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Increasing Agricultural Sustainability Through Organic Farming

Outcomes from the 2016 *Organic Confluences Summit*

Tracy Misiewicz[1], Jessica Shade[1], David Crowder[2], Kathleen Delate[3], Amber Sciligo[4], Erin Silva[5]

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Authors:

Tracy Misiewicz[1], Jessica Shade[1], David Crowder[2], Kathleen Delate[3], Amber Sciligo[4], Erin Silva[5]

Affiliations:

[1]The Organic Center, Washington D.C.; [2]Washington State University, Pullman, WA; [3]Iowa State University, Ames, IA; [4]University of California, Berkeley, CA; [5]University of Wisconsin, Madison, WI

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SUMMARY

The U.S. agricultural system is highly productive, yet many current practices are associated with degradation to water, air, soil and biodiversity. Many studies have demonstrated that organic farming practices not only reduce negative environmental impacts but also can be applied within conventional operations to improve their sustainability. To increase the adoption of conservation farming practices, it is crucial that agricultural policymakers, educators and scientists recognize that organic farming is a key tool for meeting conservation objectives. Furthermore, they must work together to reduce barriers that hinder farmer adoption of organic farming

This report is based on presentations and discussions that took place at the 2016 *Organic Confluences: A Summit to Turn Environmental Evidence into Policy Practice*. It covers the current research on the environmental impacts of agricultural practices commonly used in organic farming in the areas of soil health, water quality, biodiversity, native pollinators, and climate change mitigation. It discusses barriers that constrain adoption of environmentally friendly organic practices on farms, and provides recommendations to increase the adoption of sustainable farming practices on existing and transitioning organic farms.

Presentations and discussions from the conference established that numerous long- and short-term studies demonstrate that organic practices can play an important role in improving the health of our planet. Facilitating the adoption of organic farming practices that promote natural resource conservation provides an opportunity to improve the environmental sustainability of our agricultural system. However, barriers such as access to resources, risk perception, conflict among regulatory programs, and lack of connectivity among agricultural educators, scientists, and policymakers often hinder farmer adoption of environmentally friendly farming techniques.

Increasing the adoption of environmentally friendly best practices on farms is complex, requiring the management of numerous competing pressures. Improvements in research, policy, and extension and communication among the three can change the balance of competing factors. Addressing the challenges discussed in this report, including the reduction of competing production, marketing and regulatory tensions, will increase adoption of on-farm conservation practices on existing organic farms while facilitating new organic farmer transition to environmentally friendly organic farming, creating a pathway for farmers to increase the use of conservation practices.

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INTRODUCTION

Over 330 million acres of land in the United States are devoted to agriculture.[1] While the U.S. agricultural system is highly productive, many current practices are associated with degradation to water, air, soil and biodiversity. Numerous long- and short-term studies have demonstrated that organic practices can play an important role in improving the health of the environment because organic systems are typically designed to be more sustainable than conventional systems.[2] Furthermore, many of the techniques used in organic farming can be applied within conventional operations to improve their sustainability.

The United States Department of Agriculture (USDA) defines organic agriculture as a "production system that is managed to respond to site-specific conditions by integrating cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity" (CFR205.2). As such, the USDA National Organic Standards explicitly require that organic producers manage their farms in a manner that fosters biodiversity and improves natural resources. Organic farmers meet these requirements by using farming practices that protect the environment and promote ecosystem services. For instance, the use of hedgerows, native plant buffer strips, and cover crops reduce soil erosion, nutrient runoff pollution and support a diversity of wildlife including pollinators and beneficial insects by providing habitat and nutritious food.[3-7] In return, the farm benefits from enhanced ecosystem services include improved pollination of crops, higher water quality, better pest control via beneficial insects and healthier soils—all of which reduce the need for costly inputs.

Facilitating the adoption of organic farming practices that promote natural resource conservation provides an opportunity to improve the environmental sustainability of our agricultural system. However, barriers such as access to resources, risk perception, conflict among regulatory programs, and lack of connectivity among agricultural educators, scientists, and policymakers often hinder farmer adoption of environmentally friendly farming techniques.

To increase the adoption of conservation farming practices, it is imperative that agricultural policymakers, educators and scientists recognize that organic farming is a key tool for meeting conservation objectives. Furthermore, they must work together to reduce barriers that hinder farmer adoption of organic farming. The first *Organic Confluences: A Summit to Turn Environmental Evidence into Policy Practice* (May 23, 2016, Washington D.C.) brought together scientific experts, farmers, policymakers, and organic stakeholders to review the most up-to-date research on the environmental benefits of organic farming practices. It also sought to assess the availability and efficacy of existing programs designed to incentivize the adoption of environmentally friendly organic farming techniques, and to identify challenges to the adoption of environmentally friendly organic farming practices. This report is based on presentations and discussions among conference participants.

Here we review current research on the environmental impacts of agricultural practices commonly used in organic, discuss barriers that constrain adoption of environmentally friendly organic practices on farms, and provide recommendations to increase the adoption of sustainable farming practices on existing and transitioning organic farms.

OVERVIEW OF RESEARCH SUPPORTING THE ENVIRONMENTAL BENEFITS OF ORGANIC FARMING PRACTICES

SOIL HEALTH

Soil health is dependent on a combination of biological, chemical, and physical properties such as beneficial microbial activity, nutrient availability, and the size and type of soil aggregates.[8] Healthy soils are essential for resilient crop production, with positive contributions to soil water retention—which improves crop performance in times of drought—and supporting a diversity of organisms vital to decomposition and nutrient cycling.[8] They can also maintain carbon stores in both labile and stable soil carbon

pools for long periods of time, contributing to global climate change mitigation.[9, 10] Soil is paramount to a productive and sustainable agricultural system, yet many conventional farming practices actively deplete soil quality.[10, 11] Conversely, a growing body of research points to the implementation of organic farming techniques to improve and maintain the health of our soils and their ecosystems.

Because the use of synthetic fertilizers is prohibited, organic producers increase soil fertility by incorporating cover crops, animal manure and/or compost into the soil, all of which increase the amount of soil organic carbon (SOC).[12-17] SOC is a key component of healthy soils with positive impacts on physical, chemical and biological soil properties. It provides structural stability to the soil, reduces erosion, protects against soil compaction, and improves aeration, water infiltration and water-holding capacity. SOC serves as a reserve for nutrients essential to plant growth including nitrogen, phosphorus and sulfur, and it composes the base of the soil food web, providing a foundation for all soil life.[8, 18, 19]

In a review of six long-term organic comparison sites across the U.S.,[20] higher soil quality was determined in the organic systems, particularly for enhanced carbon and nitrogen storage, leading to competitive yields and greater economic returns than the conventional sites. The addition of manure fertilization, along with the inclusion of legume forages/cover crops in the crop rotation, was essential for sufficient soil quality to support optimal yields across all sites.

Soil quality results from the Long-Term Agroecological Research (LTAR) experiment in Iowa showed that after 15 years, overall soil quality, and especially soil nitrogen mineralization potential (an indicator of plant available nitrogen in the soil), was highest in the four-year organic crop rotation with two years of legume forage crops. The organic soils also had more soil organic carbon, total nitrogen, microbial biomass carbon, and particulate organic matter carbon (POM-C), higher concentrations of the nutrients phosphorus, potassium, magnesium and calcium, and lower soil acidity than conventional soils, all the while maintaining yields equal to or exceeding those of the conventional plots.[13]

Results from this same study also suggest that the improvements in soil health through employment of organic farming techniques can provide exceptional benefit to farmers during extreme climate events. In 2012, despite serious drought conditions during the growing season, organic management enhanced agroecosystem resilience and maintained a critical soil function—the capacity to supply nutrients to the crops. During that period, POM-C was higher in the organic than the conventional soils,

Dr. Michel Cavigelli discusses research on how organic farming supports soil health.

likely because of altered rates of decomposition of new residue carbon inputs during this especially dry year. Soil quality enhancement was particularly evident for labile soil carbon and nitrogen pools, which are critical for maintaining nitrogen fertility in organic systems, and for basic cation concentrations, which control nutrient availability.[13]

Studies comparing conventional and organic farms have also found that organic operations experience increased growth and activity of beneficial soil organisms including microorganisms, beneficial fungi, and earthworms.[12-15] For instance, a study by Mäder *et al.*[12] compared biodynamic, bioorganic and conventional farming systems in Europe over a 21-year time period and found that organic soils had greater biological activity, greater soil stability, more biomass and higher diversity than conventionally managed soils. The study found that organic soils contained 40 percent more root colonization by mycorrhizae, a 1.5 – 3x greater abundance of earthworms, almost two times greater density of spiders and arthropods, and higher microbial diversity than in conventional-till agriculture.

Case Study

The USDA Agricultural Research Service's Farming Systems Project (FSP), established in 1996, provides long-term comparisons of three organic cropping systems—a two-year, three-year, and six-year organic rotation and two conventional cropping systems—one utilizing no-till and another utilizing chisel tillage. Results from this study support an association between system performance, soil health, and crop diversity, with lengthening crop rotations improving agronomic, economic and environmental performance.[17] Specifically, corn grain yield was greater in the six-year organic rotation than the three- and two-year organic rotations. The nitrogen mineralization potential in the organic system at the FSP was, on average, 34 percent greater than conventional no-till after 14 years.[21] Furthermore, particulate organic matter, nitrogen and soil organic carbon (SOC) in all organic systems were greater than in the conventional no-till system.[17] This result reflects the fact that plant residues in no-till systems largely accumulate at the soil surface, while in organic systems burial of plant residues resulted in greater soil carbon at a depth of 4-10 inches. Soil carbon at these depths is more resilient to tillage than soil carbon at the surface.[10]

No-till farming is advocated throughout the U.S. for soil quality enhancement that may occur in some soil strata with the reduction of tillage. However, research at a different USDA experimental site showed that even with tillage in the organic plots, soil organic carbon and nitrogen were higher after nine years in an organic system that included cover crops and animal manure compared with conventional no-till systems that also included cover crops, suggesting that organic practices can potentially provide greater long-term soil benefits than conventional no-till.[22]

WATER QUALITY

Agriculture is one of the primary non-point sources of pollutants to U.S. waterways.[23] Excess water runoff and subsurface drainage transport nutrients, sediments, and pesticides to surface waters of lakes, streams, rivers, and estuaries, decreasing water quality and placing aquatic biodiversity at risk.[24, 25] Nitrate pollution stemming from soil fertility treatment is of particular concern for water quality. Nitrogen leaching can lead to groundwater contamination, and nitrogen and phosphorus runoff are of particular concern because they are drivers of eutrophication leading to the formation of hypoxic "dead zones" devoid of oxygen and unable to support life. Dead zones are present in many major bodies of water including the

Great Lakes, Chesapeake Bay and the Gulf of Mexico[26] and are attributed in large part to nitrate runoff from mineral fertilizers applied to conventional agriculture. [17, 18]

Simply managing nitrogen fertilizer application in conventional systems is not a viable solution to control the problem of excess nitrate runoff.[27, 28] Jaynes *et al.*[27] found that even when fertilizer was applied at rates well below the economic optimum for corn production, NO3-N concentrations in drainage water still exceeded drinking water standards. Accordingly, a broader range of environmentally friendly farming techniques such as those

Dr. Cynthia Cambardella (center) presented her research demonstrating that organic farming practices can reduce nitrate pollution in water.

utilized in organic farming must be adopted to reduce nutrient loss and restore water quality.

A number of studies, ranging from Europe to the U.S., have found that organic farms experience less nutrient loss than their conventional counterparts.[29-34] Organic practices such as the use of diverse crop sequences and cover crops decrease the amount of water lost through increased uptake and evapotranspiration, thus decreasing the amount of soil nitrogen leached.[35-37] Organic farmers also utilize alternative soil fertility treatments in lieu of mineral fertilizers. Composted animal manure and green manure for fertilization increase soil organic carbon, enhancing soil nutrient- and water-holding capacity.[38] While most studies comparing nutrient loss from organic and conventional farms have not isolated the relative contribution of each individual farming practice in reducing water pollution, a combination of techniques is thought to play a role in reducing nitrogen loss.

Case Study

One of the most compelling studies to evaluate the effects of organic farming systems on water quality comes from published research by Cambardella *et al.* in 2015.[32] The USDA-Agricultural Research Service's Organic Water Quality (OWQ) experiment established in 2011 evaluates organic and conventional crop rotations on Iowa State University's Agricultural and Biosystems Engineering and Agronomy Research Farm (Ames, IA). Unlike the majority of studies that rely on models or mathematical calculations to estimate water flow rates coupled with nutrient concentration data from lysimeters to estimate nitrate loss, the OWQ experiment rigorously quantified water flow and nitrate loss by installing subsurface drainage lines and equipment to collect water samples and monitor subsurface drainage water flow and nutrient loss.

Subsurface drainage water NO3-N concentrations and NO3-N loading loss for a conventional corn-soybean rotation, an organic corn-soybean-oat/alfalfa-alfalfa rotation, and organic pasture were quantified from 2012–2014. Nitrate concentrations in subsurface drainage water were consistently higher in the conventional crop rotation than in the organic crop rotation or organic pasture. Tile water nitrogen loading loss for the three-year period spanning 2012-2014 from the conventional system was nearly twice as high as the nitrogen loss from the organic cropping system.[32] Furthermore, NO3-N concentration in tile water collected from 2013 -2015 exceeded the drinking water standard of 10 ppm 76 percent of the time in the conventional cropping system compared to only 26 percent of the time for the organic cropping system[32] (2015 data, Cambardella, unpublished data). These results suggest that organic farming practices, such as the application of composted animal manure and the use of cover crops within extended cropping rotations, can improve water quality relative to conventional cropping systems.

BIODIVERSITY

Sustainable agricultural systems depend on diverse and abundant communities of insects, microbes and other organisms to provide ecosystem services. For example, ecological communities provide a wealth of services and resources that support human life, including fuel, biological control, pollination, carbon sequestration, climate control, purification of air and water, production of high quality soil, flood control, and nutrient cycling. Researchers estimate that the global value of such ecosystem services provided to humans exceeds 125 trillion

dollars per year.[39] Moreover, numerous studies demonstrate that increased on-farm biodiversity often improves the diversity of agricultural organismal communities that have been linked to services such as pollination, biological control, soil quality, and runoff reduction.[40-46] These ecosystem services reduce the need for external inputs and increase yields—improving profits and sustainability. Furthermore, such practices can aid conservation efforts by contributing to the overall health of surrounding ecosystems, improving connectivity among fragmented habitats, and providing food and nesting resources to wildlife.[47] However, agricultural intensification is a leading cause of biodiversity loss worldwide,[48] which threatens the provisioning of ecosystem services on farms.

A large body of literature suggests that organic farming systems can help mitigate biodiversity loss, leading to greater provisioning of ecosystem services. Common practices that increase agricultural diversity, such as crop rotations, cover crops and prohibition of synthetic pesticides, can benefit a wide range of organisms. Compared to conventional farms, organic farms generally have greater species richness (the number of species) and overall abundance (number of individuals within a species) of carabid beetles, spiders, earthworms, beneficial parasitoids, vascular plants, birds, bees and other native pollinators, soil microbes and fungi, and small rodents.[12-14, 49-53] It is also important to note that communities of organisms are impacted by the quality of habitat on an individual farm and by the quality of habitat that surrounds a farm. While the majority of studies show organic farming positively impacts biodiversity, it is still unclear whether those benefits are strongest in intensively developed landscapes, where organic farms can provide refugia in an otherwise hostile environment,[52, 54-58] or in complex, heterogeneous landscapes, where species already inhabiting semi-natural areas are present and are able to benefit from environmentally friendly farming practices. Future research on this topic will aid in determining where organic farming can provide the greatest benefit for biodiversity conservation.[59, 60]

Finally, while species richness and abundance are central measures of biodiversity and community health, it is also important to consider species evenness—the relative abundance of species. Oftentimes conventional agricultural pest management practices can ripple through the food web, affecting a wide range of organisms. As a result, many species will become rare while a small number dominate the landscape, further contributing to pest outbreaks.[61] Organic farming methods assuage this ecological damage while simultaneously providing protection against agricultural pests by promoting evenness among natural enemies and other organisms.[62]

Professor David Crowder speaks about his research examining biodiversity on organic farms.

Case Study

Crowder *et al.*[44] provided evidence for this in a landmark study that investigated the role of organic farming practices in mediating the evenness of beneficial predator and pathogen communities on farms, and the extent to which this evenness contributed to pest control. Beneficial insects and pathogens that attack the Colorado potato beetle, an important pest, were surveyed in conventional and organic potato fields in Washington. Researchers found that while farming system had no effect on species richness, organic potato fields had much higher beneficial species evenness. In organic farms, the most abundant species made up only 38 percent of the community of beneficial predators and pathogens, as compared to the conventional potato fields where the single most abundant species constituted up to 80 percent of the community. The researchers then surveyed the literature to determine whether these results were unique to organic potato fields in Washington or were a feature of organic systems in general. A meta-analysis of the published data showed that overall, organic farms have significantly greater species evenness within beneficial predator and pathogen communities than conventional farms growing the same crops. To determine if these differences in evenness translated into improved pest suppression, the researchers experimentally manipulated the evenness of beneficial pathogens and predators in field experiments and determined the effects on pest densities and resulting potato yields. Results showed that more even predator and pathogen communities strengthened pest suppression and increased yields. These results demonstrate the importance of species evenness in maintaining sustainable agricultural ecosystems, and strongly suggest that organic farming offers a means to do so.

NATIVE POLLINATORS

Pollinators are essential to crop production, particularly fruit, vegetables and nuts, and are positive indicators of agro-ecosystem health. Native pollinators such as solitary bees, bumblebees, and butterflies are often overlooked in favor of managed European honey bees when it comes to crop production. However, over the last decade, losses in honey bee stocks have highlighted the importance of alternative, native pollinators threatened by agricultural intensification.

While many studies have focused on agricultural causes of population declines in managed honey bees including the effects of pesticide exposure and lack of habitat, far fewer have closely examined the factors leading to declining populations in native bees.[63, 64] The work that has been done suggests that native pollinator decline is primarily driven by humans, and that habitat loss due to agricultural intensification is a primary causal factor.[65-67] Many pollinators rely on natural or semi-natural habitat for nesting and food resources, and a lack of landscape heterogeneity and connectivity within and across agricultural landscapes act to isolate populations, leading to inbreeding depression and reductions in food and nest site availability.[68, 69]

Many commonly practiced organic farming techniques support both native and managed pollinator health by providing a more diverse landscape that affords abundant and higher-quality food and habitat. Organic farms are required to manage their operations in a manner that "maintains or improves the natural resources of the operation" [7 CFR 205.200], which includes the health of pollinators. Many farmers meet this requirement by implementing techniques that increase on-farm plant diversity such as planting hedgerows, multiple crops and cover crops, all of which have been demonstrated to increase native pollinator diversity on farms, leading to increases in farm pollination services and greater crop yield—even when honey bees are present.[70]

The enhancement of field edges with flowering plantings is a method commonly used by organic farmers to increase the diversity and abundance of pollinators on farms.[71-74] Research specifically aimed at assessing the use of flowering hedgerows on farms as a tool for native pollinator conservation has demonstrated that they can increase native pollinator richness and abundance.[75, 76] They also contribute to the persistence of native pollinators in the landscape including specialized and less common species,[76, 77] promote the presence of native bees in nearby fields,[75] and increase the diversity of pollinator communities across the landscape.[78] For instance, M'Gonigle *et al.*[76] analyzed 330 surveys of native bees and flies across 15 sites over the course of eight years. They found that the use of hedgerows increased both the diversity of pollinators (number of different species) and the persistence of pollinators on the landscape between flowering seasons. Furthermore, they found that less common pollinator species and species that specialize on particular plant food sources benefited more by hedgerows than common species, highlighting the value of this restoration technique for conservation of species of concern.

Dr. Amber Sciligo discusses how organic farming practices can benefit native pollinators.

The use of cover crops and polycultures are also integral techniques used in organic farming, and their ability to increase biodiversity on farms has been well established.[79, 80] Recent research finds that increasing crop diversity can increase native pollinator diversity and abundance on farms by increasing the number and diversity of floral food resources as well as extending the duration of time over which floral resources are available in an agricultural landscape.[81-83] Furthermore, these increases in diversity are directly linked to increases in yield and fruit quality. [83]

Case Study

Sciligo *et al.*[84] provides clear support for using crop diversity as a farming tool to support native pollinator health and increase farm productivity. This study measured pollinator abundance, diversity, and pollination services to the target crop of strawberry to determine whether the benefits of crop diversity can substitute for high levels of natural habitat diversity. Data were collected on 16 organic farm sites along the Central Coast growing region of California, one of the largest strawberry production regions in the U.S. Eight study farms were large monoculture fields of organic strawberries and eight were organic polyculture farms that included strawberry as a crop. Each farm type was either surrounded chiefly by intensive agriculture or chiefly by natural habitat. Researchers found that (1) fruits resulting from flowers that were open to insect pollination were of higher quality (less malformation) than fruits resulting from flowers that had excluded insect pollination, suggesting that insect pollination is important for strawberry production, despite popular, contrary belief; (2) in spite of honey bees being present and abundant on all farms, increased native bee diversity improved fruit quality and marketability, and (3) increased crop diversity on farms improved native bee diversity and strawberry marketability, and these benefits equaled or exceeded those of large-scale natural habitat, providing a substitute for landscape complexity. Together these results signal that organic farming techniques that increase on-farm crop heterogeneity can simultaneously contribute to native pollinator conservation and provide benefit to farmers.

CLIMATE CHANGE MITIGATION

Food production accounts for approximately 25 percent of global greenhouse gas (GHG) emissions, with its relative contribution expected to expand with the growing world population exerting greater demands on food production.[85] Organic agriculture is well-positioned to contribute positively to the reduction and mitigation of greenhouse gas emissions. Organic farmers and researchers have developed effective production practices that minimize the need for fossil-fuel intensive synthetic inputs while maintaining effective pest and nutrient management. Additionally, the diverse crop rotation strategies and soil-building practices required by USDA's National Organic Program reduce overall nitrous oxide emissions per land area farmed while accumulating soil carbon.[86-88]

The three primary agricultural greenhouse gasses emitted in the Unites States are carbon dioxide, methane and nitrous oxide. Crop emission sources can be divided into two categories: the emissions associated with the energy required for crop production (primarily carbon dioxide emissions related to the production of crop inputs), and the emissions directly associated with agricultural management (primarily nitrous oxide and methane). Crop inputs affecting the first category include synthetic nitrogen, phosphorus and potassium fertilizers; synthetic herbicides and insecticides; transportation inputs to the farm; and on-farm fuel consumption. Within the latter category, the emissions associated with crop management include direct nitrous oxide emissions (nitrification and denitrification of nitrogen from fertilizers, manure and crop residues) and indirect nitrous oxide (i.e. off-site) emissions resulting from nitrogen lost from the farm via volatilization, leaching, run-off and erosion.

The production, transport and use of fertilizers and pesticides are a major use of energy in conventional agriculture.[89] In particular, the manufacture of synthetic N fertilizer (and to a lesser extent, potassium and phosphorus fertilizers) represent a large contribution to the total energy input required by conventional agriculture and comprise as much as 10 percent of direct global agricultural emissions.[90, 91] This current level represents a 37 percent increase since 2001.[92] Organic production methods significantly reduce GHG emissions and use less energy because the application of fossil fuel-based synthetic fertilizers and pesticides are prohibited.[30, 93, 94] In addition to directly prohibiting energy-intense synthetic inputs, organic practices minimize the need for inputs due to the use of diverse, dynamic cropping systems as compared to fixed-sequence and monoculture cropping systems. [95, 96]

Soil tillage, a weed control technique commonly used by organic farmers in place of chemical herbicides, has been criticized for releasing carbon dioxide from the soil. However, reduced tillage practices for organic systems are continually being developed[97,98] and implemented.[99] Furthermore, recent research suggests that organic reduced tillage systems diminish greenhouse gas emissions while simultaneously increasing soil organic carbon, providing a viable greenhouse gas mitigation strategy.[100 101]

Soil and fertility management drives agricultural generation of nitrous oxide, which accounts for approximately 40 percent of agriculture's direct greenhouse gas emissions.[102] Nitrous oxide production is associated with nitrogen fertility applications (e.g. mineral fertilizers and manure) and incorporation of legume cover crops. Additionally, nitrous oxide can be associated with "indirect" sources, such as nitrogen surface runoff and leaching. On a per-acre crop production basis, lower nitrous oxide emissions have been associated with organic practices as compared to conventional, likely due to differences in N inputs under organic management, both in a given season and across the crop rotation.[86, 103, 104]

Professor Erin Silva discusses how organic farming can contribute to climate change mitigation.

Methane accounts for 35–40 percent of the total GHGs produced by agricultural activities,[105] which can be attributed to several sources, including: 1) land management (primarily from rice production); 2) manure management; and 3) enteric (microbial) fermentation from ruminant livestock. Methane from enteric fermentation and manure management represents 27 percent and 7 percent, respectively, of the total agricultural-related methane emissions. Additionally, cultivated wetland rice soils contribute to 10 percent of methane emissions. While methane emissions from ruminant livestock are greatly influenced by feed quality and efficiency,[106] a reduction in the number of replacement heifers in dairy herds often reduces methane output per unit of animal product.[107] Cows from organic herds tend to be older, reducing the need for replacement heifers.[108]

Case Study

Gattinger *et al.*[88] conducted a meta-analysis of published data from over 70 different studies to determine how transition from conventional farming to organic farming affected soil organic carbon. They found that soil organic carbon concentrations, soil carbon stocks and carbon sequestration rates were significantly higher in agricultural soils under organic management compared to those under conventional management. To determine if the observed increases in SOC were simply due to the application of imported organic matter (off-farm sources of manure for fertilization, etc.) a subset of data from organic farms with zero net input was analyzed and compared to the data from conventional farms. Even with this conservative data set, they found that soil organic carbon stocks and carbon sequestration were still higher under organic management. This study indicates that top soils from organically managed farms have significantly more carbon than top soils from conventionally managed farms, and have the potential to contribute to climate change mitigation through carbon sequestration.

CHALLENGES AND RECOMMENDATIONS: INCREASING ADOPTION OF ENVIRONMENTALLY FRIENDLY ORGANIC PRACTICES

Research supports numerous environmental benefits to soil health, water quality, biodiversity, pollinator conservation and climate change mitigation associated with organic systems (see Pages 2-8). Facilitating the adoption of organic farming practices that promote natural resource conservation provides a pathway to improve the environmental sustainability of our agricultural system. However, to do so successfully, we must overcome a number of hurdles. Farmer adoption of additional farming techniques is often influenced by access to resources and information, [110-112] risk perception,[113] and the need to maintain a profitable operation.[113] As such, increasing the adoption of conservation practices on any farm requires the management of numerous competing pressures. Some of the biggest challenges include resolving conflict among regulations, industry standards and farm programs; closing gaps in communication among farmers, researchers, and extension agents; and addressing resource scarcity on the farm. Addressing these barriers will not only improve the sustainability of U.S agriculture by increasing the acreage under organic production, but will also facilitate continuous improvement of on-farm conservation practices within existing organic farms. Here we will discuss outcomes from break-out sessions and group discussions at the 2016 Organic Confluences Summit, focusing on communication, research, regulatory and policy challenges that must be addressed to advance sustainability through organic agriculture.

Professor Kathleen Delate synthesizes the research on the environmental benefits of organic farming.

RESOLVING CONFLICTS

Conflicts among regulations, industry standards, and farm programs present a major barrier to the adoption of environmentally friendly organic farming best practices. These inconsistencies hinder organic farmers from fully adopting the suite of conservation farming practices available to them, and can impede transition to organic production as they deter practices that are central to organic farming.

For example, while organic farmers typically plant cover crops to suppress weeds and improve fertility, they also provide numerous environmental benefits such as protecting soils from erosion, improving water quality, supporting biodiversity, and building soil organic carbon. Unfortunately, while some federal agencies recognize the conservation benefits of cover cropping and reward their use, others actively discourage it. For instance, USDA's Natural Resource Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) offer payments to farmers who utilize cover crops. However, those same farmers may have difficulty accessing adequate crop insurance from USDA's Risk Management Agency (RMA) depending on when they terminate those cover crops and plow them under for green manure. While RMA has worked to create more flexibility, the risk assessment and determination to accept or reject are still largely dictated by the perceptions of the crop insurance agent.

Another conflict, reviewed by Karp *et al.*,[114] has arisen through attempts to improve food safety where regulations and requirements dictated by regulatory programs and produce purchasers discourage environmentally friendly on-farm practices. This conflict stems from the 2006 outbreak of *E. coli* O157:H7 in leafy greens and spinach produced in California that led to the development and implementation of the California Leafy Greens Marketing Agreement (LGMA). The LGMA was designed to ensure compliance with food safety best practices for produce.[115] It is a semi-public regulatory arrangement where participation is voluntary. However, once a grower is enrolled, compliance is enforced by state government officials. In addition to the requirements set forth by the LGMA, growers selling to retail companies must often meet additional requirements set by their buyers.[116] Foodborne pathogens such as *E. coli* and *Salmonella* can be vectored by various animals (livestock and wildlife), and can be transmitted through the environment via water, soil, handling by farm workers, or through contaminated equipment used for farming, processing and distribution.[114] The LGMA focuses its efforts on minimizing on-farm contamination through sources such as feces and water.[114]

The LGMA guidelines for animal intrusion emphasize monitoring for general presence of wildlife instead of focusing on animals that are high risk for transmission such as deer, pigs, cattle, sheep and goats even though some studies suggest that pathogens of greatest concern for food safety are significantly more prevalent in livestock than they are in wildlife.[117, 118] As such, farmers are required to monitor their fields for signs of animal entry including the presence of tracks, damaged plants and feces. When signs of animal intrusion are detected, the LGMA dictates that the grower creates a no-harvest buffer zone with a minimum radius of five feet surrounding the potential contamination event[115] and some buyers require even larger buffers.[119]

Loss of marketable crops due to no-harvest buffer zones can create substantial hardship for growers, particularly if they are operating small- to medium-sized farms. For instance, in a survey of 43 leafy green farmers in California, growers reported losing an average of 21 acres of crops due to LGMA buffer requirements.[120] As a result, farmers are under strong pressure to deter wildlife from entering their land to avoid negative repercussions[119, 121, 122] with the unintended consequence of actively discouraging the implementation of conservation practices on farms. For example, a survey of 181 Central Coast farmers found that 15 percent had discontinued conservation practices restoring wildlife habitat because of food safety concerns, and almost 90 percent of farmers surveyed had adopted measures such as erecting fences, setting wildlife traps, or clearing vegetation to create bare-ground buffers to discourage wildlife intrusion.[121]

While the enactment of the LGMA has had clear consequences for the implementation of on-farm conservation practices, research results have begun to emerge suggesting that the measures aimed at reducing crop contamination by discouraging wildlife intrusion may not effectively reduce pathogen risk. A recent study by researchers at the University of California, Berkeley found that the practice of removing surrounding habitat from farms does not reduce crop contamination from disease-causing pathogens such as *E. coli*.[123] The researchers analyzed fine scale spatial data with results from 250,000 tests for hemorrhagic *E. coli, E. coli,* and Salmonella taken from produce, irrigation water, and rodents between 2007 and 2013 in the U.S. and Central and South America to shed light on the contamination risk actually caused by wildlife habitat surrounding farms. Their results indicated an overall increase in pathogen prevalence in fresh produce over the course of the six-year study. As expected, proximity to livestock was directly associated with an increase in pathogen prevalence. Surprisingly, actions aimed at discouraging wildlife from residing near and entering farmland such as vegetation clearing were also directly associated with increased pathogen prevalence, suggesting that discontinuation of many conservation practices may not actually improve food safety. According to the authors of the study, "These findings contradict widespread food safety reforms of the LGMA that champion vegetation clearing as a means to improve food safety."

While the discouragement of conservation practices on any farm is problematic and the LGMA does not differentiate between organic and non-organic operations, it does create a unique set of challenges for organic farmers. In lieu of most synthetic pesticides and herbicides, organic farmers rely on the ecosystem services provided by biodiversity to aid in pest control. Furthermore, organic farmers are mandated by the National Organic Program to implement wildlife conservation measures and improve natural resources to maintain their certification. As such, formal and informal rules that emerge as a result of programs such as the LGMA have the potential to disproportionately impact organic farmers in addition to generally discouraging environmentally friendly farming practices.

Recommendation: Federal, local and industry regulations and programs must be harmonized so that farmers can implement organic best practices without penalty.

- Regulatory/programmatic missions and directives must be inventoried to identify conflicts, and those conflicts must be resolved.
- Research is needed to clarify conflicts, ensure that regulations provide science-based solutions, and assess the full reach of their impact prior to implementation.

CLOSING COMMUNICATION GAPS

Organic farmers are required to farm in a sustainable manner using techniques that decrease the use of off-farm inputs, reduce resource consumption, increase biodiversity, and preserve productivity while simultaneously tackling a diverse array of agronomic challenges including fertility management, weed and pest control, and agro-economic challenges such as yield constraints, crop failure and supply chain shortages. Organic best practices have numerous benefits to the environment. To maximize those benefits while maintaining economic viability, increased communication among stakeholders is essential.

Organic farmers, especially those who are new to farming or are transitioning from conventional farming, must receive adequate technical assistance and educational support to successfully implement new practices. In fact, lack of information is one of the primary factors that lead farmers to abandon organic farming, and is consistently cited by farmers as a significant barrier in the transition to organic farming and farming without chemical inputs.[110, 111, 112] While some of the problem lies in the shortcomings of our agricultural extension and education system, with their predominant focus on conventional agriculture, researchers must also have open communication channels with farmers to ensure that their research is addressing the most meaningful questions and producing recommendations and information that will be of use on the farm. As such, it is essential that we improve education and communication among groups to close knowledge gaps and facilitate information transfer among farmers, extension agents/educators, and scientists.

Extension and Outreach

Existing outlets for research dissemination are not sufficient to meet the needs of organic farmers. Many cooperative extension offices have experienced significant budget cuts over the past decade. As a result, they face challenges including insufficient personnel and program support that directly hinder their ability to meet the needs of farmers. In addition, organic producers face other challenges when working with local cooperative extension offices or government agencies. For instance, many educators, cooperative extension agents and USDA personnel who do not work with organic producers regularly lack a basic understanding of organic agricultural practices, the needs of organic and sustainable farmers, and existing research aimed at addressing those needs. Also, they can harbor bias against organic farming practices in general.[124-126] These challenges are not new to organic farmers. While various platforms have been created in an attempt to improve communication and information dissemination, few have adequately addressed them.

Recommendations: Organic farmers must have access to supportive and informed technical advisors.

- Technical outreach to organic farmers must be assessed to identify innovative strategies that serve the current organic system.
- Stakeholders across the organic sector must come together to examine outreach and extension, and develop a framework for creative, effective information transfer.
- Engage e-Organic and other current extension networks to evaluate current organic extension systems and funding pathways, to coordinate a cohesive network of information transfer.
- Training and education in organic farming techniques must be provided for local educators and extension agents.
- Resources must be made available for university and local extension offices that have an interest in promoting organic but do not have the means.
- Incentives should be devised to encourage extension offices that have adequate resources but still actively choose not to promote organic.
- The organic sector should embrace and advertise recent efforts by USDA's Farm Service Agency (FSA) to incorporate organic production resources at its county-level field offices.
- Implementation of mentoring programs could provide an important route for knowledge transfer as many organic farmers benefit from peer-to-peer learning.

Research Communication

Communication rifts also exist among farmers and scientists, particularly those working in conventional agriculture. Due to the lack of clear communication channels, researchers may not be fully aware of priorities relevant to organic and transitioning farmers, and research results are often not translated into actionable recommendations. Open lines of communication among scientists and farmers are necessary to ensure that existing solutions and tools are reaching their target audiences, and that researchers are aware of challenges that require research and innovation. Furthermore, if pertinent research is completed but the results are not accessible to non-scientists, relevant information may remain underutilized by farmers.

Another barrier that may hinder researchers from addressing organic producer priorities is that organic agriculture research funding programs may not consistently prioritize those questions. Organic producers must understand and rely on complex biological processes that occur over long periods. Even when scientific interests and producer needs are syncronized, the majority of research funding is restricted to short-term experiments using reductionist approaches. While these strategies are common in conventional agriculture research, they may not be ideal for sustainable and organic systems, which require more holistic methodology. Similarly, because organic farming relies on an understanding of biological processes that vary based on localized factors including topography, soil chemistry and climate, research results from one area or crop may not translate to others.

Recommendations: Research results must be accessible, understandable and translated into practicable recommendations when possible.

- Agriculture research grants should require meaningful farmer participation to ensure that research is useful to the organic farming community.
- At the completion of the research project, high priority should be placed on making meaningful tools and recommendations available to farmers.
- More funds should be allocated towards extension and education including extension and outreach activities in organic research grants, increasing extension staff and resources to ensure adequate division of effort among universities and farmers, and improvement of extension tools and resources, to ensure that research results are organized, accessible and manageable for use by extension agents and farmers.
- More funding should be devoted to long-term experiments that encompass a whole systems approach to research design, data collection, and data analysis.

RESOURCE AVAILABILITY

Farmers need more economic resources to alleviate costs and reduce risk associated with implementation of conservation techniques. Programs that incentivize practices that promote natural resource conservation have the potential to augment the number of environmentally friendly techniques practiced on organic farms while simultaneously contributing to expanding organic acreage. This is because they can provide decisive financial backing for farmers interested in exploring organic options or implementing new techniques, but were previously reluctant to due to risk of profit loss. Public sector programs that offer financial support for organic farmers to adopt conservation techniques support healthy agro-ecosystems while simultaneously contributing to a tangible risk reduction strategy for farmers. While many federal programs and agencies incorporate agricultural environmental sustainability into their goals and priorities, organic agriculture as a system is often overlooked.

These omissions are likely due to the fact that most governmental agencies lack any formal source of information on organic practices and the associated environmental benefits. To increase the number of incentive programs that support environmentally sustainable organic agricultural practices, organic needs to be considered early on during priority setting activities for agencies and programs. Furthermore, increased access to information and input from organic experts could contribute to the resolution of conflicting regulations (addressed in more depth on pp. 9-11).

Finally, even when organic is included in environmental incentive programs, those programs are still often underutilized. Even when farmers are aware and interested in programs, participation is not always straightforward. Farmers may be deterred from participating if the requirements for enrollment and participation are overly complicated or arduous, and many programs lack adequate technical assistance to support growers once enrolled.

For example, the Natural Resource Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) is designed to mitigate resource damage by implementation of environmentally friendly practices such as planting buffer strips and pollinator habitat. EQIP is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. The EQIP National Organic Initiative specifically provides financial assistance to organic and transitioning farmers to offset costs associated with the implementation of conservation practices and with addressing natural resource concerns. It also helps growers meet requirements related to National Organic Program (NOP) requirements. Unfortunately, in spite of growth in the organic farming sector, enrollment has been declining since 2009, suggesting that substantial barriers are hindering farmers from effectively utilizing this program.[127] In a recent survey, organic farmers cited a number of reasons for not utilizing EQIP. For instance, the program is structured to incentivize the implementation of new practices on farms to meet conservation goals. However, since many organic farmers are already implementing these practices as a part of their organic systems plan, many are not eligible for financial assistance. This issue stems from a basic mismatch between the purpose of EQIP and the fundamentals of organic farming. EQIP programs are specifically designed to mitigate resource damage by the worst agricultural offenders. For organic farmers who are already integrating core conservation practices on their operations, only a limited number of new practices can be implemented using NRCS EQIP funds.

On an operational level, farmers cited the cap on the amount of money that can be requested through the Organic Initiative as a barrier. The NRCS EQIP Organic Initiative has a $20,000 cap on any individual farmer's projects, which may be insufficient to fully implement some NRCS resource recommendations. When this is the

Mark Lipson records notes from break-out group discussions.

case, organic farmers must compete against conventional producers in the general EQIP pools, and do not benefit from the resources that NRCS has directly allocated for organic. Farmers also noted that USDA staff were not familiar enough with organic farming systems and certification requirements.[128]

In contrast to the EQIP program, the NRCS Conservation Stewardship Program (CSP) provides farmers with financial assistance for both installing new conservation activities as well as improving, maintaining, and managing existing conservation activities. CSP also provides payments for the adoption of resource-conserving crop rotations. This program has the potential to support organic farmers, as many of these conservation activities are requirements under the USDA organic regulations (e.g. cover cropping, crop rotation, nutrient management, and buffer strips). NRCS is authorized to enroll 10 million new acres into this program and renew up to 12.8 million acres that are under five-year contracts that expire at the end of the 2017 fiscal year.

As part of NRCS' "2017 CSP Reinvention," the agency has created a new evaluation tool that is used to evaluate management systems and natural resources on individual farming operations.

The Conservation Activity Evaluation Tool (CAET) determines whether current farm management practices meet conservation thresholds, and allows farmers to select practices and enhancements that work for the farm's conservation objectives. The CAET also scores and ranks individual farms' activities based on the local and state conservation priorities to determine whether a particular farm's plan will obtain payments for conservation practices. For the 2017 fiscal year, NRCS is offering a number of activity "bundles" for cropland, pastureland, rangeland, and buffers, and many of these bundles are geared towards the organic production requirements. However, since NRCS has earmarked over 60 percent of the payments to reward new practices and enhancements, organic farmers, who already implement many of the CSP activities, may find their farms ranked lower than their conventional counterparts. Establishing an organic initiative within CSP, which would designate a certain amount of funds specifically for organic producers (much like the Organic EQIP Initiative), could assist organic producers in accessing the payments from this program and reward the good farming practices that organic farmers are already implementing on their operations.[129]

The Agricultural Marketing Services' (AMS) Organic Certification Cost Share Program (OCCSP) is another example of a USDA financial assistance program that has lagged in enrollment. The OCCSP assists certified organic operations by reimbursing up to 75 percent of their certification costs, up to $750 per year. Farmers have cited a number of reasons for underutilization of OCCSP.[128] Access to the program can be challenging and cumbersome, particularly in states that do not have a high population of organic farmers, and, therefore, do not have a streamlined process for advertising availability of the program or disbursing the cost share program funds. Some producers are generally opposed to government assistance and view this program as a direct subsidy rather than reimbursement of a business expense. Producers that obtain certification via a non-profit certifier rather than a state agency certifier often view interacting with yet another agency to access cost share funds as too burdensome. Some producers believe that the application process is too complex, and the funds provided by the cost share program do not reimburse enough of the associated costs of certification to make it worth their time. Finally, some farmers feel that the program application window is too narrow.

Recommendations: To facilitate farmer participation in existing programs, agencies must expand their outreach and education to inform farmers about opportunities.

- Improve information dissemination for resources that consolidate information on programs, regulations, and incentive programs that affect organic growers.
- Increase the number of incentive programs that explicitly support organic systems
- Ensure that existing programs that explicitly support organic farmers adequately meet their needs, are accessible, user friendly and transparent.
- Include an organic expert/advocate on advisory panels and in listening sessions that impact any agricultural policy decisions.
- Create an advisory committee that could serve as a formal source of information on organic farming systems for governmental agencies as they design programs and set priorities for environmental sustainability.

NEED FOR A SYSTEMS APPROACH

Ecological processes such as water and nutrient cycling, and balanced interactions among organismal communities support agricultural productivity while simultaneously contributing to natural resource conservation. Organic agriculture is an integrated production system that relies on interactions among local biotic and abiotic factors to sustain healthy ecological processes.

The majority of organic agriculture research takes a reductionist approach, attempting to isolate and evaluate the effect of one single practice. However, practices are not implemented in a vacuum, and farmers are ultimately forced to consider a combination of environmental objectives, productivity, and cost-efficiency when facing production and business decisions. Research must consider a multitude of parameters to evaluate and improve the entire farming system. While the research community has begun to recognize that more research should take a whole systems approach,[130] very little research currently meets this need.

Likewise, the importance of considering the whole system must be recognized when developing and implementing agricultural policy and programs. While much of the policy discussed in the preceding sections have isolated individual practices commonly implemented by organic, the assembly of organic practices as a whole must be understood and addressed to create system-level change. The benefits of organic systems are greater than the sum of the parts. Only when agencies encourage system-level transition as opposed to practice-by-practice adoption will the full benefits of organic agriculture be realized.

Recommendations: Research and policy must focus on organic farming as a system as opposed to a set of isolated individual practices.

- Increase funding for long-term research and research that takes a whole system approach, assessing effects across the farm system and incorporating a variety of metrics including sustainability, yield, and profitability
- Increase policies and programs that encourage the adoption of organic systems as opposed to simply rewarding individual practices
- Increase policies and programs that reward organic systems that integrate best organic practices as opposed to simple substitution of conventional methods and materials.

Participants listen to presentations on the intersection of environmental research and policy.

CONCLUSION

Organic farming practices build soil health, support biodiversity, conserve natural pollinators, decrease water pollution and contribute to climate resilience. Furthermore, these same practices result in ecosystem services that directly benefit farmers by improving crop quality and yield, and by reducing the need for costly inputs. In spite of these documented benefits, organic agriculture is rarely considered when policymakers and regulatory agencies set priorities and develop programs aimed at improving the sustainability of our agricultural system. By breaking down barriers that hinder farmer transition into the organic sector while simultaneously incentivizing environmentally sound farming techniques, policymakers are positioned to leverage existing government frameworks to meet conservation goals while simultaneously promoting a sustainable agricultural production system that benefits America's farming communities.

In addition to promoting the overall sustainability of U.S. agriculture, there is also room for improving organic agriculture. While all certified organic farmers are mandated by the NOP to support biodiversity and improve natural resources, farms vary in the types and extent of practices used. Implementation of conservation practices from farm to farm reflects the farmer's individual values, and personal experiences. Adoption of new or additional conservation techniques within organic farming is often influenced by the same factors facing conventional farmers when considering transition to organic. These factors include access to information and technical expertise, and competing recommendations and demands from farm certifiers, auditors, regulators and buyers. Furthermore, farmers must balance these tensions with resource availability and risk management, all the while maintaining profitability. Finally, many of these variables are likely to differ based on the size of the farm, the commodities produced, and the geographic locality. As with all farmers, organic farmers must navigate an intricate landscape as they consider the best on-farm conservation practices for their operations.

Increasing the adoption of environmentally friendly best practices on farms is complex, requiring the management of numerous competing pressures. However, improvements in research, policy, and extension and communication among the three can change the balance of competing factors. Addressing the challenges discussed in this report, including the reduction of competing production, marketing and regulatory tensions, will increase adoption of on-farm conservation practices on existing organic farms while facilitating new organic farmer transition to environmentally friendly organic farming, creating a pathway for farmers to increase the use of conservation practices.

Participants applaud a presenter at the Organic Confluences Summit.

Appendix

FEDERAL AGENCIES AND PROGRAMS THAT PARTICIPATED IN THE 2016 *ORGANIC CONFLUENCES:* *A Summit to Turn Environmental Evidence into Policy Practice*

Here we identify and briefly describe agencies and programs that participated in the 2016 Organic Confluences Summit. We feature tools and resources currently available for organic farmers and other stakeholders when they exist.

United States Department of Agriculture

The United States Department of Agriculture (USDA) houses 29 different Agencies and Offices.[131] USDA's mission is to provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management. USDA recognizes the importance of sustainable agriculture in maintaining the productivity of U.S. farmlands and preserving natural resources for generations to come. As such, part of its vision is to preserve our nation's natural resources through conservation, restored forests, improved watersheds, and healthy private working lands. One of its primary goals is to ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources.[132]

USDA's National Organic Program

The National Organic Program (NOP) is a regulatory program housed within USDA's Agricultural Marketing Service. It is responsible for developing national standards for organically produced agricultural products. These standards assure consumers that products with the USDA Organic seal meet consistent, uniform standards.[133]

Key activities of NOP include maintaining the list of certified organic operations and helping new farmers and business learn how to get certified; developing regulations and guidance on organic standards; managing the National List of Allowed and Prohibited Substances; accrediting certifying agents to certify organic producers & handlers; establishing international organic import and export policies; investigating and taking action on regulatory violation complaints; facilitating the work of the National Organic Standards Board, a Federal Advisory Committee; overseeing the Organic Certification Cost Share programs to support certified organic operators; providing training to certifying agents, USDA staff, & other stakeholders; and engaging and serving the organic community.[133]

USDA's Economic Research Service

The Economic Research Service (ERS) anticipates trends and emerging issues in agriculture, food, the environment, and rural America, and conducts high-quality, objective economic research to inform and enhance public and private decision making. ERS shapes its research program and products to serve those who routinely make or influence public policy and program decisions, and ensures quality, objectivity, and transparency in the statistical information it provides.[134]

ERS has been examining organic production and marketing issues for over three decades. It initially focused its studies on the emerging organic produce sector. In the 1990s, it began a U.S. statistical reporting series on certified organic acreage and livestock based on information from organic certifiers. During the past decade, ERS has substantially expanded research on the organic industry, examining the adoption of organic farming systems, production costs and returns in major crop and livestock sectors, and the characteristics of organic supply chains and consumer demand.[135]

USDA's Farm Service Agency

The Farm Service Agency (FSA) administers farm commodity, crop insurance, credit, environmental, conservation, and emergency assistance programs for farmers and ranchers. Its mission is to serve our nation's farmers and ranchers professionally, efficiently, equitably, and in a manner that is customer-, taxpayer- and employee-friendly. One of its primary goals is to increase stewardship of America's natural resources while enhancing the environment by providing resource stewardship opportunities on private lands and by targeting natural resource needs to maximize benefits.[136]

FSA also provides information aggregation services through its Bridges to Opportunity Program. This service allows FSA employees to provide farmers with information and resources on topics of interest that are offered by local, state, regional and national agricultural organizations.

One FSA program that promotes natural resource conservation and explicitly considers organic farmers is the Conservation Reserve Program (CRP). CRP is a land conservation program where, in exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. For instance, CRP can provide organic farmers with monetary assistance to establish natural borders around organically farmed land to improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.[137]

Additional FSA services that can support organic farmers include Marketing Assistance Loans, Farm Storage Facility Loans, and the Non-Insured Disaster Assistance Program.[137]

USDA's Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is the primary federal agency that works with private landowners to help them conserve, maintain and improve their natural resources. The Agency emphasizes voluntary, science-based conservation; technical assistance; partnerships; incentive-based programs; and cooperative problem solving at the community level. NRCS uses the Conservation Effects Assessment Project (CEAP) to quantify the environmental effects of conservation practices and programs, and develop the science base for managing the agricultural landscape for environmental quality. The goal of the program is to improve the efficacy of conservation practices and programs by quantifying conservation effects and providing the science and education base needed to enrich conservation planning, implementation, management decisions and policy. Research, modeling, assessment, monitoring and data collection are all used to translate science into practice.[138, 139]

NRCS also offers a number of voluntary programs to provide technical and financial assistance to help manage natural resources in a sustainable manner. Programs range from assistance to develop conservation plans, install conservation practices or enhancements, purchase conservation easements, and grants for innovation and targeted initiatives. The NRCS Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. The EQIP National Organic Initiative specifically provides financial assistance to help implement conservation practices for organic producers and those transitioning to organic to address natural resource concerns. It also helps growers meet requirements related to NOP requirements and certain program payment limitations.[138]

USDA's Agricultural Research Service

The Agricultural Research Service (ARS) is the U.S. Department of Agriculture's chief scientific in-house research agency, and is tasked with the job of finding solutions to agricultural problems that affect Americans every day from field to table. ARS prioritizes sustainability by conducting research to develop and transfer solutions to agricultural problems of high national priority, and provide information access and dissemination to enhance the natural resource base and the environment, among other things.[140]

One ARS research activity that contributes to our understanding of sustainability in organic systems is the Farming Systems Project (FSP) located in Beltsville, MD. The FSP is a long-term comparison of five cropping systems established in 1996 to: (1) study the basic biology and ecology of farming systems using a multidisciplinary, systems approach and (2) address farmer-defined management and production barriers to the development and adoption of sustainable cropping systems in the mid-Atlantic. FSP also places special emphasis on organic farming to better understand fundamental differences between conventional and complex organic systems to better serve the needs of organic farmers.[141]

USDA's ARS currently has one scientist—Dr. Eric Brennan—exclusively devoted to organic agriculture research. Dr. Brennan focuses on crop improvement and protection, and his research is based out of the ARS research station in Salinas, CA.

USDA's National Institute of Food and Agriculture

The National Institute of Food and Agriculture (NIFA) provides leadership and funding for programs that advance agriculture-related sciences and invest in and support initiatives that ensure the long-term viability of agriculture. NIFA collaborates with leading scientists, policymakers, experts, and educators in organizations throughout the world to find innovative solutions to the most pressing local and global problems. One of NIFA's focuses is to support scientific progress, made through discovery and application that sustains natural resources and the environment.[142]

NIFA provides funding for research, education and extension activities that promote understanding of the ecosystem services of organic agriculture. The two main competitive programs specific to organic are the Organic Transitions (ORG) program, which prioritizes research on ecosystem services, and the Organic Agriculture Research and Extension Initiative (OREI) program, which focuses on projects that enhance the ability of organic processors and producers to improve the quality of organic products.[143, 144]

USDA National Agroforestry Center

Agroforestry intentionally combines agriculture and forestry to create integrated and sustainable land-use systems to take advantage of the interactive benefits from combining trees and shrubs with crops and/or livestock. The USDA National Agroforestry Center (NAC) accelerates the application of agroforestry through a national network of partners through which they conduct research, develop technologies and tools, coordinate demonstrations and training, and provide useful information to natural resource professionals.[145]

USDA's Climate Hubs

USDA's Climate Hubs are a unique collaboration of agencies across USDA. Agencies supporting the Hubs include the Agricultural Research Service, Natural Resources Conservation Service, National Institute of Food and Agriculture, Forest Service, Farm Service Agency, Risk Management Agency, Rural Development, Animal and Plant Health Inspection Service, and the Climate Change Program Office. The mission of the Climate Hubs is to develop and deliver science-based, region-specific information and technologies, with USDA agencies and partners, to agricultural and natural resource managers that enable climate-informed decision-making, and to provide access to assistance to implement those decisions with the vision of a robust and healthy agricultural production and natural resources system.[146]

Cover cropping, a technique commonly used by organic farmers, is one tool actively promoted to address both climate adaptation and mitigation. The Climate Hub also partners with the USDA Office of the Chief Economist to publicize the Ten Building Blocks for Climate Smart Agriculture.

USDA's Building Blocks for Climate Smart Agriculture & Forestry

Building Blocks for Climate Smart Agriculture and Forestry is USDA's framework for helping farmers, ranchers, and forestland owners respond to climate change. The effort relies on voluntary, incentive-based conservation, forestry, and energy programs to reduce greenhouse gas emissions, increase carbon sequestration, and expand renewable energy production in the agricultural and forestry sectors. It is implemented across multiple USDA agencies and programs such as NRCS EQIP and the Rural Development's Rural Business-Cooperative Service (RBS).[147]

USDA Office of Environmental Markets

The USDA Office of Environmental Markets (OEM) was established in response to Section 2709 of the 2008 Farm Bill directing USDA to develop uniform guidelines for quantifying environmental benefits from conservation and land management activities to facilitate participation of farmers, ranchers, and forest landowners in emerging environmental markets. The office coordinates USDA environmental markets activities and provides market information and support for other federal and state agencies, the private sector and the public.[148]

USDA's Foreign Agricultural Service

The Foreign Agricultural Service (FAS) integrates work on expanding trade in sustainable and organic products throughout the FAS mission goals, including: creating and maintaining a global market intelligence information system; negotiating and enforcing market-expanding trade agreements; preventing or resolving foreign technical barriers to trade; pursuing the development of rules-based international systems that facilitate global trade; and enhancing partner countries' capacity for agricultural development and participation in international trade through USDA-led technical assistance and training.[149]

FAS works to preserve the ability of U.S. agricultural exporters to market organic and sustainable products to foreign consumers, and ensure that any foreign government efforts to regulate approval of organic and sustainable labels provide equal access to U.S. exporters. Once the markets are open, FAS partners with U.S. agricultural trade associations, cooperatives, state regional trade groups and small businesses to share the costs of overseas marketing and promotional activities that help build commercial export markets for these products.[149]

National Academies of Sciences, Engineering and Medicine: Board on Agriculture and Natural Resources

The National Academies of Sciences is not a federal agency but was created by Congressional mandate in 1863 to be a source of independent, non-governmental advice on matters of science and technology. Within its operational arm, the Board on Agriculture and Natural Resources (BANR) is the major program unit of the National Academies of Sciences, Engineering, and Medicine responsible for organizing and overseeing studies on agriculture, forestry, fisheries, wildlife, and the use of land, water, and other natural resources. A variety of problems and causes drive work on the issues in these fields. Often conflicts arise between growing demands for food and resources and the impacts of developing and producing those resources on the natural ecosystem. The need to sustain, restore and improve the productivity of agriculture for the economic well-being of the nation can also generate vital questions.[150]

The Board maintains a critical overview of the several fields under its purview so that it is aware of relevant work relating to public policy formulation, research frontiers, technological developments, human resource needs, economic and social trends. The Board is also responsible for planning new studies, conducting oversight on projects carried out by its subsidiary committees, and making an annual appraisal of emerging issues related to food, fiber, fuel and the natural resource base supporting their production.[151]

One study relevant to the organic community is Toward Sustainable Agricultural Systems in the 21st Century that makes recommendations to help farming systems shift away from exclusively emphasizing low costs and high production and toward developing a more holistic perspective of how farms provide benefits to society.[150]

White House Council on Environmental Quality

The Council on Environmental Quality (CEQ) coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. Additionally, CEQ oversees the Office of the Federal Environmental Executive whose role it is to promote sustainable environmental stewardship throughout the Federal government.[152]

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Our Vision

A sustainable and secure food system that promotes the health of humans and the environment.

Our Mission

Our mission is to conduct and convene credible, evidence-based science on the environmental and health effects of organic food and farming and communicate the findings to the public.

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