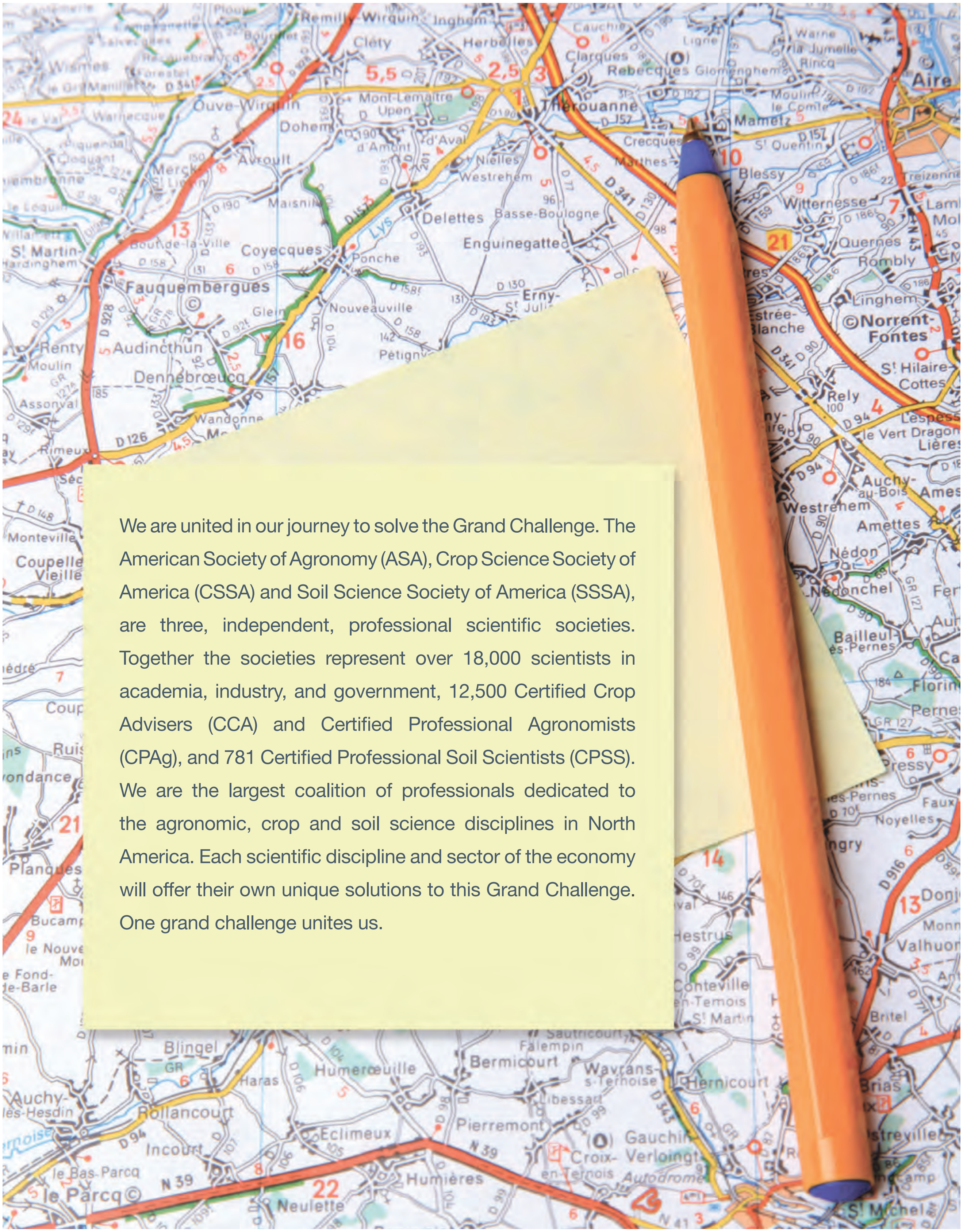
Soils: The Foundation of Human and Environmental Health

SOIL SCIENCE SOCIETY OF AMERICA



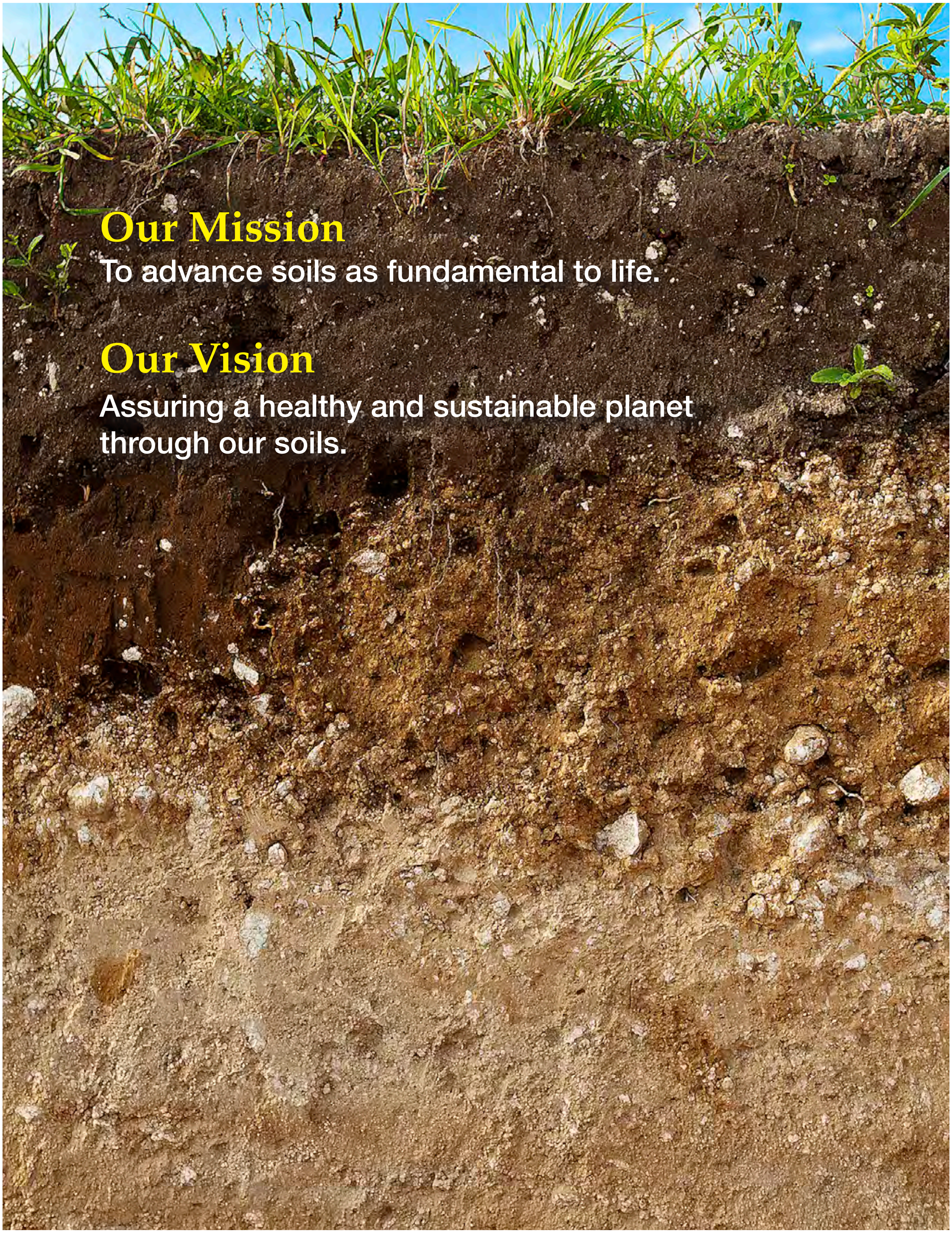
We are united in our journey to solve the Grand Challenge. The American Society of Agronomy (ASA), Crop Science Society of America (CSSA) and Soil Science Society of America (SSSA), are three, independent, professional scientific societies. Together the societies represent over 18,000 scientists in academia, industry, and government, 12,500 Certified Crop Advisers (CCA) and Certified Professional Agronomists (CPAg), and 781 Certified Professional Soil Scientists (CPSS). We are the largest coalition of professionals dedicated to the agronomic, crop and soil science disciplines in North America. Each scientific discipline and sector of the economy will offer their own unique solutions to this Grand Challenge. One grand challenge unites us.

The Grand Challenge

The United Nations estimate the global population will increase to 9.8 billion by 2050, requiring at least a 50 percent increase in production to meet the demands of this population. Our challenge is to sustainably increase production of nutritious food, fiber, and reliable sources of energy while protecting shared water, soil, and air resources in shifting and increasingly uncertain climatic and socio-political conditions.

The Grand Challenge is to sustainably improve the human condition for a growing global population in a changing environment.

This report lays out a vision and recommendations that will enable innovative, science-based solutions and address critical funding and infrastructure needed to achieve solutions.



Our Mission

To advance soils as fundamental to life.

Our Vision

Assuring a healthy and sustainable planet through our soils.

Science Frontiers

The Soil Science Society of America promotes science-based solutions to solving many of our local and global challenges in managing the natural resources that support life. These science frontiers identify the most promising opportunities in the next decade to help solve the grand challenge.

Judiciously managed and properly restored, world soils have the capacity to grow adequate and nutritious food for present and future populations.

Food, Energy, And National Security Through Soil Education

Healthy soil is a key to national security. Food and water security are tied to political stability on a global scale. Degraded soils are associated with reduced quantity and quality of food, water supplies, and environmental health. Increasing risks of food insecurity are also related to higher global energy demand, which is expected to increase by 50 percent by 2030. Decline in crop yields and agronomic production exacerbate food-insecurity that currently affects 854 million people globally. Low concentrations of protein and micronutrients aggravate malnutrition and hidden hunger that affects 3.7 billion people, disproportionately children.

There is a clear relationship between an increasing population and soil degradation. Soil degradation is caused by biophysical, social, economic and policy factors. To eradicate hunger, global food production must be steadily increased by 2 percent per year. To eradicate malnutrition, soil quality must be restored sooner than later, especially in highly populated developing countries. Judiciously managed and properly restored, world soils have the capacity to grow adequate and nutritious food for present and future populations. Innovative technologies exist to bring about a quantum jump in food production, especially in developing countries.

The development and adoption of these tools, relies on infrastructure, support services and political will. Educational outreach in combination with restoration of degraded soils and ecosystems are needed to promote improved food and water security. Promotion of conservation production systems is especially needed to facilitate food security and stability in developing countries. Conservation agriculture will maximize soil ecosystem services by increasing soil carbon reserves. Soil security provides economic security, promotes public health, and offers climate change adaptability for a fraction of the cost of other types of initiatives.

Climate Change and Soil Processes

Soils are intricately linked to atmospheric-climate system through the carbon, nitrogen, and hydrological cycles. In fact, soils and soil disturbance are a major source of greenhouse gas (GHG) emissions, including methane, nitrous oxide and carbon dioxide. Simultaneously, soils may provide a sink for GHG. Altered climate will, therefore, have an effect on soil processes and properties, and at the same time, the soils themselves will have an effect on climate.

Carbon stored in soil as soil organic matter is critical for improved soil structure, fertility, water storage and purification. These factors also promote soil health and food security. Changes in precipitation amount and distribution affect critical processes of the soil-plant system. Soil erosion by wind and water will increase as rainfall intensity increases or as drought occurs. Increasing soil organic matter can mitigate both of these impacts. Nitrous oxide emissions from excessive nitrogen fertilizer application and methane production from various agricultural production practices are the largest components of agricultural greenhouse gas emissions. Greater precipitation variability and higher temperatures will enhance greenhouse gas emissions and complicate mitigation management.

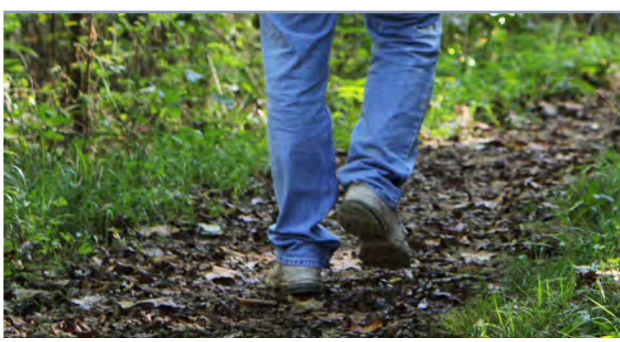
Our challenge is to understand how climate change will influence the complex interactions that control the role of soils in mitigating greenhouse gas emissions. We need to elucidate biological and geochemical soil processes controlling carbon and nitrogen transfers from managed ecosystems and implement practices to reduce emissions and increase carbon capture.

Healthy Soils, Healthy People

A healthy soil functions as a vital living ecosystem that sustains plants, animals and humans. Soils host a quarter of the world's biodiversity and have provided tools for medicines and antibiotics. Soil is both the source of and a means to eliminate disease. Exploration of the life cycle and management of soil-borne pathogens can help reduce food contamination and improve human health. Yet only a small fraction of soil microbial communities has been studied.

There is a need to harness the microbial diversity in soils for the development of new pharmaceuticals. We need to understand soil's capacity to treat and deactivate pathogens in waste materials and contaminated waters.

Soil is resilient if it is nurtured. Managing for soil health can be accomplished by disturbing the soil as little as possible, adding organic matter, growing diverse species of plants, eliminating practices that cause salinization, and keeping the soil covered all the time. There is a critical need to improve our understanding of the mechanisms to control soil health and to prevent soil degradation from inappropriate agricultural practices, such as overgrazing, deforestation, pollution, and expanding urban areas.



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Soil and Water Quality

Soil and water are vital resources in urban, agricultural, and natural ecosystems. Healthy soils prevent water pollution by resisting erosion, absorbing and partitioning rainfall, and degrading, immobilizing, and detoxifying chemicals, wastes and wastewaters. The physical, biological, and chemical processes of soils make these improvements to water quality possible.

Soil erosion and water runoff from soils are the major pathways by which sediment, nutrients, pesticides, and other pollutants reach surface water. Nutrient laden water causes excessive blooms of algae and aquatic plants, which upon death and decomposition suffocate aquatic life.

Soil and water conservation management practices help protect water quality. However, implementation of conservation methods has often not cured our damaged water systems, due to incomplete implementation of a system of practices and lasting legacies of past management. This has led many to question the efficacy of these measures and to call for stricter land and nutrient management strategies, but this in part reflects the complexity of managed ecosystems. Sources of pollution in watersheds need further study in order to better target mitigation practices and enhance watershed modeling efforts related to water quality.

The increasing applications of domestic and industrial waste to soils can exceed the soils treatment capacity. Contaminated soils will degrade drinking water and reduce productivity of food crops. Properly treated wastes provide a critical tool to recycle carbon and nutrients. The challenge is to find more effective ways to manage and recycle waste in soil so as to conserve soil resources and protect the environment. We need to investigate the risks associated with soil-based treatment of waste and identify scientific solutions to managing those risks.

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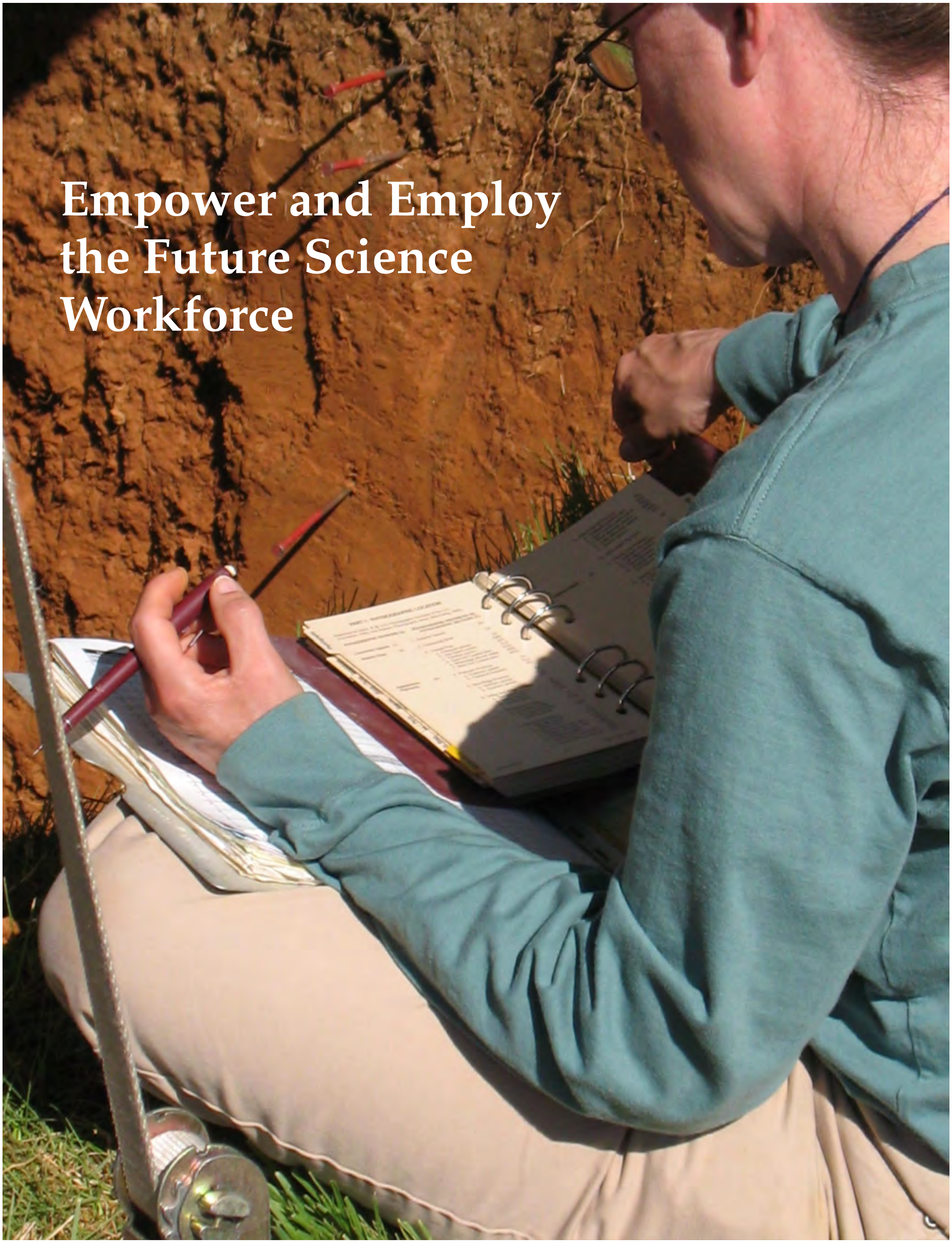
Empower and Employ the Future Science Workforce



Critical Needs

Each of the science frontiers will require cross-cutting areas of critical infrastructure to be in place.

Augment federal funding for food and agricultural science within relevant federal agencies.

The core research programs at federal research agencies, such as USDA, NSF and DOE Office of Science, from theoretical studies to innovative technology development, are fundamental to research development and essential for scientific progress. They provide the long-term foundation for new ideas that stretch the imagination, and lay the groundwork for innovations for the future. They support the maturation of new technologies needed for nearer-term small and large programs and missions. Maintaining these core activities is a high priority and budget allocations should not be allowed to decrease simply to address overruns in the costs of other programs or missions.

The success and stability of American agriculture are dividends of historic investments in research and its application. Renewed investment will help society continue to reap the rewards of future discovery and help the U.S. maintain its competitive edge around the globe. U.S. agricultural research is conducted by a system of interdependent entities: federal laboratories, universities, industry, societies and associations, NGOs and more. Agricultural innovation is necessary to meet the grand challenge and should be a priority on the U.S. international and domestic agenda.

Empower and employ the future science workforce

A diverse and robust workforce is essential if the U.S. is to face the challenges and opportunities in the food and agricultural sectors. .

Agriculture is innovating at a rate comparable to any other productive industry. It is increasingly global and information-based. There is a growing gap between the supply of new graduates trained in agriculture-related fields and the demand for professionals by global food and agriculture employers and academia. Food and agriculture industries should work closely with educational institutions to close the employment pipeline gap necessary to meet global food, agriculture and natural resources challenges.

A steadily increasing need for industry professionals outpaces the supply. For example, from January to August 2014, an average of 11,600 job ads were posted each month – and nearly 34,000 people were hired each month – in agriculture research, economics and engineering fields. Given the current state of the research workforce pipeline, life science and agricultural companies are concerned about their ability to successfully fill this workforce need.

The challenge of feeding 9.1 billion people by 2050 will only be met by boundary-breaking innovation. We need to attract the best and brightest to innovative careers in food and agriculture by communicating to them the breadth and depth of novel job opportunities available, alleviating their concerns about entering the field and identifying non-traditional places to recruit food and agriculture talent while improving diversity.

The 2012 President's Council of Advisors on Science and Technology (PCAST) report on agricultural preparedness recommended that, in order to meet the need for a diverse and competent scientific workforce on agricultural and food issues, the USDA, in collaboration with NSF, must expand a national competitive fellowship program for graduate students and postdoctoral researchers. We must empower the potential food and agriculture related workforce to seek professional level opportunities that the public and private sector offer.

Cultivate the application of innovative, science-based practices through Education and Extension

A significant part of the public good derived from agricultural research is the delivery of unbiased research-based information and education to the public. The nationwide Cooperative Extension System network, for example, is integral to the core mission of federal and state land-grant institutions. Through extension, land-grant colleges and universities bring vital, practical knowledge gained through research and education to agricultural producers, small business owners, consumers, families and young people.

New science-based information makes its way into the classroom and, through extension leadership, to people who put the knowledge into practice to improve their lives. Schools and universities educate and train the next generation of scientists, educators, producers and citizens, and prepare the workforce for a thriving economy. Extension translates the knowledge gained through research and education into innovations that provide solutions to problems people face.

On a global scale, we must improve access to and education on modern agricultural practices that will ultimately improve yield and reduce farmer risk. The role of extension in providing U.S. farmers with innovative, science-based agronomic practices may be the model best suited for use in other countries to meet global challenges that begin with enhancing food and agricultural production.

The success of American agriculture is the dividend of historic investments in research and its application.

Improve computational capabilities by integrating databases for genetic resources and agricultural research and equip a work-force trained in digital data infrastructure

Creating a digital data infrastructure that not only stores a wide range of data but is also easily and reliably searchable is a challenge faced by many scientific disciplines. Improved integration and interoperability of data resources, including genetic data bases and other scientific collections, will be fundamentally important to meet 21st century agricultural challenges.

Deeper integration of experimentation, computation, and theory, as well as the routine use of accessible digital materials data, represents a shift in the usual way research is conducted. The availability of high-quality experimental and computational data also presents an opportunity for data mining and analysis to expand and accelerate discovery of new materials and predictions of materials with new functionalities. In addition, real-time analysis of experimental data with modeling and simulation tools can enable data interpretation, guide the evolution of ongoing experiments, and provide rapid management recommendations.

Even with development of a broadly accessible data infrastructure and new tools integrating experiment, computation, theory, and data, the next generation of scientists and professionals must be able to expertly use these tools to achieve success. This challenge will be met in part through formal education in the application of this integrated approach for undergraduate and graduate students who will pursue careers in industry, national laboratories, and academia. For professionals already in the workplace, additional training may enable the widespread use of new tools and research methods. Also, before the future generation workforce can be equipped to take advantage of the digital data infrastructure, instructors must first be provided information on these new tools, research approaches, and their value.

Promote innovation through public-private partnerships

Public-private partnerships improve the capacity of researchers to address the grand challenge by bringing together the necessary experience, knowledge, investment, technologies and resources. Creating the right environment for partnerships will often require collectively addressing regulatory and legislative frameworks – including protection of intellectual property rights and science-based consideration of new technology by regulatory agencies – to turn new ideas into innovative products for farmers.

Agricultural innovations come from both public and private sector research. Research priorities for both sectors depend on a complex mix of factors, including benefits to farmers, consumers and the environment, as well as a return on research investment. By working together through public-private partnerships these two sectors can pursue unique or otherwise speculative projects to enhance the quality of life for all global citizens.

For the public sector, public-private partnerships offer an efficient way to bring timely and relevant tools to local farmers, while helping to build agricultural knowledge at a local level. For the private sector, collaboration provides a necessary innovative approach to meet financial and resource constraints. As a result greater innovation can be put in the hands of our world's farmers to meet the grand challenge facing us in the near future.

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Science Policy Office | 900 2nd Street, NE, Suite 205
Washington, DC 20002 | 202.408.5558
sciencepolicy@sciencesocieties.org
www.soils.org

Soil Science Society of America