

2024 Report:

Flood Mitigation Practices & Policies

Recommendations for farmers and legislators

in the Delaware River Watershed and beyond

by Sara Nicholas

Introduction

A changing climate is escalating the impact and damage from storms, floods, and drought across the globe and right here in the Delaware River Watershed. While floods and droughts have long affected cities, towns, and farms, the intensity of these events and resulting infrastructure damage and crop losses have greatly accelerated in recent years.

This is a costly and burdensome problem, both on farms and for communities downstream.

While farming itself can contribute to climate change, it doesn't have to. There are farming practices that can help mitigate the impacts of climate change at a relatively low cost.

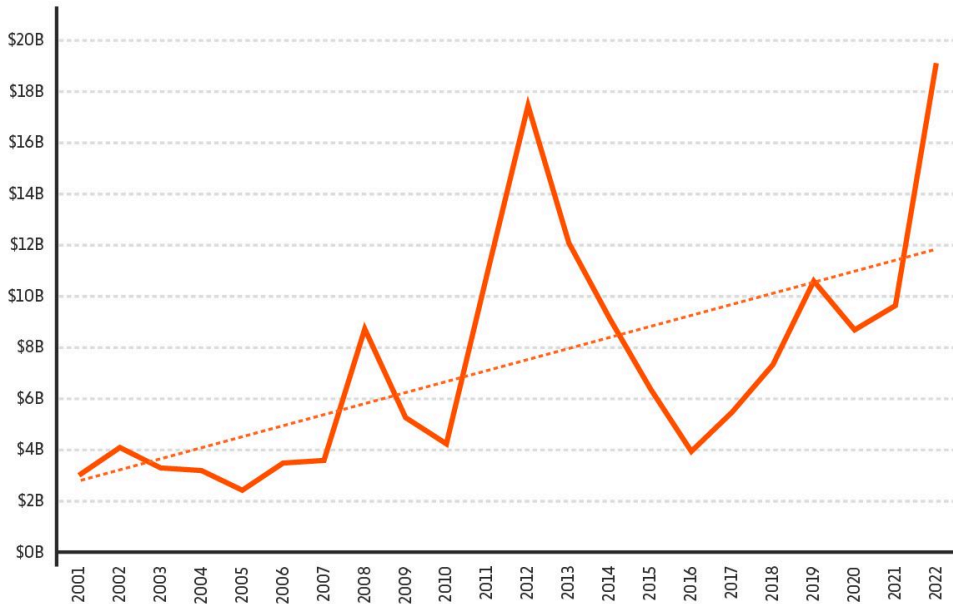
This report summarizes recent trends in national, state, and regional climate-related impacts and shares a set of recommendations for how farms can play a greater role in reducing climate-related losses and damages related to flooding through developing healthier soils, diversified (and woody) crops, land set-asides, and other means.

The high cost of a changing climate

A view from the national level

Payouts to farmers through the Federal Crop Insurance Program have risen dramatically in the past 20 years—from \$3 billion in 2001 to just over \$19 billion in 2022, [according to the Environmental Working Group \(EWG\)](#). EWG data found that annual payouts in 2022 were 546% higher than in 2001. U.S. taxpayers support 63% of these payments, which don't include additional support for crop insurance companies that taxpayers underwrite through other national programs. Many payouts are due to weather-related disasters.

Federal Crop Insurance Program Payouts to Farmers from 2001–2022 (EWG)



LEGEND

- Payout values, in billions of U.S. dollars
- - - Trend line

Storm-event damage to roads, bridges, and other infrastructure has also accelerated in recent years due to increasing rainfall intensity. [The National Oceanic and Aeronautic Administration \(NOAA\) reports](#) that the U.S. has sustained 383 weather and climate disasters since 1980, in which overall damages/costs have reached or exceeded \$1 billion. The total cost of these 383 events in consumer price index adjusted value exceeds \$2.72 trillion.

And the trend is increasing. As [reported in *The New York Times*](#), by September 2023, the U.S. had already seen the number of billion-dollar disasters fueled by climate change reach 23 that year alone.

Our flood-prone Keystone State

With its abundance of rivers and streams, Pennsylvania is particularly vulnerable to storm-event damage, resulting in economic losses and loss of life.

[A 2017 study by Penn State University and Florida Gulf Coast University](#) shows a 71% increase in very heavy rain events in Pennsylvania since 50 years ago. Because of the state's topography and prevalence of rivers and streams, most Pennsylvania communities (2,467 out of a total of 2,562) are in the National Flood Insurance Program, and 831,000 Pennsylvania residents live in floodplain areas at risk of future and repeat flooding. That's out of a state with a population of 12.8 million—or 15.4% of all Pennsylvanians residing in floodplains.

The summer of 2018 saw historic levels of flooding and flood damage across the Commonwealth. On August 31, 2018, motorists had to be rescued from their cars when flash flooding hit Lancaster County. More than 10 inches of rain fell over nine hours in Mount Joy, [according to the National Weather Service](#).

Repeat flooding events during 2018 across the state resulted in damages to 5,206 homes, and \$163.5 million in damages, but the federal government only covered \$62 million of those costs and [left a \\$101.5 million tab for the state to pick up](#). According to disaster payment rules under the Federal Emergency Management Agency (FEMA), 800 or more homes in a single storm event have to be damaged in order to receive federal financial help, and the damage must be documented as an immediate casualty of that rainfall—this is why only events totaling \$1 billion in damages or higher are listed by FEMA. In

Pennsylvania, many homes are damaged later through mudslides that result from the soggy ground caused by the rainfall. Damage such as this would not be eligible for any federal disaster payments.

According to [a study from the Pew Charitable Trusts](#), Pennsylvania taxpayers have paid more than \$1.2 billion for insurance costs from damage through 14 flood disasters in the state from 2003 to 2018. These increasingly intense weather events affect all property owners in Pennsylvania, but farms take a double hit with both crop and soil losses, as well as other infrastructure damage. [A 2022 Penn State Extension paper](#) summarizes crop losses in Pennsylvania from weather and climate events, finding that 91% of the crop insurance payments to Commonwealth farmers from 1989 to 2021 were climate-related. The majority of these losses were due to drought and were in the two commodity crops most prevalent across state farmlands—corn (46%) and soybeans (12%), while apples accounted for 24% of payments.

[An interactive map of Pennsylvania and other Mid-Atlantic states](#), supported by a NOAA study, profiles the predicted changes in temperature, stream health, agricultural production, and other factors by county.

Fortunately, Pennsylvania is still rich in farmed and forested lands, which can act as natural sponges for rainwater absorption and slow groundwater release in times of drought. However, these important functions depend on farms and forests maintaining healthy soils. Farms and forests can't mitigate the climate crisis alone, but they can play a powerful role in reducing stormwater volumes and damage, sequestering carbon through plant and tree growth, and providing floodways to accommodate flood flows where they do less harm.

In the Delaware River Watershed

Most of the Delaware River Watershed lies upstream from Pennsylvania's most populous city, Philadelphia. This area includes Bucks and Chester Counties, which, according to FEMA flood maps, are among the top five counties in Pennsylvania experiencing multi-year flood damages.

[This interactive map](#) shows each state's county-level flood losses.

Bucks and Chester counties are also home to many active farms, including many annual crop farms that have the most potential to mitigate small to medium storm events through improved soils and woody plantings.

Bucks County

(data source for all statistics: [USDA NASS](#))

Bucks County lies north of Philadelphia, and its eastern boundary is formed by the Delaware River, separating Pennsylvania from New Jersey. Bucks County's landscape is rural, especially in comparison to neighboring Philadelphia County. The county's many streams and rivers eventually flow into the Delaware River, which subsequently empties into the Delaware Bay, south of Philadelphia.

As of 2017, about 77,255 acres of land in Bucks County were used for agricultural production. The total number of farms is 824, and the average farm size is 94 acres. Farmland in crop production amounts to 78% (60,259 acres). In Bucks County, crops account for 72% of farm product sales. The largest agricultural sales are nursery stock, greenhouse-grown plants, sod, and floristics, generating a total of \$28M/year. Grains—including oil seed, dried peas, and beans—are second, generating \$13.5M/year. Given its proximity to Philadelphia and New York, Bucks County is under strong development pressure. Yet from 2012-2017 (the latest USDA agricultural census data available), there was a 21% increase in farmland acreage as farms grew in size—a surprising find, given that overall farmland acreage in Pennsylvania decreased during that same period.

Interestingly, almost 40% of farms make less than \$2,500/year (by value of sales), suggesting many are not likely the primary source of income for the owners. 47% of farms in Bucks County are between 10 and 50 acres, smaller than Pennsylvania's average farm size of 139 acres. In addition to the 13% of farms that plant cover crops for soil health, 21% of farms practice no-till, 16% practice reduced tillage, and 13% still use intensive tillage. Bucks County also experienced a net increase in average farm size from 2012-2017.

The USDA agricultural census also asks for cultural and social information. Of all Bucks County farmers, 84% use the internet, 2% are certified organic, 16% sell directly to consumers, 30% hire farm labor, and 96% are characterized as family farms. These social data sets are all about average for Pennsylvania farmers as a whole.

Chester County

(data source for all statistics: [USDA NASS](#))

Chester County lies west and south of Philadelphia County and, like Bucks County to the north, is rural in comparison to the state's most populous county and city. The rivers and streams in the southwestern part of the county flow into tributaries of the Susquehanna River, which in turn flows into the Chesapeake Bay. The rest of the county's waterways flow into the Delaware River. Chester County, like Bucks County, has among the highest median incomes of any county in the state.

There are 150,514 acres of land in Chester County used for agricultural production. Of that farmland, 70% (or 105,360 acres) is in crop production. The number of farms is 1,646, and the average farm size is 91 acres, also below the state average. In addition to the 22% of farms that plant cover crops for soil health, 28% of farms employ no-till practices, 11% practice reduced tillage, and 17% still use intensive tillage. By value of sales, 33% of farms in Chester County make less than \$2,500/year, while 30% make more than \$100,000/year—an unusual split into revenue extremes. As a whole, Chester still has more conventional working farms than Bucks County, but relative to the rest of Pennsylvania it also has a large percentage of farms that are not likely the owners primary source of income. From 2012-2017, Chester saw a 5% decrease in the overall number of farms and an 8% decrease in total farmland acres.

Chester is the leading agricultural county in Pennsylvania for nursery, greenhouse, and floriculture crops and is second in the state for raising horses. Just 3% of farms here are certified organic, 74% use the internet, 13% sell directly to consumers, 43% use farm labor, and 96% are family farms. Like Bucks County, Chester County has crops with five main uses, including hay, corn for grain, soybeans, corn for silage, and wheat for grain.

FARM CASE STUDY: Planning for floods in Berks County



Willow Run Farmstead in Berks County, Pennsylvania.

Deanne Boyer raises grass-fed beef and pastured pork on [Willow Run Farmstead](#) in Reading, PA, the seat of Berks County (also in the Delaware River Watershed). The farm has been in her family for at least three generations and has pastures that run alongside two different creeks on the property, much of which is in the 100-year floodplain.

On July 9, 2023, the farm received 10 inches of rain in a 24-hour period—the most Deanne had ever seen. She checked with older family members who still remember Hurricane Agnes coming through the region and said this storm was more intense, with water levels tipping the five-foot mark on their fences. The storm, part of a summer event that caused historic flood losses in Vermont and the northeast, hit Reading first and caused record damages, resident evacuations, and infrastructure and property losses.

“We don’t get casual rains anymore. We just get downpours or nothing.”

While the farm is no stranger to flooding, Deanne and her family have taken proactive measures to ensure that even mega-storm events cause minimal damage. In 2017, they installed riparian buffers along the creeks that help soak up and slow flood waters. They put the lowest-lying pasture along the creeks in the USDA Conservation Reserve Enhancement Program. They also built berms along their driveway—where floodwater in storms tends to flow—to divert the water into their pasture. Deanne says her pasture, which has been in the Pasa Soil Health Benchmark Study for five years, has had the water infiltration rate measured at five inches per hour—an enviable rate of absorption—so

diverting rainwater there acted as a temporary holding tank that could be filled and refilled again. The berms also helped divert flood waters coming onto their property from a neighboring farm that has less permeable soils.



A massive rain event inundated the farm in the summer of 2023.

Despite great preparation and planning, a 10-inch rainfall in 24 hours still created serious challenges. Deanne had to move their livestock to the highest ground during the storm and didn't lose a single animal. They also spent hours during the storm digging deeper ditches to divert more water into their pastures. "When the National Weather Service says we're getting lots of rain, I take it very seriously," she reports, "I am now planning for the 12-inch rain event in a 24-hour period."

The Boyers have double sump pumps in their basement that held up through the storm and had minimal clean-up of the barnyard area with storm debris, such as branches that got stuck in their high-tensile fencing. While the impact on the Reading area was historic, they escaped with essentially no damage.

Deanne says good planning and good soils made all the difference and sets them up well for future events. Asked if the federal and state agriculture agencies should be helping farmers create customized "flood plans," she agreed that a comprehensive approach made sense.

Recommendations for three levels of flooding

Farms are an important part of mitigating the impacts of climate change. While they can't reverse climate impacts alone, they are a comparatively cost-effective part of the solution.

So what potential do the farms of Bucks and Chester counties, and other farms throughout the region, have to reduce flood flows and their damage? And what potential do farms have to mitigate periods of drought? It depends on the size and intensity of the weather event.

Meteorologists talk about storms in terms of their periodicity: a 100-year flood should occur only every 100 years¹ or so, although these criteria no longer make much sense in current times, where 100-year storms can happen every few years. Still, the concept of small, medium, and large storms makes sense in terms of a farm's ability or inability to absorb significant levels of flood waters and keep them from heading downstream where they can damage road infrastructure, homes, and businesses. The duration and area of inundation of the storm, as well as the value and extent of built infrastructure in the path of the flood flow, are also factors that determine how much damage a storm can do. An "isolated" shower over a small area of land will produce less runoff than a storm event of similar intensity and duration over a larger region. The total volume of flood flow generated is the best metric for estimating the size of storm events. Similarly, droughts vary in duration, intensity, geographic scope, and in the resulting economic and environmental damages.

For the purpose of this report, we have used simple terms to describe weather and climate-related events as **small** (1–10 year storm event), **medium** (10–100 year storm event), and **large** (100+ year storm event).

¹ While "once in a century" is a common colloquial interpretation, according to the [US Geological Service](#), "the term '100-year storm' is used to define a rainfall event that statistically has this same 1% chance of occurring. In other words, over the course of 1 million years, these events would be expected to occur 10,000 times. But, just because it rained 10 inches in one day last year doesn't mean it can't rain 10 inches in one day again this year." Still, it's clear that [the frequency of extreme weather events is on the rise](#).

To mitigate damage from small storm events – we must invest in healthy soils.

Healthy soils can act as sponges to soak up and slowly release flood waters.

For the past eight years, Pasa has been coordinating the [Soil Health Benchmark Study](#), a farmer-driven research study that assesses and benchmarks the health of farm soils. Annual soil health tests empower farmers to track various indicators in their fields, including organic matter content, aggregate stability (how well soil holds together), water holding capacity, and pH. Importantly, the study also collects detailed field management

records from each farm so collaborating farmers can connect how their practices impact the soil. Results are shared with individual farms, and farmers can benchmark their results against peer farms within their cropping-system cohort, which include pastured livestock farms, diverse vegetable farms, and row crop farms.

A [2021 study report summarizing three years of the study](#) showed that pasture-based grazing operations, which are largely perennial systems, consistently scored top marks in terms of the key indicators of healthy soils.

The study continues to illuminate the many paths to achieving healthy soil. When it comes to mitigating flood damage, keeping the soil covered is key:

*“Living vegetation protects soil from wind and water erosion while also supplying the soil with fresh organic matter. Linking together annual crops, cover crops, and perennial pastures and forages to **maximize days of living cover** is a fundamental soil-building practice.*

True to their perennial nature, most of our pastured livestock farms had living cover all 365 days of the year, or with only a short gap where one of the study fields may have been used to grow an annual feed crop.

Impressively, many of the no-till row crop farms also achieved year-round living cover, typically by planting spring cash crops into living winter cover crops, then terminating the cover crops with herbicides before the cash crop emerged from the soil—a practice commonly known as “planting green.”

Generally, vegetable farmers had the fewest days of living cover, either because they left the pathways between vegetable beds bare during the summer growing season, or because they did not consistently plant a fall cover crop in fields with late-season cash crops.”

In annual cropping systems (including vegetable and row crops), practices that increase living cover, such as planting cover crops, may be the best place to start investing to mitigate flood impacts.

At about the same time that Pasa’s Soil Health Benchmark Study got underway, researchers at the Natural Resource Defense Council (NRDC) were examining the ability of soils to infiltrate floodwaters. [In 2015, NRDC published a study](#) showing that for every additional one percent of organic matter in the soil (a clear measure of health), an acre of farmland could absorb and hold an additional 20,000 gallons of rainfall per storm event. The potential for farm soils to reduce flooding was immediately obvious, but it’s also important to note that this increase in soil organic matter can’t happen overnight.

In a 2024 presentation to the Pennsylvania Soil Health Coalition, Dr. Dean Hively of the U.S. Geological Survey (USGS), shared a not yet published finding from Maryland indicating that certain cover crops, if left in the field until May 1 instead of terminating them in March, added an astonishing 69% more biomass. This cover crop biomass is key for building organic matter in the soil. Incidentally, [Maryland pays farmers between \\$20-\\$60/acre/year to plant and maintain cover crops](#).

To return to Bucks and Chester counties, we looked at USDA farmland census data to see how many acres have the potential to plant cover crops and what it would cost to implement just one soil health conservation practice: planting cover crops. USDA has estimated the average per-acre price for cover crops—including seeding, planting, and terminating the cover crop—at \$37/acre.

Bucks County has 824 farms and 77,255 acres of farmland, of which 78% is in cropland—that’s 60,259 acres of cropland that could be prioritized for soil health improvements. Subtracting the acres that are already using cover crops from that total would leave 52,426 acres that could be targeted for soil health improvements. For 52,426 acres x \$37/acre, it would cost \$1,939,762 per year to address them all—over 10 years, this would be an investment of \$19 million.

This county-wide farmland conservation investment could reduce the flow of stormwater across the Delaware River Watershed by an estimated 1,048,520,000 gallons²—that’s more than 1 billion gallons per storm event kept from flowing off farms towards Philadelphia and surrounding communities.

Chester County has 1,646 farms and a total of 150,514 acres of farmland, of which 70% or 105,360 acres is in cropland. Subtracting acres that are already planted with cover crops from the total leaves 82,181 acres to be improved by cover crops x \$37/acre, which amounts to \$3,040.697 per year. \$3 million/year for 10 years would be an investment of \$30 million.

The per-event reduction in stormwater flow from this investment would be 1.6 billion gallons² of rainwater into the Delaware River and Susquehanna River watersheds and communities.

This 10-year investment figure also assumes that farmers would stop planting cover crops if they’re not paid to do so each year. However, a [2022-2023 National Cover Crop Survey](#) by Sustainable Agriculture Research Education (SARE), Conservation Technology Information Center (CTIC), and American Seed Trade Association (ASTA) found that 90.3% of the farmers who were receiving cover crop incentives reported that they would definitely or probably continue planting cover crops after the payments ended because they saw the value of healthier soils for farm production and soil protection, while only 3.3% said they definitely or probably would drop cover crops at the end of the incentive program.

Because flood gauges don’t measure stormwater in gallons but in cubic feet/second, it’s hard to equate what these huge gallons-of-rainwater reductions would mean for a typical flood or how much damage it might reduce. There is general consensus, however, that even farms with healthy soils and high soil water infiltration rates are not able to accommodate large flood flows quickly enough to dramatically reduce flooding and damages, so it’s safe to say that healthier farm soils will better mitigate small flood events, but probably not 100-year storm events.

Several USDA Farm Bill programs already provide cost-shares to farmers for planting cover crops, including the Conservation Stewardship Program (CSP) and the Environmental

² Calculation based on NRDC figure stating a 1% increase in organic matter equates to 20,000 gal/acre absorbed x 52,426 acres to be improved by cover crops. This is an estimate: the exact amount of rainwater that infiltrates the soil during a rain event will vary depending on a variety of factors including the intensity of the rain event and condition of the soil.

Quality Incentives Program (EQIP). On November 3, 2023, the [NRCS's Pennsylvania office announced](#) the availability of another \$15 million for cover crops for Commonwealth farmers through EQIP with a first-come, first-served enrollment period over the next five years.

This funding recognizes not only the importance of cover crops in improving soil health but also the frustration that many farmers—especially small-acreage farmers—have felt over

1. *Calculation based on NRDC figure stating a 1% increase in organic matter equates to 20,000 gal/acre absorbed x 82,181 acres to be improved by cover crops. This is an estimate: the exact amount of rainwater that infiltrates the soil during a rain event will vary depending on a variety of factors including the intensity of the rain event and condition of the soil.*

the years competing with bigger farms and bigger projects, such as manure storage lagoons, for the same limited pool of CSP and EQIP dollars. This additional \$15M in funding would cover the cost of planting and maintaining cover crops for every crop farmer who doesn't currently use them in Bucks *and* Chester counties for the next three years.

Another “hidden” benefit of healthy soils is boosting farm income in general. The Soil Health Institute estimates that, beyond the implications for stormwater reduction, healthy soils create an additional \$8.2 billion in profits for farmers across the U.S.

A second, and increasingly popular, approach to improve soil health is a suite of practices called agroforestry. These include: riparian buffers; silvopasture (adding trees to pastures or animals to forests); alley cropping (alternating rows of trees and crops); forest farming (raising produce in forest settings); and windbreaks. Unlike most cover crops, which provide a living cover on the soil and limit soil erosion, agroforestry combines soil improvement with growing a marketable product. Typical examples include growing hazelnuts, chestnuts, pawpaws, elderberries, along with other fruit trees and berry bushes.

Many farmers are looking to agroforestry as a way to diversify their farms from a monoculture or rotation of one or two crops. Woody species enrich the soil by shedding leaves, twigs, bark, and other plant materials, and by exuding carbon through their perennial roots. Trees and shrubs sequester carbon in their trunks and branches, as well as in the soil. They can also provide shade, forage, and fodder for livestock, and create habitat for pollinators and other wildlife.

Many agroforestry practices are cost-shared through NRCS programs in most states across the country, but the practices depend on a small number of technical assistance providers who know how to install them. To install alley cropping systems on three demonstration farms in Pennsylvania, Pasa reached out to an expert from Vermont, Meghan Giroux of Interlace Commons. We also regularly work with Austin Unruh of Trees for Graziers, one of the few silvopasture technical experts in Pennsylvania, to share his knowledge with farmers in our community as well as other providers. Pasa's new Climate-Smart Farming and Marketing program is working to build more technical assistance capacity for these and other conservation farming practices, both here in Pennsylvania and with partners across the Eastern Seaboard.

Unlike cover crops, the true cost of installing various agroforestry practices varies widely and is difficult to calculate. NRCS state chapters publish cost tables for each conservation practice that vary from state to state. Some base the cost of alley cropping tree purchases on more classic conservation planting costs for pine seedlings (30 cents apiece), which do not produce the income stream that a fruit- or nut-bearing tree more commonly used in alley cropping systems, like chestnuts or apples, would (\$60+ apiece). These costs also don't reflect the need for fencing, which can run thousands of dollars per acre, or shelters like tubes and stakes which can be crucial for the survival of seedlings. Agroforestry is also a long-term investment, as many tree species don't begin to produce until they are five to seven years in the ground.

Since these practices are relatively new, there isn't a lot of data on the payback period, annual income stream, or true per-acre cost. [Pasa's three demonstrations of alley cropping plantings](#) cost \$5,000 apiece in plant materials and other materials, not including planting labor, fencing, or irrigation. These were also small projects on 3 acres. It may be too soon to quantify the per-acre cost of most agroforestry projects, but the carbon benefits are tantalizing. [According to a paper co-authored by Andrew Currie](#), who is leading Pasa's Climate-Smart Program, and published in *Ecology Law Quarterly*, "agroforestry sequesters two to five times more carbon per acre than the most effective—and better-known—climate-friendly practices for annual crops, such as no-till agriculture and cover crops. Agroforestry also offers substantial environmental and economic benefits: clean water, reduced fertilizer and pesticide use, greater resiliency, and higher profitability per acre."

[In a U.S. Forest Service summary of agroforestry projects in the 2017 USDA Census of Agriculture](#) on Pennsylvania counties' adoption rate for agroforestry practices, Chester County was second in the Commonwealth, behind only Lancaster County.

Prioritizing our investments in healthy soils.

While policymakers and planners like to develop priority lists for where best to target public investments, the reality is that with any voluntary practice, it's up to the landowner. Dam removal in Pennsylvania is a classic example of, list after list, targeting the dams that were most likely to fail, were dangerous to swimmers or boaters, provided the least service to the public, or prevented high-value aquatic species from migrating. In the end, dam removals occurred randomly according to the preference of the dams' owners. That said, we can generalize about the optimum priorities for soil health investments through cover crops or agroforestry practices, assuming all landowners have an equal interest and commitment to mitigating climate change.

Farmland priority investment sites:

- **Farms above flood-prone cities and townships in the watershed.** Since water flows downhill, it makes sense to invest in farmland soils that sit above population centers to limit flood damages to homes, businesses, and infrastructure sitting lower in the watershed where non-infiltrated floodwaters will flow.
- **Farms in annual crops.** Cropland including annual vegetables and row crops would be the highest priority since the potential for improvement is higher than on perennial pastures.

To mitigate damage from medium storm events – **we must adapt.**

Whether it's adapting existing programs or adapting farm products to be more flood tolerant, these storm events are likely too large to rely on healthy soils alone for mitigation.

- 1. Adjust current policies and programs to help farms survive increasingly extreme weather and climate events.**

Sometimes short-term solutions to simply keep farms afloat after climate events are critical and typical of what the federal government has been doing on an increasingly expensive basis. In response to heavy and prolonged flooding in the Northeast U.S. in June, July, and August 2023, [USDA's Farm Services Agency \(FSA\) created policy exemptions](#) for the six New England states along with New York, Pennsylvania, and New Jersey to allow farmers to access more loans, more crop disaster assistance, and other practices, including emergency haying and grazing on Conservation Reserve Program lands.

Altered policies included the following:

- Expanded [Farm Storage Facility Loan](#) availability;
- Extended [emergency haying and grazing](#) on Conservation Reserve Program lands;
- [Noninsured Crop Disaster Assistance Program](#) notification waivers;
- Extended deadlines for the [Emergency Assistance for Livestock, Honeybees, and Farm-Raised Fish Program](#);
- Extended deadlines for the [Livestock Indemnity Program](#); and
- Extended deadlines for the [Tree Assistance Program](#).

USDA's Risk Management Agency (RMA) also authorized modified crop insurance reporting requirements for producers in Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont, cutting through some red tape to get assistance.

In the fall of 2023, the FSA [announced](#) that the agency will provide more than \$3 billion through the [Emergency Relief Program \(ERP\) 2022](#) for "commodity and specialty crop producers impacted by natural disaster events in 2022." USDA stated that "ERP 2022 covers losses to crops, trees, bushes, and vines due to qualifying calendar year 2022 natural disaster events including wildfires, hurricanes, floods, derechos, excessive heat, tornadoes,

winter storms, freeze (including a polar vortex), smoke exposure, excessive moisture, qualifying drought, and related conditions.”

2. Add soil health as an incentive payment or discount to existing disaster programs.

Additional federal agencies beyond USDA could invest more proactively to help build healthy soils that can mitigate at least small climate events. One target would be FEMA’s Community Rating System, which provides National Flood Insurance Program (NFIP) discounts to communities that adopt flood-prevention, planning, and mitigation measures.

Adding soil health building (paying for farmers to plant cover crops or agroforestry practices) to the current list of 10 practices that communities can adopt for insurance discounts would be a direct and preventative way to lower flood losses and risks. Communities could pay upstream farmers for these improvements and reap the discounts and benefits.

At the state level, FEMA’s Pennsylvania agency, PEMA, runs a disaster-prevention grant program called [Building Resilient Infrastructure and Communities \(BRIC\)](#). Local governments must apply to the program, which the state then applies for through the federal program. The program promises to be proactive and innovative but can be very competitive and difficult to apply. Revising the program to be more accessible and making more funds available would be a start. Adding soil health improvements on upstream farms as part of what local governments can apply for would also meet the innovative intent of the program.

Another innovation comes from the world of research. The nonprofit group [LandCore](#) received a grant to conduct research establishing quantifiable connections between healthy soils and crop loss risk, and is working with the third largest U.S. agricultural lender. Farmers are currently not penalized for poor soil health practices because commodity crop losses are covered by Farm Bill crop insurance payments. These [researchers equate insurance reductions for farmers who use good soil practices with safe-driver discounts](#).

3. Rethink or shift crops and agricultural practices in flood-prone areas.

Planting more trees and woody species on farms can help them adapt to more flooding and sequester carbon at faster rates—growing woody stems, such as willow and red osier dogwood, for biomass also serve this purpose.

Researchers at the University of Nebraska conducted a literature review of multiple studies on which farm practices and crops provide the best levels of infiltration and which do not. They looked at 89 studies from six continents and ranked them from best to worst:

- Trees and native grasses provided the best infiltration
- Improved soil health through planting cover crops
- No-till only
- Crop rotation
- Grazing “cropland” actually reduced infiltration rates

4. Link crop insurance to weather-related impacts

In response to the devastating floods that hit Vermont particularly hard in the summer of 2023, Senators Peter Welch (D-Vt.), Bernie Sanders (I-Vt.), Ed Markey (D-Mass.), and Elizabeth Warren (D-Mass.) introduced the [Withstanding Extreme Agricultural Threats by Harvesting Economic Resilience \(WEATHER\) Act](#). This legislation calls for the development of an index-based insurance policy that is more responsive to crop and income losses faced by farmers as a result of extreme weather.

The bill would do the following:

- Direct the Federal Crop Insurance Corporation to collaboratively research and develop an index-based insurance policy designed to support farmers in withstanding agricultural income losses closely correlated with weather conditions—including growing conditions applicable to small-scale farmers.
- Create a multi-peril index insurance product for farmers based on weather indices correlated to agricultural income losses using data from NOAA, satellites, climate models, and other data sources.
- Payout within 30 days in the event of indices exceeding any of the predetermined county-level thresholds for the following events: high winds, excessive moisture and flooding, extreme heat, abnormal freeze conditions, hail, wildfires, drought, and other perils the Secretary determines appropriate.

Some farmers have already persuaded their crop insurance agents to consider this approach on a case-by-case basis, but a comprehensive approach would make more sense than leaving decisions entirely in the hands of independent insurance agents.

FARM CASE STUDY: Creating a climate-based crop insurance policy



Pittsburgher Highland Farm in Westmoreland County, Pennsylvania.

Mark Smith owns one farm and leases another as part of his [Pittsburgher Highland Farm](#) in Westmoreland County. Smith, a former real estate broker, is all-in on sustainable farming: he runs a grass-fed cattle operation on pasture and built a tiny house to earn agritourism side income. He has silvopasture and dual-use solar projects in the works, so he's also a very innovative farmer. His shaggy herd of Scottish highland cattle with upward pointing horns is another give-away.

When a series of annual droughts started to impact his lands and cattle operation, Mark got innovative again.

He talked to his insurance agent, and they worked out a unique crop insurance contract that is tied to weather and rainfall rather than simply crop production. "I'm lucky because I have a good agent," says Mark.

The key to his insurance policy is viewing the grass he grows to feed his livestock as a crop. If he can't grow enough grass to support his livestock or cut hay to supplement their feed in the winter, he has to buy additional feed that affects his profitability and the health of the farm. The insurance is based on the amount of rainfall during the growing season (the

policy references six months) compared to the average rainfall of his census tract, multiplied by the total number of acres in pasture.

If rainfall is low and he can't feed his livestock, he will get an insurance payment to cover the loss. If he does get plenty of rain, he sees no payment.

The trend at the farm over the past 10 years has been increasingly low rainfall. Smith says six of the past ten10 years have been very low, to the point where his creeks dry up, and grass production is poor. In addition to having to pay for supplemental feed, Smith spends half his day hauling water to one farm site or another—a huge time sink and hard labor.



Drought conditions have become the normal for summers at Pittsburgher Highland Farm.

“This year [2023], our wells and creeks were dry by May. We get thunderstorms that are hit or miss, and they mostly miss us.”

The once-reliable rains that nourished his farms are no longer a given, so insurance has to ensure that he can continue to farm. “It’s not profit; it all gets plowed back into the farm,” he notes.

To mitigate damage from large storm events – we must give floodwaters a place to go.

When storms or other climate events are very large and very severe, the best principle is simply to create room for the floodwaters to go where they do less damage.

1. Cities are using public parks as stormwater management tools.

When New York City experienced record flooding through a rain event in September 2023, the subways filled with water, and many low-lying neighborhoods like Brooklyn were flooded. Low-lying Hoboken, New Jersey, however, often a repeat victim of flooding, escaped relatively unscathed. As [The New York Times reported](#), its thoughtful planning and use of civic infrastructure, like parks, help Hoboken collect and store stormwater underground until it can be released without doing much damage.

In Pennsylvania, the city of [Lancaster's stormwater management plan](#) includes collecting rainwater from storm runoff in underground drainage tanks beneath city parks and adding trees to improve infiltration and soak up rainwater.

2. Land buy-outs for floodways

[In Austin, Texas, urban planners trying to solve repeat flooding](#) purchased land as a floodway and then added agroforestry practices to make that land doubly useful as parkland and in agricultural production. The process included extensive community input.

3. Permanent floodplain easements on farms

American Rivers and other conservation groups are asking farmers to be part of the floodway solution by putting farmland that is chronically flooded into a permanent floodplain easement program. [This campaign](#), which seeks to embed this concept in the next federal Farm Bill, would pay farmers who voluntarily give up producing on this land. The easements offer protection for downstream cities, and landowners can provide critical wildlife habitat, and avoid the cycle of repeat disaster payments on the same lands.

4. First, do no harm

One of the first impulses and activities that communities and many farmers undertake after a storm is to bulldoze small- and medium-sized streams to get rid of debris, operating on the theory that these bulldozed streams would convey floodwaters more efficiently in future storm events.

[Senate Bill 690](#), introduced in Pennsylvania's state legislature in the fall of 2023, would authorize local governments to work with conservation districts to do stream-clearing maintenance under 10-year "emergency permits." While many farmers and other landowners have expressed frustration at the red tape involved in getting stream-clearing permits, streams are living systems that support a wide variety of life, which, in turn, supports mammals, birds, and many living things.

Bulldozing streams may temporarily convey floodwater faster, but the practice ultimately leads to scouring, soil loss, habitat loss, and wildlife loss. It is far from a permanent solution. Debris will inevitably fill up again and require repeated clearing. Streams with intact floodplains can slow and spread floodwaters effectively if given enough room to hold and infiltrate floodwaters, while continuing to provide multiple biological benefits, including water purification. Bulldozing streams should be avoided at all costs.

Summary

Farmland has untapped potential to make a real difference in a world where major weather events will continue to cause increasing economic and environmental damage and misery.

Depending on the size of the weather event, practices like improving soil health and creating and maintaining major floodways make farmers an essential part of the solution.

Amending current federal and state programs to accommodate these increasingly severe events makes great sense, and creative approaches that look beyond the conventional approaches do, too. In addition to lessening damage and economic loss, many of the solutions proposed here have multiple additional benefits for soil productivity, wildlife habitat, cleaner air and waters, carbon sequestration, and limiting erosion and soil loss.



Weavers Way Farm in north Philadelphia installs an alley cropping system to boost environmental resilience and diversify revenue.

We hope some combination of policymakers and farmers themselves take up these ideas and work with Pasa and similar groups to put them into action sooner rather than later. We are always ready to take your questions and suggestions and work together toward a more stable, resilient, and sustainable world. **P**

Thoughts or questions about this report? Email us policy@pasafarming.org or call 814.349.9856.

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About the author



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Prior to joining Pasa, Sara worked as the Policy Director for Pennsylvania's Department of Conservation and Natural Resources and conducted fieldwork in forestry, stream restoration, and riparian buffer planting. She holds a master's degree from Yale's School of Forestry and Environmental Studies.

About Pasa

Pasa Sustainable Agriculture is a 501(c)(3) nonprofit that supports sustainable farms and equitable food systems through farmer-driven education, research, and community. We're based in Pennsylvania and increasingly engaging with farmers and partners across the Mid-Atlantic and the Northeast.

Our mission: Cultivating environmentally sound, economically viable, community-focused farms and food systems. Visit pasafarming.org to learn more about our work.

Resources by topic

Impact & cost of extreme weather events

NOAA list of 357 weather events (1980-2023) that have each cost more than \$1B

<https://www.ncdc.noaa.gov/billions/events.pdf>

New York Times article on cost of climate change

<https://www.nytimes.com/2023/09/12/climate/billion-dollar-disasters.html>

Penn State and Florida Gulf Coast University study of how flooding and new legislation are impacting rural Pennsylvania

<https://www.rural.pa.gov/download.cfm?file=Resources/reports/assets/45/Flood-Mitigation-2017.pdf>

Report on the 2018 flash flood damage on Lancaster, Pennsylvania

<https://weather.com/news/news/2018-08-31-mount-joy-flash-flooding-stranded-cars>

Pennsylvania Department of Environmental Protection blog post on the cost of flood damage in 2018

<https://paenvironmentdaily.blogspot.com/2019/02/pema-over-1015-million-in-flood-damage.html>

Pew Charitable Trusts report on weather events (2003– 2018) costing Pennsylvanians almost \$1.2 billion

<https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2019/01/pennsylvania-flood-risk-and-mitigation>

Penn State Extension paper on agricultural and crop loss in 2022 due to weather and climate activities

<https://extension.psu.edu/crop-loss-and-climate-risk-in-pennsylvania>

2017 Census of Agriculture Bucks County, Pennsylvania profile

https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Pennsylvania/cp42017.pdf

2017 Census of Agriculture Chester County, Pennsylvania profile

https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Pennsylvania/cp42029.pdf

Environmental Working Group (EWG) report on the dramatic rise in crop insurance payouts

<https://www.ewg.org/research/crop-insurance-costs-soar-over-time-reaching-record-high-2022>

Inside Climate News' summary of EWG Report above

<https://insideclimatenews.org/news/28012022/flood-drought-crop-insurance/>

Stanford University paper on climate-related crop insurance payouts (1991-2017)

<https://earth.stanford.edu/news/global-warming-increased-us-crop-insurance-losses-27-billion-27-years>

Interactive maps

Interactive map of Pennsylvania and other Mid-Atlantic states predicting changes in temperature, stream health, and agricultural production

<https://www.marisa.psu.edu/outlooks/>

Interactive map of each state's county-level historical flood risk and potential flood-related costs

<https://www.fema.gov/data-visualization/historical-flood-risk-and-costs>

Farming practices shown to mitigate climate-related damage & impact

Overview of Pasa's Soil Health Benchmark Study

<https://pasafarming.org/soil-health-benchmark-study>

Pasa's Soil Health Benchmarks 2021 Report

<https://pasafarming.org/resources/soil-health-benchmarks-2021-report/>

2022-2023 National Cover Crop Survey Report

<https://www.sare.org/wp-content/uploads/2022-2023-National-Cover-Crop-Survey-Report.pdf>

Resources about Pasa's pilot alley cropping projects on three Pennsylvania farms

https://pasafarming.org/topic_area/agroforestry/

NRDC (Natural Resources Defence Council) 2015 report on benefits of increasing soil organic matter

<https://www.nrdc.org/experts/lara-bryant/organic-matter-can-improve-your-soils-water-holding-capacity>

NPR review of 2021 US Soil Health Institute study showing economic benefits of cover crops and no-till

<https://www.kcur.org/2023-09-22/cover-crops-and-no-till-make-farmers-more-money-study-says>

American Flood Coalition pilot project testing farming practices potential for flood mitigation

<https://floodcoalition.org/2022/12/afc-pilot-innovative-farming-practice-can-reduce-flooding/>

Article on agroforestry's potential to mitigate climate change

<https://www.ecologylawquarterly.org/print/farming-with-trees-reforming-u-s-farm-policy-to-expand-agroforestry-and-mitigate-climate-change/>

U.S. Forest Service summary of agroforestry projects in the 2017 USDA Census of Agriculture

<https://www.fs.usda.gov/nac/maps-data/census-agriculture/assets/AF-Census-State-Summaries.pdf>

Incentives, innovations to insurance & civic planning

Pennsylvania NRCS EQIP dollars for cover crops

<https://paenvironmentdaily.blogspot.com/2023/11/nrcs-pa-offers-pennsylvania-producers.html>

Maryland's Cover Crop Program

https://mda.maryland.gov/resource_conservation/pages/cover_crop.aspx

FSA USDA created policy exemptions for flood-impacted states in the Northeast to allow producers to access more loans in 2023

<https://www.fsa.usda.gov/news-room/news-releases/2023/usda-offers-disaster-program-flexibilities-for-flood-impacted-producers-in-the-northeast>

FSA USDA announced that they will provide over \$3 billion worth of relief for commodity and specialty crop producers impacted by natural disasters in 2022

<https://www.fsa.usda.gov/news-room/news-releases/2023/usda-to-provide-more-than-3-billion-to-commodity-and-specialty-crop-producers-impacted-by-2022-natural-disasters>

<https://www.fsa.usda.gov/programs-and-services/emergency-relief/index>

Morning Ag Clips article on market-based, actuarially-sound model for determining risk-mitigation benefits and related cost savings

<https://www.morningagclips.com/grant-quantifies-farm-risk-mitigation-through-improved-soil-health/>

PEMA 2022 application for BRIC funding

<https://www.pema.pa.gov/Grants/BRIC/Pages/default.aspx>

2023 legislation that calls for development of an insurance policy that is more responsive to crop and income losses due to extreme weather.

<https://www.welch.senate.gov/wp-content/uploads/2023/12/WEATHER-Act-Bill-Text.pdf>

Lancaster, Pennsylvania, created a stormwater management plan, which includes planting more trees.

<https://www.cityoflancasterpa.gov/stormwater-information/>

Urban planners in Austin, Texas, purchased land as floodway and adopted agroforestry practices.

<https://attra.ncat.org/publication/urban-agroforestry-case-study-utilizing-agroforestry-in-floodplain-restoration-projects/>

Conservation groups assessment of the benefits of permanent floodplain easement program

<https://www.americanrivers.org/resource/the-multiple-benefits-of-floodplain-easements/>

Senate bill that authorizes the local government to do stream-clearing under "emergency permits"

<https://www.legis.state.pa.us/cfdocs/billinfo/billinfo.cfm?year=2023&sInd=0&body=S&type=B&bn=690>