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# USDA Conservation Technical Assistance and Within-Field Resource Concerns

Andrew B. Rosenberg and Steven Wallander







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# USDA Conservation Technical Assistance and Within-Field Resource Concerns

Andrew B. Rosenberg and Steven Wallander

## Abstract

The U.S. Department of Agriculture's (USDA) Conservation Technical Assistance (CTA) program provides conservation planning and field-level assessments of conservation strategies, partnering with a network of county field offices, conservation districts, and State agencies. The CTA program supports these efforts with more than \$700 million per year in Federal funding. A similar amount of technical assistance funding is provided to directly support the planning required to enroll land in the USDA's working lands programs, such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (USDA, Office of Budget and Program Analysis, 2019). The CTA program and the working lands programs help reduce soil erosion, improve water quality conditions, and address other resource conditions referred to as resource concerns. This bulletin looks at how many fields in several major commodity crops have self-reported, on-field resource concerns and whether the producers received technical assistance to address these concerns from USDA or other sources. Using field-level data from the Agricultural Resource Management Survey (ARMS) for soybeans, wheat, oats, and cotton, the analysis focuses on within-field, predominately soil-related concerns—such as water-driven erosion, wind-driven erosion, soil compaction, poor drainage, low organic matter, within-field water quality concerns, or some other concern—that are self-reported by survey respondents. Respondents report that 49 percent of fields represented have at least one resource concern and 26 percent have multiple resource concerns. Of the fields represented with at least one concern, only 24 percent received technical assistance. Fields with three or more respondent-reported concerns are more likely to have received assistance. The largest source of assistance is the USDA's Natural Resources Conservation Service (NRCS), but other USDA agencies, cooperative extension, and non-USDA entities also provide technical assistance. Notably, 25 percent of the fields having received technical assistance for at least one resource concern obtained assistance from multiple sources.

**Keywords:** resource concerns, technical assistance, working lands conservation programs, soil health, conservation practice, erosion, soil compaction, low organic matter, poor drainage

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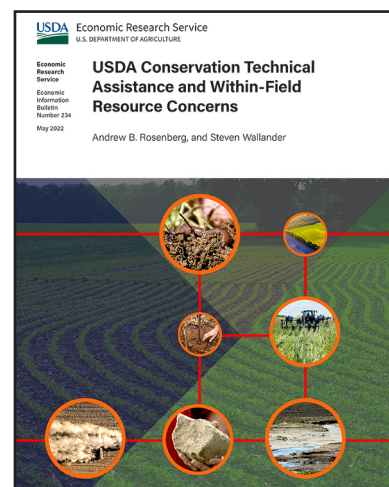
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# USDA Conservation Technical Assistance and Within-Field Resource Concerns

Andrew B. Rosenberg and Steven Wallander

## What Is the Issue?

The U.S. Department of Agriculture's (USDA) working lands conservation programs and technical assistance programs, largely administered by USDA's Natural Resources Conservation Service (NRCS), annually invest about \$5 billion to increase the adoption of conservation practices across the agricultural landscape. Nearly \$2 billion has been allocated per year to conservation technical assistance alone, both as a standalone resource and to support financial assistance programs. At the core of these programs is the resource assessment and planning process. Through this voluntary process, USDA employees work with producers (farmers and ranchers) and landowners to identify and then address resource concerns, such as soil erosion and low organic matter, using a wide range of conservation practices. Many producers have also received technical assistance from several other sources, such as State agencies, conservation districts, technical service providers, and cooperative extension agents. National assessments and inventories such as the National Resources Inventory (NRI), Rapid Carbon Assessment (RaCA), and Conservation Effects Assessment Project (CEAP), are currently conducted for many resource concerns. This bulletin complements existing national inventories of resource concerns by examining the extent of technical assistance participation among fields with specific concerns.



## What Did the Study Find?

This bulletin used information from field-level surveys of farmers (crop producers) growing wheat, soybeans, oats, or cotton—which collectively account for 43 percent of planted cropland in the United States—to examine within-field, soil-related resource concerns.

- Forty-nine percent of the represented fields have at least one self-reported resource concern.
- Water-driven erosion was the most prevalent self-reported resource concern (24 percent of fields). Comparing these estimates to the NRI revealed farmer reporting of resource concerns is consistent with a model-based national inventory.

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- Soil compaction (22 percent of fields), poor drainage (19 percent), and low organic matter (13 percent) were other common self-reported concerns.
- Farmers reported multiple resource concerns for 26 percent of fields.
- Farmers reported at least one concern on 54 percent of the fields in the Midwest region, 52 percent of fields in the West region, 46 percent of fields in the Atlantic region, 45 percent of fields in the Plains regions, and only 25 percent in the South region.
- In the West region, wind-driven erosion and low organic matter were the most prevalent self-reported concerns, while in the Midwest, South, and Atlantic regions, water-driven erosion, soil compaction, and poor drainage were most prevalent.

USDA technical assistance supports the adoption of conservation practices to address producer resource concerns through its nine-step planning process. Producers can also seek assistance from several other partners and sources. The data in this bulletin reveal the extent of technical assistance for a large fraction of cropland by resource concern, region, and source of assistance.

- Farmers received technical assistance from a Federal or non-Federal source for 24 percent of fields with at least one untreated resource concern. Over one-third (37 percent) of represented fields have a self-reported resource concern but have not yet received assistance.
- Farmers were more likely to receive technical assistance to treat water-driven erosion (30 percent of fields reporting water-driven erosion) than for soil compaction (18 percent).
- Farmers were twice as likely to receive technical assistance on fields with three or more self-reported resource concerns compared with fields having one resource concern.
- USDA's NRCS was a source of technical assistance for 67 percent of the fields that obtained assistance, followed by other local sources (36 percent) and the Cooperative Extension Service (19 percent). Some fields received assistance from multiple sources (25 percent).
- The Cooperative Extension Service was used as a source of assistance more often in the Atlantic and Southern regions and less often in the Midwest, Plains, and West regions.

## How Was the Study Conducted?

To examine the prevalence of resource concerns and technical assistance, this bulletin used the Agricultural Resource Management Survey (ARMS), an annual survey of farm production practices conducted jointly by USDA's Economic Research Service and National Agricultural Statistics Service agencies. Specifically, this research used data from the Production Practices and Cost Report, a crop-specific, field-level version of ARMS, which surveys growers of different crops each year on a rotating basis. This bulletin used four versions of the survey: oats (2015), cotton (2015), wheat (2017), and soybeans (2018). These ARMS versions asked farmers whether they have any of a set of within-field soil and water resource concerns, and if they received technical assistance to evaluate each concern on the surveyed field. Finally, if a farmer received technical assistance for a particular concern, the farmer was asked about the source of assistance received. The data represent the first national-level assessment of self-reported resource concerns and technical assistance.



# USDA Conservation Technical Assistance and Within-Field Resource Concerns

## Introduction

USDA's working lands programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Conservation Technical Assistance (CTA) program, provide financial assistance and complementary technical assistance to agricultural producers to develop conservation plans and adopt conservation practices on land in active production.<sup>1</sup> Implementation of financial assistance programs such as EQIP and CSP depends on the planning services provided by CTA. Technical assistance involves identifying within-field and off-field resource concerns and working with producers to address those concerns. Some of the prescribed practices in the plans may be eligible for financial assistance—Federal payments that cover a portion of the costs of implementing practices—through EQIP, CSP, or the other working lands programs.<sup>2</sup>

In the 2015 Agricultural Resource Management Survey (ARMS) farm-level questionnaire, USDA's Economic Research Service (ERS) asked farm operators whether their operation ever received financial assistance from EQIP or CSP and whether they ever received technical assistance. Of all agricultural operations, 11 percent received financial assistance at some point; those operations cover 33 percent of all agricultural acres. Technical assistance has been somewhat more common, with 16 percent of all operations, spanning 37 percent of all agricultural acres in the United States, obtaining assistance at some point.

For many reasons, only a portion of U.S. agricultural producers participate in working lands programs. Program funding is limited, and national, State, and local program leaders target program funds to address specific resource concerns and practices. Additionally, some applicants may not be eligible for financial assistance. For example, in EQIP, producers are restricted based on the program's payment limitations and Highly Erodible Land compliance provisions, among other restrictions (USDA, NRCS, 2016). On-field resource concerns also play an important role. Working lands programs are provided on a voluntary basis, and producers are more likely to participate if they perceive there are sufficient on-farm benefits to seek financial and technical assistance for a given field. Part of this assessment of benefits includes farmers evaluating whether they have significant within-field resource concerns. For example, an ERS analysis of the 2016 ARMS field-level questionnaire indicated 30 percent of corn farmers did not apply for conservation funding because they were unaware of any environmental problems on their fields. This percentage greatly exceeds the 8 percent of corn farmers who did not apply because they believed

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<sup>1</sup> In this bulletin, the term agricultural "producers" (or just producers) refers to all types of agricultural producers (e.g., farmers and ranchers), or landowners that may receive financial or technical assistance from NRCS. The term "farmers" refers to producers that grow crops. This term is only used when referring to the results from ARMS.

<sup>2</sup> Other programs with any spending from 2002 through 2020 include: Agricultural Management Assistance (AMA), Agricultural Water Enhancement Program (AWEP), Chesapeake Bay Watershed Initiative (CBWI), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development Program (RCD), Watershed Rehabilitation Program (WRHB), Emergency Watershed Protection Program (EWP), and Wildlife Habitat Incentive Program (WHIP).



obtaining the necessary technical assistance to complete the application was too difficult.<sup>3</sup> This implies that availability of technical assistance is not a major constraint for most farmers. Further, financial and technical assistance programs have limited budgets, and some producers may apply for financial assistance but not receive it if their proposals are determined to have less environmental benefits than other applicants.

This bulletin seeks to fill two gaps in knowledge. First, the data in this bulletin provide new insights about the prevalence of self-reported soil and water resource concerns on cropland for four major commodity crops (cotton, oats, soybeans, and wheat). Second, this bulletin explores the degree to which farmers with resource concerns receive technical assistance from NRCS or from other sources. This bulletin complements existing national inventories and assessments of resource concerns and provides estimates of the prevalence of concerns, such as soil compaction, for which there are no other national inventories.

## What Are Resource Concerns?

Farming requires the combination of multiple resources—soil, water, air, plants, animals, and energy. When management practices are expected to degrade one of these to an extent that the sustainability or intended use of the resource is impaired, then a given land unit is said to have a “resource concern.” The Natural Resources Conservation Service (NRCS) has identified 47 specific resource concerns that form the basis of conservation planning, with each falling into 1 or more of the 6 broad categories listed above (USDA, NRCS, 2019). NRCS formally defines a resource concern as:

“...the resource condition that does not meet minimum acceptable condition levels as established by resource planning criteria shown in the Field Office Technical Guide (FOTG), Section III. This implies an expected degradation of the soil, water, air, plant, animal, or energy resource base to the extent that the sustainability or intended use of the resource is impaired.”

Officially defined resource concerns can apply to some or all types of agricultural land use: cropland, rangeland, pasture, forests, farmsteads, associated agricultural lands, and water. This bulletin focuses on a subset of within-field resource concerns related primarily to soil and water on cropland—i.e., water-driven erosion, wind-driven erosion, soil compaction, poor drainage, low organic matter, within-field water quality concerns, and any other soil or water concerns.

The specific resource concern of water-driven erosion can provide a good example of a within-field resource concern. Like other soil resource concerns, erosion results from a combination of geographic factors, such as local climate and high slopes, as well as past and ongoing management and land-use decisions, such as years of conventional tillage (USDA, NRCS, 2008). Erosion removes topsoil rich in organic matter, impairing soil productivity. Erosion can also lead to downstream pollution, resulting from increased sediment and nutrient loads entering waterways.

Producers may take steps to address within-field resource concerns on their own. A producer may choose to directly resolve their field’s concerns, particularly if the concern impacts profitability, and the implemented practices are not cost prohibitive. For example, to reduce soil compaction over the long term, producers may increase their fields’ soil organic matter or may limit the use of heavy machinery to days when fields are dry (USDA, NRCS, 1996). Alternatively, if directly addressing a resource concern is too costly or time-consuming, producers may decide to continue using their current management system.

If producers have significant resource concerns but lack the ability to implement the appropriate practices, or need financial assistance to cover costs, they may contact their local NRCS office or conservation district

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<sup>3</sup> Producers could cite multiple reasons for not applying, and not all producers had a specific reason.

to request technical and/or financial assistance. The amount of financial and technical support available for specific resource concerns or practices depends on program priorities set at the local, State, and Federal levels (USDA, NRCS, 2010a).

Addressing many resource concerns may affect both within-field productivity and on-farm and off-farm environmental quality. In some ways, the public, off-farm benefits of addressing resource concerns complement the private, within-field benefits; in other ways, there is a trade-off between the two types of benefits. For programs providing payments for adopting practices, producers are more likely to participate if there are private benefits, such as positive yield impacts or reduced input or management costs (Bowman et al., 2016). On the other hand, if producers have adequate incentive to adopt practices on their own, it may not be an efficient use of program funds to finance their implementation (Claassen et al., 2014). A primary goal of this bulletin is to determine whether producers found it beneficial to seek outside guidance to treat self-reported resource concerns.

## Resource Inventories and Assessments

Resource concerns have become central to USDA and State conservation programs largely as a result of years of research on their effects on soil productivity and environmental quality (Magdoff and Weil, 2004). To build the conservation programs on this scientific foundation, NRCS has developed and regularly updated several national resource inventories and assessments.

The National Resources Inventory (NRI), which was first released in 1977 as an extension of an earlier series of studies called the Conservation Needs Inventory, tracks certain resource concerns, including water-driven and wind-driven erosion using data from over 800,000 points across the United States (Schnepf and Flanagan, 2016). Wetlands and land-use change are other major areas of focus for the NRI. The NRI serves as a foundational dataset for tracking soil erosion, with erosion estimates based on extensive soil and land-use data obtained from careful interpretation of remote sensing imagery as well as administrative data (USDA, NRCS, 2020a).

The Soil and Water Resources Conservation Act (RCA) extended the USDA's assessment and planning authority beyond the scope of NRI by directing the Department to assess trends in soil, water, and related resources while also evaluating needs for program and policy actions related to those trends (USDA, RCA, 2011). With respect to soil health, the 2011 RCA Appraisal focused on erosion, soil carbon, and soil salinity (USDA, RCA, 2011). Other resources assessed by the RCA Appraisal include wildlife habitat, wetlands, water quantity, and water quality. Beyond the RCA Appraisal report, a variety of other RCA publications provide additional resource assessments.

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to assess the environmental impacts of conservation practices and programs and build the scientific foundation for agricultural conservation. Among other efforts, CEAP conducts detailed surveys of management practices and uses the resulting data as inputs in field and watershed-scale, process-based simulation models, such as the Soil and Water Assessment Tool (SWAT) and the Agricultural Policy Environmental eXtender Model (APEX) (USDA, NRCS, 2011). USDA also conducts national assessments of soil properties such as soil organic carbon in compilations of soil surveys conducted across many years, with the data available in the Soil Survey Geographic Database (SSURGO). These large inventory and assessment efforts provide a critical foundation for USDA conservation programs; however, each of these efforts only focus on a subset of the 47 official NRCS resource concerns. Many concerns are difficult to evaluate in a nationally comprehensive way because they require detailed, on-site assessments usually only undertaken during the technical assistance process. Field visits or direct monitoring can provide potential alternative sources of data, but field visits only provide data for fields that already received technical assistance. Additionally, direct monitoring is too costly to be a practical approach at scale.

This bulletin takes the novel approach of asking agricultural producers to self-report their resource concerns in a nationally representative survey. For resource concerns requiring careful within-field assessments, self-reported data offer a data source that includes both NRCS program participants and non-participants. Furthermore, since producers are more likely to initiate the conservation planning process if they identify at least one resource concern, self-reported resource concerns provide information unavailable in other national assessments.

The self-reported resource concerns used in this bulletin have some limitations and key differences from other types of national assessments of concerns. Producers may evaluate resource concerns differently from USDA programs and conservationists.<sup>4</sup> In some cases, producers may not identify a concern, or a potential concern, where a conservation planner would. The types of concerns included in the survey were selected to include those concerns about which farmers would likely have reasonably good information. The survey and this bulletin do not attempt to evaluate the link between off-field resource concerns and technical assistance. The survey and this bulletin offer a snapshot in time and do not capture the dynamic nature of resource concern assessments. It is possible some fields had resource concerns in prior years that were addressed. It is also possible local weather, recent program participation, or other factors varying over time could influence farmers' assessments of resource concerns. Lastly, farmers are also not asked about the potential for a field to develop a resource concern in the future, which conservation planners would consider in the conservation planning process.

## What Is Conservation Technical Assistance?

Conservation technical assistance, sometimes shortened to technical assistance in this bulletin, is a service that helps producers to develop skills and knowledge for maintaining the natural resources involved in agricultural production. It ranges from providing recommendations from recent scientific studies to developing plans and designs for implementing specific management activities, or to providing technical support about how to install conservation practices (Stubbs, 2010). USDA and other organizations work with land managers to develop field-level resource assessments and management recommendations to address resource concerns. Technical assistance can be a standalone service or in support of financial assistance programs. Various sources offer technical assistance for conservation practices, with the NRCS serving as the largest provider in the United States (USDA, NRCS, 2010b). Other important sources include State agencies, conservation districts, technical service providers, and cooperative extension agents, each of which is described in the next section.

Producers may seek technical assistance for several reasons. First, technical assistance provides them with a way to gain practical knowledge from trained technicians about practices that can improve their farm's productivity and sustainability. Second, technical assistance may help to clarify the benefits and risks of adopting a new practice. Third, producers may seek technical assistance for fields where they may not know the causes of the problem. Field visits from conservation planners can reveal underlying causes of issues about which producers were previously unaware. For example, low organic matter is often difficult to diagnose without proper soil testing experience. Fourth, producers may seek technical assistance as part of the application process of applying for and receiving cost-share assistance for adopting conservation practices through USDA working lands programs such as EQIP.

Technical assistance is useful for both producers and for those in charge of conservation program delivery working to achieve program goals. The information gathered during field visits can provide producers with field-level guidance about practices to improve both a field's environmental quality and productivity. Technical assistance can also help to ensure practices are implemented appropriately. At the program level, data collected through technical assistance can help target cost-share funds for programs—such as EQIP and CSP—to address priority resource concerns.

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<sup>4</sup> Soil Conservationists at NRCS are responsible for working with landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems (USDA, NRCS, 2022).



While national inventories provide information on the overall prevalence of resource concerns, and the RCA program reports provide information on total technical assistance provided, a dataset such as ARMS that brings both of these together is needed. Some studies have examined how producers adopt practices to resolve resource concerns. For example, a few studies have emphasized the importance of perceived benefits or the applicability of soil health practices (Arbuckle and Roesch-McNally, 2015; Bergtold et al., 2012; Dunn et al., 2015; Gillespie et al., 2007), as well as the influence of biophysical factors such as erodibility in adoption decisions (Soule et al., 2000; Wade and Claassen, 2017). Much less is known about producers' decisions to receive technical assistance, a topic of substantial relevance even for producers who adopt practices without financial assistance. For example, field-level assessments conducted by NRCS conservationists may reveal additional resource concerns or provide additional treatment suggestions for resource concerns. Thus, this bulletin determines how many farmers with self-reported resource concerns have received technical assistance.

## Where Can Agricultural Producers Receive Conservation Technical Assistance?

The largest provider of conservation technical assistance is the USDA's Natural Resources Conservation Service (NRCS). NRCS conservation technical assistance, supported by several programs within the agency, is largely implemented through the conservation planning process. Typically, the conservation planning process begins when a producer reaches out to NRCS. An NRCS conservationist will subsequently visit the operation to work with the producer to determine which resource concerns are present on each field and how severe they are using a rigorous field-level assessment process for each concern. The planning process is comprehensive and progressive, and an assessment is completed for many resource concerns regardless of whether they were already identified by the producer (USDA, NRCS, 2014). The conservationist and producer will then evaluate different scenarios involving combinations of practices for each field to address each concern and develop an appropriate conservation plan based on an in-depth inventory of soil data and other field-level data compiled during screening (USDA, NRCS, 2014). NRCS conservationists select practices to address the resource concerns identified after accounting for agronomic and environmental benefits in addition to economic costs. Once a producer has developed a conservation plan, the producer may use it to apply for financial assistance in programs such as EQIP or CSP (Wallander et al., 2019). Once a plan is in place, NRCS can also assist with practice design, implementation, and evaluation (USDA, NRCS, 2010b).

Within NRCS, the CTA program serves as the largest source of conservation technical assistance. The CTA program has served as the primary resource for developing conservation plans, but CTA also assists with practice design and implementation (USDA, NRCS, 2010b). It funds technical assistance activities that occur separate from or before receiving financial assistance (USDA, NRCS, 2010b). Additionally, CTA assists producers in meeting compliance provisions outlined in the Food Security Act of 1985 (USDA, NRCS, 2010b).

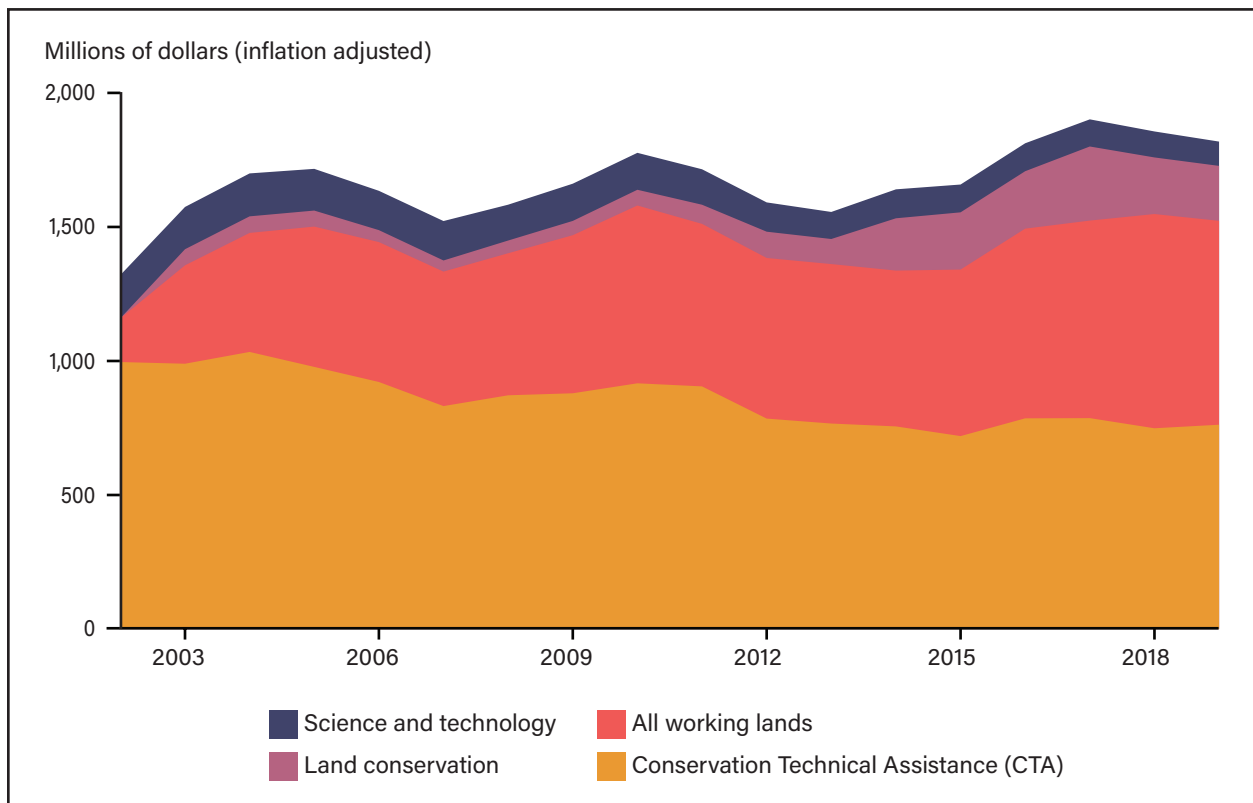
NRCS working lands programs also provide technical assistance. Technical assistance that a producer receives while under a financial assistance contract is funded through working lands programs, such as EQIP or CSP. Activities funded through working lands programs are like those funded by CTA but consist primarily of activities required to complete cost-sharing contract obligations. NRCS's *Conservation Programs Manual* has specified that technical assistance for financial assistance contracts may include "development of implementation requirements, designs, operation and management plans, and conservation practice or activity layout" and that "NRCS is responsible for reviewing and certifying all conservation practices and activities after the participant completes them." Alternatively, producers can choose to receive technical assistance for NRCS contracts from State agencies or technical service providers (USDA, NRCS, 2020b).

The scope of NRCS technical assistance has changed over time. NRCS started in 1933 as the Soil Erosion Service (SES), and it consisted of demonstrations of the benefits of soil conservation. Congress subsequently passed the Soil Conservation Act in 1935, which established a more permanent Soil Conservation Service

(SCS) and expanded the use of demonstration projects. By 1994, when the SCS was given its current name—the Natural Resources Conservation Service—the agency had expanded its focus to include expanded financial assistance administration and a larger variety of resource concerns (USDA, NRCS, 2021).

Until the early 2000s, the majority of the NRCS budget was allocated toward technical assistance (Pavelis et al., 2011). Budgets for NRCS financial assistance programs have increased substantially in recent years, but funds for technical assistance have modestly increased. Figure 1 shows how NRCS’ technical assistance spending has changed since 2002. CTA spending—which is funded through annual appropriations bills—has decreased after adjusting for inflation. On the other hand, spending on technical assistance in support of working lands programs—which are funded through each multi-year Farm Bill—has increased with total program funding. The total budgeted amount for CTA and in support of working lands programs was about \$1.5 billion in 2019 (USDA, OBPA, 2019). Finally, technical-assistance spending for science and technology such as soil surveys has decreased slightly over the same period.

Figure 1  
**Natural Resources Conservation Service (NRCS) technical assistance spending (from Resource Conservation Act reports)**



Notes: The consumer price index for urban consumers (CPI-U) is used to convert nominal values to real (adjusted for inflation) 2019 U.S. dollars. For working lands programs, the figure only includes USDA, Natural Resources Conservation Service (NRCS) technical-assistance spending in support of financial assistance programs. Land conservation category includes technical assistance provided by NRCS in support of land conservation programs. Financial assistance for the Conservation Reserve Program is provided through the USDA, Farm Service Agency. Within “Science and technology,” most funding goes to soil surveys. In later years, “All working lands” largely comprises the Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP); it also includes several smaller programs throughout the years: Agricultural Management Assistance (AMA), Agricultural Water Enhancement Program (AWEP), Chesapeake Bay Watershed Initiative (CBWI), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development Program (RCD), Watershed Rehabilitation Program (WRHB), Emergency Watershed Protection Program (EWP), and Wildlife Habitat Incentive Program (WHIP).

Source: USDA, Economic Research Service using data from USDA, Natural Resources Conservation Service, Resource Conservation Act Report, National Conservation Programs Profile.

Several sources outside USDA also offer technical assistance. Conservation districts, in addition to their roles in prioritizing resource concerns and organizing program delivery at the local levels, are a significant source of conservation technical assistance (USDA, NRCS, 2010a). Depending on agreements made between conservation districts and NRCS, either organization may serve as the primary source of technical assistance in each locality (USDA, NRCS, 2010b). State agencies may also play a key role in providing funding and technical assistance for localities through conservation districts (Intertribal Agricultural Council, 2008).

Producers participating in NRCS working lands programs may decide to receive some level of technical assistance from third-party sources called technical service providers (TSPs). Certified TSPs—the majority of which are in the private sector—can provide technical assistance to producers participating in farm bill conservation programs such as EQIP, and producers may be reimbursed for these services. TSPs may help with conservation planning and designing practices. Producers can be reimbursed for services provided by TSPs for contracted conservation activities (USDA, NRCS, 2020b). In 2009, obligations to TSPs were nearly \$50 million of the total USDA technical assistance budget (Stubbs, 2010).

Alternatively, producers may engage the Cooperative Extension System (CES), a nationwide, noncredit educational network connecting agricultural producers to land-grant universities across the United States, to learn practical information stemming from the latest science and technological research (USDA, NIFA, 2020). Some of the CES' funding comes from USDA's National Institute of Food and Agriculture (NIFA), as well as from State and local governments. Extension offers a two-way flow of information between land-grant universities and producers—via publications, workshops, training, and other forms of communication (Brugger and Crimmins, 2015). In 2019, soil and water were among the most highly funded subjects of investigation by NIFA, accounting for about \$130 million of funding (USDA, NIFA, 2021). However, in real U.S. dollars, USDA's support of extension activities has steadily declined since the 1970s, while the share of State funding has increased over the same period (Wang, 2014).

## Data Used

This bulletin has relied on data from the crop-specific, field-level version of the Agricultural Resource Management Survey (ARMS)—an annual survey jointly sponsored by the USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS). The crop-specific, field-level version of the survey, called ARMS Phase 2, surveys growers of specific crops each year, and for most years, only surveys one crop. This phase of ARMS is conducted in the fall of each survey year, typically after the crop has been harvested. For each surveyed farm, the survey collects data on farm management activities for a randomly chosen field. Respondents are asked to list all their fields being used to grow the target commodity, then the enumerator randomly selects one field to be the subject of the questionnaire. This bulletin has used several different years of the Phase 2 survey: oats (2015), cotton (2015), wheat (2017), and soybeans (2018).<sup>5</sup> These survey years provided 6,284 survey responses in total to analyze. The response rate was 53 percent across the four survey versions. Table A1 in appendix A identifies the States included in each year's surveys.

In this bulletin, all estimates for the share of fields with given resource concerns or fields receiving technical assistance are calculated using the ARMS Phase 2 weights (USDA, ERS, 2021). Weights account for sample stratification as well as survey nonresponse. When responses were weighted by crop acreage, responses across all survey versions used in the analysis covered land in all major regions of the contiguous United States and represent approximately 138 million acres of cropland, 43 percent of all planted acreage in cropland in the United States in 2018 (USDA, NASS, 2020). Statistics in this bulletin often pooled across all survey versions,

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<sup>5</sup> These questions were also included in the corn (2016) survey. However, the wording for this version restricted the response to those fields that received technical or financial assistance, so a larger share of survey respondents indicated they did not have the concerns. Thus, this year of the survey has been omitted from the analysis.



and since soybeans encompass a larger area of cropland, this research weighed survey responses from the soybeans (2018) survey more heavily. Thus, percentages across all versions resemble those of the soybeans (2018) survey version most closely. Furthermore, in most cases contained within this report, percentages are reported for fields rather than acreage. Scaling the report's results with acreage-based results is less reliable, as resource concerns may only apply to part of a field. Results are only acreage-weighted when ARMS results are compared with results from the National Resources Inventory (NRI), where this caveat is acknowledged.

In each of the survey versions used for the analysis, farmers were asked whether they have several within-field resource concerns.<sup>6</sup> Specifically, they were asked whether fields have water-driven erosion, wind-driven erosion, soil compaction, poor drainage, low organic matter, within-field water quality concerns, or other concerns. Other concerns could include any soil or water concerns not explicitly asked about. Subsequently, farmers were asked if they received technical assistance to address each specific resource concern on the surveyed field. Finally, if a surveyed farmer did receive technical assistance for a particular concern, the farmer was asked about the sources of assistance. Farmers could indicate they received assistance from the NRCS, a cooperative extension service, from a USDA agency other than NRCS, or from some other non-Federal source, such as a conservation district or State agency. Farmers could list multiple specific sources.

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<sup>6</sup> The "ARMS Farm Financial and Crop Production Practices" webpage on the USDA, ERS website includes information on questionnaires and manuals, as well as documentation on survey methods.

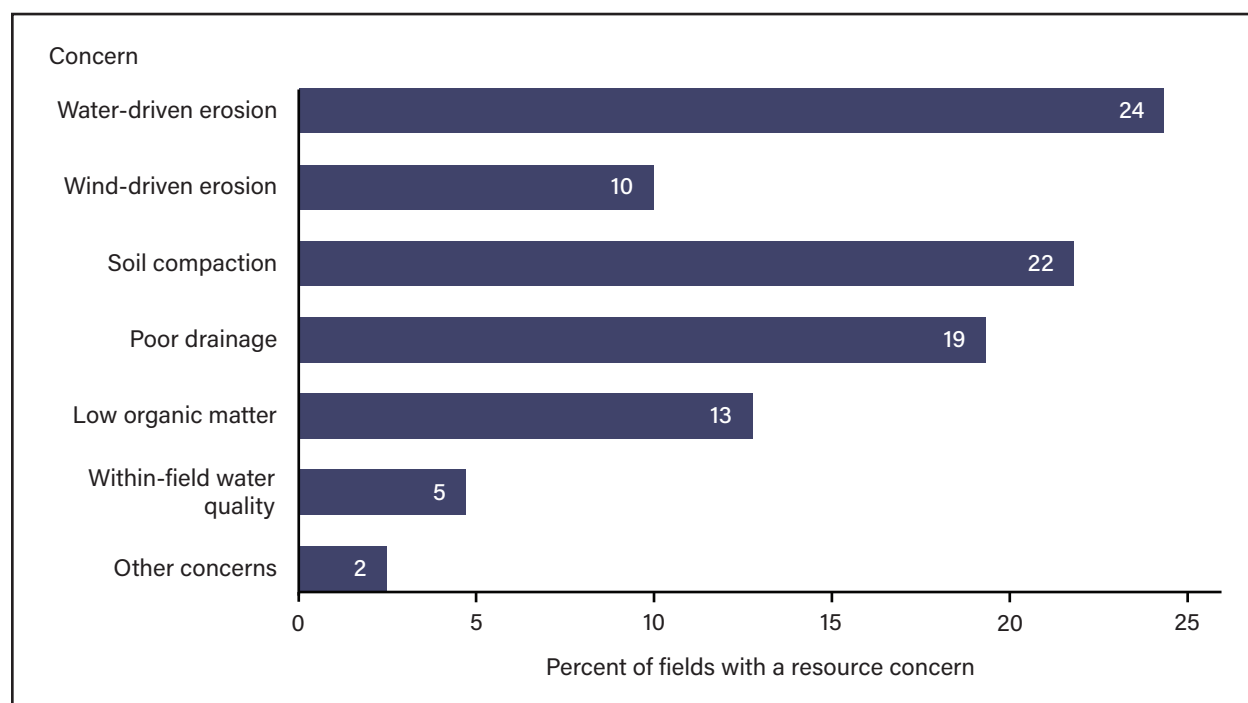
## Resource Concerns

### How Prevalent Are Resource Concerns?

Figure 2 provides the percentages of fields with each self-reported resource concern included in the 2015, 2017, and 2018 ARMS Phase 2 surveys. Fields can have multiple resource concerns. The two resource concerns most commonly reported were water-driven erosion and soil compaction. Specifically, farmers reported water-driven erosion on 24 percent of all represented fields and soil compaction on 22 percent of fields. Poor drainage was also commonly reported, impacting 19 percent of the fields represented.

Other resource concerns were less commonly reported. For example, farmers reported wind-driven erosion occurring on 10 percent of the represented fields, and low organic matter was present on nearly 13 percent of the fields. The least common specific resource concern was within-field water quality, with farmers identifying the concern for only 5 percent of their fields. The low percentage of self-identified within-field water quality concerns could reflect that water quality concerns affecting farm productivity for the crops studied—such as high salinity—are relatively rare. In addition, the low percentage of self-assessed within-field water quality concerns could indicate the surveys do not capture water quality issues such as downstream nutrient loading. The low percentage of fields with water quality concerns may also be observed because fields with within-field water quality issues can be difficult to farm. Finally, relatively few farms self-report “other,” unspecified resource concerns, which may suggest the list of soil and water concerns is fairly comprehensive according to farmers’ perspectives.

Figure 2  
**Prevalence of self-reported soil and water resource concerns across all surveys**



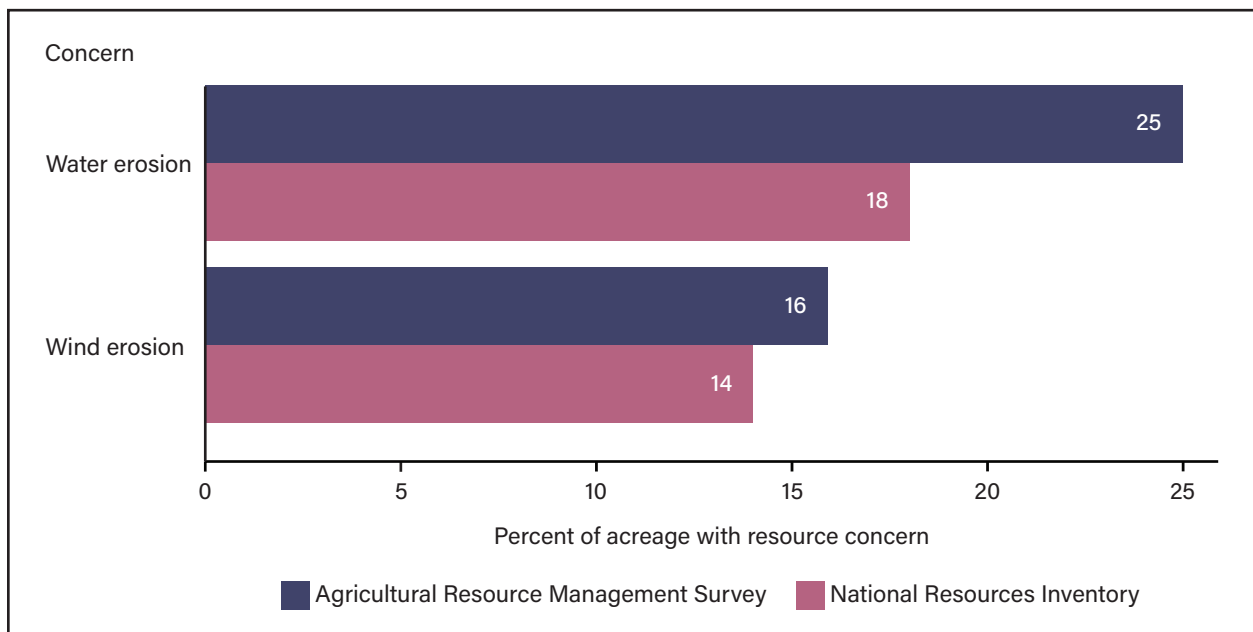
Notes: The figure includes soil and water concerns included in each of the Agricultural Resource Management Survey (ARMS) versions. The “other concerns” category represents within-field soil and water concerns not already specified in the list.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

Using self-reporting of resource concerns, this bulletin estimates the prevalence of resource concerns, such as soil compaction and within-field water quality, that do not currently appear in national assessments. To show self-reported data can reliably measure resource concerns on a national scale, ARMS estimates are compared with NRI estimates of concerns for which national assessments are available in figure 3. The 2017 NRI summary report states there are roughly 316 million acres of cultivated cropland in the United States (USDA, NRCS, 2020a). Using widely accepted calculations of an erodibility factor, the NRI report indicates just over 57 million cropland acres—or roughly 18 percent of all cultivated cropland—have a serious issue with water-driven erosion (i.e., sheet and rill erosion). The NRI report also estimates nearly 45 million acres of cropland—roughly 14 percent of all cultivated cropland—have a serious issue with wind-driven erosion. To get comparable ARMS estimates, ARMS Phase 2 responses are scaled with acreage weights, so they are nationally representative for the crops covered. Based on ARMS data, 25 percent of cropland for the four major commodities represented in this bulletin has water-driven erosion, and 16 percent has wind-driven erosion.

The estimates from the two sources are similar but slightly higher for the self-reported ARMS estimates than the NRI estimates. The differences could suggest farmers perceive erosion as a concern below the erodibility threshold NRI uses to identify fields experiencing erosion. Alternatively, the crops or States not represented in the ARMS data but captured in the NRI data might have a lower prevalence of erosion. Lastly, fields covered by ARMS may only have erosion concerns on a portion of their acreage, whereas the calculations in this bulletin assume the entire field is subject to each reported concern.

Figure 3  
**Comparison of self-reported and model-based inventory of erosion**



Note: National Resources Inventory (NRI) estimates directly from USDA, NRCS, 2020a.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018, and USDA, Natural Resources Conservation Service (NRCS), National Resources Inventory for 2017.



## Resource Concerns Often Occur Together

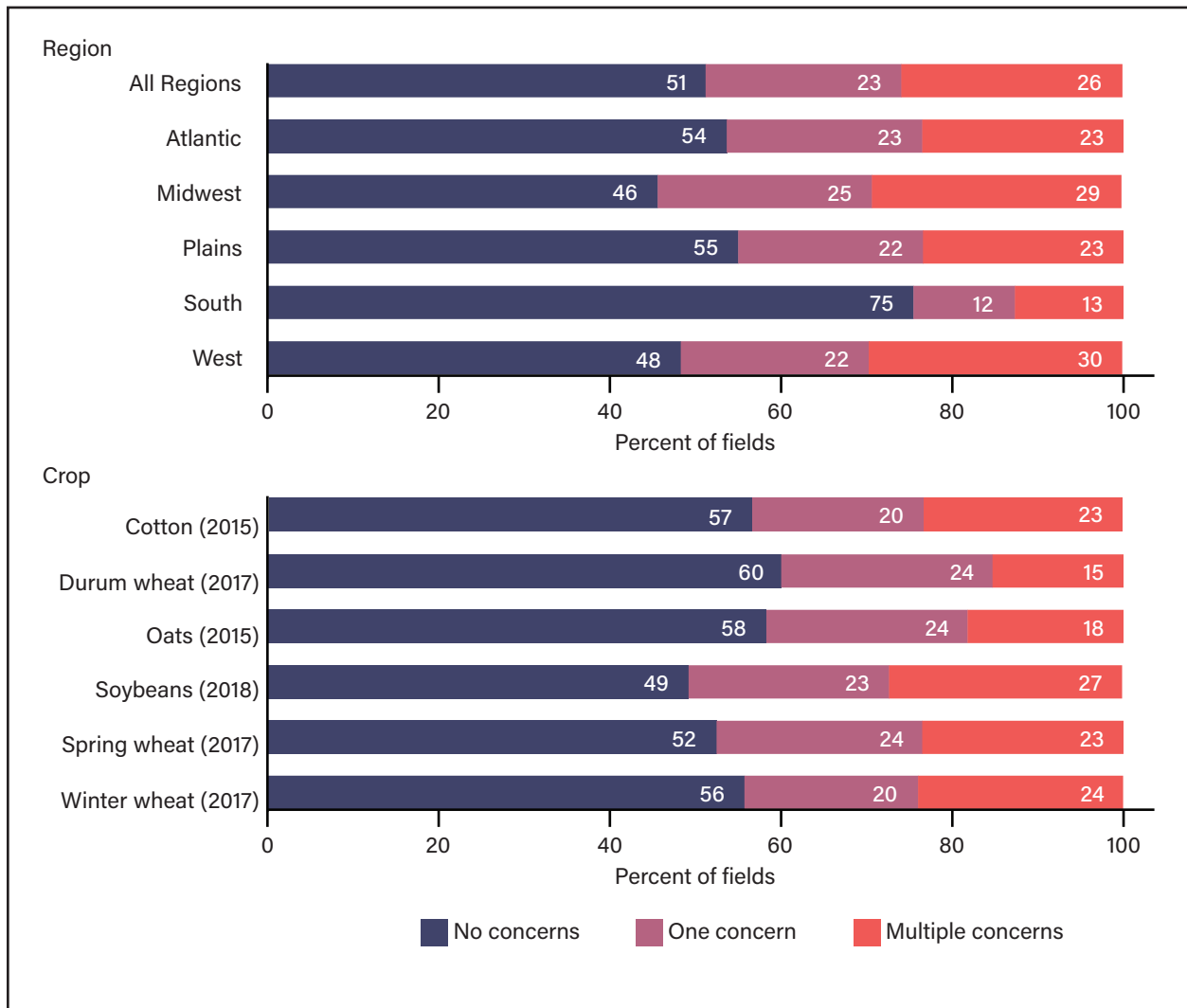
Since many soil health concerns are caused by the same management activities or environmental factors, fields may have several resource concerns at once. However, the relationships between concerns will vary, and certain combinations of resource concerns will be more likely than others. Farmers reported at least one resource concern for 49 percent of all represented fields (figure 4). Of those fields with at least one resource concern, 26 percent have two or more concerns (figure 4). Though not shown, this bulletin also found 13 percent of fields have three or more concerns.

The percentages of fields with at least one self-reported resource concern vary across crops, from 40 percent of fields planted in durum wheat to 51 percent of fields planted in soybeans (figure 4). Most of this variation across crops appears to come from differences in the percentages of fields with multiple concerns. For example, durum wheat fields were least likely to have multiple self-reported resource concerns, and soybean fields were most likely to have multiple self-reported concerns. Differences across crops may reflect crop-specific risks or differences in the geography and climate suitable for crops. Furthermore, farmers may grow a certain crop on a field based on factors that influence the likelihood of resource concerns, such as having certain soil qualities.

Farmers in the Midwest and West regions were most likely to report at least one resource concern (figure 4). In the Midwest, farmers report at least one resource concern on 54 percent of their fields, and multiple concerns on 29 percent of their fields. In the West, 52 percent of the represented fields have at least one concern, and 30 percent have multiple concerns. In the Plains—the second largest region by the number of fields—farmers reported that 45 percent of the represented fields have at least one concern, and 23 percent have multiple concerns. In contrast, farmers in the South region only identified resource concerns for 25 percent of their fields, and they reported multiple concerns on 13 percent of fields.

Figure 4

**Percentages of fields with zero, one, and multiple self-reported resource concerns, by survey version and region**



Note: Regions are the Farm Production Expenditure Regions from USDA, National Agricultural Statistics Service, 2021. Values may not add to 100 due to rounding.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

Which self-reported resource concerns occur together? The 20 most common combinations of resource concerns represent more than 80 percent of all fields with at least 1 resource concern (table 1). To some extent, the most common combinations reflect the overall likelihoods of individual concerns. For example, water-driven erosion and soil compaction is the most common combination, one that combines the two most prevalent individual concerns. However, common underlying causes of concerns are also important. For example, wind erosion occurs with low organic matter more often than with poor drainage, although poor drainage is more prevalent overall. Appendix B provides more detail on specific associations between concerns.

Table 1

**Percent of fields with each of the top 20 combinations of self-reported resource concerns**

	Percent	Cumulative Percent
(1) Only water erosion	13.91	13.91
(2) Only poor drainage	12.51	26.41
(3) Only soil compaction	10.40	36.81
(4) Water erosion and compaction	5.61	42.41
(5) Only low organic matter	5.48	47.90
(6) Compaction and poor drainage	4.63	52.53
(7) Water erosion and poor drainage	4.08	56.61
(8) Only wind erosion	3.25	59.86
(9) Water erosion, compaction, poor drainage	2.90	62.76
(10) Water and wind erosion	2.71	65.47
(11) Water erosion and low organic matter	2.41	67.88
(12) Water and wind erosion, compaction	2.11	69.99
(13) Water erosion, compaction, and low organic matter	1.83	71.82
(14) Water erosion, compaction, poor drainage, low organic matter	1.81	73.63
(15) Compaction, poor drainage, low organic matter	1.69	75.32
(16) Wind erosion and low organic matter	1.69	77.01
(17) Compaction and low organic matter	1.29	78.30
(18) Water erosion, poor drainage and low organic matter	1.25	79.55
(19) All seven listed concerns	1.18	80.73
(20) All concerns except other concerns	1.07	81.80

Notes: There are 127 possible combinations of 7 resource concerns, but some combinations are more common than others. This table shows the 20 most common combinations of concerns.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

## The Prevalence of Resource Concerns Varies Across Regions

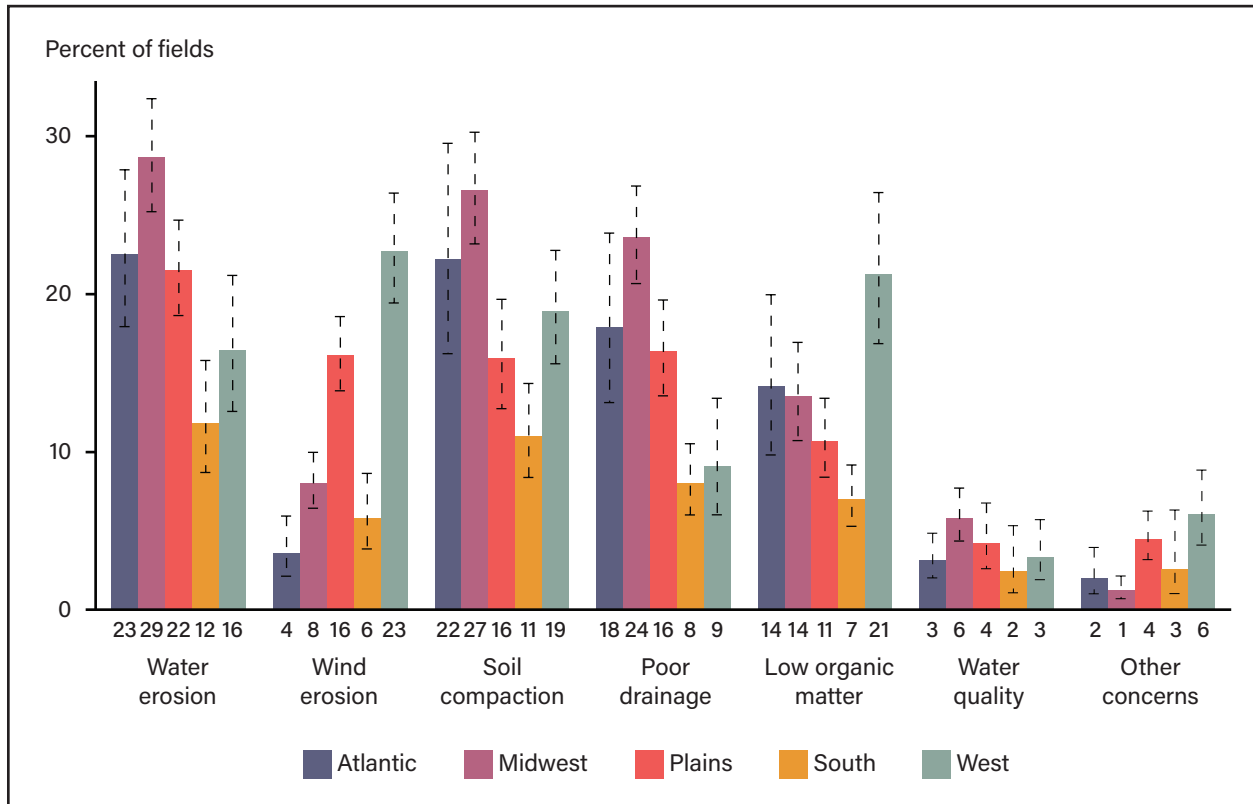
Specific resource concerns largely depend on climate and inherent soil properties that can vary considerably across regions as well as within regions at the local level. For example, NRI data established that water-driven erosion is concentrated in the Midwest and South regions, whereas wind-driven erosion is more common in the Plains and West regions. The three regions in the eastern half of the United States—the Atlantic, Midwest, and South—share the same three most common resource concerns. Farmers in the Atlantic region reported that 23 percent of their represented fields have water-driven erosion, 22 percent have soil compaction, and 18 percent have poor drainage. The percentages of fields with these same three concerns were higher in the Midwest, at 29 percent, 27 percent, and 24 percent, respectively. Although the South has similar rankings as the Atlantic and Midwest, specific concerns were less likely to be reported overall. For example, farmers in the South reported that only 12 percent of their represented fields have water-driven erosion, the region's most common concern.

The three water-related concerns most common in the three eastern regions were not as prominent in the West and Plains regions. Instead, wind erosion and low organic matter were relatively more likely to be identified in these drier and windier climates. The Plains and West regions experienced wind-driven erosion at 16 percent and 23 percent, respectively. In contrast, the wetter and less windy eastern regions were considerably less likely to experience wind-driven erosion. Low organic matter was the most common concern in the West



region, afflicting 21 percent of its fields. However, a sizable portion of fields in other regions have low organic matter, as an arid climate is not the resource concern’s only cause. Farmers reported low organic matter totaling 14 percent of the represented fields in the Midwest and Atlantic Regions, 11 percent of the fields in the Plains, and 7 percent of the fields in the South. Finally, across all regions, few farmers identified a within-field water quality concern on their fields. The Midwest had the highest percentage of fields with a within-field water quality concern at just under 6 percent.

Figure 5  
**Percentages of fields with each specific resource concern, by region**



Notes: Bar heights represent estimated percentages of fields within each region with the specified resource concern. Estimated percentages are also reported at the bottom of bars. The figure also shows 95-percent confidence intervals for estimated percentages of fields with each resource concern across regions, where bar heights represent the mean estimated percentage, and dashed lines represent the confidence interval. Confidence intervals capture sampling uncertainty in the estimates. These are computed using jackknifed standard errors for each group. Technical documentation on the Agricultural Resource Management Survey webpage on the Economic Research Service website provides further details on the procedure; The “other concerns” category represents within-field soil and water concerns not already specified in the list; Regions are the Farm Production Expenditure Regions from USDA, National Agricultural Statistics Service, 2021.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

## Technical Assistance

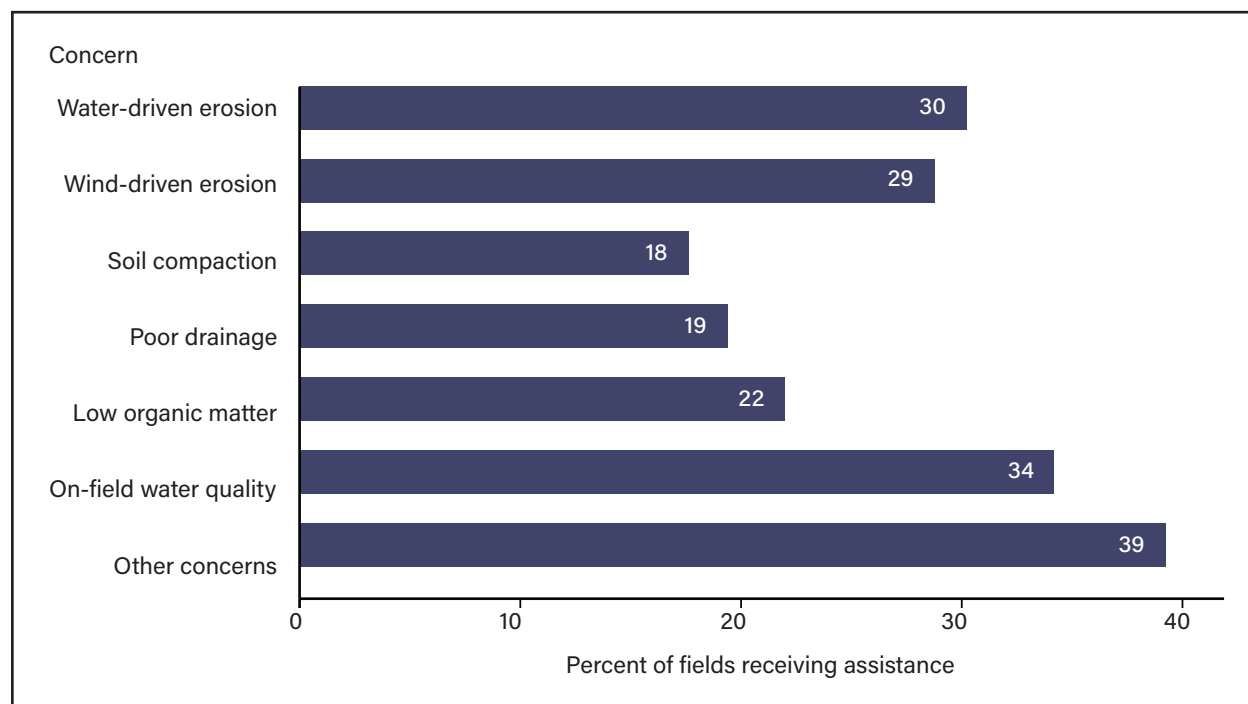
### How Prevalent Is Conservation Technical Assistance?

Of fields growing oats, cotton, wheat, and soybeans, 49 percent have at least one resource concern, and 26 percent of these fields have multiple concerns. Across the four commodities surveyed, farmers reported they received technical assistance for 24 percent of the represented fields with at least one self-reported resource concern. Consequently, 76 percent of the fields on which farmers reported resource concerns—or 37 percent of all fields growing these crops—have both one or more resource concerns and have not received technical assistance to help address any of those concerns.

Farmers with different specific resource concerns may have different incentives for seeking assistance. Farmers reported that 30 percent of the represented fields with water-driven erosion and 29 percent of the fields with wind-driven erosion received technical assistance (figure 6). Although soil compaction was nearly as common as water erosion (figure 2), farmers were much less likely to get assistance for it. Farmers only reported receiving technical assistance for 18 percent of the represented fields with soil compaction. Similarly, 19 percent of the fields with poor drainage received technical assistance. Of fields with low organic matter, 22 percent of those fields received assistance. Finally, high percentages of fields with self-reported water quality or other concerns received technical assistance (34 percent and 39 percent, respectively).

Figure 6

#### Percentages of fields receiving technical assistance for each specific resource concern



Notes: Percentages for each specific concern include all fields with concerns, including fields with multiple concerns. The “other concerns” category represents within-field soil and water concerns not already specified in the list.

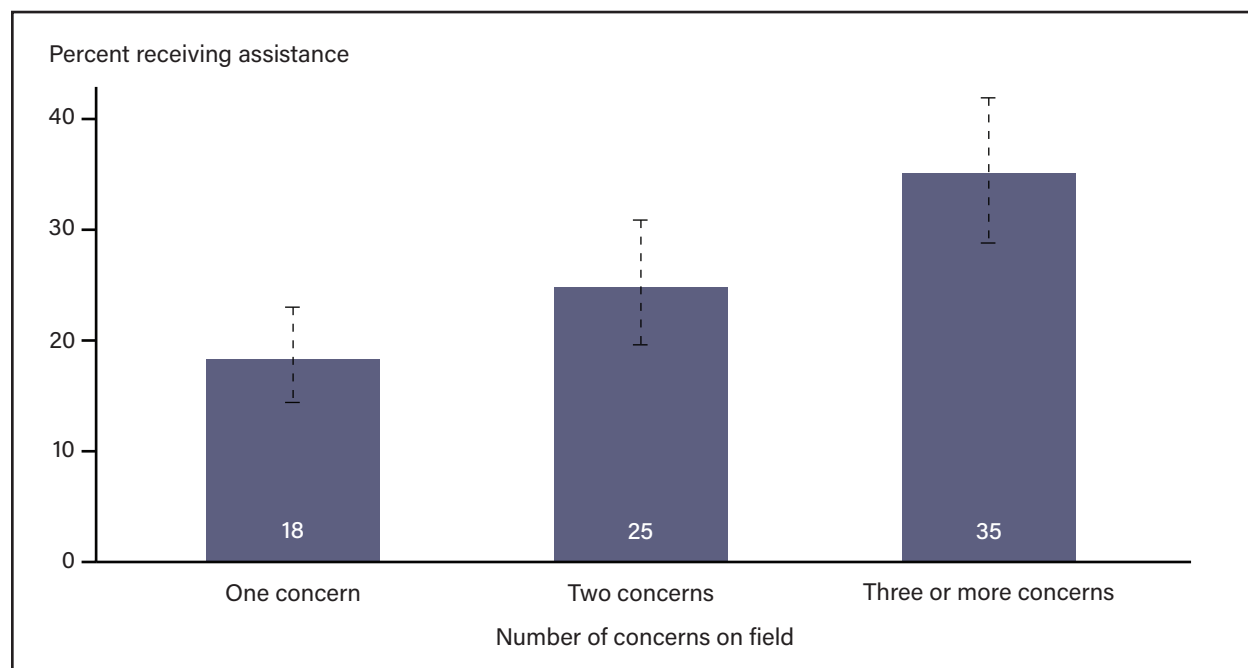
Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

These differences in rates of assistance across concerns could have several potential explanations. One reason could be that the marginal effects of specific resource concerns on productivity may differ by farm. Another

reason may be differing priorities across concerns for financial incentive programs, which rely on technical assistance to develop conservation plans and help to design and evaluate practices. Farmers may be more likely to seek technical assistance if they can more easily receive financial assistance. Finally, some concerns may often be assessed when other common concerns are already being assessed, thus farmers may be more likely to receive assistance overall.

Rates of technical assistance increase with the total number of resource concerns reported on a field. Farmers with fields having more reported concerns are significantly more likely to receive assistance. For example, farmers receive assistance 18 percent of the time for fields with one reported concern (figure 7). Farmers reported that 25 percent of the represented fields with two concerns received technical assistance, and 35 percent of the fields with three or more concerns received technical assistance. Furthermore, although not shown in the report, farmers typically received assistance for most of their concerns on fields with multiple concerns. One reason for the trend shown in figure 7 may be that farmers are more likely to request assistance if conservation practices address multiple concerns since it may save time and labor costs. These findings could also reflect the comprehensive conservation planning process conducted by NRCS. As described earlier, NRCS investigates many resource concerns in field-level assessments, which may reveal soil concerns, water concerns, and other resource concerns that the farmer did not identify before the assessment. This could influence farmers who received assistance to report more concerns (USDA, NRCS, 2014).

Figure 7  
**Percentages of fields receiving technical assistance dependent on the number of resource concerns on field**



Notes: Bar heights represent estimated percentages of fields with a given number of self-reported concerns that received technical assistance. Estimated percentages are also reported at the bottom of the bars. The figure also shows 95-percent confidence intervals for estimated percentages receiving assistance by number of reported concerns, where bar heights represent the mean estimated percentage, and dashed lines represent the confidence interval. Confidence intervals capture sampling uncertainty in the estimates. Tests of significant differences between each group are conducted using two-sided t-tests with jackknifed standard errors for each group. Technical documentation on the Agricultural Resource Management Survey webpage on the Economic Research Service website provides further details on the jackknife procedure. Differences between 2 and 3 concerns have a p-value of .011, the difference between 1 and 3 concerns have a p-value less than .001, and the difference between 1 and 2 concerns is not statistically significant.

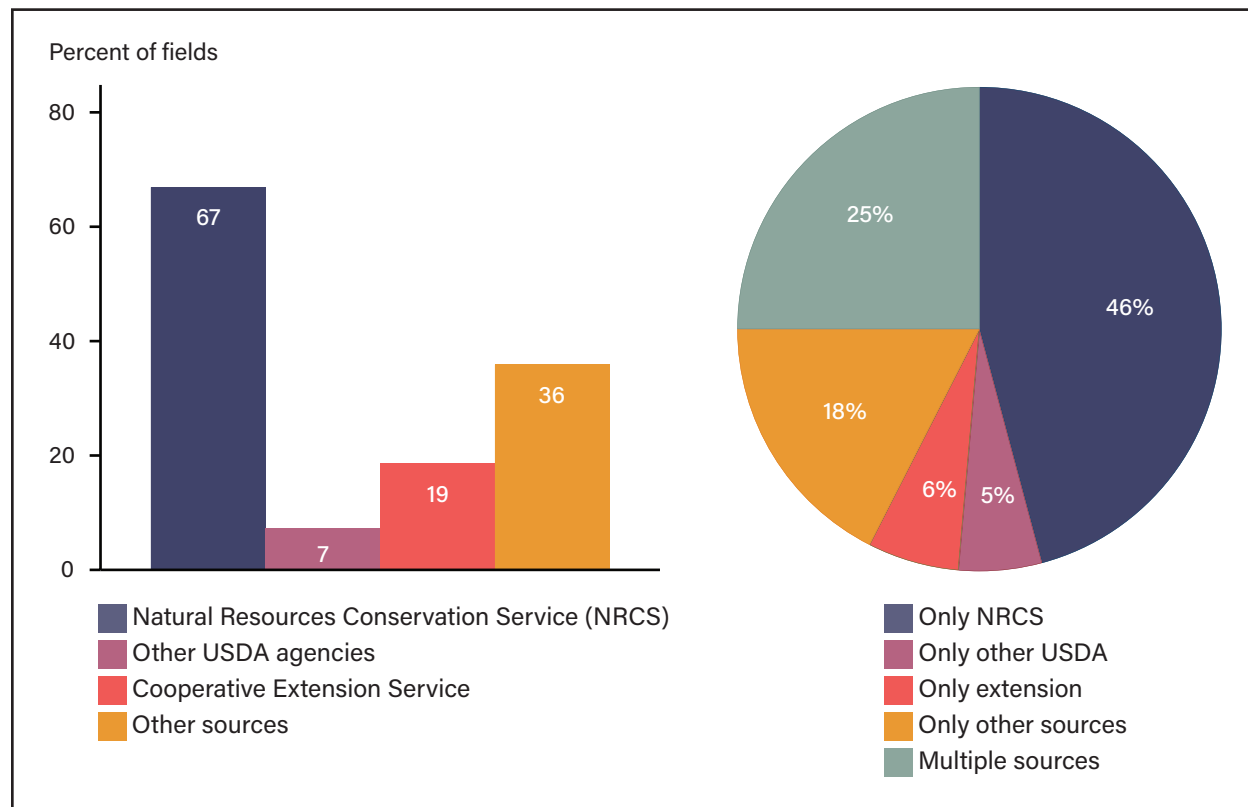
Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

## Where Do Farmers Receive Technical Assistance?

The largest source of technical assistance is NRCS. Of all fields receiving assistance, 67 percent received assistance from NRCS (figure 8). However, other sources of technical assistance were also used. Of fields receiving technical assistance, 19 percent received it from a cooperative extension agent, while 7 percent of fields received technical assistance from a USDA agency other than NRCS. Furthermore, farmers received technical assistance from other sources, such as conservation districts or State agencies, on 36 percent of the fields. Additionally, of fields having received assistance, 46 percent received it solely from NRCS, and 25 percent received it from multiple sources (figure 8).

Figure 8

### Percentages of fields receiving technical assistance from each source of assistance



Note: The figure includes all fields with resource concerns receiving some assistance.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

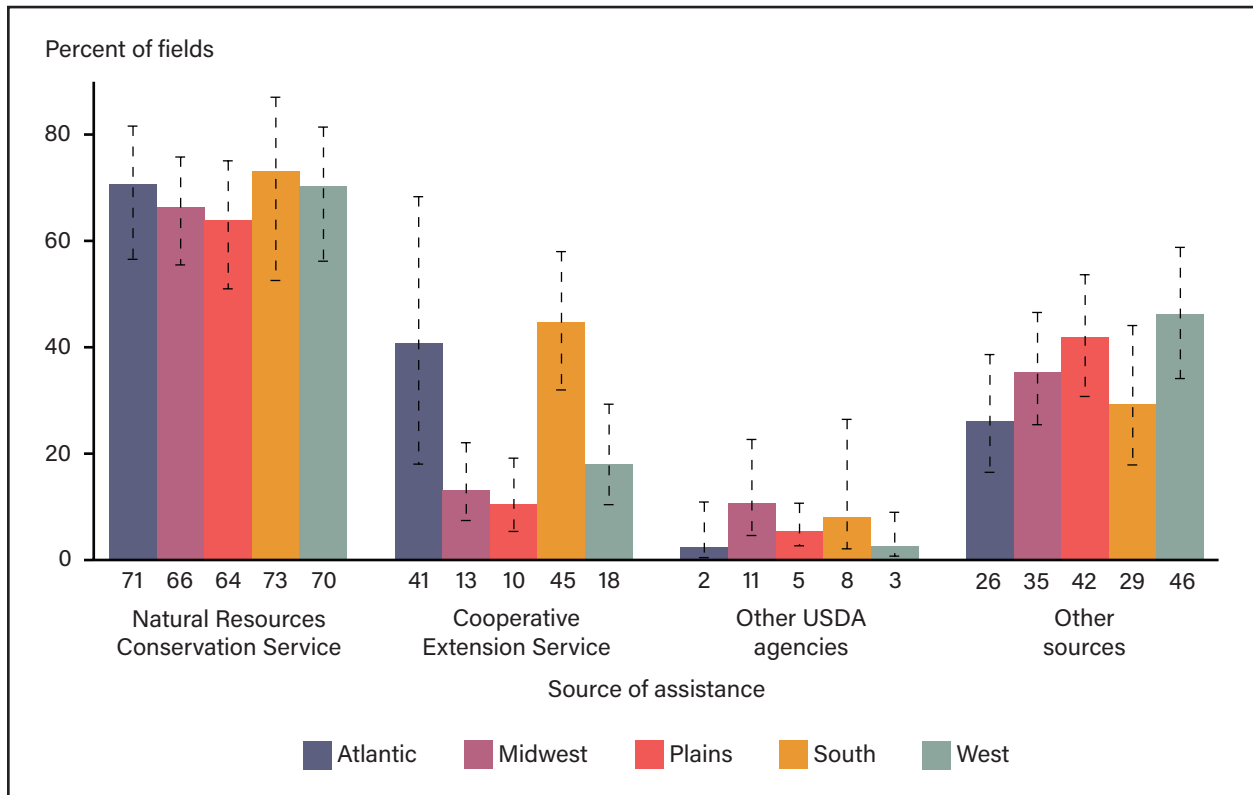
The Natural Resources Conservation Service (NRCS) has been the most common source of assistance across all regions (figure 9). However, the prevalence of technical assistance from sources other than NRCS varied across regions.<sup>7</sup> For example, in the Atlantic and South regions, 41 and 45 percent of fields receiving assistance, respectively, received it from cooperative extension agents, whereas farmers in other regions were less likely to receive assistance from this source. The prevalence of technical assistance from USDA agencies other than NRCS was highest in the Midwest, with those agencies reaching 11 percent of all fields receiving any assistance. The Plains and West regions were most likely to receive assistance from sources such as State agencies and conservation districts (42 percent and 46 percent, respectively).

<sup>7</sup> Results for t-tests of significant differences across regions are provided in the notes of figure 9.



Figure 9

**Percentages of fields receiving technical assistance from each source of assistance, by region**



Notes: Bar heights represent estimated percentages of fields within a region that have received a certain source of assistance for their concerns, for all fields in that region receiving some assistance. Estimated percentages are also reported at the bottom of bars. The figure also shows 95-percent confidence intervals for estimated percentages of each source of assistance across regions, where bar heights represent the mean estimated percentage, and dashed lines represent the confidence interval. Confidence intervals capture sampling uncertainty in the estimates. Tests of significant differences between sources are conducted between regions using two-sided t-tests with jackknifed standard errors for each group. Technical documentation on the Agricultural Resource Management Survey webpage on the Economic Research Service website provides further details on the procedure. Significant differences (at the 5-percent level) in percentages of fields receiving assistance across regions are found for Cooperative Extension and Other Sources. For Cooperative Extension, differences are significant between the Atlantic and West regions, the Atlantic and Plains, the Midwest and Plains, the Plains and South, and the South and West. For Other Sources, differences are significant between the Atlantic and Plains regions and the Atlantic and West. Regions are the Farm Production Expenditure Regions from USDA, National Agricultural Statistics Service, 2021.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

## Conclusion

This bulletin examined the prevalence of self-reported, within-field resource concerns and conservation technical assistance on fields for four major commodities—soybeans, oats, cotton, and wheat—which collectively represent about half of U.S. cropland. Farmers reported at least one resource concern for 49 percent of all represented fields and two or more concerns on 26 percent of fields (figure 4). The most common self-reported resource concerns are water-driven erosion, soil compaction, and poor drainage. The least common self-reported concerns are within-field water quality and other concerns (figure 2).<sup>8</sup>

Prior resource inventories, including NRI, have shown—for all cultivated cropland in the contiguous 48 States—water-driven erosion is most prevalent in the Midwest and South regions, and wind-driven erosion is most prevalent in the West and Plains regions. The data used in this bulletin is consistent with the prior resource inventories while also providing details about other resource concerns—such as soil compaction—which are not captured in other reports. The prevalence of resource concerns varies by region and, to a lesser degree, by crop type. The most common self-reported resource concerns (i.e., water-driven erosion, soil compaction, and poor drainage) in the Atlantic, Midwest, and South regions are similar. However, farmers in the drier Plains and West regions are more likely to report issues such as wind-driven erosion and soil with low organic matter.

Overall, farmers received technical assistance on 24 percent of the fields on which they self-reported within-field resource concerns. This implies 37 percent of the represented fields growing the four major commodities studied in this bulletin have at least one resource concern that has not received technical assistance. The likelihood of receiving technical assistance varies by resource concern. For example, farmers received technical assistance on about 30 percent of the fields they reported as having water-driven erosion, whereas farmers only received assistance on about 18 percent of fields they reported as having soil compaction. Farmers who reported multiple concerns were more likely to receive technical assistance.

Farmers receive technical assistance from various sources, with NRCS being the largest source across all regions of the United States. Farmers receiving technical assistance received it from NRCS on 67 percent of their fields. Further, farmers receiving technical assistance received it from USDA's Cooperative Extension System (CES) on 19 percent of their fields, and from conservation districts and State agencies on 36 percent of their fields.

This bulletin highlights the significance of resource concerns and technical assistance for U.S. cropland. Many farmers in the United States self-reported resource concerns that have not yet received technical assistance. This suggests many of these farmers have not participated in USDA working lands programs, as financial assistance is largely predicated on technical assistance and conservation planning. The bulletin's results highlight the number of fields likely to be interested in working lands programs. However, in this bulletin we have not attempted to determine the extent to which farmers who have and have not received technical assistance have adopted within-field practices to help address their resource concerns. Furthermore, the frequency of farmers receiving technical assistance is determined in this bulletin but may not fully capture the demand for technical assistance, particularly if staff time for technical assistance is limited. Finally, this bulletin does not address the severity of resource concerns reported by the farmers surveyed, and it is unclear exactly how well the prevalence of self-reported resource concerns represents the prevalence of resource concerns measured by more objective criteria. These questions are left for future work.

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<sup>8</sup> Other concerns could include any soil or water concerns not explicitly asked about.

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## Appendix A: States Covered by the Agricultural Resource Management Survey (ARMS)

Table A1

States included in each Agricultural Resource Management Survey (ARMS) Phase 2 Survey used in report

Regions/States	Survey version					
	Cotton 2015	Oats 2015	Durum wheat 2017	Spring wheat 2017	Winter wheat 2017	Soybean 2018
<b>Atlantic</b>						
Kentucky						X
New York		X				
North Carolina	X					X
Pennsylvania		X				
Tennessee	X					X
Virginia						X
<b>Midwest</b>						
Illinois		X			X	X
Indiana						X
Iowa		X				X
Michigan		X			X	X
Minnesota		X		X		X
Missouri	X				X	X
Ohio		X			X	X
Wisconsin		X				X
<b>Plains</b>						
Kansas		X			X	X
Nebraska		X			X	X
North Dakota		X	X	X	X	X
Oklahoma					X	
South Dakota		X		X	X	X
Texas	X	X			X	
<b>South</b>						
Alabama	X					
Arkansas	X					X
Georgia	X					
Louisiana						X
Mississippi	X					X
South Carolina	X					
<b>West</b>						
Arizona	X		X			
California	X		X			
Colorado					X	
Idaho			X	X	X	
Montana			X	X	X	
Oregon				X	X	
Washington				X	X	

Note: Only States included in at least one survey are shown.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.

## Appendix B: Associations Between Specific Resource Concerns

Multiple resource concerns are often reported for a single field. Consequently, most of the individual resource concerns identified on a field occur on fields with multiple concerns. Depending on the concern, anywhere from 65 percent to 95 percent of self-reported resource concerns occur with at least one other concern. This statistic is lowest for a poor drainage concern, with 65 percent of instances coinciding with another resource concern. In contrast, a water quality concern has the highest possibility of coinciding with another resource concern, occurring on nearly 95 percent of fields with a water quality concern.

Figure B1 presents how resource concerns correspond with each other. The figure shows the relative risk of a field having any specific concern given the occurrence of each of the other concerns. The relative risk of having resource concern  $j$ , given that the field has resource concern  $r$ ,  $RR(j,r)$ , is given by the equation below. The relative risk is the probability that the field has concern  $j$  given the presence of concern  $k$ , divided by the probability of having concern  $j$  given it does not have concern  $k$ , controlling for all other concerns  $r \in R$ :

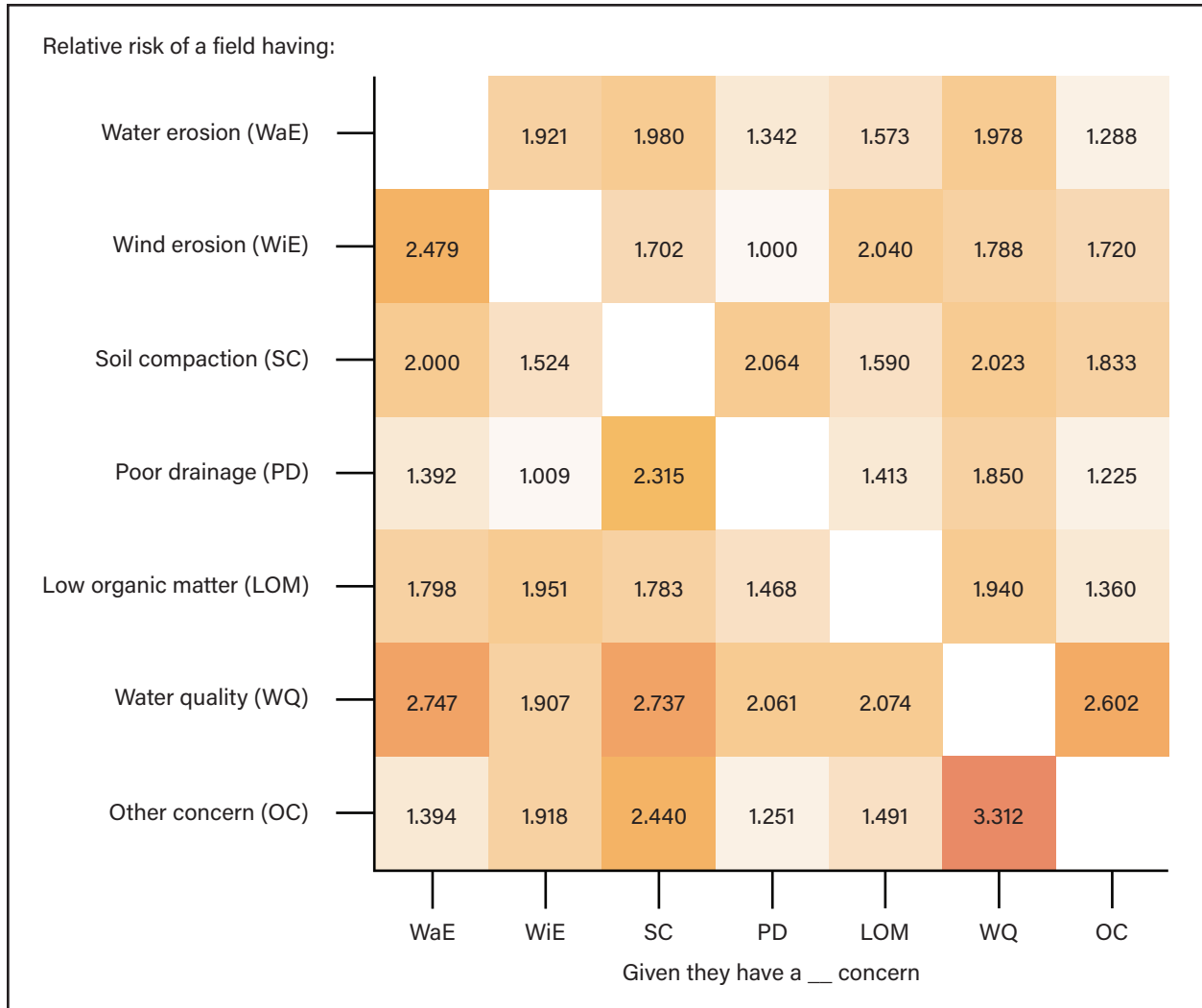
$$RR(j,r) = \Pr(j|k = 1, r \in R) / \Pr(j|k = 0, r \in R)$$

The relative risks in figure B1 are calculated based on logit regression models to estimate the probability of having any specific concern based on the presence of each other concern. For example, as presented in figure B1, a field is twice as likely to have soil compaction if it also has water-driven erosion compared with the probability it does not, all things being equal.

As noted above, a water quality concern appears to be much more likely given the presence of another concern, with the strongest predictors being water-driven erosion and soil compaction. Other than water quality and other concerns, among the most highly associated concerns appear to be water-driven and wind-driven erosion; poor drainage and soil compaction; and wind-driven erosion and low organic matter. Among the least associated resource concerns are wind-driven erosion and poor drainage. Overall, all relative risks in the figure are greater than or equal to one, meaning the presence of any specific concern never decreases the probability of having any other concern.

Figure B1

**Relative risk of a field having specific resource concerns, given the presence of other resource concerns**



Notes: The relative risk ( $RR$ ) of having resource concern  $j$ , given that the field has resource concern  $r$ , is presented as  $RR(j,r)$  in the equation below. The relative risk is the probability that the field has concern  $j$ , given the presence of concern  $k$ , divided by the probability of having concern  $j$ , given that it does not have concern  $k$ , controlling for all other concerns  $r \in R$ . Calculations are based on the following equation:

$$RR(j,r) = \Pr(j|k = 1, r \in R) / \Pr(j|k = 0, r \in R)$$

The relative risks in figure B1 are calculated based on logit regression models that estimate the probability of having any specific concern as explained by the presence of each other concern. For example, a logit regression was estimated to explain the presence of soil compaction, where regressors include the presence of water erosion, wind erosion, poor drainage, low organic matter, water quality concerns and other concerns. Thus, there were a total of 7 logit regression models estimated. As presented in the figure, a field is twice as likely to have soil compaction (SC) if it also has water erosion (WaE), compared with the probability it does not, controlling for the statuses for wind erosion, poor drainage, etc.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, Phase 2 for 2015, 2017, and 2018.



## Appendix C: Acronyms and Abbreviations Used

AMA = Agricultural Management Assistance

APEX = Agricultural Policy Environmental eXtender Model

ARMS = Agricultural Resource Management Survey

AWEP = Agricultural Water Enhancement Program

CBWI = Chesapeake Bay Watershed Initiative

CEAP = Conservation Effects Assessment Project

CES = Cooperative Extension System

CSP = Conservation Stewardship Program

CTA = Conservation Technical Assistance program

EQIP = Environmental Quality Incentives Program

ERS = Economic Research Service

EWP = Emergency Watershed Protection Program

FOTG = Field Office Technical Guide

NIFA = National Institute of Food and Agriculture

NRCS = Natural Resources Conservation Service

NRI = National Resources Inventory

RaCA = Rapid Carbon Assessment

RCA = Soil and Water Resources Conservation Act

RCD = Resource Conservation and Development Program

RCPP = Regional Conservation Partnership Program

SCS = Soil Conservation Service

SES = Soil Erosion Service

SSURGO = Soil Survey Geographic Database

SWAT = Soil and Water Assessment Tool

TSPs = technical service providers

USDA = U.S. Department of Agriculture

WHIP = Wildlife Habitat Incentive Program

WRHB = Watershed Rehabilitation Program