.0 (60)	13.0 (9)	69
Presidents between 2005-2023	52.6 (10)	47.4 (9*)	19
All Time Fellows (1962-2023)	91.7 (88)	8.3 (8**)	96
Fellows between 2007-2023	65.2 (15)	34.8 (8)	23

*1st woman CSSS President was elected in 2005. **1st woman awarded CSSS Fellow in 2007.

Table S16. Representation of gender across the Fellows in BSSS between 2017 and 2023.

BSSS Fellows			
Year	Men % (#)	Women % (#)	Total (n)
2017	86.3 (88)	13.7(14)	102
2018	84.8 (78)	15.2 (14)	92
2019	85.7 (78)	14.3 (13)	91
2020	88.3 (83)	11.7 (11)	94
2021	87.4 (83)	12.6 (12)	95
2022	87.3 (69)	12.7 (10)	79
2023	86.9 (73)	13.1 (11)	84

Table S17. Gender distribution of the Canadian Society of Soil Science Council members from 2000 to 2023.

Year	Men % (#)	Women % (#)
2000	87.5 (7)	12.5 (1)
2001	75.0 (6)	25.0 (2)
2002	75.0 (6)	25.0 (2)
2003	87.5 (7)	12.5 (1)
2004	66.7 (6)	33.3 (3)
2005	66.7 (6)	33.3 (3)
2006	77.8 (7)	22.2 (2)
2007	100.0 (9)	0.0 (0)
2008	88.9 (8)	11.1 (1)
2009	55.6 (5)	44.4 (4)
2010	66.7 (6)	33.3 (3)
2011	77.8 (7)	22.2 (2)
2012	77.8 (7)	22.2 (2)
2013	55.6 (5)	44.4 (4)
2014	55.6 (5)	44.4 (4)
2015	44.4 (4)	55.6 (5)
2016	44.4 (4)	55.6 (5)
2017	44.4 (4)	55.6 (5)
2018	33.3 (3)	66.7 (6)
2019	44.4 (4)	55.6 (5)
2020	44.4 (4)	55.6 (5)
2021	44.4 (4)	55.6 (5)
2022	33.3 (3)	66.7 (6)
2023	55.6 (5)	44.4 (4)

Table S18. Gender distribution of the British Society of Soil Science Board of Trustees (2014 to 2023). Note Board membership currently comprises President Elect; President; Past President; Professional Practice and Development Committee Trustee; Marketing, Communications and Policy-Making Trustee; and Finance Trustee.

Year	Men % (#)	Women % (#)	Total (n)
2014	75.0 (6)	25.0 (2)	8
2015	77.8 (7)	22.2 (2)	9
2016	80.0 (8)	20.0 (2)	10
2017	75.0 (6)	25.0 (2)	8
2018	80.0 (8)	20.0 (2)	10
2019	87.5 (7)	12.5 (2)	8
2020	83.3 (5)	16.7 (1)	6
2021	75.0 (6)	25.0 (2)	8

2022	85.7 (6)	14.3 (1)	7
2023	85.7 (6)	14.3 (1)	7

Table S19. Gender distribution of the British Society of Soil Science Committee Chairs (2014 to 2023). Note: Current term for the Chair of the Committees is 3 years, prior to 2019 this was not standardized. Chairs can be reelected for a second term. The Professional Practice and Development Committee represents members working in industry rather than academia.

BSSS Committee	Men % (#)	Women % (#)	Total (n)
Professional practice and development	66.7 (4)	33.3 (2)	6
Outreach	33.3 (1)	66.7 (2)	3
Early Career	50.0 (3)	50.0 (3)	6
Northern Soil Network	75.0 (3)	25.0 (1)	4
South East England Soil Discussion Group	0.0 (0)	100.0 (4)	4
Midlands Soil Discussion Group	100.0 (4)	0.0 (0)	4
Welsh Soil Discussion Group	66.7 (2)	33.3 (1)	3
South West England Soil Discussion Group	25.0 (1)	75.0 (3)	4
Scottish Soil Discussion Group	33.3 (1)	66.7 (2)	3

Table S20. Gender distribution on the Soil Science Society of America Board of Directors and for the Division Chairs over the last 10 years.

Year	Board of Directors		Division Chairs	
	Men % (#)	Women % (#)	Men % (#)	Women % (#)
2014	84.2 (16)	15.8 (3)	85.7 (12)	14.3 (2)
2015	83.3 (15)	16.7 (3)	78.6 (11)	21.4 (3)
2016	83.3 (15)	16.7 (3)	78.6 (11)	21.4 (3)
2017	83.3 (15)	16.7 (3)	57.1 (8)	42.9 (6)
2018	73.7 (14)	26.3 (5)	71.4 (10)	28.6 (4)
2019	70.0 (14)	30.0 (6)	64.3 (9)	35.7 (5)
2020	66.7 (14)	33.3 (7)	57.1 (8)	42.9 (6)
2021	63.6 (14)	36.4 (8)	57.1 (8)	42.9 (6)
2022	50.0 (10)	50.0 (10)	42.9 (6)	57.1 (8)
2023	47.6 (10)	52.4 (11)	57.1 (8)	42.9 (6)



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Where are we with gender parity in academia and professional societies? A multinational look at women in soil science

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2025-01-01
Wiley
https://doi.org/10.1111/ejss.70039
Brevik EC, Krzic M, Elbasiouny H, et al., (2025) Where are we with gender parity in academia and professional societies? A multinational look at women in soil science. European Journal of Soil Science, Volume 76, Issue 1, January-February 2025, Article number e70039

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