Received: 19 October 2020 | Accepted: 10 November 2020 | Published online: 26 June 2021

DOI: 10.1002/saj2.20210

Soil Science Society of America Journal

REVIEW & ANALYSIS

Towards diverse representation and inclusion in soil science in the United States

Tiffany L. Carter[1] | **Lydia L. Jennings**[2] | **Yamina Pressler**[3] | **Adrian C. Gallo**[4] | **Asmeret Asefaw Berhe**[5] | **Erika Marín-Spiotta**[6] | **Christopher Shepard**[7] | **Teamrat Ghezzehei**[8] | **Karen L. Vaughan**[9]

[1] Dep. of Agriculture, Austin Peay State Univ., PO Box 4607, Clarksville, TN 37044, USA

[2] Dep. of Environmental Science, Univ. of Arizona, 1110 E. South Campus Dr., Tucson, AZ 85719, USA

[3] Natural Resources Management and Environmental Sciences, California Polytechnic State Univ., 1 Grand Avenue, San Luis Obispo, CA 93407, USA

[4] Dep. of Crop and Soil Science, Oregon State Univ., 3017 Agriculture and Life Sciences Building, Corvallis, OR 97331, USA

[5] Dep. of Life and Environmental Sciences, Univ. of California, Merced, CA 95340, USA

[6] Dep. of Geography, Univ. of Wisconsin–Madison, 550 North Park St., Madison, WI 53706, USA

[7] Dep. of Plant and Soil Sciences, Univ. of Kentucky, 1100 Nicholasville Rd., Lexington, KY 40546, USA

[8] Dep. of Life and Environmental Sciences, Univ. of California–Merced, Merced, CA 95340

[9] Ecosystem Science and Management Dep., Univ. of Wyoming, 1000 E. University Ave., Laramie, WY 82071, USA

Correspondence
Karen L. Vaughan, Ecosystem Science and Management Dep., Univ. of Wyoming, 1000 E. University Ave., Laramie, WY 82071, USA.
Email: karen.vaughan@uwyo.edu

Abstract

Soil science is one of the least diverse subdisciplines within the agricultural, earth, and natural sciences. Representation within soil science does not currently reflect demographic trends in the United States. We synthesize available data on the representation of historically marginalized groups in soil science in the United States and identify historical mechanisms contributing to these trends. We review education and employment information within academia and the federal government, land-grant university participation, and available Soil Science Society of America (SSSA) membership data to gain insight into the current state of representation within soil sciences and implications for the future of this discipline. Across all domains of diversity, historically marginalized groups are under-represented in soil science. We provide recommendations toward recognizing diversity within the field and improving and encouraging diversity within the SSSA, and suggested responses for both individuals and institutions toward improving diversity, equity, and inclusion.

1 | BACKGROUND

The history of soil science, similar to the history of the United States, has been told through an incomplete lens, obfuscating and purposefully removing the contributions of Indigenous peoples and other groups persistently excluded and

Abbreviations: BIPOC, Black, Indigenous, and people of color; DEI, diversity, equity, and inclusion; HBCU, historically Black colleges and university; LGBTQ+, lesbian, gay, bisexual, transgender, queer, plus other sexual and gender minorities; NSF, National Science Foundation; POC, people of color; SSSA, Soil Science Society of America; STEM, science, technology, engineering, and math.

marginalized from the dominant narrative. This narrow view threatens the ability of soil science to contribute to solving some of our most pressing environmental and social challenges and hinders efforts to diversify the discipline (Berhe, 2020). Addressing the lack of diversity in soil science requires a clear understanding of representation within the discipline—a clarity that has not yet been achieved.

Here, we identify and discuss mechanisms that preclude marginalized voices in soil science, from both a historical and contemporary perspective. We frame the current lack of representation around the historical context in which the discipline developed, because meaningful change will only arise when soil scientists and their affiliated scientific institutions recognize and acknowledge this history. Then, we synthesize available data on the representation of historically marginalized communities in soil science in the United States, including Black, Indigenous, and people of color (BIPOC), international scholars, women, LGBTQ+ (lesbian, gay, bisexual, transgender, queer, plus other sexual and gender minorities) individuals, disabled people, and people from economically disadvantaged communities. Finally, we explicitly outline a path forward for meaningful change for individual soil scientists, academic institutions, and scientific societies.

Core Ideas

- Soil science is one of the least diverse subdisciplines of the earth and natural sciences.
- Addressing the lack of diversity in soil science requires data on representation and a commitment from societies.
- We highlight some of the barriers to equitable representation in U.S. soil science.
- We provide actionable recommendations to improve equity in soil science.
- Diversity and inclusion pave the path towards a more equitable soil science.

2 | REPRESENTATION IN SOIL SCIENCE AS A LEGACY OF HISTORICAL POLICIES

Redressing the current state of social inequity in soil science requires an acknowledgment of historical events that gave rise to our discipline today and shape our current institutions. Western soil science is rooted in colonization, manifest destiny, and westward expansion. This has led to the displacement of Indigenous people from their traditional lands and the enslavement of Indigenous and African people to work in agricultural production (Krauthamer, 2013). In the United States, land-grant universities, in partnership with their respective states, have led the nation in agricultural advances since their establishment through the Morrill Act of 1862. The 1862 Morrill Act expropriated 4.6 million ha from more than 250 Indigenous tribes. This is the land upon which our agricultural research institutions are built and where the institutions, and the soil science education they elevated as a scholarly field, continue to operate (Nash, 2019; Red Shirt-Shaw, 2020). The land granted to these institutions (approximately the size of Denmark) is estimated to be worth US$500 million when adjusted for inflation (Gavazzi, 2020). Today, the endowment principals from the sale of these Indigenous lands and the value of unsold land of the top 10 beneficiaries exceeds $1.5 billion (Lee & Ahtone, 2020).

Later, the Morrill Act of 1890 mandated that federal funds for state education be apportioned to institutions that educated African Americans, who at the time were denied admission to the majority of colleges and universities. This act encouraged continued segregation, as several states established separate, public institutions for African Americans in order to receive additional federal support, though states often underfunded these institutions (Brown & Davis, 2001). Several historically Black colleges and universities (HBCUs) were established with land-grant status.

Over 100 yr later, the Equity in Educational Land-Grant Status Act designated tribal colleges and universities as land-grant institutions (1994 land-grant institutions) and provided funding to confer such land-grant status to preexisting tribal colleges. Despite their land-grant designation, the 1890 and 1994 institutions were not granted land and were not permitted to apply for USDA integrated research, education, and extension competitive grants until 2002 (USDA-NIFA, 2015). Although all states meet the one-to-one nonfederal matching funds requirement for their 1860 institutions, they fail to provide full match for the 1890 institutions (Croft, 2019; Lee & Keys, 2013). Therefore, major disparities in allocation of funds to the 1860 (predominantly white) compared with the 1890 (HBCU) and 1994 (tribal) institutions still exist.

Outside the land-grant system, many U.S. colleges and universities have a legacy of racist and exclusionary policies. Many institutions were funded by money acquired from the sale of enslaved Africans (Harris, 2015; Stein, 2016), and people of color have been repeatedly exploited by Western science for monetary and educational gain (Wynn-Grant, 2019). Until 1954, when the Supreme Court ruled that segregation in schools was unconstitutional (Brown vs. Board of Education), the U.S. education system was racially divided. Though legally changed, remnants of segregation and lack of equal education access are still present today, contributing to persistent racial and ethnic gaps in representation in higher education (Minor, 2008). Although institutions of higher learning, especially land-grant institutions, are indispensable to our

country's agriculture and play a major role in public education, research, and development, we must recognize that the origins of these institutions are embedded in systemic racism, discrimination, and exclusion.

3 | CONTEMPORARY BARRIERS TO REPRESENTATION IN SOIL SCIENCE: INSTITUTIONAL AND SYSTEMIC BIAS AND RACISM

To broaden participation in our discipline, soil scientists must also address present-day manifestations of systemic bias and discrimination. Academic institutions have historically excluded, and continue to exclude, segments of society from pursuing higher education and employment based on economic class, gender, race and ethnicity, religion, and citizenship (Asai, 2020; Marín-Spiotta et al., 2020).

Contemporary bias across the academic hierarchy affects recruitment into early-career and leadership positions, access to economic and material resources, and opportunities for career advancement. For example, racial and gender bias has been documented in faculty evaluations of postdoctoral candidates in physics and biology (Eaton et al., 2019) and in invited talks at scientific conferences in the earth and space sciences (Ford et al. 2019; King et al., 2018; Lerback & Hanson, 2017).

Bias also manifests in interpersonal relationships. Both macro- and microaggressions and other identity-based exclusions, coupled with feelings of isolation for groups that are numerically under-represented, leads to lower retention in science, technology, engineering and mathematics (STEM) (Cabay et al. 2018; Camacho & Lord, 2011; Leath & Chavous, 2018; Yosso, Smith, Ceja, & Solórzano, 2009). Harassment, exclusionary work climates, and unique challenges of fieldwork for minoritized individuals are recognized barriers to diversifying the geosciences (Marín-Spiotta et al., 2020; Nash et al., 2019). Minoritized scientists experience racial discrimination across disciplines, including the earth sciences (Dutt, 2020), ecology and evolution (Tseng et al., 2020), and medicine (Dzirasa, 2020).

Racism experienced by BIPOC scholars is wide ranging. Black scholars are grieving, traumatized, exhausted, infuriated, frustrated, and experiencing many other disparaging emotions as they attempt to operate in a system that presents extraordinary barriers to their success (Dzirasa, 2020; Subbaraman, 2020). Incidents can range from having the police called on Black researchers in the field or at research institutions, seeing themselves reported in negative context in published literature, assumed to be the custodial staff at conferences, assumed to be students when they are tenured faculty, and an extra mentoring load compared with white colleagues because they are often the only Black researcher in the field (Dzirasa, 2020).

Though the Latinx population is rapidly growing in the United States, Latinx scholars remain under-represented in STEM and soil sciences (Landivar, 2013). Farmworkers in the United States are overwhelmingly Hispanic or Latinx. The children of Latinx farmworkers are more likely to be exposed to agricultural toxins (Fenske et al., 2000; Mills & Zahm, 2001; Rao, Quandt, Doran, Snively, & Thomas, 2007; Simcox, Fenske, Wolz, Lee, & Kalman, 1995), live below the poverty line (JBS International, 2016), and face higher levels of food insecurity (Quandt, Arcury, Early, Tapiac, & Davisa, 2004; Weigel, Armijos, Hall, & Orozco, 2007). Thus, the children of these farmworkers are not often compelled to willingly pursue careers within the field of agriculture. Latinx scholars who do pursue a STEM career often experience educational bias and racial discrimination (McGee, 2016). Latinx scholars receive differential treatment from their peers and lack mentorship from senior leadership because they are often wrongly assumed to be underqualified and incompetent (McGee, 2016; Millett & Nettles, 2006).

In addition to those shared experiences by their Black and Latinx colleagues, Indigenous scholars often face racism through invisibility (Shotton, Lowe, Waterman, & Garland, 2012). In demographic literature, Native peoples continue to be relegated to an asterisk, if mentioned at all, justifying their exclusion. This leads to students feeling alone and alienated, and often derails matriculation (American Indian College Fund, 2019).

Many Indigenous people have place-based traditional knowledge that has been shaped by thousands of years of coexistence with their traditional homelands (United Nations, 2009). However, Indigenous scholars and students often face epistemological hegemony and cultural imperialism in their studies, as they advocate for Indigenous ways of knowing, values, and contributions to be recognized in their research and education (Ogawa, 1995; Snively & Corsiglia, 2001). Indigenous scholars often spend time educating peers and faculty about Indigenous people's current existence, policy, and rights, while navigating being a first-generation student in higher education (American Indian College Fund, 2019).

Legacies of colonialism are alive today in research practices, most notably in what has been called "helicopter research" or "parachute research" (Minasny et al., 2020; van Groenigen & Stoof, 2020). These terms describe the common practice of scientists from non-Indigenous groups and/or the Global North, conducting research on Indigenous land or in a country from the Global South (David-Chavez & Gavin, 2018). Such researchers benefit from local infrastructure and local knowledge but do not involve or value local scientists or knowledge owners as equal partners in the research process (Carroll, Rodriguez-Lonebear, & Martinez, 2019; Chaudhary & Berhe, 2020). Rather, "helicopter researchers" regard local communities as raw data, provide little to no benefit to local communities, and may cause these

communities to rely on data that do not reflect their needs, priorities, and self-conceptions (Carroll et al., 2019). Therefore, many assumptions animated in the minds of researchers become self-verified leading to research practices that would not be ethical in other places. The journal *Geoderma* has dedicated a recent special issue (Volume 373) to how these practices enable colonial ideas to dominate the field of soil science.

Whereas in North America international or foreign-born immigrant students and scholars may not have the same legacy of segregation, genocide, stolen land, slavery, and barriers to intergenerational wealth as BIPOC U.S. citizens, many, in particular those from the Global South, are mistreated, harassed and discriminated in western educational institutions (Lee & Ahtone, 2020; Louis, Thompson, Smith, Williams, & Watson, 2017). Foreign-born people of color (POC) experience persistent legacies of Western colonialism, racism, xenophobia, and discrimination during their education that leads to feelings of isolation, lack of mentorship, and underestimation of their scholarly potential (Lee & Ahtone, 2020; Mani, 2020; Yamanaka, 2018).

Many U.S.-funded efforts to diversify STEM have focused on gender bias, and earth and soil science are no exception. Over the last decade and a half, the earth and soil sciences have seen an improvement in the percentage of faculty who are women, though these gains were small compared with the life sciences (Vaughan et al., 2019; Wilson, 2017). Still, soil science has one of the lowest proportion of women among geoscience research fields (Wilson, 2019). The focus on gender alone has primarily benefited white women, with little to no change observed for the representation of BIPOC individuals (Bernard & Cooperdock, 2018).

Other social identities are also under-represented in soil science. Significant barriers exist to increased LGBTQ+ participation in STEM. LGBTQ+ earth scientists reported lower professional openness about their identity compared with other STEM fields, such as life and social sciences (Yoder & Mattheis, 2016) due to lower acceptance of gender nonconforming identities and assumption of heteronormative identities (Cech & Pham, 2017; Hughes, 2018; Patridge, Barthelemy, & Rankin, 2014). Field-based training, research, and work environments can be unsafe to LGBTQ+ and BIPOC (Pickrell, 2020). LGBTQ+ individuals were more likely to experience negative workplace environments in federal agencies (Cech & Pham, 2017) and in academic settings (Patridge et al., 2014). LGBTQ+ STEM professionals reported greater feelings of acceptance and openness in STEM fields with greater participation of women. Given this, we suggest that the low numbers of women in soil science (Vaughan et al., 2019) may contribute to a less inclusive culture for LGBTQ+ soil scientists. Until recently, the lack of federal protection in employment discrimination (Bostock vs. Clayton County, Georgia, 2020) prevented open self-identification of LGBTQ+ individuals and forced these individuals to weigh potential employment loss with being out about their identity.

Several factors cause disabled people to be under-represented in STEM fields, including adequate preparation of students with disabilities; access to facilities, programs, and equipment; and acceptance by educators, employers, and coworkers (Atchison & Libarkin, 2016; Burgstahler, 1994). In educational and training settings, access to field excursions such as place-based field courses can be a barrier to disabled people, including mobility and vision challenges that could preclude individuals from accessing remote sites. Recent efforts have focused on overcoming challenges to accessibility in the geosciences, with a particular emphasis on field training and research, much of which would be relevant for soil scientists (Carabajal & Atchison, 2020; Marshall & Thatcher, 2019). Acknowledging challenges coupled with the benefits of immersive field work is important for ensuring individuals are welcomed into a safe, inclusive, equitable environment ripe for learning and advancing (Slaton, 2013).

For many students, the lack of access to outdoor spaces and socioeconomic status can be early barriers to careers in soil science. Socioeconomic status is multifaceted, as it incorporates income, financial security, social status, social class, and access to resources including higher education. Students from low socioeconomic backgrounds are less likely to perform well in the classroom and are thus less likely attend college and pursue STEM majors than their higher-income counterparts (Moakler & Kim, 2014; Rozek, Ramirez, Fine, & Beilock, 2019). The academic achievement gap between students of high and low socioeconomic status can be greater than differences in racial achievement gaps (Rozek et al., 2019), and at times race and socioeconomic status overlap. The reduction in academic achievement limits education and career opportunities, thus perpetuating the continued cycle of low socioeconomic status (Rozek et al., 2019).

4 | WHO ARE SOIL SCIENTISTS? A LOOK AT THE DATA

The lack of diversity in STEM has been acknowledged over the past few decades (Miriti, 2020). Although the enrollment rate of racially and ethnically diverse students at doctoral programs within the United States has increased over the past decade (de Brey et al., 2019), there has been little progress in the earth and soil sciences (Bernard & Cooperdock, 2018; Dutt, 2020). Due to the lack of demographic data for soil scientists, we sought information from several sources that, despite not explaining the entire field, sheds light on the lack of diversity. Bachelor and Doctorate degrees earned by field of degree, ethnicity, and race of recipients were collected for 2018 from the NSF and NCSES (2019). Demographics of

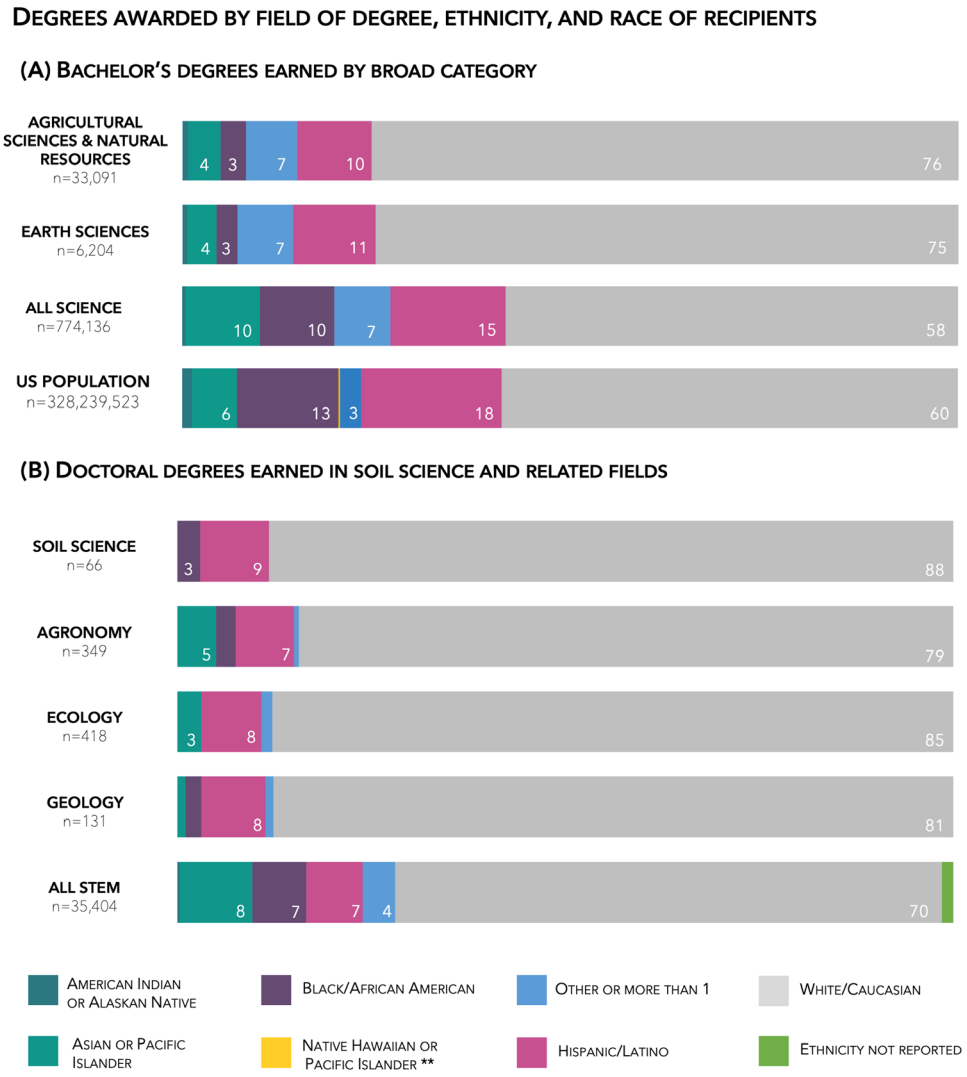

FIGURE 1 Summary of percentage of (A) bachelor's degrees earned by field of degree, ethnicity, and race of recipients in agricultural sciences and natural resources, earth sciences, and all science disciplines in 2018 compared with the population of the United States (United States Census Bureau, 2020) and (B) summary of earned doctorates in soil science and related fields in 2018 (NSF & NCSES, 2019). The broad field of degree categories are presented to illustrate the general fields in which soil scientists are trained at the university level. Due to the interdisciplinarity of soil science, many soil scientists earn degrees that fall in categories outside of "soil science" specifically, and these are examples of some alternate disciplines. Numbers on the graph indicate the percentage of total within each category, with values only being presented if greater than 2%

federal employment in Soil Science and related disciplines were collected from the U.S. Office of Personnel Management (2020). United States population demographics for 2018 were collected from the United States Census Bureau (2020). Soil Science Society of America (SSSA) membership data were collected for 2019 and were obtained from Alliance of Crop, Soil Science Societies, and Environmental Science Societies.

The representation of minoritized racial and ethnic groups in the agricultural, natural resource, and earth sciences at the university level is vastly smaller than their representation within the U.S. population (Figure 1). Although the U.S. population is diversifying quickly, access to higher education does not currently reflect this diversity. Conversely, when aggregated, all STEM bachelor's degrees awarded better reflect the ethnic and racial distribution of the United States with some discrepancies (Figure 1). Similarly, soil science, agronomy, ecology, and geology had an overall lower racial and ethnic diversity of earned doctorates than all of STEM combined in 2018 (Figure 1; NSF & NCSES 2019). Ethnic and racial diversity among those who earned soil science doctorates is dismal, with 88, 9, and 3% of recipients identified as white (non-Hispanic), Hispanic or Latinx, and Black or African American, respectively (Figure 1).

The ethnic demographics of professional soil scientists and those in related fields do not reflect the diversity of U.S. citizens (Figure 2). The lack of racial and ethnic representation among federally employed soil scientists is indisputable and

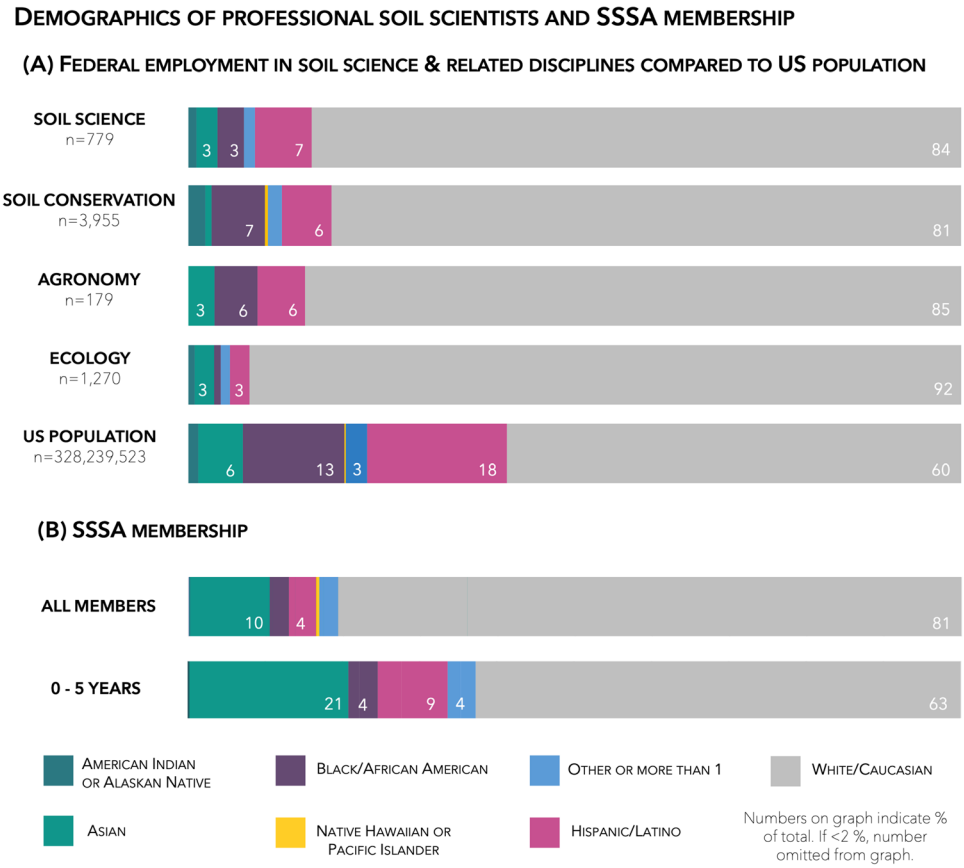

FIGURE 2 Demographics of (A) federal employees in soil science (0470, soil science series) and related disciplines (0457 soil conservation series; 0471 agronomy series; and 0408 ecology series) compared with the population of the United States (Office of Personnel Management, 2020; United States Census Bureau, 2020). (B) Soil Science Society of America (SSSA) members who self-identified both ethnicity and gender for all members (52% of 5,911 members reported) and those who have been members for only the past 0–5 yr (15.7% of 2,666 members reported). Of the total SSSA membership ($n = 5911$) who have been members for 0–5 yr (n = 2,666), 20.9% are undergraduate students, 46.8 % are graduate students, 31.4% are professional members, and less than 1% are corporate representative and emeritus members. The SSSA membership data were obtained from Alliance of Crop, Soil Science Societies, and Environmental Science Societies, an umbrella organization of SSSA. Data are presented from 2019 and numbers on the graph indicate the percentage of total within each category with values only being presented if greater than 2%

contributes to the continued barriers to diversity and representation described above. Demographic data of the SSSA membership serves as a reflection of soil scientists in the United States, though members are not required to disclose demographic information and only approximately half submitted racial or ethnic background information in their member profiles (Figure 2).

The soil science discipline is, quite literally, the study of the land; however, the membership of SSSA does not equitably encompass members from all land-grant institutions. Approximately 84% (16 of 19) of the 1890s land-grant institutions (HBCUs) are represented in SSSA membership compared with 100% membership from original 1862 land-grant institutions. The SSSA is also represented by members from five HBCUs that are not land-grant institutions. Currently, SSSA has no members from any of the 1994 land-grant institutions (tribal colleges). Though not necessarily land-grant institutions, it is important to note that SSSA membership is represented at only 6.5% (27 of 415) of the nation's currently eligible Hispanic serving institutions.

Representation and participation of women in soil science in the United States has been extensively reviewed by Vaughan et al. (2019); however, it is important to consider that women of color experience additional barriers to participation in the soil sciences that their white counterparts do not. Soil scientists lack properly curated gender demographic data, due in part to the general lack of gender nonconforming identities available as options for data collected on gender demographics. The SSSA now provides the following options for voluntary gender data collected about members: *female*, *gender non-binary*, *male*, and *prefer not to answer* (Susan Chapman, personal communication, 2020). As a global scientific society, effort needs to be placed on understanding who our community is and what they need to be successful. Without these data, we, as a soil science community, will be unable to be inclusive and thrive into the future.

Women remain underrepresented in soils-related careers, soil science leadership positions, and as soil science award recipients (Vaughan et al., 2019). Women account for far less than half of the membership (29% in 2018) of the SSSA (Vaughan et al., 2019). Of the individuals who self-reported both gender and ethnicity in 2019 (52% of members), women as a whole make up 21% of the SSSA membership (Supplemental Materials SM1). Women who identify as racial or ethnic minorities (American Indian or Alaskan Native, Asian, Black/African American, Hispanic/Latino, Native Hawaiian or Pacific Islander, or other) make up 22% of all racial and ethnic minority reporters, meaning women are generally represented in the same percentages overall as with members from under-represented groups in the SSSA (Supplemental Materials SM1). Only 15.7% of the 2,666 members of SSSA who have been members for 0–5 yr reported both ethnicity and gender representing significant uncertainty in the future diversity of SSSA members (Supplemental Materials SM1). Within this group, 37.2% identify as non-white (Supplemental Materials SM1) and are a population within the soil science community that should be a focus of inclusion efforts. These individuals are present, but either leave the soils community or do not matriculate into the professional society over time.

Individuals who self-identify as LGBTQ+ are estimated to make up approximately 4.5% of the U.S. population (Newport, 2018). This percentage is an estimate, as we still lack a national assessment of the U.S. LGBTQ+ community, as well as a comprehensive census of the LGBTQ+ community in STEM and soils-related fields. Yoder and Matthias (2016) completed one of the first assessments of the LGBTQ+ STEM professionals (including academic and nonacademic); of 1,427 surveyed LGBTQ+ respondents, 7% were in the earth sciences field. No data exist to assess LGBTQ+ representation in soils-related sciences or professional societies, such as SSSA. In soils-related federal employment, 2.7% of the USDA workforce identified as LGBT, and 84.4% identified as heterosexual or "straight" (Office of Personnel Management, 2015). These data are not sufficient, as 13.0% of surveyed USDA employees preferred not to respond, and not all employees responded to the question, providing an incomplete view of LGBTQ+ representation in soils-related fields. Self-selection of survey participants is a primary issue with many of these surveys, and therefore the results may not fully reflect the attitudes or participation of LGBTQ+ people in STEM.

Disabled people can face significant bias in science (Atchison & Libarkin, 2016). Of the non-institutionalized U.S. population between 18 and 64 yr of age, 10.6% have one or more types of disability, including hearing, vision, cognitive, ambulatory, self-care, and independent living challenges, among others (Taylor, 2018). Data available from the National Science Foundation (NSF) reports that 7.9% of employed US scientists and engineers within the biological, agricultural, and environmental life sciences reported one or more disabilities (NSF & NCSES, 2015). Data on disabled people within soil science specifically is lacking. We do not know how many disabled people work within the discipline nor what type(s) of disabilities are represented. These data are critical to identifying and removing the barriers to accessibility in soil science.

The international student population in the U.S. has been growing steadily since the 1950s and constitutes a significant proportion of higher education students, contributing $45 billion to the U.S. economy (Institute of International Education, 2020). International students represent 12% of all master's degrees and 26.7% of doctoral degrees earned in the United States (Davis, 1996), and 62% of all international students receive the majority of their funds from sources outside of the United States (Institute of International Education, 2020). However, the representation of graduate students and professionals from international backgrounds in soil science remains unclear, and more data are needed to address barriers to their success.

As STEM and the field of soil science continue in a diverse world, we must recognize and address the needs of the whole person, not just one aspect of their identity (Miriti, 2020). Strategies to enhance diversity in STEM from an intersectional perspective (Armstrong & Jovanovic, 2017; Núñez, Rivera, & Hallmark, 2020) will continue to provide insight to the soil science discipline and SSSA to formulate new approaches for fostering diversity.

5 | ACTIONS FOR IMPROVING AND ENCOURAGING DIVERSITY AND INCLUSION IN SOIL SCIENCE

Increasing diversity, equity, and inclusion in soil science is a matter of social justice. We call on all soil scientists to actively engage in anti-racist, anti-misogynistic, and anti-exclusionary actions at the individual, institutional, and societal level. We urge soil scientists to reflect on their spheres of influence within their institutions and commit to the necessary path forward at each of these levels of engagement (sensu Schell et al, 2020). Scientific associations, in particular, have the opportunity to lead cultural and structural change in the discipline (Marín-Spiotta et al., 2020). In the geosciences, two recent petitions led by the community outline important steps for societies and agencies to commit to breaking down many of the barriers to equitable participation (https://www.change.org/p/geoscientists-call-for-a-robust-anti-racism-plan-for-the-geosciences and https://notimeforsilence.org/).

5.1 | Individual actions

- Reflect on your role within soil science and commit to building an anti-racist research group (Chaudhary & Berhe, 2020).
- Acknowledge racism and colonialism in soil science and educate students by developing and implementing an anti-racist pedagogy.
- Learn the history of the land in which your institutions and field sites reside, and discuss the history with your trainees, employees, and students.
- Encourage, support, and fund research and travel for undergraduate students from historically marginalized communities.
- Support students in their efforts to foster community through outreach activities, networking, and social media.
- Promote the scholarship of minoritized scientists, through collaborations, citations, invitations as keynote speakers, panelists, and symposia organizers.
- Be a publicly open ally for minoritized scholars.
- Acknowledge intersectionality. For example, the experiences of LGBTQ+ who identify as white and cis-gender are not equivalent to the experiences of BIPOC queer and transgender people.
- Intentionally work to hire, promote, and retain diverse faculty.
- Provide and participate in professional development focused on inclusivity for disabled students.
- Collaborate with research partners from international and Indigenous communities.
- Fulfill formalized obligations through the United Nations Rights of Indigenous Peoples (UNDRIP) (Wilkinson et al., 2020).

5.2 | Institutional response and actions

- Build relationships with and recruit from community colleges, tribal colleges, and HBCUs.
- Partner with organizations already working to represent underserved communities such as National Black Farmers Association, Indigenous Food & Agriculture Initiative, the Native American Agricultural Fund, the Latino Farmers & Ranchers Association, Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS), and the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS).
- Provide accommodations that ensure inclusive pathways into soil science careers for diverse individuals while challenging social perceptions of ability (Atchison & Libarkin, 2016).
- Fairly compensate public engagement, outreach, and labor intended to increase diversity and improve workplace climate.
- Redesign evaluation and promotion processes to value contributions to diversity, equity, and inclusion (DEI).
- Mandate that all scholars contribute to DEI efforts. Do not rely on volunteers or untenured faculty to perform the institutional work that helps the university, department, or college appear more diverse than it really is.
- Recognize the discriminatory nature and unnecessary hurdles of requiring internships for graduation. Provide paid internships for first-generation and under-represented students.
- Acknowledge and address the different educational needs of BIPOC students and scholars.

5.3 | Scientific society-level response and actions

- Adopt a public statement of values around the society's commitment to diversity, equity and inclusion.
- Evaluate current practices in all society activities, including membership recruitment, grants, awards and honors, meeting planning, selection of journal review boards, society leadership, granting boards, and subdivision chair positions.
- Diversify membership of society leadership roles and all society committees.
- Implement DEI plenary sessions with no other concurrent sessions at national conferences to send a nonverbal message that DEI is a high priority.
- Do not organize society-level meetings and events in states and territories that have Religious Freedom Restoration Acts that allow businesses and private organizations to discriminate against members of the LBGTQ+ community on the grounds of religious objections.
- Fund and conduct systemic studies of society and workplace climate to evaluate and address barriers to participation specific to the society.
- Provide mentorship and funding for recruitment programs aimed at showcasing soil science disciples to historically underserved high schools (e.g., SSSA's Gateway Scholars program).
- Include leadership and senior society members on DEI committees, rather than relying only on early career researchers or POC, who have the most risk and may face reprisals for raising concerns.
- Normalize DEI work by deliberately mainstreaming it into all actions, processes, and policies of the society, rather than viewing the work as "additional."

6 | TOWARDS A DIVERSE AND INCLUSIVE SOIL SCIENCE COMMUNITY

First and foremost, building a diverse and inclusive scientific community is a moral imperative. Our soil science community should strive to achieve this DEI goal because it is the right thing to do. We also acknowledge that, in addition to being end goals of their own, diversity and inclusion lead to more creative ideas, more productive teams, and greater scientific innovation (Hofstra et al., 2020; Nielsen, 2014; Page, 2017). In fact, scientific contributions from minoritized scientists are more novel and innovative than their non-minoritized counterparts, but these ideas are disproportionately devalued or discounted in scientific discourse (Hofstra et al., 2020). They also play a disproportionate role in advancing diversity and inclusion in the field (Jimenez et al., 2019). We do not suggest that we should address the lack of representation in soil science only for scientific gain or improvement—it is a moral imperative to serve all people with equitable science practices. Despite this, members of historically marginalized communities are not well supported within the field of soil science.

As scholars, educators, and managers of the soil, our work is universally relevant. Soils are an integrated part of lived-in landscapes that are grounded in the varied perspectives and expertise of those who manage, study, and live within them. Soils are also central to addressing environmental degradation, a global crisis that continues to disproportionately affect historically marginalized communities and the diverse global population that depends on soil for food, nutritional security, and climate change mitigation (Berhe, 2020). More still, the demographics of the United States are changing toward a more diverse, majority–minority population in the coming decades (Colby & Ortman, 2015). We need a diverse soil science workforce to effectively prioritize and implement critical resource management to serve the growing human population. We cannot address the grand environmental challenges that lie ahead of us while representing the communities we are here to serve without the diverse representation of ideas and lived-experiences in the soil science discipline. We call on all soil scientists to join us in creating a more just and equitable soil science to better serve and protect soils and humanity.

ACKNOWLEDGMENTS

The authors thank Beth Jacques and Susan Chapman at ASA–CSA–SSSA membership services for their timely, helpful responses to all data requests. E.M.S. and A.A.B. acknowledge support from NSF HRD 1725879 and 1725650. We recognize and thank the countless individuals who walked this path before us, paving the way for equity and the strength to voice our concerns. The authors acknowledge that this examination of diversity in soil science is in no way complete. Data are lacking for several dimensions of diversity, including gender, sexual orientation, gender identity, persons with disabilities, and socioeconomic status, among others. The data and discussion presented here, though incomplete, are meant to serve as a critical starting point for further discussions and analyses about how our academic and professional community can equitably serve all members of our global society. We acknowledge that identity categorization is a complex topic with changing definitions over time. Here we use consistent terminology for clarity and recognize that some readers may prefer different terms.

AUTHOR CONTRIBUTIONS

Tiffany L. Carter: Formal analysis; Writing-original draft; Writing-review & editing. Lydia L. Jennings: Conceptualization; Writing-original draft; Writing-review & editing. Yamina Pressler: Conceptualization; Writing-original draft; Writing-review & editing. Adrian C. Gallo: Conceptualization; Writing-original draft; Writing-review & editing. Asmeret Asefaw Berhe: Conceptualization; Writing-original draft; Writing-review & editing. Erika Marín-Spiotta: Conceptualization; Writing-original draft; Writing-review & editing. Christopher Shepard: Conceptualization; Writing-original draft; Writing-review & editing. Teamrat Ghezzehei: Conceptualization; Writing-original draft; Writing-review & editing. Karen L. Vaughan: Conceptualization; Writing-original draft; Writing-review & editing; Project Administration.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ORCID

Asmeret Asefaw Berhe https://orcid.org/0000-0002-6986-7943

Karen L. Vaughan https://orcid.org/0000-0002-9787-2766

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Carter TL, Jennings LL, Pressler Y, et al. Towards diverse representation and inclusion in soil science in the United States. *Soil Sci Soc Am J*. 2021;*85*:963–974. https://doi.org/10.1002/saj2.20210