CENTER FOR SUSTAINING AGRICULTURE
& NATURAL RESOURCES

Annual Report

WASHINGTON STATE UNIVERSITY
**Center for Sustaining Agriculture
and Natural Resources**

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ANDY WILCOX, Wilcox Farms

DIRECTOR'S
Message

It's never been easy to encapsulate or describe the Center in a two-minute elevator speech or a one-page brochure. We've never had that one shiny object or captivating image to promote. Instead, we've always been invested in a lot of different ventures, with much of our work behind the scenes. Even so (30 years after a controversial establishment), the Center has proven to be a consistently productive force helping people turn innovative ideas into impact. As one of our CSANR Affiliated faculty members puts it, we are *"the little engine that does."*

"the little engine that does."

WSU Centers undergo an annual and five-year review process in order to be re-authorized. Here is a productivity snapshot from our last five-year report, submitted in 2021.

2016-2020

- 51 CSANR Affiliated Faculty from ten CAHNRS Units, four other WSU Colleges, and three partner agencies—each of these investigators engaged in a CSANR funded project

- 23 Graduate Students directly supported with CSANR Funding

- $30,042,938 in extramural research and education funding leveraged through CSANR investments, partnerships, and leadership

- 55 peer reviewed research and 74 peer reviewed extension publications generated through investments in CSANR Affiliate Faculty, institutional partnership projects, or directly led by CSANR staff.

That's a pretty good ROI for a core investment of around $400,000 per year. However, more important than the productivity stats are the impacts that come from these future-focused investments.

"What's the magic sauce?", you ask? A committed and passionate team of partners, including Advisory Committee and Leadership Team members, staff, affiliated faculty, collaborating institutions, funding agencies, and donors. While we maybe don't have that one shiny object, we have a history of great people working together to produce inspired solutions for the future of agriculture and the environment. Take a look at the following pages of the 2021 annual report for some of the great ideas we are working on.

Thanks, Chad

WSU releases roadmap for Soil Health Initiative

Written by Scott Weybright & Chris Benedict

A 124-page "roadmap" that outlines current challenges and pathways to help maintain healthy soils as an agricultural and environmental resource has been released.

Aerial view of the Long Term Agroecological Research and Extension at WSU's Mount Vernon Research and Extension Center.

The Washington Soil Health Initiative, recently funded with a $2.1 million annual allocation from the Washington State legislature and Gov. Jay Inslee, is a partnership among Washington State University, the **Washington State Department of Agriculture** and **Washington State Conservation Commission**.

"The Soil Health Initiative is a win-win for groups that haven't always gotten along: farmers and environmental groups," said Chris Benedict, a WSU Extension Regional Extension Specialist and a leader in the initiative. *"We all want to maintain agricultural productivity across the state and protect our soils. From an environmental perspective, we hope to see carbon sequestration or water quality benefits from this partnership."*

Key industries involved include growers of potatoes, wine and juice grapes, dryland agriculture and tree fruits, such as apples, pears, and cherries, among others.

The initiative includes a series of Long Term Agroecological Research and Extension (LTARE) projects, envisioned to run for at least 15 to 20 years, which is much longer than most grant-funded projects. Some sites will be considered large-scale in the agricultural research world, with experiments on a dozen or more acres. A pilot site is already in operation.

In 2019, the legislature included initial funding to explore viability of the project. Scientists launched the first LTARE site at WSU's Northwestern Washington Research and Extension Center in Mount Vernon, as mandated in the initial funding.

Deirdre Griffin-LaHue, a WSU assistant professor of soil health and sustainable soil management at WSU Mount Vernon oversees the site's LTARE, which began this spring after years of planning. The 16-acre site will benefit farmers as the experiments age.

"We set it up after talking with local stakeholders to address soil challenges they think are most relevant," Griffin-LaHue said. *"The focus is on broader systems, not individual factors where a researcher changes one thing to see what impact it has."*

The project is also adaptable, so if a currently popular crop falls out of favor, it can be replaced in the experiments.

"If we set this up 10 years ago, we would have included green peas," LaHue said. *"But now very few farmers grow them. We have a long-term framework, but we can adapt within that."*

The Mount Vernon LTARE is one of several included in the initiative. Planning for a tree fruit plot is underway near Wenatchee, and a potato location will likely start near Othello in the coming years.

Tianna DuPont, a tree fruit Extension specialist at WSU's **Wenatchee Tree Fruit Research and Extension Center**, is leading the planning effort for their LTARE.

"We have an advisory group established to help identify specific goals and treatments, so we have a thought-out plan that's focused on where the needs and the curiosity of the industry overlap," she said.

DuPont is also working with Griffin-LaHue and other national experts who have started LTARE plots to glean helpful tips and to not repeat mistakes they may have learned the hard way.

Partnerships with WSDA and the Conservation Commission are a key aspect of the initiative, allowing for research that goes beyond helping farmers grow better, more productive crops.

"With the Soil Health Initiative, food scientists or nutritionists within the WSU medical school could get involved with soil scientists," Benedict said. *"There are opportunities to develop new technologies and instruments to assess soil health that could include partnerships in engineering."*

Other priorities include developing universal, low-cost soil health measurement tools and metrics, preservation of existing soil organic matter and increasing the public's understanding of soil health.

"This is a huge project, and we're really excited to finally have this roadmap in place," Benedict said. *"Now we'll all start working on measuring and improving soil health in Washington to help the entire state."*

New WSU report charts biochar path

Written by Scott Weybright & Karen Hills

Conversion of biomass (left) to biochar (right) offers potential benefits like drawing carbon dioxide from the atmosphere. Biochar can be a valuable soil amendment in agriculture. *Photo courtesy Biomacon*

Biochar from orchard waste is applied to a commercial orchard in central Washington during tree planting to improve soil health. *Photo by David Drinkard*

PULLMAN, Wash. — A team of biochar producers, practitioners, scientists, and engineers have published a **roadmap for future development of the biochar industry** in the Pacific Northwest and beyond.

This collaborative effort between individuals from industry, universities and government, has resulted in a 184-page report, Biomass to Biochar: Maximizing the Carbon Value. The effort was led by Jim Amonette, a researcher with Washington State University's Center for Sustaining Agriculture and Natural Resources and the U.S. Department of Energy's **Pacific Northwest National Laboratory**, and was supported by the U.S. Forest Service and Washington Department of Ecology's **Solid Waste Management Program**.

"The participants worked together over several months to produce a comprehensive report that assesses the current state of the biochar industry, identifies the barriers to its development as a key carbon-drawdown strategy, and recommends the research and development needed to overcome these barriers," Amonette said. *"The cross fertilization of ideas that occurred between participants representing the various industry sectors was truly outstanding and resulted in a unique report that balances scientific, engineering, business, regulatory, and producer perspectives. Thanks to the hard work of this group, we know what the industry needs to grow and prosper while addressing the multiple problems we face in the Pacific Northwest. We hope the solutions recommended are transferrable to other regions where similar problems and opportunities exist."*

Biochar is the carbon-rich solid produced by heating biomass under low-oxygen conditions to a temperature where its chemical structure transforms to a more stable form. The conversion of biomass to biochar shows significant promise as one of a suite of climate change mitigation strategies and offers the possibility of near-term, widespread deployment.

In addition to the climate benefits, biochar has potential to improve forest and soil health, decrease wildfire risk, bolster ecosystem services, and revitalize rural economies. The Pacific Northwest offers fertile ground for this advancement, with the region's abundance of forest and agricultural lands along with existing industrial and academic expertise.

Despite the growing number of studies on biochar, a number of technical, economic and policy barriers have prevented biochar from realizing its full potential. The roadmap proposes strategic investments to address these barriers including additional research and development, business support infrastructure, and collaborative policy development. In particular, the report outlines a proposed long-term integrated research program to resolve the most important technical issues associated with the large-scale development of biochar technology needed to draw down large quantities of carbon dioxide from the atmosphere in the coming century.

The Value of Blogging

Written by Andy McGuire

Many people prefer videos and podcasts over blogs, so why write about the value of blogging? Text-based media like blogs have advantages over videos and podcasts. Blogs can provide a method of influencing people's thinking which Extension publications and journal papers do not. And with their unique position in the information environment, blogs can attract a different audience than traditional outreach methods.

The CSANR's blog, **Perspectives on Sustainability**, is now nearly ten years old and has 335 posts and over 900 comments. I have been writing for it from the beginning. What I learned is that although blogging is past its peak on the internet, it is a valuable outlet for Extension, one that should be taken as seriously as Extension publications and journal articles.

Advantages of text-based media

Although only online, blogging keeps some advantages of printed text that video and podcasts lack:

- Easily scannable, especially with headings and subheadings
- Easily searchable
- It represents reflection, revision, and review. There are exceptions, but blogs do this more often than videos or podcasts.
- Reading discourages multitasking, a scourge of our age
- Citations are more common

Improve quality of discussions

Although Extension publications and journal papers share the text-based advantages of blogs, blogging can do things they cannot. The main one, which I use often, is to clarify complex issues. Online discussions on social media are often simplistic, one-sided, or lack critical details. A well-written blog can swiftly add depth and nuance to a hot topic. Unlike an Extension publication, it can evaluate results and ask tough questions. Asking questions and providing rational answers is key to impacting the online thinking on a topic.

For instance, I used series of blog posts on cover crop mixtures to show the development of the idea, the underlying theory, and what continuing research results found. This effort allowed for development and evaluation of ideas not possible in Extension publications and in a much more accessible form than journal papers.

Finally, because the CSANR blog still allows comments (whereas many outlets have dropped them), it allows for interactions with readers, especially on more controversial topics.

Engage a wider audience

These advantages of blogging over more traditional publications have the added benefit of attracting a wider audience. For example, in a series of blogs posts I challenged the more extreme claims of regenerative agriculture. Blogging allowed me to address this relevant topic in a timely manner and evaluate claims being made by farmers, consultants, and some scientists. These posts resulted in audience engagement beyond Washington state, across the country, and even to other countries. Blogging provides a way to reach this greater audience, to influence (hopefully for the positive) their thinking, or at least help them ask the right questions. Again, this could not be done in Extension publications nor with a peer-reviewed opinion paper, often behind a paywall.

Regarding the CSANR blog's audience, consider the page views of CSANR blog posts to Extension publications (data from Google Analytics), for 2021:

Top-10 CSANR blog posts
~16,000 unique page views

Top-10 Extension Publications
~20,000 unique page views

As you can see, blogs attract people in large numbers, but often for different reasons than Extension publications. Blogs should therefore be used as an additional, equally valuable outlet for outreach efforts rather than replacing Extension publications.

Blogs are also not a substitute for peer-reviewed papers, but as Hulcr (2016) states, universities *"still value a cryptic research publication that is never cited more than a blog post that influences thousands."* If Blogging is going to become an accepted method of Extension, this will need to change.

Blogging can degrade to a *"7 Secrets in Your Neighbor's Fridge"* formula-based fluff. This was probably the demise of many blogs since blogging's heyday in the early 2000s. However, for the University, a well-run blog can be a great compliment to its science, reaching new audiences and increasing impact. For blogging to become more prominent, universities must come up with new ways of evaluating online impact, rewarding such efforts, and intentionally link blogs to Extension publications and journal papers.

Hulcr, J. 2016. Who Should Talk About Science? https://www.insidehighered.com/views/2016/06/02/universities-need-communicate-much-more-effectively-about-science-essay *(accessed 19 January 2021).*

Washington SoilCon and Virtual Engagement

Written by Chris Benedict

The last two years taught us how to adapt to rapid changes in our daily lives, including the major pivot to remote education. Remote education is nothing new, as WSU has delivered remote video and audio education since the late 1980's in response to the state legislature's directive for increased accessibility By 1996, the deployment of the WSU Salishan Learning Center in Tacoma began and by 2003 there were 10 centers across the state. Remote education looks dramatically different today, especially since the wider deployment of high-speed internet. People have 24/7 access to any number of topics from a wide array of sources. The deployment of remote educational delivery and participation at mass scale (almost overnight), however, made the beginning of the pandemic in 2020 unique.

In the fall of 2018 CSANR was awarded a grant from USDA's **Western SARE** () to *"...train ag professionals, researchers, and producers in Washington State and the broader PNW on the latest research-based information related to managing soil health in the region."* We planned to deliver this curriculum in a single, large-scale conference event called Washington (WA) SoilCon. As the pandemic developed during the planning phases in 2020, it became increasingly clear that it would be necessary to deliver the first WA SoilCon entirely remote. Though it initially seemed like a disadvantage and a bunch of technical headaches, the organizers began to see advantages to this format: we could access experts from around the world and simultaneously reach an audience almost anywhere. Organizers assembled a week-long event with speakers from around the world with close to 1000 registrations. We received several feedback comments speaking to the efficacy and accessibility of the virtual format, and we found that in many regards, SoilCon increased engagement with soil health topics to a greater degree with an online format rather than in-person.

Building on the momentum from 2021, organizers decided to double down on the remote delivery model. The 2022 WA SoilCon took place over two days in February with over 900 registrations. Utilizing remote delivery has shown a much greater potential to reach a larger audience, and we have learned how to improve the effectiveness of remote delivery by deploying additional attendee feedback mechanisms. By continuing to adapt and refine remote education, we hope to provide increased accessibility for underrepresented groups, promote flexible and continuing education while maintaining valuable connection between industries.

For more information on Washington SoilCon

- Check out **CSANR's YouTube Page** (and subscribe!)
- **2021 SoilCon Conference Recordings** (Conference/Presentation Material) (Working version)
- **2022 SoilCon Conference Recordings** (Conference/Presentation Material) (Working version)

Intern Engagement

While CSANR doesn't have a formal instructional role, we have long engaged in *"value-added educational experiences."* These experiences have included supporting service-learning projects, sponsorship of student participation in the Tilth Conference, undergraduate research experiences, co-sponsoring the inaugural WSU Ag Hackathon (D1G1TAL AgATHON), and more recently a concerted effort to help build undergraduate skillsets in extension activities through internship programs. One major effort over the past few years is the USDA NIFA sponsored **Research & Extension Experiences in Sustainable and Organic Agriculture** project, which is a focused undergraduate cohort training model led by Doug Collins over the past few summers. In addition to this formal project, we've also been using undergraduate and graduate internships in extension on several other funded projects as a strategy for skill-building educational experiences. You can see the work of several of these students on both the CSANR Perspectives blog and the AgClimate.net blog as follows.

Nicole Bell
Written by Karen Hills

Nicole came to us as a recent graduate of Oregon State University with a bachelor's degree in Environmental Science and a strong interest in science communications. During her time with CSANR, Nicole wrote six original blog posts on topics including climate change impacts and opportunities for fruit and vegetable supply chains, the 2021 Pacific Northwest heat dome, carbon sequestration potential in soil, and leasing of water rights. Nicole showed great adaptability and enthusiastically dove into topics that were new to her and sought information beyond what was provided to better understand the subject matter.

Nicole finished her internship in September and is currently pursuing a M.S. in Horticulture in the **Garden Ecology Lab at OSU**. For her M.S. she is completing a systematic review of the state of the research on native bees in urban settings. To further her interest in science communications, she is creating an iNaturalist guide for bees in the Portland, Oregon area and collaborating with OSU Master Gardeners on a social media campaign called PruneBetter, providing short videos and informational material about pruning a variety of species.

In her own words: *"Working with CSANR was a great experience for me! This internship gave me the opportunity to further develop my science communication skills and apply them consistently. Even better, I received helpful feedback and got to work with experts in both agriculture/science communication, and this left me with more confidence about my skills and how to ask questions for future endeavors. The work CSANR does covers a broad range of agricultural specializations and topics, so this was a great match for developing science communication abilities."*
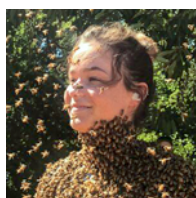
Katie Doonan
Written by Chad Kruger

Katie grew up on a hay and cattle ranch in Eastern California and made her way to WSU where she double degreed in Organic and Sustainable Ag and Biology. She served as a CAHNRS Ambassador while a student and was one of WSU's Top Ten Seniors and the Aggie of the Year. While an undergrad, Katie worked in CSANR Affiliate Faculty John Reganold and Isaac Madsen's labs, including on a BIOAg funded project working with root scanning in an intercrop of pea and canola. Katie's 2021 internship with CSANR was focused on authoring a new chapter on climate change for the WSU Master Gardener Handbook. This was a monumental task of creating a substantive new piece of peer reviewed curriculum from the ground up — a commitment not for the faint of heart! The chapter is currently in the final stages of revisions for publication and will include a companion presentation of the material.

After completing her internship, Katie applied for and was selected to be our new CSANR Extension Coordinator! In this role, Katie is responsible for CSANR's communications efforts, including this annual report, managing our social media presence, the CSANR Perspectives on Sustainability blog, the website, coordinating outreach events like the BIOAg Symposium, and facilitating overall improvement in our communication strategy and curriculum. Katie's education and background help her merge the technical science with practical experience in thinking about our communication strategy. Katie is also working directly with me on the WSARE Professional Development Program project for Washington State. We are exceedingly pleased to have Katie on board with the team in a permanent role after a highly successful internship!

An Interdisciplinary, Research-Practice Partnership to Improve Our Science Communication

Written by Sonia A. Hall

AgClimate.net is a regional blog managed by a team of collaborators from Washington State University (WSU), Oregon State University, University of Idaho and the Northwest Climate Hub. Our target audience is professionals who work with agricultural producers and natural resource managers, and our purpose is to discuss science-based topics related to climate change and agriculture and natural resources in the Pacific Northwest. As lead editor of AgClimate.net, my focus is on the quality, diversity and accessibility of the content we share. We have a base of around 325 subscribers to our blog articles, but relatively little feedback on whether our content meets their needs or areas where we can improve. To better understand this gap, we hired Ying-Chia Louise Hsu, a Ph.D. candidate at WSU's Edward R. Murrow College of Communication, to carry out a scientific communication audit of AgClimate.net in 2021. During this audit Louise delved into existing readership data collected from our blog platform, e-newsletter, and social media accounts. Her work challenged us (the AgClimate.net team) to more clearly define our outreach goals, prioritize audience segments, and help us understand possible improvements that these data suggest. Louise provided specific recommendations for improving our blog content and its dissemination, which we are currently implementing.

We could have stopped there, but in collaboration with Dr. Paul Bolls, the Associate Dean of Research and Graduate Studies at Murrow, Louise envisioned a series of research projects that could help us understand our audience's needs more deeply, including exploring what motivates them to read more and engage with the content we spend time and effort developing. Louise is currently working on two of these research projects, in close collaboration with Dr. Bolls and myself.

The first project is a climate science blog and audience survey, designed to explore how readers use climate science blogs and help us improve the blog's content to better meet their needs. Louise

Ying-Chia Louise Hsu is a Ph.D. candidate at WSU's Edward R. Murrow College of Communication.

fielded the survey in early April and is currently collecting data. The second project, which we are in the process of designing, will be a laboratory experiment using psychophysiological measures—eye movement, heart rate—to examine readers' responses to different ways of presenting climate science information. Participants will be presented with modified versions of AgClimate articles, and their cognitive and emotional responses to what they are reading will be captured. This will allow us to test specific changes to how a message is presented in our articles, and therefore directly inform changes we might make in writing styles and content structure.

This partnership is currently providing actionable insights to improve AgClimate and subsequent CSANR communication efforts while also giving Louise the real-life experience and satisfaction of applying her communications expertise. In addition, it is giving her the opportunity to publish our collaborative research in peer-reviewed journals, thereby strengthening her academic achievements at Murrow College of Communication. That's what I call a win-win.

Lawrence Hickman Endowed Graduate Fellowship
in Sustainable Agriculture

In late 2019, Ellen Hickman Williams made a significant donation to WSU CSANR to establish a graduate fellowship in honor of her father Lawrence Earl Hickman. The Hickman family owns a Whitman County farm which Lawrence leased to a relative as he pursued a legal career. Ellen explained that her father Lawrence stayed involved with overall farm practices & conservation methods even after leasing the farm. *"Many a Sunday drive for me, involved seeing if our car would make it across a deeply rutted mud farm road so Dad could inspect the field. In the late 1970s, Dad and Norman [the tenant] received a Whitman County Conservation award for planting grass strips in draws to reduce erosion, and for alternating crops on the hill. Then in Lawrence's last 20 years he planted, pruned and watered over 1,000 black walnut trees in the draws above canyons & along the creek and roadside on Jenkins Road."* The recipient of this fellowship shall be involved in graduate research in one of the following areas as it relates to dryland farming systems: precision agriculture, crop rotation, climate change, soil health, technology to reduce fossil fuels, niche crop variety development for local processing, integrated pest/weed management using natural ecosystems, transportation systems for getting crops to market economically and the economics for transitioning farm operations to all the above.

CSANR had the honor of selecting two graduate students to receive the fellowship for the 2021-22 Academic Year—Madeline Desjardins and Kristen Bullough.

Madeline Desjardins
Ph.D. Student, WSU Department of Crop and Soil Science

I grew up on Maui, which up until 2016 was the last Hawaiian Island still producing sugarcane. During my lifetime there has been a shift on Maui from this intensive monocropping system towards what is intended to be a more diversified and sustainable agricultural model. I witnessed a community in transition, with all the challenges, disagreements and compromises that happen while switching to a different agricultural system. I also experienced how these changes can be enriched and complicated by the different groups deciding on implementing changes to the way our food is grown.

After completing my undergraduate studies in liberal arts at St. John's College in Annapolis, MD, I returned to Maui and participated in the Farm Apprentice Mentorship Program (FAM), which was designed to train and fund the next generation of farmers on Maui. After graduating from the FAM Program, I began working as an intern on a farm, and was eventually employed full time on another. During this time, I became interested in soil health. I was interested in how important soil health was to the overall health of the farm and the larger environment, and as I delved further into this subject, I became interested in pursuing a graduate degree in soil science.

Coming from farming and transitioning into research, I wanted to continue to interact with farmers in my work. Washington State University's Northwestern Washington Research and Extension Center (NWREC) in Mount Vernon was the perfect place for me

Kristen Bullough
Developing a predictive model for Stripe Rust in Eastern Washington

When I was a child, I was set on becoming a vet. I loved studying living things and spent my time doing research and participating in other scientific activities. But when I got the opportunity to shadow a vet, I realized that the medical field was not for me. I spent a few years wondering what I would do with my life, and what goal I should work towards. Finally, I ended up in a floral design class in high school. This led to a leadership position in the club Future Farmers of America, which led to several award-winning science projects and other agricultural opportunities. These opportunities opened my eyes to the world of agriculture, and I knew that this was where I belonged. I could use my talents with data and scientific experimentation, so I put all my energy and focus into getting ready for college by taking several AP courses in my senior year of high school, including AP environmental science and AP statistics.

I completed my bachelor's degree with honors in 2018. The degree was a Bachelor of Science in plant science with an emphasis in research and a minor in crop biotechnology. I learned a lot of valuable information on crop systems and other general plant science knowledge. I ended up in a plant pathology class as an elective, but I found my calling in that class. It was my second to last semester, and I was in my class when I realized that I could do plant pathology lab forever and be incredibly happy doing so. I decided right there to eventually pursue this, even if it wasn't right away.

to end up, as I can work in an extension setting where a majority of the work is centered around communication and collaboration with the farming community. My research relating to the soil's biological, chemical, and physical mechanisms is complemented by extension work, which is necessary to enact changes in management and adoption of more sustainable practices.

My work in Dr. Deirdre Griffin LaHue's Soil Health Lab at the NWREC focuses on the impacts of long-term biosolids applications and cover crop grazing on soil health and sustainable crop productivity in dryland grain systems. Biosolids are treated wastewater products that can be land applied as an alternative to synthetic fertilizers. Bio-solids provide a way to close the nutrient loop by recycling urban waste and redistributing nutrients and organic matter from these densely populated areas back into the less populated agricultural areas where much of the food is grown.

While previous research shows that biosolids are a suitable alternative to synthetic fertilizer, more work needs to be done to explore how biosolids impact soil health. In my Ph.D, I am address-ing this knowledge gap by investigating how biosolids influence physical, biological, and chemical soil health properties, and whether biosolids can help growers establish cover crops in arid dryland systems. This project is an excellent opportunity to work within a framework that includes a variety of stakeholders putting our research into practice. My project spans a large portion of the state and addresses several important and pressing sustainability challenges, from urban wastewater management to soil health and sustainable productivity in dryland agricultural systems.

During my career I hope to work with farmers and other stakehold-ers to produce quality research with a view to its adoption and implementation. My passion for this work is rooted in my belief that we can enact changes to our food system that promote environmental health without compromising productivity. I believe that this is made possible through dynamic collaboration between stakeholders, farmers, researchers, and policy makers.

In 2020, I found myself sitting at my job, my mind wandering back to that plant pathology lab. I realized that I wanted to go back to school and learn more about the things I was passionate about, not just apply the lab and data analysis skill I had acquired. My husband and I decided to take the leap and move 12 hours away so I could go to graduate school in Washington.

I have been a graduate student at Washington State University for a year now, and I am still learning how to balance my time between my project, classes, my 1.5-year-old son, and my personal health. I am currently working on a project to develop a predictive model for Stripe Rust in Eastern Washington, using a network of spore traps at key locations. I would be happy to study anything related to fungi, as they are my favorite subject to learn and read about.

For a career, I hope to become a USDA scientist or some other pathology-related position in the industry. Eventually, I would like to become a professor and teach, but before I feel comfortable doing that, I would like to get some real-world experience to bring to the academic side of plant pathology.

My overall goal in life is to show my son that with passion and hard work, you can become whatever you want to, and help create a world that will be better than when we started. I will do this by learning all I can while I am getting my PhD and using that knowledge to help people out in the field.

New tools and new rules for water use and allocation in agriculture and beyond

Written by Georgine Yorgey, Associate Director, CSANR

In the Columbia River Basin, as in other basins across the western United States, water allocation decisions and processes are important for making the most of naturally variable water resources for diverse instream and out-of-stream purposes. Tradeoffs inherently exist with so many competing uses for water, especially during drought years when available water is limited. Maximizing opportunities for water to be tasked to its highest valued potential use, both within agricultural systems and across its many competing uses, is important for making the most out of scarce water resources. Improved information increases the efficacy of new management approaches, and emerging information technologies provide opportunities for enhancing the region's resilience to drought by making water use more flexible. Such information-related innovations are already changing the legal and management landscape of water resources in the western U.S.
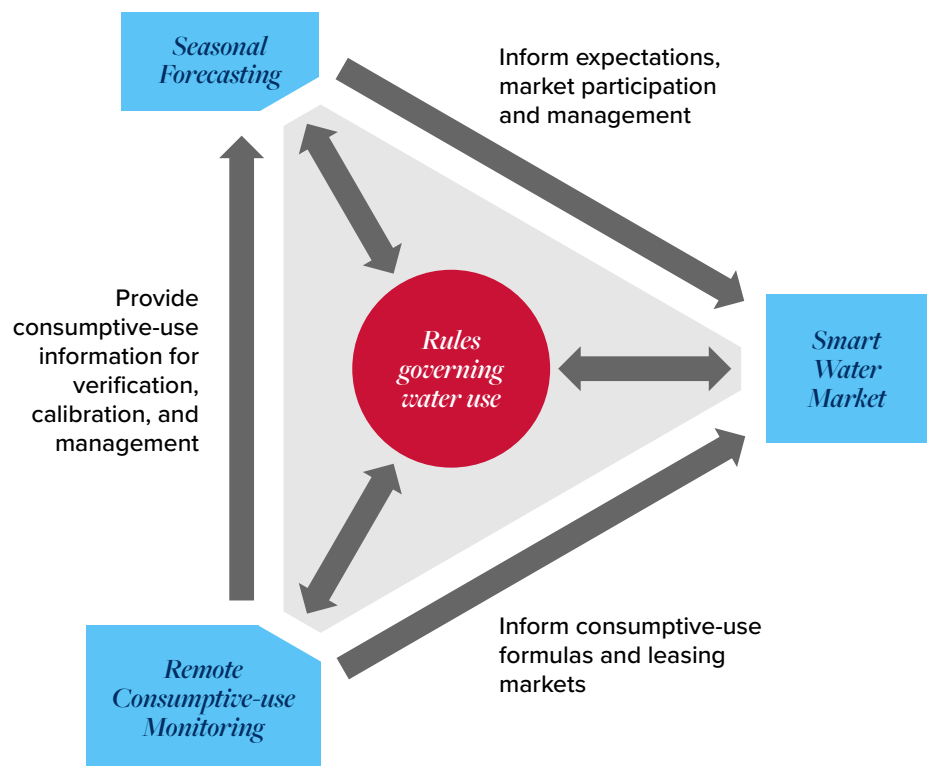
Figure 1. The three focal technologies of this project complement each other, and provide information that, in combination with the rules that govern water use, creates new opportunities for water use.

The *Technology for Trade* project, a five-year project launched in 2018, contributes to enhanced efficiency of water use by furthering the development of information technologies and complementary innovations in the rules that govern water use. In particular, the Technology for Trade team aims to further the development and application of three promising and complementary emerging technologies: improved seasonal forecasting, remote measurement of crop water consumption, and computer-aided 'smart' water markets. In addition, legal, regulatory, and contractual innovations can be important to allow water users to use these technologies as effectively as possible while protecting the water rights of others.

The project is led by the Water Research Center at Washington State University and includes partners from the Center for Sustaining Agriculture and Natural Resources, as well as the School of Economic Sciences, the Department of Civil and Environmental Engineering, and the Department of Biological Systems Engineering at Washington State University. Other partners are from the University of Washington, the University of Idaho, the University of Utah, Aspect Consulting, and ERA Economics.

Improved Seasonal Forecasting

The forecasting effort utilizes seasonal climate forecasts that are currently available with lead times of about eight months (i.e. the North American Multi-Model Ensemble), and is exploring regional translation to forecasts of water availability and related metrics. The seasonal forecasting effort will identify when, where, and what metrics can be forecast with enough lead time, accuracy, and precision to be useful in decision-making. For example, improved seasonal water forecasting could help farmers plan their planting and water use activities earlier and with less uncertainty. Timely and informed decisions could then facilitate water transfers during times of shortage, including dry-year (options) contracts or public reverse auctions to augment instream flows.

Remote Consumptive Use Measurement

The Technology for Trade team is also working on a number of methods for remote detection and quantification of consumptive use in a spatially explicit manner using both satellite and drone-based imaging. Evapotranspiration is closely related to crop consumptive water use. The focus of this technology is thus irrigated agriculture, which is an important economic engine and accounts for the majority of regional out-of-stream consumptive water use. A model is being revised to not only detect water stress in a spatial manner, but to quantify water use differences within a field. This could be used to better guide variable rate irrigation systems and improve yields. During dry years, consumptive use measurements could support improved deficit irrigation strategies, and perhaps partial leasing of water rights. At a basin scale, satellite-based imagery could help protect water rights against increases in consumptive use elsewhere in a watershed and complement existing water metering efforts.

Computer-Aided 'Smart' Water Markets

This aspect of the project examines both the barriers to more active water markets, and possible methods for easing the process of matching multiple sellers and buyers of water and help navigate the highly complex regulatory constraints for a successful trade. This could facilitate temporary transfers during times of shortage to the most valuable uses, both in-stream and out-of-stream, in ways that do not impair other water users. The team carried out a water management survey across the Yakima, Okanogan, Methow, and Walla Walla watersheds in Washington State, and also built a functional *"agent-based"* trading model that can be used to explore interactions between water policy and water markets.

AgAID Institute
Written by Jordan Jobe

In September 2021, WSU began leadership of a new Agriculture-Artificial Intelligence (AI) research Institute: the **AgAID Institute**. As the growing population increases food demand, agriculture faces complex challenges related to labor, water scarcity, weather events and climate change. The AgAID Institute is developing AI solutions to help address these pressing challenges and spur the next agricultural revolution with the use of AI. We're building tools and workflows to help mitigate the effects of labor costs and shortages, and to better manage regional resources such as water, despite climate uncertainties. The Institute will bring more data and science-guided information to the fingertips of agricultural workers to help them make better decisions.

The Institute's mission is to build and foster partnerships between AI and Ag communities and create a transdisciplinary ecosystem for technology innovation and knowledge transfer. This collaboration between university partners in agriculture (WSU, UC Merced) and computer science (OSU, UVM) creates technology innovation at a variety of levels and partnering with Heritage University (which serves a Native American population), and Wenatchee Valley College (which works with many Latinx students) develops pathways for the inclusion of under-served communities toward higher level professions at the intersection of Ag and AI. By increasing AI education and closing skill gaps, the Institute aims to help transform this critical labor force and create new opportunities for computing and STEM majors.

CSANR is a partner in this effort, with members of the Center engaged in several AgAID Institute *"thrusts"* or project focuses. We are currently working on the *"Broadening Participation"* thrust, which promotes integral involvement from the people who will use the tools—the farmers, workers, and managers—throughout all stages of the development process.

By leveraging our breadth of experience in Extension and Outreach, we are working with farmworkers- particularly those in apple orchards, cherry orchards, and vineyards- to develop solutions to the complexities of pruning, thinning, irrigation, frost mitigation, and water availability that involve their experience from the outset. This helps to ensure accessibility to more technical career opportunities and ensures that the AI solutions are practical and add value, which makes them more likely to be used in dynamic real-world situations. We are partnering through K-12, college, and workforce training efforts (for example, with 4-H and STEM education programs) to raise AI skill levels and open new career paths to increase compensation and improve quality of life for the agricultural workforce, while attracting more people to agriculture and computing professions.

This Institute aims to be truly interdisciplinary and aligns well with a significant amount of the work from historic CSANR involvement - from leveraging our work forecasting water supply and demand in the Columbia Basin to our extensive connections with growers across the state. Using AI can improve our ability to understand water demand and availability, while working directly with farmworkers to develop technology that improves their career prospects.

As these pathways continue to develop, we look forward to contributing to CSANR's mission of providing practical solutions to the new, complex challenges facing agriculture and natural resource management.

Climate Analogs for Specialty Crops: See the Future Now

Written by David I. Gustafson

This article is part of a series, Climate Friendly Fruit & Veggies, highlighting work from the Fruit & Vegetable Supply Chains: Climate Adaptation & Mitigation Opportunities (F&V CAMO) project, a collaborative research study co-led by investigators at the University of Florida and the Agriculture & Food Systems Institute. Other collaborators include researchers at the University of Arkansas, University of Illinois, the International Food Policy Research Institute, the World Agricultural Economic and Environmental Services, and Washington State University. This project seeks to identify and test climate adaptation and mitigation strategies in fruit and vegetable supply chains as demand for fruits and vegetables increases.

Figure 1. We have always longed to see the future, whether via prophets, crystal balls, science fiction, or even through the use of Ouija boards.

"It's tough to make predictions, especially about the future." So said Yogi Berra, repeating a version of the apparently Danish proverb whose origins have been lost. Nevertheless, as difficult and logically impossible as it might be, humanity has an innate longing to see the future (Figure 1). Ancient kings kept prophets among their advisors. Fortune tellers make a living by gazing into crystal balls. Hasbro sells Ouija boards for $20.99. And among the most popular of today's entertainment genres is science fiction.

In our modern era, world leaders have created the Intergovernmental Panel on Climate Change, which has institutionalized efforts to see into the future through a complicated synthesis of scenario-based forecasts from an array of dozens of computer models. These models are developed to quantify our best understanding of how the climate works, tested to see if what they'd predict under past conditions is similar to what was actually observed, and used to simulate the impact of still-accelerating greenhouse gas concentrations on our climate. These forecasts are normally presented in the form of complicated graphics with lines that curve upwards through a statistical cloud toward an uncertain future (Figure 2). Such approaches have been demonstrably insufficient and ineffective when attempting to communicate with growers on how climate change will impact their farming operations.
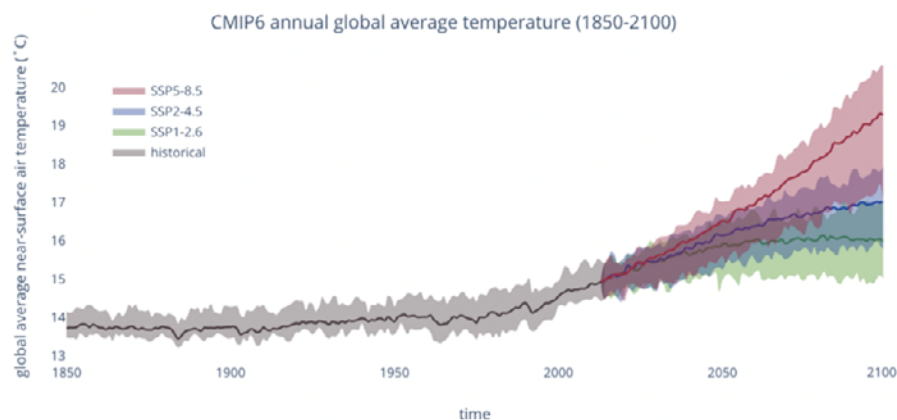

Figure 2. An example showing potential future global average temperatures based on climate models. The gray shaded area shows the range of historical simulations and the colored areas show future scenarios. Credit: Copernicus Climate Change Service, ECMWF, https://climate.copernicus.eu/latest-projections-future-climate-now-available.
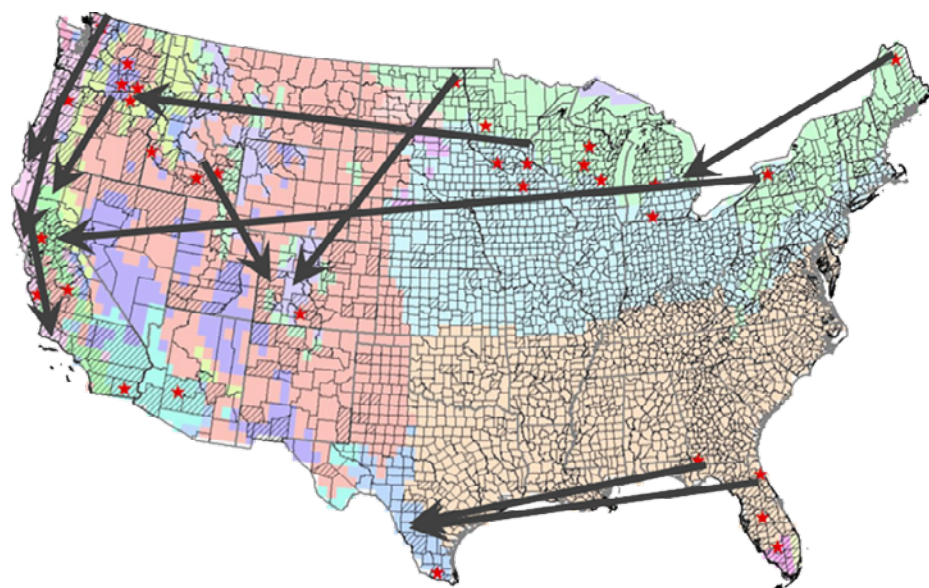
Figure 3. Select analog pairs for fruit and vegetable production areas in the U.S. Each pair includes a target (start of arrow) and analog (arrowhead) county, and use current and mid 21st century climate conditions. The target locations are those whose mid 21st century growing conditions resemble current conditions at the analog location. Colors show current climate regions. Source: Sid Chaudhary & Kirti Rajagopalan (unpublished preliminary results).

But what if growers could actually speak with someone—another grower, for example—who is currently farming amid conditions that they themselves are likely to encounter in the future? Such conversations could form the basis for the most effective transfer of actionable technical information to inform climate adaptation in agriculture (what the U.S. Department of Agriculture calls extension).

'Climate Analogs' make it possible for such conversations to take place. The premise is fairly simple: Is there a U.S. county whose current climate has key characteristics that resemble the climate that my county will likely experience 10, 20, 50 years in the future? The forecasts of multiple climate models are used to pick counties that have the best statistical match, based on climatic characteristics that we know are important for agricultural production. This results in the formation of an 'analog pair'—counties in which the current climate of one is similar to the future climate of the other.

Once an analog pair is identified, growers who are concerned about future conditions can speak with farmers in the paired county, who are farming under

those conditions right now. They can learn about which crops do best, what pests and diseases to expect, what are the biggest weather-related challenges for each crop, and how these things are managed. The information obviously won't be completely perfect, but that's not the most important point. The goal is to spark creative thinking to help more effectively plan for the future. That's adaptation.

The concept can be applied anywhere in the world. For instance, the CBS news show *"60 Minutes"* recently featured a two-segment special that looked at wine grapes, focusing primarily on regions of England, which are now beginning to resemble past growing conditions in France. This ongoing trend has massive financial implications for this tremendously important industry.

The example of wine grapes highlights a unique aspect of climate adaptation for fruits, vegetables, and other specialty crops. They typically require considerable built infrastructure rather close to where the crops are produced. In the case of wine grapes, this is a winery, often immediately surrounded by the grapes that are locally fermented and bottled into wine. Many

other specialty crops also require processing facilities to be nearby, and this often represents a major financial investment, meaning that movement of specialty crop production to a new region requires long-term planning, as well as access to capital and unique expertise.

Our team is helping test this approach to climate adaptation extension. Two members of our multi-disciplinary, multi-institutional research team, Washington State University researchers Sid Chaudhary and Kirti Rajagopalan, have identified analogs for specialty-crop producing counties in the United States (Figure 3). They discussed these analog pairs in a series of free webinars in January 2022. We organized a follow-up workshop (held virtually in March 2022) where Extension professionals with knowledge about specialty crop production practices in these identified target and analog counties were paired to discuss the climate change implications for these important food crops and the management practices and technologies that could be considered under future conditions in the target county. The workshop was also an opportunity for initiating partnerships for a nationwide Specialty Crop Extension Network for climate adaptation.

Nothing is certain in life. Especially not the distant future. However, climate analogs have tremendous potential to help growers of fruits, vegetables, and other specialty crops better prepare for that future by, in a way, seeing it now through the eyes of growers who are already experiencing it.

Grad student wins fellowship to study buckwheat's potential

Written by Scott Weybright

Rachel Breslauer didn't grow up in an agricultural setting. Hailing from a town an hour and a half outside New York City, she became interested in food security and food justice in high school.

While earning her bachelor's degree at Cornell University, Breslauer worked a few on-farm research projects in dairy and cropping systems. Those experiences brought her to WSU, where she earned a master's degree. Now she's working on a Ph.D. in WSU's **Department of Crop and Soil Sciences**, focusing on alternative crops and looking at how to bring newer crops and diversity into fields.

"I'm a very people-focused person," Breslauer said. *"I love working with farmers and consumers, improving the connection between the people growing food and the people who buy it."*

Breslauer plans to graduate with her doctorate in 2023 and applied for a U.S. Department of Agriculture fellowship program to support her studies.

"I'm very impressed by the work Rachel has been doing," said Kevin Murphy, her advisor and WSU associate professor of international seed and cropping systems. *"She definitely deserves this fellowship, and I see it having a positive economic impact for farmers interested in growing buckwheat. I'm excited to work with Rachel through this fellowship, and to contribute to the crop diversification research she'll be conducting with buckwheat."*

In Washington state, buckwheat is often grown as a cover crop, not harvested or sold. Breslauer will investigate whether growers can turn buckwheat into a

Rachel Breslauer in a field of field of buckwheat.

profitable crop thanks to a new **USDA National Institute of Food and Agriculture predoctoral fellowship**.

"We know cover crops are valuable," she said. *"The main question is, what varieties can perform well as cover crops and be productive as well?"*

To answer that question, Breslauer received the $120,000 NIFA Agriculture and Research Initiative fellowship, which includes professional development, research, and travel funding.

Cover crops are planted primarily to slow erosion, improve soil health, help control pests, and diseases, or other benefits. But they are often plowed under and not harvested for sale.

Buckwheat seeds, however, can be sold and milled into gluten-free buckwheat flour. It's used to make pancakes, breads, cookies, and is very popular for making soba noodles. Soba means buckwheat in Japanese and Japan is the largest market for selling the crop.

Buckwheat is grown in central Washington state for export to Japan. It must be grown carefully to make sure that buckwheat seeds don't contaminate wheat grown later in the field. Buckwheat is a common allergen that can't be mixed with wheat shipments.

As gluten-free products grow in popularity in the U.S., the domestic market for buckwheat flour is growing. If growers are already growing it as a cover crop, why not harvest it?

"Buckwheat is very short-seasoned, it can go from planting to harvest in as little as 10 weeks," Breslauer said. *"It would be planted at the same time as when used as a cover crop, but kept a few weeks longer than normal so it can go to seed."*

Breslauer is based at WSU's Northwestern Washington Research and Extension Center in Mount Vernon, Wash., and her work will be on research plots at Viva Farms in Burlington and the Organic Seed Alliance Research Farm in Chimacum. She completed two field trials last year as preliminary work, funded through WSU's Center for Sustaining Agriculture and Natural Resources BioAg grant program.

The USDA fellowship funds her assistantship, allocates extra funds for project assistance, enables her to send seed to collaborators at the Crop Research Institute in the Czech Republic for varietal testing, and enables her to travel to several conferences during the award period.

Breslauer is also involved in a separate project assessing how buckwheat varieties perform in different food products, which will help identify market opportunities for the crop in the Pacific Northwest.

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Tobin Northfield

Identifying biologically based paths reducing insecticide resistance in codling moth

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Franck Carbonero, Achour Amiri, Charles Edwards

Integrative analyses of pome fruits associated microbiota for decay prevention and health benefits

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Chris Benedict, Ian Burke, Deirdre Griffin LaHue, Gabe LaHue, Teal Potter, Navdeep Singh

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Faculty + Staff

CHAD KRUGER
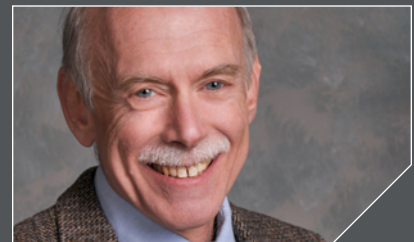Director

GEORGINE YORGEY
Associate Director

JIM AMONETTE
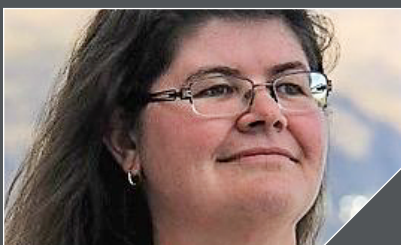Adjunct Research Professor

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Associate in Research

JORDAN JOBE
Associate in Research

ANDREW MCGUIRE
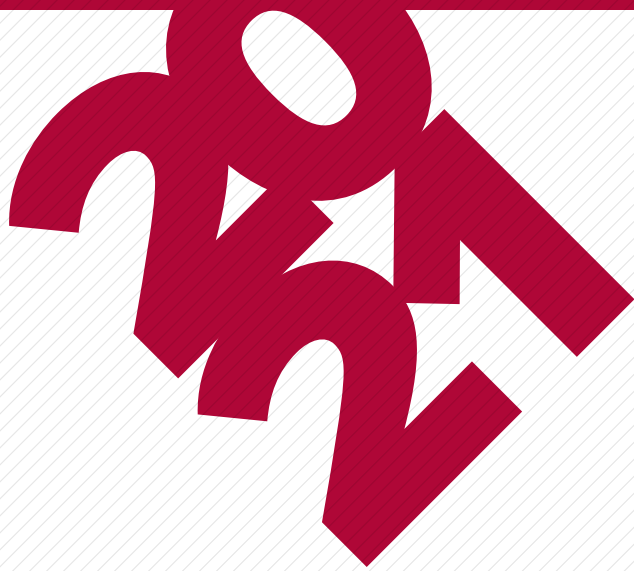Irrigated Cropping Systems Agronomist

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