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PROGRAM INTRODUCTION

Soil health: model programs in the USA

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Abstract Population growth, increasing drought, and natural resources degradation are significant global issues. Fortunately, management practices to improve soil health can address many of these issues in ways that are both good for the farmer and the environment. In 2012, the United States Department of Agriculture (USDA) Natural Resources Conservation Service initiated its "Unlock the Secrets in the Soil" campaign to assist farmers and ranchers with adopting soil health systems. Other notable efforts at the federal level include research and education projects by USDA Agricultural Research Service, National Institute of Food and Agriculture, and Sustainable Agriculture Research and Education program. The importance of improving soil health is also recognized far beyond federal government programs. The Soil Health Institute, a nonprofit charity, was established to safeguard and enhance the vitality and productivity of soil through scientific research and adoption. Crop commodity organizations are promoting soil health, such as the Soil Health Partnership. The Nature Conservancy is helping companies and private landowners incorporate soil health into their sustainability efforts. Such efforts are supported by the Foundation for Food and Agriculture Research, as well as by some of the leading global food companies such as General Mills. These are just a few of the many efforts to improve soil health in the USA. The significance of the expanding global population, natural resource challenges, and responsibilities to current and future generations truly make enhancing soil health a global imperative.

Keywords carbon sequestration, climate change, environmental quality, farmer programs, water quality

1 Introduction

The world population is predicted to grow by another two billion by 2050, yet many of the soils on which we rely to grow food have lost about half of the basic building block that makes them productive (i.e., organic matter). At any given time, about 1% of farmland in the world is under drought, yet this is predicted to expand to 30% by 2100. Degradation of natural resources is occurring worldwide, with nutrient and sediment contamination of waterbodies, along with loss of pollinators and other wildlife and their habitats. Time is short for addressing these issues that impact all the people of the world. Fortunately, the concept of soil health is one of those rare win-win opportunities where management practices to improve soil health are not only good for the farmer, but also for the environment.

Soil health is often defined as the continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals and humans. Such functions include infiltrating rainfall, providing nutrients and water to plants, cycling and sequestering carbon, decomposing and filtering contaminants, suppressing plant diseases, and others. Accordingly, soil health is a holistic concept, owing to the many chemical, physical and biological properties of soil, as well as to the many processes occurring in soils and the functions they provide.

Although, the importance of soil health has been recognized for millennia by those who manage land, it has

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recently received elevated attention and renewed importance in the USA. This importance is now recognized globally. The following are examples of soil health programs developed and implemented by government and non-government organizations in the United States.

2 United States Government Programs

2.1 USDA-NRCS

Perhaps the greatest influence in the US soil health movement has been the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS). This influence began in the 1930s with a focus on reducing soil erosion. In 1935, the United States Congress passed a law recognizing that "the wastage of soil and moisture resources on-farm, grazing, and forest lands...is a menace to the national welfare," and it directed the Secretary of Agriculture to establish the Soil Conservation Service as a permanent agency in the United States Department of Agriculture (USDA). In 1994, its name was changed to the Natural Resources Conservation Service (NRCS) to better reflect the broadened scope of the agency's focus. NRCS provides voluntary, incentive-based technical and financial assistance to advance conservation adoption on working lands through their conservation planning process.

In 2012, NRCS officially launched an "Unlock the Secrets in the Soil Campaign" that included strategic media efforts for delivering core messages to raise awareness and drive adoption, including:

- Healthy soils are high-performing, productive, resilient soils;
- Healthy soils save money, improve land conditions, and help landowners generate income; and
- There are many on-farm and off-farm environmental and wildlife benefits associated with improving soil health.

This campaign generated very strong interest in soil health from farmers, ranchers, environmental groups and others. Recognizing that training was needed for its field staff and stakeholders, NRCS then established a national "Soil Health Division" with employees strategically positioned around the USA to increase the ability of the NRCS to provide locally relevant training and assistance to farmers, field conservationists, soil and water conservation districts, and many others based on the latest soil health science. Four soil health management principles were developed that can be applied across production systems, climates and scales. Their broad applicability is a reason why these four principles continue to be used effectively today in training programs and in working with a diversity of landowners, namely:

- minimize disturbance,
- maximize soil cover,
- maximize the presence of living roots, and
- maximize biodiversity.

An example of "minimize disturbance" is no-tillage, "maximize soil cover" and "maximize the presence of living roots" can be achieved with cover crops, and "maximize biodiversity" can be achieved with different mixes of cover crops and through crop rotation. While some groups explicitly add "integrate livestock" as a fifth principle when such an option is available for a farmer, livestock integration is also included in "maximize biodiversity" to ensure the principles remain broadly applicable for all situations. These are generally the same principles advocated for achieving a more regenerative agriculture.

NRCS has since integrated new and updated soil health resource concerns into its conservation planning process, is rolling out technical and financial assistance on soil health testing and management planning, and is updating all relevant conservation practice standards to enable their effective use to address soil health problems across the country. NRCS collaborates with and financially supports diverse partners across the country on quantifying soil health status, establishing technical guidance on how to design and implement soil health management systems, and quantifying and communicating outcomes such as economic benefits to producers, and environmental benefits to society of high functioning soil health management systems. NRCS continues to promote soil health to stakeholders, customers and the general public.

Other highly notable efforts by the US government include programs ranging from basic to applied research led by USDA Agricultural Research Service and the National Institute of Food and Agriculture, along with on-farm research and education projects led by USDA Sustainable Agriculture Research and Education program. Detailed information on programs of the Agricultural Research Service and National Institute of Food and Agriculture can be found on their websites, while the Sustainable Agriculture Research and Education program is briefly described below.

2.2 USDA-SARE

The Sustainable Agriculture Research and Education (SARE) program is a grants and outreach program funded through the USDA National Institute of Food and Agriculture. Most SARE funding is distributed to universities, nonprofit organizations, farmers and ranchers through competitive grants. The SARE Outreach arm also has a major role for the program, having published over 30 books and bulletins, dozens of fact sheets and pamphlets, and produced a large variety of videos and web-based information.

The SARE program started funding competitive grant projects on various aspects of soils from the beginning of the program in the late 1980s. The first major publication related to soil health was the book *Managing Cover Crops Profitably*, first published in 1992. That book has now gone through three editions, has sold over 50000 print copies, and at least an additional 50000 copies have been distributed for free in electronic formats. Over the years, SARE has also funded about 1000 competitive-grant projects involving cover crops and hundreds of additional projects on other aspects of soil health. The motivation for the SARE program to work on soil health has been driven by the interest of farmers and ranchers in this topic, particularly producers focused on improving the sustainability and resiliency of their operations. Farmers and ranchers are part of the national, regional and state leadership structure of SARE who also participate in reviewing grants submitted to the SARE program.

Each of the various SARE grant programs includes opportunities for grantees to receive funding for soil health projects. Some of those projects are research focused, others are specifically education projects with producers, and some are professional development training for agriculture educators. Farmers and ranchers also receive direct grant funding from SARE to try new approaches on their own farms, with cover crops and soil health being popular subjects. Typically, over 50 soil health related projects are funded by SARE each year across the USA. Those projects are conducted by university researchers, extension educators, agency staff, nonprofit staff, and some directly by farmers and ranchers.

The SARE Outreach program addresses a wide range of sustainability topics, but cover crops and soil health have been the single biggest area of activity for the program in recent years. Some examples of current or recently completed activities include:

•National bulletin, *Cover Crop Economics*, a 24-page report released in June 2019 with several thousand copies already distributed.

•A revised fourth edition of the SARE book, *Building Soils for Better Crops: Sustainable Soil Management*, to be completed in 2020.

•A series of 12 fact sheets on cover crop ecosystem services was recently completed and published through SARE.

More information on these resources and other USDA-SARE programs can be found on the SARE website.

3 Non-Government Organizations

3.1 Soil Health Institute

In 2013, the Samuel Roberts Noble Foundation and the Farm Foundation convened leaders from agricultural industry, farms, ranches, government agencies, and non-government organizations to examine the current state of global soil health and its roles in vibrant, profitable and sustainable ecosystems. As the group identified diverse and complex issues regarding soil health, it became clear that a collaborative organization was needed to promote accurate, science-based information, create a sense of urgency and coordinate leadership. Thus, the Noble Foundation and the Farm Foundation created the Soil Health Institute as a nonprofit organization to safeguard and enhance the vitality and productivity of soil through scientific research and advancement. To achieve this mission, the Institute works with many stakeholders to identify gaps in research and adoption; develop strategies, networks and funding to address those gaps; and ensure beneficial impact of those investments to agriculture, the environment and society.

The Soil Health Institute has developed and implemented a comprehensive, strategic approach to address priorities for advancing adoption of soil health systems. This comprehensive strategy includes assessing the business case for farmers and ranchers, developing a widely applicable soil health measurement program, providing locally relevant farmer training, conducting priority research and development, quantifying impacts of adoption, informing policies and educating consumers.

Assessing the business case includes conducting partial budget economic analyses on about 125 farms and 124 long-term agricultural research sites. It also includes evaluation of yield stability as a surrogate for economic risk.

To identify and recommend the most effective measurements of soil health, the Institute is assessing over 30 soil health measurements at these long-term agricultural research sites across the USA, as well as Canada and Mexico. This is the most comprehensive, strategic assessment of soil health measurements known to exist. Details on the overall strategy, specific measurements and associated methods are described in Norris et al.[1]. The farmer training program involves establishing local learning networks co-led by farmer mentors and technical specialists who not only provide the training but are also continuously engaged as a resource to other farmers.

Priority research and development projects include developing a decision support tool for farmers to assist with building drought resilience in their soils, exploring the connections between soil health and human health, and understanding/managing the soil microbiome. The Institute is also assessing the impacts of soil health system adoption on productivity, carbon sequestration, greenhouse gas emissions, and water quality. These efforts help ensure that the Institute can provide evidence-based information to policymakers.

The Soil Health Institute believes that educating consumers about the many environmental benefits that accrue through soil health will create more market demand for food, fiber and fuel grown using soil health systems. Consequently, the Institute has developed and released the documentary *Living Soil* describing how innovative farmers across the USA are using soil health practices to improve their economic situation and benefit the environment, lesson plans and resources for students, and additional resources for farmers and consumers.

3.2 Soil Health Partnership

The Soil Health Partnership was established in 2014 when The Nature Conservancy (TNC), Bayer, the Environmental Defense Fund, and the National Corn Growers Association shared the vision of developing a farmer-led research network which measured the impacts of implementing soil health practices on working farms. The Soil Health Partnership is administered through the National Corn Growers Association and serves as their flagship sustainability program.

In partnering with farmers, supply chain companies, non-government organizations and government agencies, the Partnership aims to increase wide scale adoption of soil health practices across the USA by working side-by-side with farmers as they implement new soil health management practices with the goal of improving soil health. This involves collecting on-farm data over time that enables farmers to improve economic and environmental sustainability today and for generations to come.

An important aspect of the Soil Health Partnership approach is a team of nine experienced field managers that work together with farmers in their respective regions, coordinating testing, measurement and advancing progressive farm management practices that will enhance sustainability and farm economics.

The Partnership measures basic soil nutrients and soil health indicators throughout the multi-year trials. This process is creating an in-depth data set to support farmer decisions and to understand the long-term changes in soil health. The Partnership looks for impacts on yield, input use, and farmer profitability. They examine the near-term risks associated with adoption of practices, and long-term risk reduction and increased resiliency that comes from these soil health-promoting practices.

The Soil Health Partnership network currently spans over 16 states in the USA (Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Tennessee and Wisconsin) and continues to grow.

3.3 The Nature Conservancy

Recognizing that soil health is not only good for farmers but also for the environment, several environmental organizations are also working to advance soil health. Notably, The Nature Conservancy (TNC) is leading efforts to encourage landowners to assist their land managers with adopting soil health systems. A major collaboration among the Soil Health Institute, Soil Health Partnership, and TNC is supported by the Foundation for Food and Agriculture Research, as well as by one of the leading global food companies, General Mills.

TNC is a global environmental nonprofit working to create a world where people and nature thrive. TNC has over a million members and a diverse staff of over 400 scientists, working to impact conservation in 79 countries and territories across six continents.

In North America, the Conservancy is collaborating with farmers, ranchers, government agencies, agribusinesses, food supply chain businesses and others to sustainably intensify agricultural production while safeguarding land and water. TNC has been working on agriculture sustainability since the mid 1990s, but their soil health efforts began in 2016, when they launched the *reThink Soils* roadmap report. This report outlines the significant on- and off-farm benefits conferred from soil health, including estimates that improving soil health on at least half of US croplands by

2025 could deliver up to 7.4 billion USD in water and climate benefits annually. By elevating the role of soil health in cropland management systems, the Conservancy and its partners can improve the long-term viability of US farming and create a soil health model for farming systems around the world, while meeting their conservation mission.

The goal of TNC is to help the agriculture sector reduce nutrient runoff from cropland into US waterbodies by 20% by 2025. One way to do this is to improve soil health and nutrient management practices on more than half of US corn, soybean and wheat cropland. However, TNC recognizes this goal is not something they can achieve on their own, therefore, a significant amount of the efforts of TNC focus on partnerships and helping others set and meet ambitious goals around soil health.

TNC has farmland soil health projects in 20 states. Each of these are designed to address either research, market, or policy barriers to soil health practice adoption by contributing towards a national strategy with seven program elements:

•Demonstrate to scale: advance knowledge of how to scale adoption of soil health practices through research and demonstration projects.

•Farmer advisors: support those who advise farmers, such as agriculture retailers and certified crop advisors, to include conservation agriculture practices in the suite of services they sell.

•Supply chain: work with companies that have set sustainability goals to help implement those on the ground.

•Non-operator landowners: provide farmers and landowners with the legal, cost-sharing, and risk-reduction tools to increase the adoption of soil health practices on rented land.

•Policy: create the enabling environments and public investments to increase adoption of soil health-promoting practices.

•Communication: leverage strategic communications to increase knowledge about the benefits of soil health.

•Science and economics: conduct research to help close knowledge gaps that will help drive adoption of soil health practices, including through innovative market incentives.

TNC work at the state scale involves local staff with agronomic, soil science, ecology, watershed management, and engineering backgrounds. TNC national team for soil health includes staff with backgrounds in soil science, agriculture economics, conservation biology, policy, landscape architecture, journalism and law.

TNC works with many collaborators, from the national to local scales, to achieve their goals. They work across the entire supply chain, including with banks, agriculture retail companies and certified crop advisors, traders, food manufacturers and retailers. TNC also partners with universities, private researchers, local conservation organizations, commodity and trade groups, and other nonprofits that are also committed to increasing the adoption of soil health and nutrient management practices. In addition, TNC works with local, state and government agencies to help increase and utilize public assistance for farmers implementing soil health and other conservation practices.

3.4 Foundation for Food and Agriculture Research

The Foundation for Food and Agriculture Research (FFAR), a nonprofit established by the United States Congress in the 2014 Farm Bill, builds unique public-private partnerships to fund cutting-edge food and agriculture research. Since its creation, FFAR has funded over 130 projects and partnered with over 300 distinct organizations. FFAR funds research in six challenge areas, one of which is the Soil Health Challenge Area that explores linkages between soil health and farm productivity, economics, human health, management practices and other areas. To date, FFAR has invested over 30 million USD in soil health research.

The Soil Health Challenge Area supports four key focus areas: resiliency/adaption, site-specific decision-making, well-being and adoption. Research in this area encompasses multiple facets of soil health, including the development and adoption of soil health management practices, soil health decision support tools and broad system transformations around ecosystem services.

FFAR-awarded projects extend across 40 states in the USA and engage farmers, partners and scientists around the globe. Over the next four years, FFAR will continue focusing on supporting pivotal tools and practices that can be applied across scale, region and production systems for coordinated advancements in soil health that result in increased productivity, well-being and environmental resilience.

4 Summary

The significance of the expanding global population, natural resource challenges, and the responsibilities to current and future generations make enhancing soil health a truly global imperative. Programs led by government

organizations such as USDA-NRCS and USDA-SARE, along with non-government organizations such as The Nature Conservancy, Soil Health Institute, Soil Health Partnership and FFAR are just a few of the many efforts that are now underway to improve soil health in the USA and that are offered as models for others engaged in advancing soil health.

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