Science Societies

Managing forever chemicals on the farm

New report provides guidance for USDA conservation programs

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USDA/FPAC Photo by Preston Keres.

PFAS "forever chemicals" pose a growing risk to agriculture because they persist in soil, water, and living systems, potentially harming human health and reducing farm productivity. A recent report from the National Academies of Sciences, Engineering, and Medicine outlines how USDA conservation programs can help identify, monitor, and mitigate PFAS on farms using existing frameworks while highlighting major gaps in knowledge.

More than 70 years ago, the wonders of chemistry brought forth per- and polyfluoroalkyl substances (PFAS). This diverse family of chemicals resists heat, water, and oil, conferring excellent durability for a variety of products. The unique chemical structures also allow these compounds to persist in nature, rendering them "forever chemicals." PFAS are a growing concern because they have been associated with immune system disruption, organ damage, and cancer in people.

Like all contaminants, PFAS can enter an agricultural system through a point or a nonpoint source, but once on the farm, these chemicals have the potential to linger and circulate throughout the environment, moving from soil to water to plants and animals. The presence of PFAS on the farm has the potential to compromise the economic value of crop- and rangeland. Managing PFAS is complicated by the lack of data on the source, transport, and fate of these compounds.

In response to these challenges, the USDA commissioned the National Academies of Sciences, Engineering, and Medicine (NAS) to develop a framework for how USDA's Farm Production and Conservation (FPAC) programs could respond to PFAS contamination. They were asked to characterize the scope of the challenge and identify how FPAC programs and practices might cause or exacerbate the problem, how they could mitigate or avoid PFAS contamination, and what research gaps exist for managing lands with PFAS contamination through the lens of conservation practices. Their work began at square one.

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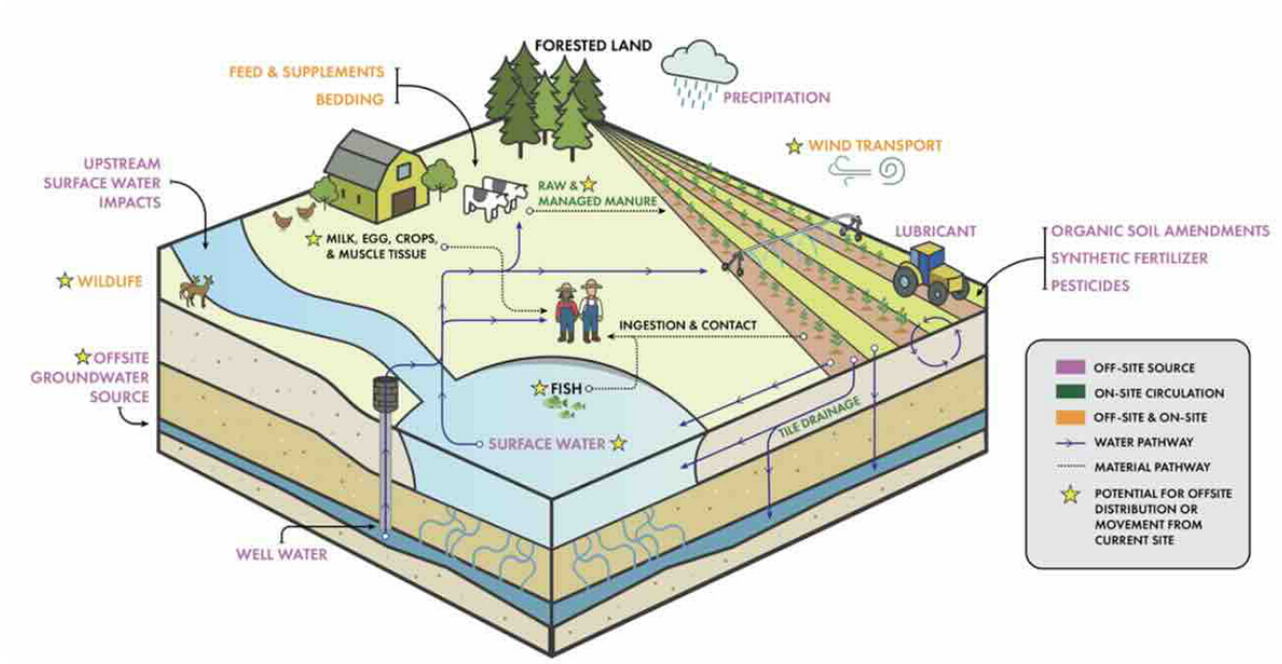
"PFAS are not readily degraded in soils as microorganisms have never encountered such substances," says SSSA and ASA member Jim Ippolito, the Rattan Lal Endowed Professor of Soil Health and Soil Fertility at The Ohio State University. "This report is geared toward what USDA's Natural Resources Conservation Service (NRCS) can do and provides suggestions for how the agency can move forward to deal with PFAS in the environment."

Ippolito led the NAS committee who brought their experience to the discussion. They began by evaluating existing USDA conservation programs, practices, and initiatives to identify paths for mitigation. The committee also pointed to new research opportunities to address knowledge gaps and clarify how to address these objectives. The work is laid out in the NAS report, "PFAS in Agricultural Systems: Guidance for Conservation Programs at USDA."

The problem with PFAS

The extent of PFAS uptake depends on a variety of factors, including the structure of the particular PFAS and the concentration at the source of contamination. The interaction of PFAS with soil is also controlled by the soil's characteristics, which may depend on organic carbon content, surface charge, and pH. Once in the soil, PFAS transport depends on local topography, climate, and land management practices on the farm, which affect leaching, runoff, wet and dry deposition, uptake by plants, and bioaccumulation. Depending on the structure, these compounds can also penetrate deeper, leaching into groundwater, opening a conduit to move farther into the environment.

To complicate matters, PFAS display an array of characteristics; some can repel water and fat while others attract proteins. These compounds also persist in the human body at different timescales. This variability allows the compounds to bioaccumulate in plant and animal tissue.



Conceptual model of the entry and cycling of PFAS on agricultural land. Reproduced with permission from National Academies of Sciences, Engineering, and Medicine (2026).

Leveraging existing conservation architecture

The committee began by reviewing more than 160 conservation practice standards that were developed to monitor nutrients, sediment, and pesticides within various USDA programs. They discussed how to incorporate PFAS into the nine-step conservation planning process based on resources available, especially in light of uncertainty about this group of contaminants on the farm. They also discussed how to include PFAS into the five-year review process of conservation practice standards.

“For farmers who are dealing with PFAS, it is important for them to know that it is not their fault,” says ASA and SSSA member Ellen Mallory, *professor of Sustainable Agriculture at the University of Maine and a committee member*. “We were tasked with looking for a framework that might be effective for addressing these compounds and [that] could help alleviate PFAS issue on farms.”

The committee focused on three conservation programs—the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Conservation Reserve Program (CRP). These programs provide the framework to begin the process of finding approaches to identify, monitor, control, and remediate PFAS on the farm. For conservation planning, PFAS could be incorporated into existing categories of resource concerns or could be recognized as a distinct resource concern.

This farmer received funding from one such USDA conservation program, known as EQIP, to install micro-irrigation tubing in his tomato fields. USDA photo by Lance Cheung.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) presents the greatest opportunity to manage PFAS for the widest range of farmers, ranchers, and forest stewards. This long-standing, nationwide program was established to help farmers control soil erosion, minimize nutrient and pesticide runoff to groundwater and surface water, and manage and optimize the use of fertilizer and other soil amendment inputs. Customers can also access financial assistance through EQIP's Conservation Innovation Grants (CIG) subprogram, which supports the development of new innovative tools, approaches, practices, and technologies to further natural resource conservation on private lands. The program could advance conservation measures and approaches that show promise for PFAS mitigation on agricultural lands or introduce conservation measures or approaches proven effective in one geographic area to other regions.

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) provides farmers, ranchers, and forest stewards the ability to expand their efforts with established conservation programs through field trials or new enhancements to address PFAS mitigation. This program also provides a pathway to refine promising research to improve both conservation practices and supportive enhancements to align more directly with controlling PFAS.

Conservation Reserve Program

The Conservation Reserve Program (CRP) establishes and maintains vegetative conservation cover on highly erodible and environmentally sensitive land. The committee points to two programs that could serve as models to address PFAS—CLEAR 30 and the Soil Health and Income Protection Program. Both were authorized through the CRP in the 2018 farm bill. The first enrolls land with water quality practices that are set to expire into new 30-year contracts. The second program establishes three- to five-year contracts to maintain perennial vegetation as cover on less-productive farmland located in the Prairie Pothole Region. A congressionally authorized pilot program would offer the Farm Service Agency clear direction and authority to address PFAS on CRP-administered land and provide participants compensation through annual rental payments for loss of production due to conservation efforts.

The Conservation Reserve Program (CRP) establishes and maintains vegetative conservation cover on highly erodible and environmentally sensitive land. Photo courtesy of Flickr/USDA.

Bringing research into focus

Beyond existing conservation programs, the committee believes research is essential to address the existing knowledge gaps. Research is needed to address how different PFAS compounds move through different soil types based on the local soil characteristics. Other areas ripe for exploration is how to slow or stop the movement of PFAS through the environment. Recent work has explored the use of various sorbents, like biochar, modified clays, activated carbon, nanoparticles, and water treatment residuals. In addition, the committee identified the need to develop protocols to test materials, such as soil amendments, prior to introduction on farm operations to limit PFAS contamination.

Photo by Jed Stinner (USDA-ARS).

The committee also pointed to the need to develop new and extend existing models to predict the occurrence, fate, and transport of PFAS on the farm. The findings generated by the models should be integrated into conservation practices, programs, and initiatives to support decision makers. The committee highlighted existing models for groundwater and the Web Soil Survey that currently combine data on proximity to a contaminant source, agricultural land use, climate, and other relevant features.

In addition, the committee identified practices for established waterways through the construction of barriers, such as field strips, buffer strips, and removal structures. These practices could be explored with an eye toward PFAS; however, the committee acknowledges that major research gaps exist with regard to the risk/benefit of different land management practices (e.g., till/no-till, cover crops, crop rotation, crop density, pond filters, irrigation, etc.) for this suite of chemicals. Additional research is needed to understand the uptake of PFAS by plants and animals, especially to prevent bioaccumulation in crops, livestock, and wildlife.

Finally, the committee also suggested the creation of a separate conservation standard to characterize and control PFAS in agricultural systems. Designating PFAS as a resource of concern would ensure that it receives proper consideration in future conservation planning and elevate the most effective solutions for broader application.

Three paths forward

The committee established three overarching paths to guide the NRCS as the agency moves forward. First, the committee identified opportunities within existing conservation programs to address on-farm PFAS contamination and mitigation. Folding PFAS into existing programs designed for pathogens and chemicals offers a model and framework that has been proven effective on the farm. Pilot initiatives could be pursued within existing programs to begin the process of mitigating PFAS contamination on agricultural lands.

Second, the committee determined that agriculture would benefit from a working definition of PFAS (i.e., structural features, detection limits for specific PFAS compounds, and thresholds for investigation). At this time, regulations vary from the local to the federal level, which limits how research and conservation programs can address PFAS. The committee notes aligning regulations could help conservation planners in contextualizing PFAS occurrence at agricultural operations. This approach could also generate data that will support robust, regional models to improve predictions of the fate of PFAS contamination. With the establishment of new guidance, field conservationists will require additional training to assist producers manage these forever chemicals.

Finally, research is necessary to understand the fate and transport of PFAS under different environmental and soil conditions. These efforts could lead to nationwide screening levels to identify background PFAS concentration and clarify the range of contamination on agricultural land. By addressing these knowledge gaps, researchers could develop new methods and practices to mitigate and prevent further contamination. In this effort, the committee supports establishing a coordinated, national network of researchers that would improve existing resources for managing these contaminants in agricultural systems.

“The most important point that could be pursued in the future is the creation of a national coalition of scientists to focus on the fate and transport of PFAS in different soils,” says Ippolito. “We haven’t scratched the surface of this question, and NRCS could be instrumental in the creation of a task force of researchers across the United States to tackle this issue.”

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The first step on a long journey

Identifying, mitigating, and controlling PFAS across diverse agricultural landscapes will not be an easy task. Ippolito acknowledges that the report is the first step of a larger process to address these contaminants. The report encompasses a culmination of the committee’s efforts to engage existing programs, establish field trials, and catalyze new paths of research. It also identifies opportunities for NRCS to work with other agencies to develop a nationwide screening level for different types of agricultural production facilities, soil types, and climatic systems. These efforts will produce additional tools to support field staff in their efforts to guide customers in mitigating PFAS risk. Ippolito encourages society members interested in PFAS research to keep their eyes open for future funding opportunities, especially with the USDA NRCS.

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National Academies of Sciences, Engineering, and Medicine (2026). *PFAS in agricultural systems: Guidance for conservation programs at USDA*. https://doi.org/10.17226/29272

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