WASHINGTON STATE UNIVERSITY

Center for Sustaining Agriculture and Natural Resources

# Biennial Report

## 2024 & 2025

**Accessibility note: This PDF reflects our best effort to support digital accessibility. A fully accessible version is available at csanr.wsu.edu/biennial-report.**

# Director's Message

By the time you read these words, I will have concluded my service as director of CSANR. I think back to early 2008 when the CAHNRS dean asked me to serve as interim director. Who knew then what nearly two decades would bring, or where the Center would be today? I'm certainly amazed and proud of what the CSANR team, our affiliates, and our partners have accomplished together.

The list of accomplishments is long, both in terms of academic contributions and practical knowledge that has informed farm and ranch management decisions, industry strategy, and public policy across the state. That's what we were established to do, and the CSANR team, affiliates, and partners have come together time and again to put our collective shoulders to the no-till drill.

Earlier today, I watched a CSANR team member present the Dairy Climate Roadmap to the Washington State Dairy Federation—the culmination of more than two decades of collaboration between several partners to make Washington's dairy sector one of the most sustainable in the world. It made me think about the state's Agricultural Climate Resilience Plan we helped WSDA develop; multiple Columbia River Supply & Demand Forecasts we partnered to produce; our substantial body of work in organics recycling research, education, and training; and the establishment of the world's most robust soil health experimental site network. Like the Dairy Climate Roadmap, each of these accomplishments was built on a foundation of vision and partnership.

Nearly 20 years after stepping into this role, I'm proud of what we've built together and confident that the Center is well-positioned to continue making vital contributions toward a sustainable, resilient, and regenerative agricultural system and community in Washington. I hope you're as eager as I am to see what the Center's next chapter will bring.

Thanks and Go Cougs!

Chad Kruger

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*Page 2: Chad Kruger. Photo: Tonya Kruger.*
*Page 2 and front cover: Mount Vernon Research and Extension Center field day.*
*Above: Compost Facility Operator Training participants tour a facility. Photos: Margaret*

# CSANR People

**Jim Amonette**
Senior Research Fellow

**Kirsten Ball**
Associate Research Fellow

**Christopher Benedict**
Senior Extension Fellow

**Douglas Collins**
Senior Extension Fellow

**David Granatstein**
Senior Extension Fellow

**Margaret Griset**
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**Sonia Hall**
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**Allie Higginbotham**
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**Jordan Jobe**
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**Alex Kirkpatrick**
Science Communications Specialist

**Chad Kruger**
Director

**Andrew McGuire**
Senior Extension Fellow

**Teal Potter**
Research Associate

**Corinn Rutkoski**
WA Soil Health Initiative Extension Coordinator

**Chris Sater**
Laboratory Manager

**Heleene Tambet**
Associate in Research

**Aaron Whittemore**
Research Associate

**Georgine Yorgey**
Senior Research Fellow

Not pictured: **Katie Doonan,** Extension Coordinator

## Advisory Committee

**Brad Bailie**
Lenwood Farms

**Brenda Book**
Washington State Dept of Agriculture

**Kevin Corliss**
Ste. Michelle Wine Estates

**Tim Crosby**
Cascadia Foodshed Financing Project

**Maurice Robinette**
Lazy R Ranch

**Díanna Sanchez**
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**Anne Schwartz**
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## Faculty Leadership

**Michael Brady**
Economic Sciences

**Ian Burke**
Crop and Soil Sciences

**Deirdre Griffin LaHue**
Crop and Soil Sciences

**Kris Johnson**
Animal Sciences

**Laura Lavine**
Entomology

**Kevin Murphy**
Crop and Soil Sciences

**Kiwamu Tanaka**
Plant Pathology

**Kirti Rajagopalan**
Biological Systems Engineering

**Clea Rome**
Clallam County Extension

**Matthew Whiting**
Horticulture

**Meijun Zhu**
Food Science

# About CSANR

## What we do

The Center for Sustaining Agriculture and Natural Resources at Washington State University invests in research and partnerships to create systems-level solutions for Washington. We work alongside producers, agencies, and scientists to turn small investments into big results.

CSANR has played both direct and supportive roles in shaping sustainability across Washington state. We helped launch the Bread Lab, the Eggert Family Organic Farm, the Organic and Sustainable Agriculture major, WSU's organic research portfolio, and the Washington Soil Health Initiative. By seeding transformative ideas and providing a collaborative space, we help innovations grow into lasting impact.

## Our origins

In 1990, WSU held 16 town hall meetings where more than 1,500 Washington citizens recommended how the university could better serve them. Sustainable agriculture and natural resources emerged as a top priority.

The following year, the Washington State Legislature established CSANR. In our early years, we focused on providing reliable information about sustainable agriculture. As sustainability concepts have become part of mainstream agriculture, our role has evolved: today we catalyze cutting-edge research on pressing issues such as climate change, soil health, energy security, and emerging challenges in food and farming systems.

For more than three decades, CSANR has advanced science-based solutions for Washington agriculture—connecting researchers, producers, and communities to shape a more resilient future.

# A Decade of Leadership

## Honoring Georgine Yorgey's continuing impact

Now leading the WSU Energy Program, Georgine Yorgey continues to shape CSANR's statewide work through research, extension, and collaboration.

Georgine joined CSANR in 2009 and quickly established herself as an innovative leader in Extension programming and outreach. Her success stems not only from her remarkable productivity but also from her ability to engage producer associations, public agencies, policymakers, and industry leaders to build the consensus and partnerships needed to tackle major challenges.

After nearly ten years of serving as associate director of CSANR, Georgine Yorgey started a new leadership role as director of the WSU Energy Program. She continues to bring her expertise to CSANR initiatives like the Dairy Roadmap and Apple Lifecycle Assessment projects as an affiliate.

## Leadership in Action

### AgSymbiosis and resource recovery

Georgine's leadership helped support the 25 farm-based digesters in the Northwest with policy work, extension, and exploration of other complementary technologies that can be used alongside digesters. These farm-based digesters produce an estimated 126M kWh of renewable energy annually while reducing greenhouse gas emissions. She also supported state-level frameworks, like Washington's Sustainable Farms and Fields Program, to incentivize sustainable waste practices and attracted millions in funding for innovative solutions.

### Water for agriculture

Georgine led or contributed to extension efforts for three Columbia River water forecasts (2011, 2016, and 2021), fostering dialogue among agricultural, environmental, and residential stakeholders. Her work supported the Office of Columbia River in the development of water projects delivering 516,641 acre-feet of instream and out-of-stream water with agricultural benefits exceeding $100 million annually, helping establish more sustainable water use.

*Top: Georgine presents at a Dairy Digester Workshop in Othello, WA. Photo: Chad Kruger*

## Real-world impact

As associate director of CSANR, Georgine led many high-impact projects that engaged both traditional and non-traditional Extension audiences. For example, she directed the multimedia Climate Resilience Case Studies project, co-edited and managed the 39-author Extension handbook *Advances in Dryland Farming in the Inland Pacific Northwest*, oversaw the *Anaerobic Digestion Systems* series of Extension publications, and launched the *Carbon and Cow$* podcast, which had at least 400 listeners.

Georgine's reputation is such that many state agencies and non-governmental organizations recognize her as a trusted conduit to the best available science on climate solutions, organic waste management, and water resources. She is frequently sought out as an Extension collaborator by WSU researchers and has served as principal investigator or co-PI for ten large, multi-disciplinary, federally funded projects over the past decade. Georgine is central to the leadership and design of most of these projects, and her collaborators credit her for helping them understand how their research ideas can translate into real-world actions.

Georgine has authored more than 20 peer-reviewed journal articles and book chapters, 35 peer-reviewed Extension publications, and numerous technical and multimedia resources. Over her career, Georgine has secured over $5 million in funding to support her programs.

## Looking ahead

Since stepping into her new role as director of the WSU Energy Program in October 2024, Georgine has made an immediate impact.

Chad Kruger, who worked closely with Georgine as director of CSANR, shared "Georgine is talented and productive in unprecedented ways. She has already blown away expectations in her new role."

In her new role, Georgine leads a unit that is helping Washington transition to a more sustainable energy future. The Energy Program is supporting the electrification of public fleets, testing in-window heat pumps for renters, and working on issues related to agriculture, such as least-conflict solar siting and facilitating a pilot installation of a heat pump water heater on a regional dairy.

Despite these additional responsibilities, Georgine remains deeply engaged at CSANR, continuing to bridge research, extension, and leadership to address the challenges of food, energy, and water sustainability.

## CSANR's Stellar Team

CSANR fellows, faculty leadership, and affiliates received numerous CAHNRS Awards in 2024 and 2025.

**Georgine Yorgey**
Faculty Excellence in Extension

**Kirti Rajagopalan**
Early Career Excellence Award

**Soil to Society Team**
Team Interdisciplinary Award

**Manuel Garcia-Perez**
Faculty Excellence in Research Award

**Meijun Zhu**
Land Grant Mission Award

**Troy Peters**
Faculty Excellence in Extension Award

**Chad Kruger**
Faculty Administrator Award

# Research with Real Impact

## Collaborative solutions for Washington

Through collaboration with state and federal agencies, industry groups, and research partners, our work informs investments that deliver results statewide.

**$2.5M**

CSANR supported projects that helped establish 25 anaerobic digesters for 143K dairy cows, generating 126M kWh/year of renewable energy worth $2.5M.[1]

**$30M**

CSANR's work laid the foundation for Washington State's investment of $30M in funding for anaerobic digesters, alternative manure management, and GHG-reduction research and demos.[2]

**$100M**

The Office of Columbia River worked with CSANR, WSU, and partners to develop 516K acre-feet of irrigation water supply, supporting $100M in annual productivity, informed by the Columbia River Forecast.[3]

### 3,700+ Participants

CSANR-supported events, tours, and trainings reached thousands of producers, policymakers, and professionals.[1, 3–6]

### 64K Tons Emissions

Farm and energy projects backed by CSANR cut 64K tons of $CO_2e$ annually, equivalent to taking 14K cars off the road.[7]

### 188K Acres

CSANR supported Sustainable Farms & Fields projects, which helped 650 producers adopt climate-friendly practices.[7]

*Impacts reflect outcomes documented 2023–2024, resulting from CSANR work conducted 2003–2024.*

1. Boone et al. 2023. ***Advancing Organics Management***. 2. Roth et al. 2023, ***Increasing the Economic Value and Sustainability of Washington's Agricultural Sector through Industrial Symbiosis***. 3. Hall et al. 2023, WA DNR Climate & Drought Outlook Brief. 4. Yorgey et al. 2024. ***Carbon Markets Education.*** 5. Kruger et al. 2023. ***Adapting to a Changing Climate.*** 6. Includes events and training attendees plus engaged podcast listeners. 7. Yorgey et al. 2023, ***Mitigating Climate Change.***

# Logistics for Agriculture

## Hickman Fellowship funds transportation studies

Hanouf Alhunayshil, a PhD student in economics, received the Lawrence Hickman Fellowship to examine how transportation costs impact dryland farming producers.

*Photo: WSU*

Growing up in Saudi Arabia's Qassim region, Hanouf developed an appreciation for agriculture, which plays a vital role in the local economy and cultural identity. This connection shaped her interest in the systems that move agricultural products from producers to markets.

"Improving the efficiency of transporting agricultural commodities has a direct impact on reducing environmental burdens, supporting rural producers, and strengthening food systems," she said.

At WSU, Hanouf has analyzed over 1.5 million records of agricultural truck shipments from 2017 to 2023 collected from Bulkloads.com. Working with the Transportation Research Group (TRG), she examined regional and seasonal variations in bulk trucking rates, identifying key cost drivers like fuel and labor.

She found that these costs show strong persistence over time, creating long-term pricing pressures on producers, particularly those with already narrow margins in dryland regions. Transportation often makes up the largest post-farm cost for high-volume crops.

In a related project, Hanouf worked with the TRG to develop a U.S. Port Performance Index to evaluate how efficiently ports operate. This index offers more granularity and timeliness than existing Bureau of Transportation Statistics metrics, covering over 70 ports monthly rather than 25 ports annually. It tracks performance indicators for both agricultural and non-agricultural trade flows.

"Enhancing the movement of food and essential goods is not only economically important but also a contribution to global sustainability," Hanouf explained.

The Lawrence Hickman Fellowship supports Hanouf's dissertation and her efforts to link transportation policy with agricultural sustainability. After completing her PhD, she plans to return to Saudi Arabia to contribute to infrastructure and sustainability, particularly in agriculture and logistics.

## About the Fellowship

The Lawrence Hickman Graduate Fellowship in Sustainable Agriculture supports research benefiting dryland farming systems, honoring a farmer-lawyer who saved his family's homestead farm near Onecho.

# BIOAg Projects & Impact

## CSANR seed funding drives innovation

For nearly 20 years, CSANR's Biologically Intensive Agriculture and Organic Farming program (BIOAg) has supported sustainable agricultural research.

BIOAg provides WSU researchers with competitive grants to test new ideas and explore emerging opportunities in sustainable agriculture. Many of these small projects later expand into large initiatives, supported by major external grants. Since 2020, direct investment of $1.46 million in funding through BIOAg helped researchers secure more than $20 million in extramural support. In 2024 and 2025, projects spanned seven departments and included eight new faculty, exploring topics from soil carbon and compost incentives to honey bees, pest management, livestock forage, and youth farmers markets.

### 2024 Projects

- Scalable soil carbon assessment for incentive programs
- Biopesticides to protect honey bees from Varroa mites
- Erosion reduction through conservation tillage
- At-school youth farmers markets and healthy food choices
- Forage protein reservoirs to enhance cattle diets

### 2025 Projects

- Identifying Delia root maggots in vegetables
- New codling moth pathogens for tree fruit growers
- Compost incentive programs: motivations and challenges
- Tannins as sustainable biopesticides for potato diseases
- Biomass-derived pyrolysis oils to manage insect-vectored diseases

**$1.4M » $20M+**

**BIOAg-funded researchers have secured major extramural funding, returning $14 for every $1 invested since 2020.**

# Bridging Science & Practice

## BIOAg supports human-centered pest solutions

Molly Sayles received a BIOAg grant to study how grower decisions influence pest management in Wenatchee Valley pear orchards.

As an undergraduate, Molly Sayles was inspired by a visiting entomologist.

She liked the idea of studying bugs, but also wanted to work with people. Her interest in the interactions between insects and people led her to WSU, where she recently graduated with her PhD. She appreciated the program's down-to-earth atmosphere and strong mentorship.

Molly's research, supported by a BIOAg grant, focused on a persistent pest in Wenatchee Valley pear orchards: the pear psylla. This tiny insect produces sticky excretions that damage fruit. Growers have long relied on insecticides for control, but resistance is increasing and sprays can harm beneficial insects that keep psylla in check.

Integrated Pest Management (IPM) offers a more sustainable solution. It combines tools like pruning, conserving natural enemies, and carefully timing sprays. Other Pacific Northwest regions have broadly adopted IPM, but Wenatchee Valley growers have been slower to make the shift.

To understand what shapes grower decisions, Molly conducted interviews with farmers, consultants, and other stakeholders. She also hosted field workshops to share experiences and build community around IPM practices.

Molly's research highlighted the often-overlooked social and human dimensions of entomology. By understanding how growers make decisions about IPM, she aimed to support more sustainable pest management.

"Molly connects research with the realities growers face every day," said Louis Nottingham, her faculty advisor. "Molly helped early adopters of IPM to spread the word, and the number of IPM acres in the Wenatchee area is growing."

The BIOAg grant was crucial to Molly's research, funding travel for in-person interviews, educational workshops, outreach materials, and recording equipment needed to capture detailed conversations.

"Very few people in entomology do qualitative social research like this," she said. "This grant allowed me to fill a vital gap in applied pest management research by focusing on people as well as bugs."

*Molly at a Pear Psylla Field Day she organized in Peshatin, WA. Photo: Scott Weybright, WSU*

# Kaiser Grant Projects

The Verle Kaiser Conservation Endowment funds soil conservation and erosion-prevention education in the Palouse and Inland Empire.

## Growing Minds program plants seeds of conservation

The Walla Walla County Conservation District's Growing Minds program is inspiring Dixie Elementary students to learn about local ecosystems and the role they can play in caring for them. Thanks to Kaiser grant funding, the program planted over 350 trees, shrubs, and other plants along a riparian buffer.

In April 2025, students took part in an engaging classroom lesson and an outdoor forest health demonstration, learning how fire and disease spread through forests and how healthy riparian zones help keep waterways clean. They discussed sustainable forest management, the importance of riparian buffers for streambank stability and wildlife habitat, and the challenges posed by invasive species and erosion.

With additional plantings still to come, the program is building knowledge and excitement that will carry into hands-on restoration work.

## Palouse Conservation District cultivates environmental stewards

The Verle Kaiser endowment supported the next generation of conservation leaders across Whitman County through the Palouse Conservation District's Taking Root program. This initiative has engaged over 300 students in soil health and natural resource education.

Program highlights include hosting 149 students at the Whitman County Soil and Land Evaluation Competition and delivering aquatic ecology workshops to 75 high school students. The initiative also supported 40 students competing in the Southeast Regional Envirothon Competition, where teams tackled environmental problem-solving challenges.

Beyond student engagement, the program created soil health activity kits for students through local libraries and provided virtual training workshops for educators. This investment is growing environmental literacy and inspiring future careers in natural resource conservation.

*Participants gather for awards and a career discussion. Photo: Mindy McAllister, Palouse Conservation District*

# Artificial Intelligence Literacy for Agriculture

## A digital toolbox for agricultural professionals

By Alex Kirkpatrick, CSANR

A new series of video lectures explores the increasing presence of AI in agtech, and the role of ag professionals as communicators of innovation.

Ag professionals such as crop consultants and Extension agents are impactful science communicators. From fields to research centers, ag professionals are trusted advisers standing at the frontier of science and society. They will play a critical role in agriculture's acceptance or rejection of AI.

AI is set to reshape agriculture. More than a buzzword, AI is a science and a set of innovations that now underpin many everyday technologies. We already see AI innovations changing the nature of global industry, human work, and sustainability. Meanwhile, the market for agricultural AI specifically is rapidly expanding. In anticipation of these emerging impacts, we developed 10 online video lectures with accompanying readings and resources. Our goal is to equip ag professionals with a stronger understanding and awareness of AI in agriculture, and the confidence to communicate its potential risks and benefits to others.

To achieve our goal, we have created a digital space where ag professionals can explore and engage with video lectures at their own pace. The project draws from a foundation of theory, literature, and interviews with ag professionals. During interviews, ag professionals expressed strong curiosity about AI, what it is, where it operates, and how it might advance or complicate sustainability. Many described both optimism and uncertainty, noting challenges in defining, recognizing and explaining AI's influence on agriculture and the future of farming. These insights and more guided the design and delivery of the videos, which were written and refined in close collaboration with ag and science communication experts. The series covers topics such as defining AI and machine learning, communicating risk, public understanding, AI ethics, and the economic impacts of automation.

*Alex Kirkpatrick presents on AI in agriculture in a new video series. Photo: Alex Kirkpatrick*

Through this initiative, which was supported by Western Sustainable Agriculture Research and Education and Agriculture AI Institute for Transforming Workforce and Decision Support, we aim to empower ag professionals to lead trustworthy, transparent, and well-informed conversations about the role of AI in sustainable agriculture.

Explore the AI Literacy toolbox: **csanr.wsu.edu/AI-Literacy**

# Organic & Climate-Smart Agriculture Report

## Resilient climate policy starts with producers

By Margaret Griset, Heleene Tambet, and Georgine Yorgey, CSANR

A new report to the state Legislature highlights how farmers and ranchers can play a powerful role in tackling climate change—if they have the right support.

The *Organic and Climate-Smart Agriculture Report*, released in May 2025, found that climate-smart and organic practices can help cut greenhouse gas emissions, build resilience across the state's diverse agricultural landscapes, and provide benefits to the public.

The report was developed by CSANR, the Washington State Conservation Commission, and KR Creative Strategies, but its clearest message comes from the producers themselves: climate solutions must start with the needs of farmers and ranchers. If policies and programs don't work for producers, they won't work at all.

### What is climate-smart agriculture?

Climate-smart agriculture (CSA) refers to practices that reduce emissions while helping farms adapt to climate change. Examples include cover cropping, reduced tillage, precision fertilizer use, soil amendments, and anaerobic digesters.

Many CSA practices overlap with organic practices, which are often associated with a smaller climate footprint per acre. However, organic farming prohibits synthetic inputs while CSA can include synthetic fertilizers or herbicides. Both approaches can be part of the solution.

### Producers' perspectives

In addition to reviewing the scientific literature, the project team interviewed Washington farmers, ranchers, and industry partners. Four consistent themes emerged:

1. **Flexible, ongoing funding**
   Producers need continual financial and technical support to identify programs and adopt new practices.
2. **Research and baseline data**
   Research tailored to Washington production systems and stronger baseline tracking are essential.
3. **Support for agriculture's broader value**
   Keeping farmland and rangelands in production avoids emissions caused by conversion to housing or infrastructure, while protecting a vital industry.
4. **Producer-centered approaches**
   Climate programs must work with producers by aligning grant-based funding with agricultural calendars, involving farmers in the design process, and using familiar language.

### Agriculture's role

According to the state greenhouse gas inventory, agriculture contributes about 7% of Washington's emissions. Potent

greenhouse gases are largely associated with livestock digestion, soil management like fertilizer use, and manure storage (primarily by dairies).

But the inventory doesn't capture the whole picture. Some aspects—fuel use by farms, emissions from fertilizer production, food waste—are accounted for under other sectors or not included in the inventory.

At the same time, agriculture can actively remove carbon from the atmosphere. Certain practices not only reduce emissions, but also improve soil water retention, reduce erosion, and result in more consistent yields for farmers while delivering benefits like cleaner air and water.

## Rangelands, livestock, and dairy

Washington's rangelands hold substantial carbon stocks, and their preservation is critical. Grazing management can deliver modest carbon gains, while preventing rangeland degradation avoids massive carbon losses.

Livestock systems, especially dairies, also offer powerful mitigation tools based on emerging technologies. Tools include anaerobic digesters and methane-capturing lagoon covers, manure solids separation systems, and feed additives that reduce enteric methane.

*Rangeland management and preservation can avoid carbon losses. Photo: Tip Hudson, WSU*

These technologies face barriers of cost, scale, and infrastructure. For example, digesters are currently only viable for large dairies, and feed additives are difficult to deliver on extensive rangelands. Still, given the scale of livestock systems in Washington, they can make an important contribution to any serious climate strategy.

## Supporting soil carbon sequestration and organic systems

Well-managed croplands can draw down carbon and improve soil health. The potential gains are usually modest but accumulate over time, with the greatest opportunities in high-yielding, irrigated systems.

Key practices can help sequester carbon in soils. For example, production can be intensified through cover cropping, double cropping, and elimination of fallow periods. Farmers can reduce or eliminate tillage, plant perennial crops, and use soil amendments including compost, manure, and crop residues.

Some of these practices are central to organic farming, including cover cropping and organic amendments. Organic systems can build better soil structure, support long-term resilience, and emit less per unit area than conventional systems, primarily due to reduced use of synthetic inputs. Per-unit output emissions can be higher or lower, depending on yields.

Organic certification provides a well-established, trackable framework. Barriers to adoption, such as high certification costs and market access, can be addressed with policy support and incentive programs.

*Continued on page 16*

*Continued from page 15*

## Protecting land

When farmland is converted to housing or infrastructure, stored carbon is released and future sequestration is lost. Urban and low-density residential areas are also associated with significantly higher emissions than farmland. Policies that protect farmland and rangelands from conversion can help avoid these emissions.

Similarly, ensuring agriculture's viability in the state is a climate solution; pushing food production elsewhere is often associated with higher overall emissions.

## The role of innovation, long-term data, and carbon markets

Washington is well positioned to continue to lead in climate innovation thanks to several emerging technologies and strategies, including using biochar made from forest waste, enhanced rock weathering using ground basalt, electrification of irrigation pumps and farm equipment, and agrivoltaics.

However, scientific data gaps remain, particularly in measuring emissions reductions across Washington's farming and ranching systems. These gaps mean uncertainty, and therefore hesitancy, for producers.

The Washington Soil Health Initiative's long-term research sites are collecting data around the state to inform better tracking and policy. Funding these efforts is critical.

Lack of data about Washington cropping systems contributes to fewer agricultural carbon credit programs. Of the programs that exist, many pay only for new practices, leaving out long-term adopters. Programs don't cover full costs and may exclude farms that are small or have limited administrative capacity. Public funding should help support both early and new adopters.

## Don't ignore the food system

Agriculture's climate impact doesn't stop with agricultural practices; effective climate action requires systems-level thinking. Fertilizer production and dietary choices, along with food waste, processing, and transportation, all contribute significantly to emissions but are often overlooked in inventories and policies. Better accounting and policy alignment could help ensure that climate efforts reflect the whole food system.

## Moving forward: climate action must work for producers first

Washington's agricultural sector is positioned to lead on climate action if policies support producers.

Ultimately, the success of Washington's climate-smart agriculture depends on ongoing collaboration among farmers, researchers, and policymakers. By supporting innovative solutions, improving local data, and maintaining flexible, farmer-centered programs, the state can lead the way in supporting resilient farming communities and low-emissions production systems.

The report was supported with funding from Washington's Climate Commitment Act.

Access the full report:
**csanr.wsu.edu/organic-climate-smart-report**

*Blueberries at Mount Vernon Research and Extension Center. Photo: Margaret Griset*

# Dual Benefits of Cover Crops

## Protecting soil while producing renewable fuel

By Scott Weybright, WSU College of Agricultural, Human and Natural Resource Sciences

New research finds that some cover crops can safeguard soil and serve as valuable biofuel feedstocks, opening new possibilities for farmers and processors alike.

After harvest, much of Washington's farmland sits bare through the winter. This downtime can mean erosion, weeds, and missed income for farmers. Research from WSU and Pacific Northwest National Laboratory (PNNL) suggests that certain cover crops could protect soil while supplying a new source of renewable fuel and income.

A team led by Miki Santosa, a graduate student in WSU's Department of Biological Systems Engineering and a chemical engineer at PNNL, tested four winter cover crops over multiple years in western and central Washington. The study, published in *Biomass and Bioenergy*, found two standouts. Triticale, a wheat-rye hybrid, produced abundant biomass, while hairy vetch, a legume, fixed nitrogen and yielded consistently at low cost.

"The idea is to unlock new cover crop supplies," said Miki, the paper's corresponding author. "We don't want to harm the economics for farmers or hurt the soil, so we looked closely at pain points farmers experience when cover crops are used."

*Co-authors Doug Collins and Teal Potter stand in a field of triticale. Photo: Chad Kruger.*

The project—conducted jointly by CSANR, the Institute for Northwest Energy Futures, and PNNL—also evaluated how each crop could be processed into biofuel using hydrothermal liquefaction, a method that converts mixed biomass into a renewable fuel.

"The ultimate goal is to provide refineries and processors with more renewable feedstocks," Miki said. "Working with farmers and the agriculture industry to find suitable crops is vital to reaching that goal."

The ability to combine different crop residues in one process could simplify how biofuels are produced and create new markets for farmers.

Importantly, the study found that harvesting biomass for fuel did not reduce the soil benefits normally associated with cover crops. "Removing triticale, which grew very abundantly, didn't hurt the soil," said Chad Kruger, CSANR director.

That finding points to a promising future: cover crops that improve soil health and contribute to clean-energy goals.

"Cover crops have always been grown to help the soil," Chad said. "Now farmers may be able to get paid for them as well. Add that to the benefits of biofuels, and it's a win for both agriculture and the environment."

# Waste to Fuels Technology Partnership

## From organic waste to statewide impact

By Margaret Griset, Georgine Yorgey, and Chad Kruger, CSANR

> Nearly two decades of collaboration have transformed Washington's wastes into renewable energy, healthy soils, and thriving new industries.

In 2006, the Washington State Legislature established the Waste to Fuels Technology Partnership (WTFT) between the Department of Ecology and WSU. The goal: turn Washington's organic wastes from a liability into a resource. Nearly two decades later, with CSANR leadership and contributions from more than 50 faculty, staff, and students across WSU, this partnership has delivered environmental and economic benefits statewide by creating roadmaps, building expertise, engaging communities, and supporting new technologies to derive value from organic wastes.

The partnership began with work led by Mark Fuchs, who recognized the potential in organic residuals. The 2004–2005 biomass inventory revealed 16.9 million tons of organic materials annually that could potentially be converted to beneficial uses. This work was the foundation for strategic planning across multiple agencies and partners.

### Research & capacity building

Ecology's investment gave Washington access to WSU's research capacity, engaging more than 17 faculty and dozens of graduate students in engineering, soils, economics, and policy. This approach created a pipeline of specialists now serving agencies, businesses, and communities statewide.

The partnership provided a proving ground to test ideas and reduce risk before scaling. Pilot systems for anaerobic digestion, pyrolysis, and nutrient recovery refined new processes, attracted investment, and since 2017 helped affiliated researchers leverage $6.6 million in competitive grants.

Early studies explored biofuels from crop residues, food waste, and manure, tested nutrient recovery for dairies, and cataloged 42 feedstocks to guide technology and economics. Reviews of pyrolysis technologies, supply chains, and business models charted viable pathways and laid the groundwork for the emerging regional biochar industry.

*Biochar application. Photo: Dani Gelardi, WSDA*

## Partnership outcomes

Today, multiple advances across Washington can be traced directly to WTFT research, Extension, and policy groundwork:

- **Exploratory projects:** Pilot studies tested biodiesel, biohydrogen, and ethanol production from crop and food residues, and evaluated compost and biosolids for soil carbon and water storage. While some remained pilot scale, they provided key data for today's advances.
- **Mortality composting:** Practical tools now enable small processors to compost animal byproducts, reducing methane emissions and recycling nutrients.
- **Soil health policy:** WTFT helped lay the groundwork for the Washington Soil Health Initiative, established in 2020 with the Washington Conservation Commission, WSDA, and WSU. By 2024, WaSHI invested $3.1 million to support climate-friendly practices on 188,000 acres.
- **Biochar:** Studies of feedstocks and soil effects supported an industry that now includes about 20 producers. Today, composters market biochar-enriched compost, and workshops build ongoing collaborations.
- **AgSymbiosis:** WTFT research inspired a legislative study tour of Denmark, showing how waste and energy systems can be linked. The effort informed planning by Washington ports and economic development councils, as well as WSU's Institute for Northwest Energy Futures.
- **Pasco wastewater upgrade:** WTFT expertise informed a $67 million waste-reuse facility upgrade that added digesters and nutrient recovery systems, sustained 300+ jobs, helped food processors manage waste, and now serves as a model for other municipalities.

## Engagement & community impact

Each biennium, the partnership reached 500 to 1,500 people through workshops, field days, and webinars, while publications and online materials reached tens of thousands more. This engagement built not just technical knowledge, but networks of people committed to turning waste into resources.

Mortality composting workshops exemplified this approach, training livestock producers, processors, regulators, and compost operators. Participants reported dramatic knowledge gains, with 88% indicating they were likely to adopt the practices.

The Northwest Bioenergy Summit (2012–2024) connected diverse stakeholders whose collaboration advanced commercialization of bioenergy solutions. In 2023, 196 participants from agencies, industry, NGOs, and academia rated information quality and networking opportunities above 4.6 out of 5.

Faculty also provided extensive technical assistance to entrepreneurs and communities by interpreting science and supporting project development. This one-on-one engagement proved crucial for translating the research achievements into real-world applications and business successes.

Through sustained investment from Ecology and WSU, Washington has moved from treating organic residuals as waste to recognizing them as resources for renewable energy, healthy soils, and sustainable communities.

*Edaleen Dairy. Photo: Andgar Corp.*

# Encouraging Compost Use Through Incentives

## From pilot program to policy lessons

By Michael Brady, WSU School of Economic Sciences; Heleene Tambet and Georgine Yorgey, CSANR

A pilot program to reimburse farmers for compost use helped turn organic waste into healthier soils while providing insights for future climate and waste-reduction policies.

Organics make up the largest share of Washington's waste stream; diverting organic waste from landfills reduces processing needs and greenhouse gas emissions. It also returns carbon and nutrients to the soil, improves soil health and structure, and supports a circular economy. Applying compost to farmland sequesters carbon in the soil and, when used instead of synthetic fertilizers, reduces emissions associated with fertilizer production.

While compost use has become more widespread in agriculture, there is still room for significant growth. Barriers to compost use in commercial agriculture include variable nitrogen availability,[1,2] and contaminants such as metal and glass in municipal compost.[3] Transporting compost is costly and energy intensive due to its high moisture content, so agricultural demand is strongest near production sites.

In 2022, the Washington State Legislature passed ESHB 1799 to keep organic waste out of landfills, and the Compost Reimbursement Program (CRP) launched in 2023. The program reimbursed farms for 50% of eligible costs—up to $10,000 per farm per year as long as funds were available—for compost purchases and field application.[4] Although the program ended in 2025, a partnership between the Washington State Department of Agriculture (who shared anonymous data from the program), WSU Researchers (who analyzed the data and wrote this article), and the Solid Waste Management Program of the Washington Department of Ecology (who funded the work) provided insights into the program and more broadly contributed to better understanding of agricultural demand for compost.

### Compost production

In 2023, Washington had 54 permitted composting facilities across 26 of the state's 39 counties,[5] processing 1.16 million tons of organics. Diversion rates have been roughly 50% over the past decade, and substantial increases will be needed to reach the state's goal of 75% by 2030. Counties producing the most compost are

1. Gale, E.S. et al. (2006). Estimating plant-available N release from organic amendments. J. Environ. Quality. 2. Hills, K., Brady, M., Yorgey, G., & Collins, D. (2019). Value and cost of compost in western WA. CSANR technical report. 3. Hills, K., Jobson, T., & Yorgey, G. (2020). Survey of large commercial compost facilities in Washington. CSANR report for Ecology. 4. WSDA (2024). Compost Reimbursement Program: Annual report to the Legislature. 5. Ecology (2023). Washington waste generation and recovery data (2021).

*Silver Springs Organics composting facility in Rainier, WA. Photo: Margaret Griset*

Snohomish (29% of all compost produced in the state by weight), King (17%), Pierce (10%), and Lincoln (8%). All other counties together produced less than 5% of the total. Feedstocks were largely mixed food scraps and yard debris (75% by volume). Food processing waste, manure with bedding, and other materials each accounted for 5% or less.

## Program design

In total, $2.92 million was available through two rounds of funding. However, the two rounds differed in some important aspects.

While the first round required that compost come from a permitted compost facility, the second round of the program in fall 2024 allowed participating farms to accept compost from permit-exempt facilities. This change removed some barriers to participation for farms in rural counties. Another change to the program design was that applications were not accepted on a first-come, first-served basis; everyone was able to apply during an application window and a lottery was used if applications exceeded available funds. This change was intended to remove the advantage that bigger, better-resourced farms may have had in submitting applications quickly.

In the first round, reimbursements were capped at $10,000 for all farms. However, in the second round, the funding cap differed by farm size: the maximum reimbursement amount was $10,000 for farms of 10 acres or less, $15,000 for farms between 10 and 50 acres, and $20,000 for 50 acres or more.

## Participating farms

The CRP was available to farmers across the state, attracting many first-time compost users but fewer first-time acres. In other words, most of the land receiving compost under the program had compost applied in the past, but many farms used compost for the first time due to the program. This pattern reflects the fact that farms that had not previously used compost spent less on compost. For farms spending less than $15,000 in total on compost, half were trying compost from a compost facility for the first time. This percentage fell to 28% among those spending between $15,000 and $25,000. There were no first-time compost users amongst farms spending over $25,000.

Organic farms made up a relatively large share of farms that were not first-time compost users. New users often applied compost to small areas and on crops like

*Continued on page 22*

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vegetables, while past users frequently applied compost to large orchards. Because legislative guidance indicated that one goal of the program was to increase the number of farms using compost, these findings supported maintaining the maximum reimbursement at $10,000.

Though organic farms participated at a high rate—accounting for 40% of applicants despite only representing 2.5% of all farms in the state—conventional farms accounted for more first-time users of compost. Conventional farms submitted 60% of applications, operated more acreage, were more likely to apply compost annually, and applied at higher rates (likely due to crop types).

Interest in the program grew from the first to the second year. Over half (55%) of the second-year participants had not participated in the first year. Building a robust platform has been a WSDA priority, limiting outreach efforts.[6] Still, the program was nearly fully subscribed, suggesting that more interest—including from first-time users—could be garnered with more intentional outreach.

## Compost use on farms

The most common reasons for purchasing compost with the CRP were to improve soil health and structure, enhance plant growth, and manage water and weeds. Respondents also cited reducing or eliminating the need for synthetic fertilizers.

Of the 84 farms that participated in the first year, the median volume of compost purchased was 73 cubic yards (ranging from 6 to 975 cubic yards). The average area of application was more than 19 acres, but the median was only 3 acres, indicating that a few operations applied compost across large areas.

Compost was most frequently applied to tree fruit, with orchards comprising 40% of all fields and 85% of all acreage in the program (Figure 1). Most of these orchards were growing apples (19% of fields and 47% of acreage), followed by pears (16% and 35%), and cherries (6% and 3%). The second-largest category was various vegetables, which represented 24% of fields but a small share of acreage. This category included tomatoes, garlic, broccoli, squash, carrots, kale, pumpkin, and "market crops," each constituting less than 6% of fields and 1% of acreage. The "other" category, which included raspberries and Christmas trees, had the third-highest field share at 12%.

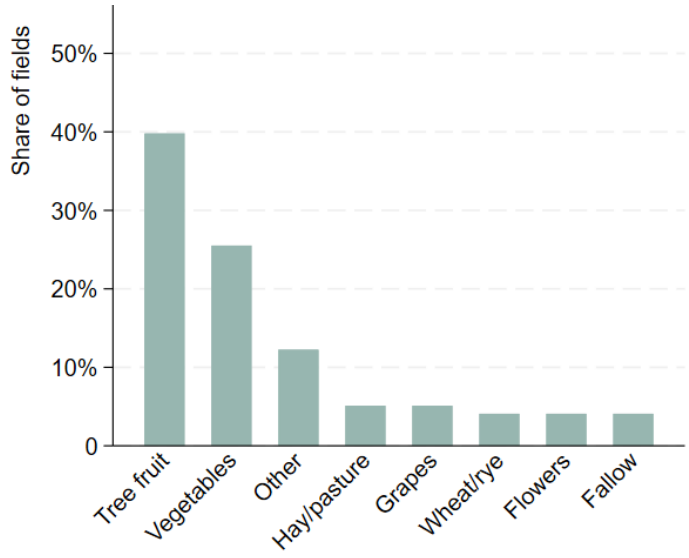
Over one-third of participating fields (40%) were organically certified, but the share differed by crop: nearly two-thirds of tree-fruit acreage, half of wheat and rye, and 35% of vegetable fields were certified.

## Program outcomes

One way to assess the program's cost and success is by comparing it to the value of the greenhouse gas emissions it helps avoid. The program's public cost is estimated at $53 to $114 per metric ton of CO2e, slightly higher than the $50-per-metric-ton price in Climate Commitment Act auctions as of March 2025.

However, the program delivers additional benefits, including reduced waste, improved soils, and knowledge that supports future compost use. Over time, some costs could shift elsewhere in

6. Thedell, D., Washington State Department of Agriculture, personal communication.



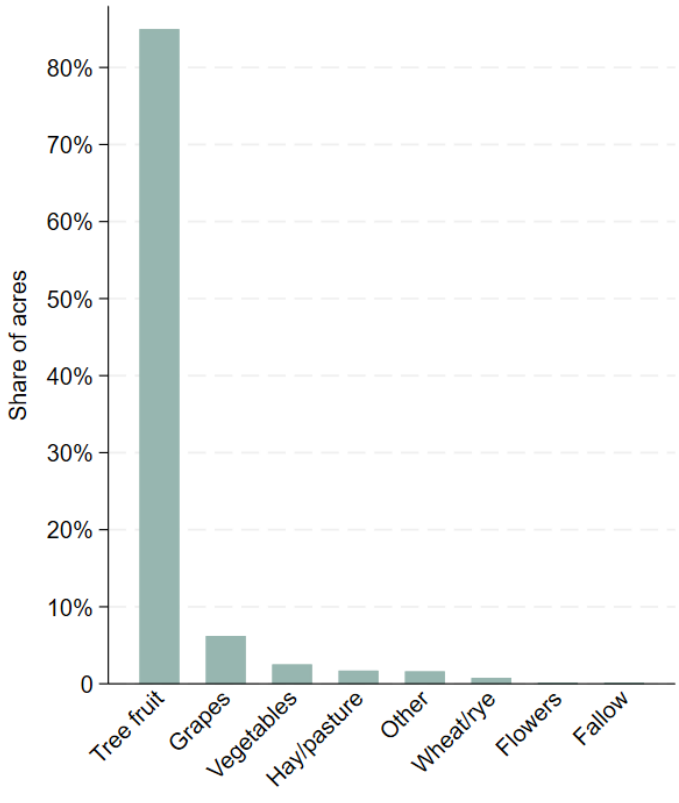




*Figure 1. First-round CRP crops as percentage of enrolled fields (left) and acres (right). Source: WSDA*

the organic waste system, for example, if municipal residents who want their waste recycled share more of the expense. The transportation and application costs, which made up about 32% of total participant spending, could also decrease as demand and markets mature due to increased efficiency from greater specialization in this activity.

Another way to evaluate success is to ask how well it achieved its stated goal of encouraging farmers to try compost. The program effectively reached farmers who had never used compost and who may have been uncertain of its benefits. Roughly 40% of fields participating in round one tried compost from a compost facility for the first time. Even among organic farms, nearly a quarter had not used compost before participating in the program. For first-time farms in particular, the subsidy helped reduce uncertainty about an untried practice, allowing farmers to observe its effects and practice application methods.

If a compost subsidy program is reintroduced, it could build on the CRP by encouraging first-time users to access the program and encourage expanded data collection. Continued subsidies could also help farms manage uncertainty given the variable impacts of applying compost due to compost composition, soils, crops, and other environmental factors.

## Looking forward

While subsidies can be helpful, they should complement these broader efforts to reduce barriers to compost use in agriculture. Additional efforts to encourage compost use could include continued research, addressing contamination issues, and lowering barriers to applying compost—for example, by offering spreading equipment through conservation districts. Public support for expanding compost adoption could divert waste from landfills, reduce emissions, improve soil, and contribute to a more circular economy by helping Washington capture the value of its organic resources.

# The Next Generation of Compost Leaders

## CSANR impact on organics recycling

By Margaret Griset and Douglas Collins, CSANR

> Our Compost Facility Operator Training equips professionals with hands-on skills and the latest science to improve organic waste management and support Washington's composting goals.

Managing organic waste on-site, especially on farms with poultry or livestock, presents both risks to water quality and opportunities to reduce fertilizer inputs. At the same time, community and commercial composting capacity is becoming increasingly important across Washington.

In 2022, Washington's Organics Management Law was passed to address how organic waste is reduced, managed, incentivized, and regulated. The law set a goal to cut landfill disposal of organic material by 75% by 2030 compared with 2015 levels. It also requires many local governments to offer separate organic-material collection. The Washington State Department of Ecology's 2024 Compost Market Study estimates that Washington already composts about one million tons of organic material each year, with demand expected to triple by 2035.

The Compost Facility Operator Training (CFOT) program, created through a partnership with the Washington Organic Recycling Council, has long supported composting workforce development. That mission has become even more important as the state expands its composting capacity under the new law.


*CFOT participants with their compost pile. Photo: Margaret Griset*

Hosted each fall at WSU's Puyallup Research and Extension Center, this training blends science-based classroom instruction with hands-on experience and field tours. Compost facility operators, regulators, entrepreneurs, and others spend five days learning how to manage compost operations that are both environmentally sound and economically viable. The program quickly sells out each year, underscoring the demand for practical, science-based training.

Now in its 30th year, the program annually welcomes 45 to 50 participants. Most attendees come from Washington and neighboring states, including Alaska, Idaho, and Hawaii. The curriculum covers compost biology, facility design, odor and emissions management, compost quality, and regulatory compliance. Practical field stations, compost-pile building, and tours of working facilities provide real-world learning opportunities. The goal is to equip participants with the skills needed to understand or improve compost operations.

One participant reflected, “This was incredibly valuable—especially because it enrolled regulators and processors, small and large facilities, wastewater treatment plants, yard waste, and municipal solid waste sources.” Comments about the training demonstrate the program’s success in building expertise and fostering a community across sectors.

Following the course, 57% of attendees planned to implement changes in how they operate or regulate compost facilities. Nearly every participant committed to sharing their knowledge, extending the program’s impact to an estimated 1,628 additional individuals. A dozen participants were launching composting businesses.

Meanwhile, WSU completed a new compost research facility at its Puyallup Research and Extension Center in 2025. Supported by the Department of Ecology, this 100-cubic-yard site features industry-standard aeration systems and real-time emissions monitoring. In collaboration with WSU’s Civil and Environmental Engineering team, researchers are studying how different composting approaches affect emissions to inform permitting processes and best practices.

The new site expands opportunities for collaboration among researchers, regulators, and composting professionals. While the research facility operates separately from the CFOT program, it contributes to a shared goal: improving composting systems through science and practical insight. CFOT participants benefit from proximity to this work, gaining exposure to current research and observing how technologies such as aeration can influence environmental outcomes.

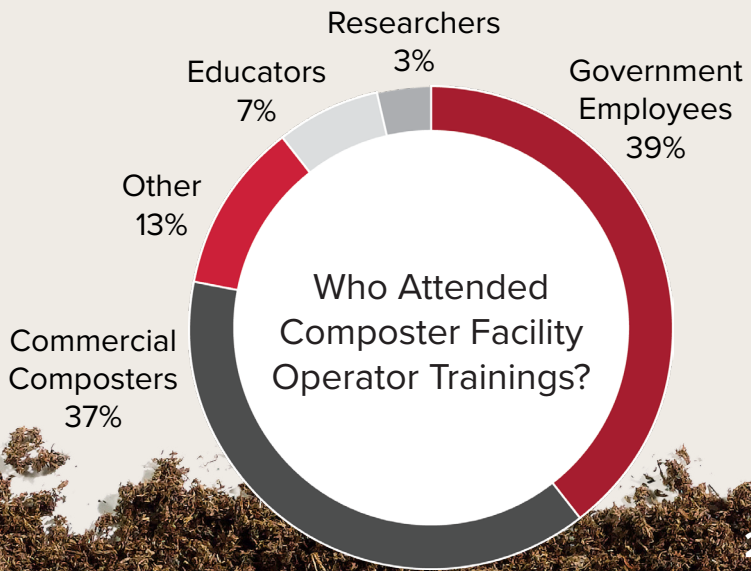
The CFOT program is the only comprehensive, hands-on composting training in the region. As regulatory requirements tighten and facilities scale up, the program’s blend of science, practical skills, and peer networking continues to fill a critical workforce need.

## CFOT Highlights 2024–2025

93 participants from 4 states

99% planned to share with 1,628 people

12 new facilities planned



# Building a Climate Roadmap

## Resilience through partnership and action

By Dani Gelardi, Washington State Department of Agriculture

> With the right planning, tools, and resources, Washington agriculture is well positioned to adapt and remain resilient to climate change.

Climate change creates new challenges for Washington agriculture, including extreme weather, wildfires, flooding, increased pest pressure, worker safety risks, and water supply volatility. However, our diverse geographies, cropping systems, state funding, and history of science-based innovations position it to adapt and remain resilient.

The Climate Resilience Plan for Washington Agriculture, released by the Washington State Department of Agriculture (WSDA) in February 2025, lays out practical steps to help farmers stay productive, protect resources, and keep the state's agricultural industry strong for generations to come. It also provides a playbook for institutions that support agriculture, such as state agencies, local jurisdictions, and research universities.

### Climate Resilience Plan priorities

- **Safeguarding operational resilience:** Enhancing emergency preparedness, recovery, and response measures to address climate impacts.
- **Supporting agricultural innovation:** Fostering sector-wide innovation through research, education, partnerships, and workforce development.
- **Encouraging climate-smart practices:** Promoting the voluntary adoption of sustainable farming practices that mitigate climate risks and enhance resilience.

*Imperial Gala apples at Turkey Orchard. Photo: WSU*

The plan was shaped by a collaborative process that included climate science reviews, feedback from agricultural stakeholders, and assessments of current WSDA programs. More than 500 farmers, farmworkers and staff from agricultural organizations shared their experiences, helping us shape realistic and impactful strategies. Collaborating with other scientists across WSU, CSANR researchers contributed to the plan by providing a summary of the state of the science relating to climate change and Pacific Northwest agriculture.

The Climate Resilience Plan also supports broader efforts in the state, aligning with Ecology's Washington State Climate Resilience Strategy and the state's Enhanced Hazard Mitigation Plan (2023).

## Key elements of the plan

- **Agricultural climate risks and adaptation opportunities:** Identifies risks and strategies for both on- and off-farm climate adaptation.
- **Goals, strategies, and actions:** Proposes 27 strategic, measurable actions to enhance agricultural resilience across Washington's agricultural sector.
- **Implementation and evaluation:** Details the process for putting the plan into action, with a focus on ongoing evaluation and improvements.
- **Stakeholder engagement:** Summarizes the experiences and perspectives of over 400 farmers and 200 farmworkers.
- **Research:** Synthesizes the latest science on climate change impacts to agriculture, and the local and national policy measures to mitigate those risks.

## Next steps

The Climate Resilience Plan describes six goals, 14 strategies, and 27 actions to address risks and enhance resilience.

WSDA is ready to implement the plan. The plan's actions require a high level of coordination and collaboration with stakeholders. WSDA will support stakeholders as they integrate the strategies into their own operations, and will continuously update the plan based on feedback, evolving science, and changing conditions.

Some strategies can move forward with existing resources, but fully realizing the plan will require additional funding and collaboration. WSDA will work with partners to pursue opportunities, maximize available resources, and take meaningful steps toward greater agricultural resilience.

# Resilience Plan

### Goal 1

Increase agriculture's preparedness for, response to, and recovery from climate-related extreme events.

### Goal 2

Support the adoption of climate-resilient agricultural practices.

### Goal 3

Safeguard a sufficient quantity of high-quality surface and groundwater for people, farms, and aquatic ecosystems.

### Goal 4

Prepare the agricultural workforce for a changing climate.

### Goal 5

Minimize impacts from pests, weeds, and disease.

### Goal 6

Ensure that laws, policies, and regulations efficiently work towards climate resilience and agricultural viability.

Explore the Climate Resilience Plan:
**agr.wa.gov/ClimateResilienceWaAg**