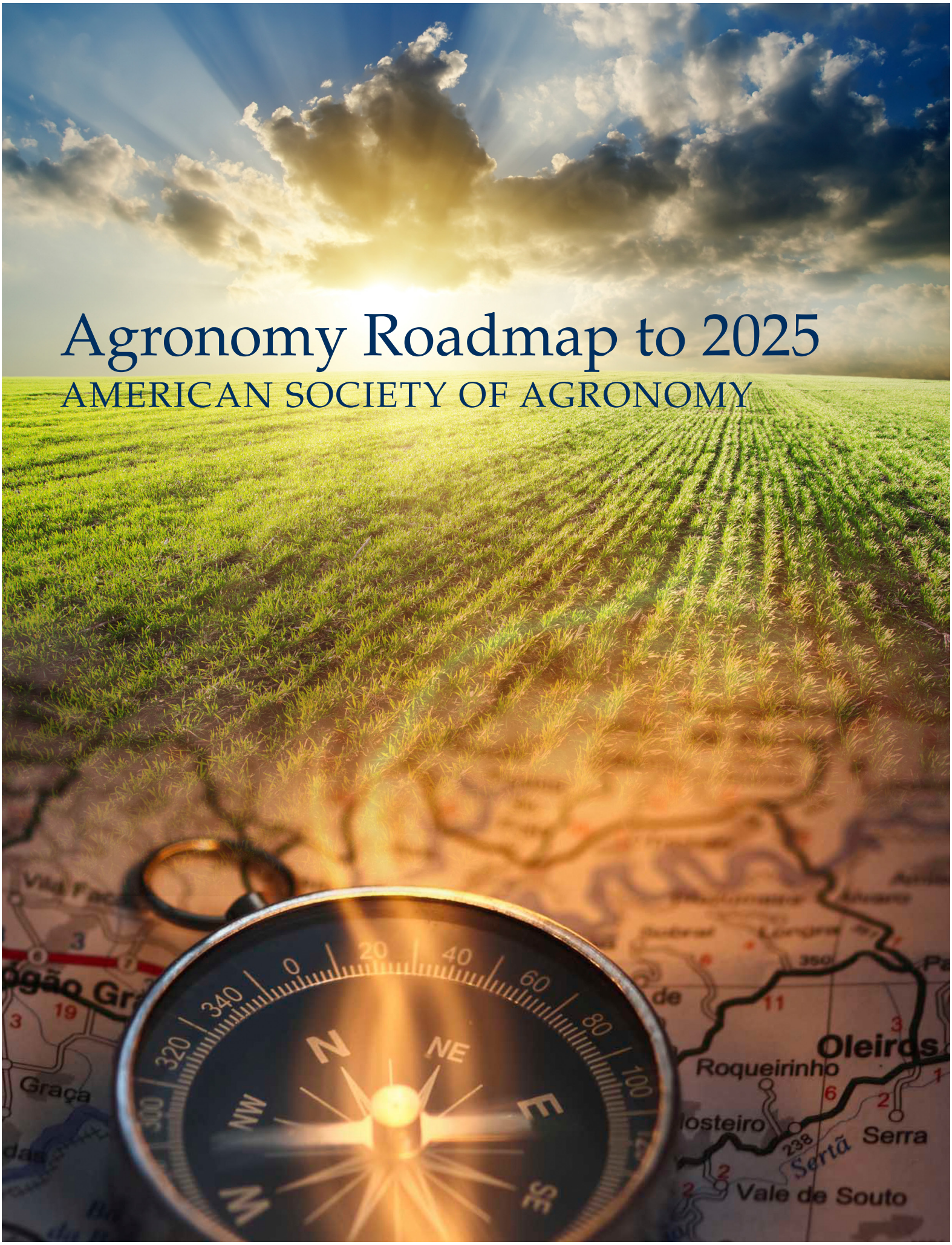
Agronomy Roadmap to 2025
AMERICAN SOCIETY OF AGRONOMY
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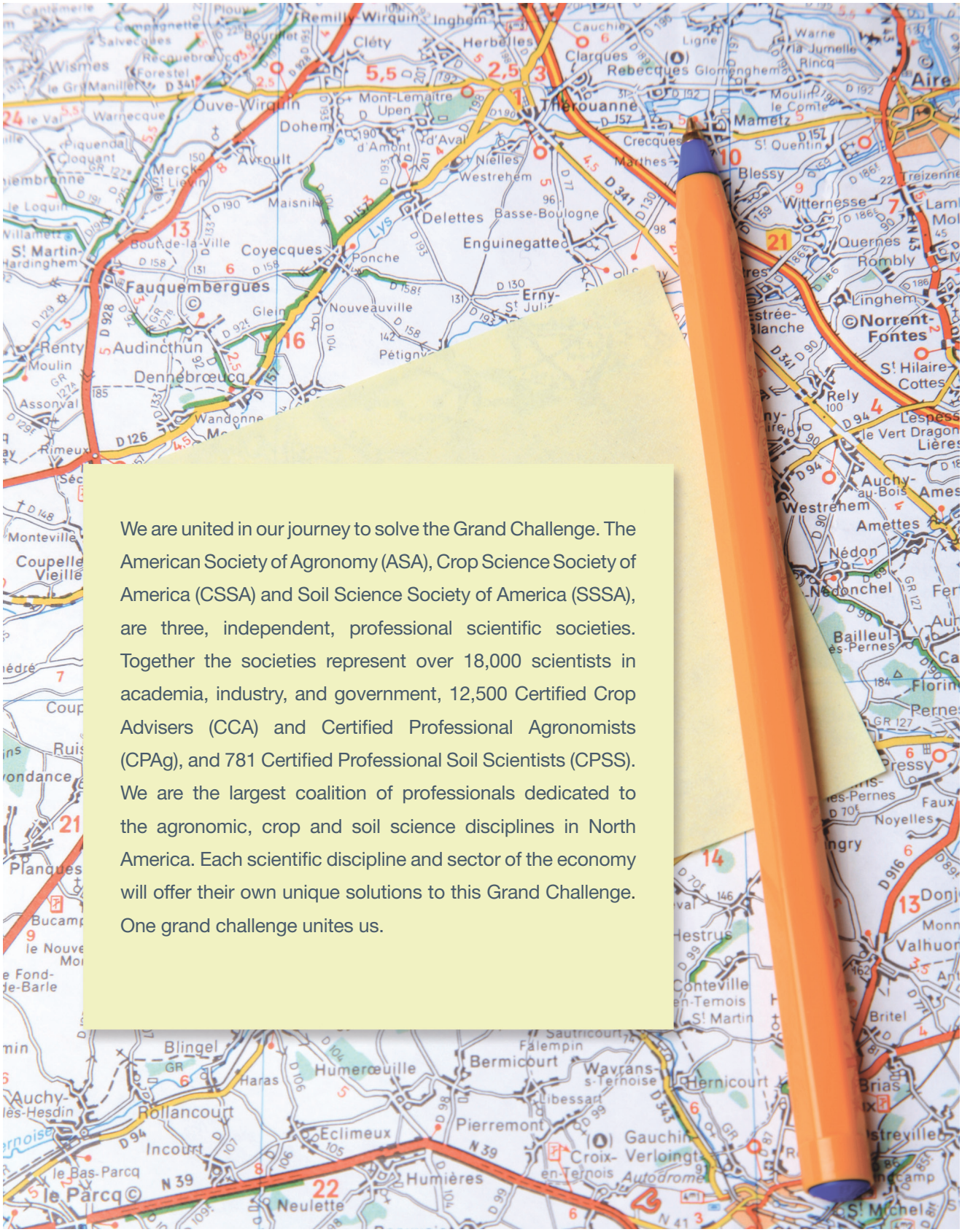


We are united in our journey to solve the Grand Challenge. The American Society of Agronomy (ASA), Crop Science Society of America (CSSA) and Soil Science Society of America (SSSA), are three, independent, professional scientific societies. Together the societies represent over 18,000 scientists in academia, 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 9.1 billion by 2050, requiring at least a 70 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

Knowlege to Feed and Sustain the world.

## Our Vision

ASA members will integrate and apply science to sustainably double agronomic production.

# Science Frontiers

The American Society of Agronomy promotes science-based solutions to solving many of our local and global challenges in managing the natural resources that support life. The following science frontiers identify the most promising opportunities in the next decade whose investigation will establish a foundation of information that will propel the scientific discipline beyond the current state of knowledge while addressing the grand challenge.

## Sustainable Intensification

The goal of sustainable intensification is to increase food production from existing farmland while minimizing pressure on the environment. This is a response to the challenges of increasing demand for food from a growing global population, in a world where land, water, energy and other inputs are in short supply, overexploited and often used unsustainably. Any efforts to 'intensify' food production must be matched by a concerted focus on restoring ecosystem processes and functionality within the landscape. Failing to do so will undermine our capacity to continue producing food in the future.

*Any efforts to 'intensify' food production must be matched by a concerted focus on restoring ecosystem processes and functionality within the landscape.*

Agricultural crops convert air, sunlight, water, and available plant nutrients into food, feed, fiber, and fuel. They also remove nutrients such as nitrogen, phosphorus, and potassium from water and soil. These same nutrients, if not applied according to sound agronomic principles, can negatively impact the environment, affecting air, soil and water quality. Nitrogen fertilizer is limited in supply because of its energy-intensive production process. Phosphorus and potassium are also limited because they are extracted from finite geologic deposits.

Water resources for irrigation are also often limited. Therefore, future food security and environmental quality will depend on improving the efficient use of nutrients and water, while also enabling a continuation of rapid increases in crop yields on land currently in production.

## Enhancement of Ecosystem Services Provided by Agriculture

Agriculture is multifunctional; it is both dependent on and can be complementary to ecosystem functions that produce goods. The study of natural and managed ecosystems, including agroecosystems, has shown that these systems provide services that generate goods essential to life.

Ecosystem goods include clean air, water, soil, diverse plant and animal species, and wildlife habitat. Through agricultural and plant production, soil can provide multiple services that include food, feed, fiber, and fuel production, as well as carbon storage, erosion control, plant growth, nutrient cycling, and water filtration and storage. Improving and maintaining soil quality through proper management and care of soil is critical for the production of these goods.

While ecosystem services are difficult to value monetarily, they have intrinsic value because they produce goods that support our health and economy. As society realizes the value of these services and goods, new ecosystem service markets are developing. To ensure that these markets are based on sound science, it is critical to understand the multifunctional relationships occurring in major agroecosystems in order to enhance the ecosystem services that can be provided.

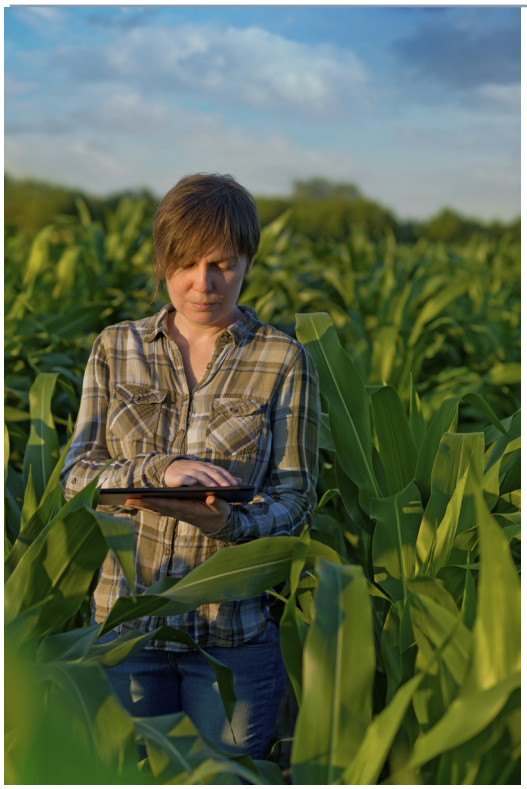
*While ecosystem services are difficult to value monetarily, they have intrinsic value because they produce goods that support our health and economy.*

## Socially and Economically Viable Agriculture Systems

Agricultural systems are the foundation of human health, economic development and political stability. The viability of any farming system depends largely on its ability to contribute to the economic security of the key actors in the farm and food system. Socioeconomic complexities tied to agricultural sustainability, including contribution of farming to community well-being, and food adequacy, food quality, and distributional equity issues. Productive and sustainable agricultural systems will be achieved through high-quality, interdisciplinary, and integrated research, continuing education, extension, and application.

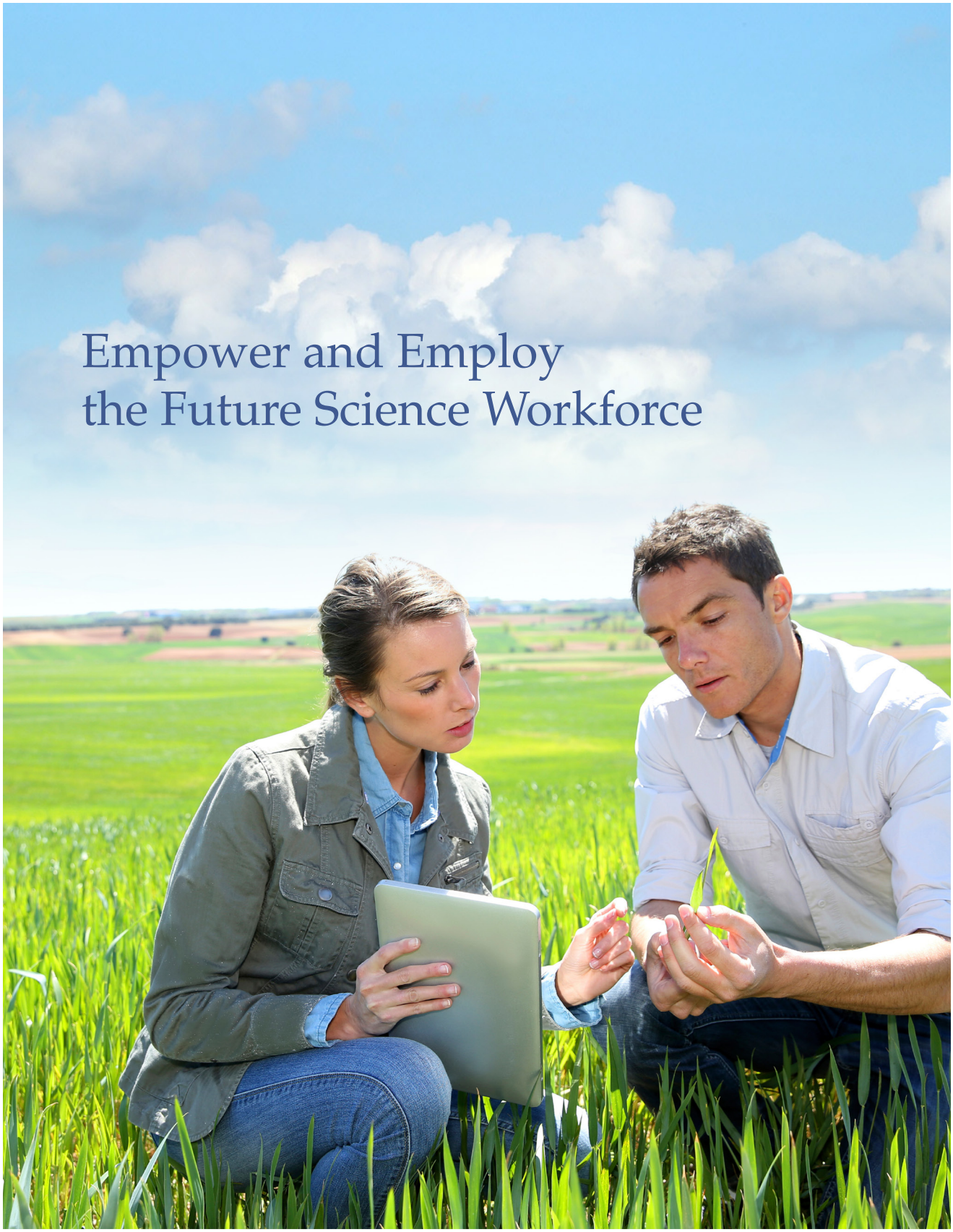
U.S. farmers are under pressure to satisfy multiple, often competing demands, such as increase crop yields with fewer inputs, fulfill consumer preferences, and make a living—all with increasingly scarce natural resources such as land and water. To evolve farming systems that meet all of these demands, national agricultural policy, research programs, and food markets will need to develop a more holistic perspective of how farms provide benefits to society.

This goal can be reached through two parallel efforts: an incremental approach, in which ongoing endeavors to develop agricultural techniques that are more efficient; increase productivity and enhance landscape quality; and a transformative approach, in which multiple research areas are brought together to design new innovative farming systems that balance the competing demands on sustainability.



*Productive and sustainable agricultural systems will be achieved through high-quality, interdisciplinary, and integrated research, continuing education, extension, and application.*

# 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, agricultural and natural resources 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 thepublic and private sector offer.

## Cultivate the Application of Innovative, Science-based Agronomic 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.

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.

*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 Workforce 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.

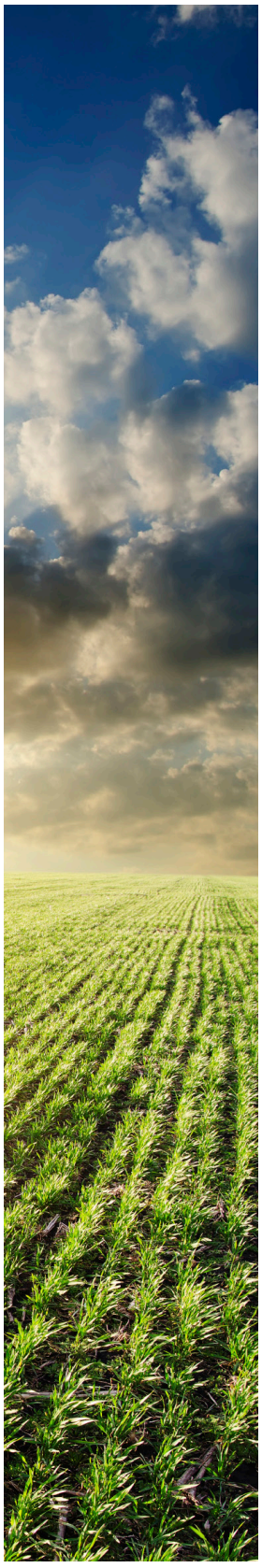
Deeper integration of experimentation, computation, and theory, as well as the routine use of accessible digital materials data, represents a shift in the usual way research is conducted. The availability of high-quality experimental and computational data also presents an opportunity for data mining 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 Partnerships between the Public and Private Sectors

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.



# Agronomy Roadmap to 2025

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May 2015
Photos: istock