

2019 Annual Report of Accomplishments and Results

Washington

Washington State University

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your Plan of Work. Use this space to provide updates to your state or institutions as needed.

1. Executive Summary (Optional)

The primary goals of the Washington State University (WSU) Agricultural Research Center (ARC - the Agricultural Experiment Station of the State of Washington) and of Washington State University Extension are to conduct research beneficial to the citizens of Washington State and to extend relevant research results generated here and elsewhere, as well as research-informed programmatic engagement, to stakeholders within the state and beyond. We strive to create outcomes that improve the economic viability, environmental sustainability, community resilience, and quality of life for our people. We recognize that we have unique land grant research and outreach missions to serve the people of Washington to enhance their quality of life and to evaluate both short and long-term consequences of potential policies, decisions and actions. The ARC provides leadership in discovering and accessing knowledge by carrying out high quality research that contributes to a safe and abundant food supply; promotes the well-being of individuals, families, and communities; encourages sustainability of agricultural and economic systems; promotes energy innovation; and encourages careful stewardship of natural resources and ecological systems. WSU Extension creates programs with measurable deliverables and outcomes that leverage the research base of the University and academia to address primary and timely issues in ways that lead to economic development, improved policy and governance, sustainability and resilience as well as personal, family, and environmental wellbeing. The synergy provided by integrating research capacity, problem-solving skills and the statewide engagement of ARC and Extension enables unique capacity to address pressing issues and problems while recognizing different perspectives. This maximizes the delivery of valuable contributions to our residents and society.

The WSU ARC and WSU Extension have many natural and structural links. Washington State University faculty have responsibilities that include both research and outreach, with many having formal joint appointments. This is particularly true within the College of Agricultural, Human and Natural Resource Sciences (CAHNRS), which houses both ARC and Extension. More than 100 faculty with ARC or Academic positions hold partial Extension appointments. An additional approximately 100 faculty have full Extension appointments with a primary focus on off-campus program delivery, applied outreach and direct engagement. The focus of our joint efforts is to provide science-based knowledge and outreach programs to meet the primary needs of the people of Washington State. As part of this core mission, the ARC has made significant commitments to focus on fourteen high priority research areas that advance our land-grant mission in discovery and development research. These research areas are (1) precision and automated agricultural systems, (2) soil-plant interactions: chemical, physical, and biological processes, (3) sustainable food production from livestock, (4) developing food processing, safety, quality, and supply solutions for production of high quality and safe food, (5) promoting health and wellness of individuals, families, and communities, (6) reducing the impact of pests and diseases affecting Washington agriculture, (7) crop improvement and sustainable production systems, (8) enhancing sustainability across diverse agricultural systems, (9) natural resources, (10) integrated research and societal engagement to address global water challenges, (11) functional genomics in animal improvement, food safety, and human health, (12) integrated crop and weed management systems, (13) molecular plant sciences: plant productivity in a dynamic environment, and (14) bioenergy and biofuel.

WSU Extension delivers significant outreach related to (1) natural resource stewardship; (2) food safety; (3) health and wellness; (4) youth and family development; (5) governance, (6) sustainability, and (7) community economic development. The efforts of ARC and Extension are a committed element of a broader set of programs addressing issues in these areas that reside in the many WSU colleges and interdisciplinary centers, including CAHNRS; the Voiland College of Engineering and Architecture; the College of Arts and Sciences; the College of Pharmacy; the College of Veterinary Medicine; the new Elson Floyd College of Medicine, and the Center for Environmental Research, Education and Outreach. Within Extension, specific examples of focused outreach efforts include the Food Systems Program, the Child and Family Research Unit, the AgWeatherNet program, the William D. Ruckelshaus Center (a joint program with the University of Washington), the Division of Governmental Studies and Services, and the Metropolitan Center for Applied Research and Extension. Additionally, through close partnerships and collaborative agreements, our Research and Extension faculty also extend the research conducted by faculty at other regional centers of expertise, including among others the University of Washington, Oregon State University, and the University of Idaho. In 2019 Extension began intentionally developing stronger programmatic and project-based collaborations with the E. F. School of Medicine, focused on efforts to improve a statewide culture of health, on a pilot project to address agricultural worker behavioral health and suicide prevention, on response to a growing opioid crisis in the state, and more generally in connection to that college's unique distributed model for rural delivery of medical services and education to address health inequities.

WSU researchers have garnered millions of dollars in extramural support to leverage their capacity grant funds into discovery and development research important to the citizens of Washington State. Between 2016 and 2019, WSU was the top university in the nation for total dollars awarded from USDA for research and development and over 80% of that total was from ARC and Extension faculty. The Northwest Advanced Renewables Alliance supported transformational research to make a sustainable aviation biofuels industry a reality which remains a strong initiative following the successful completion of that grant. The largest gift to Washington State University overall is still from the Washington Tree Fruit Commission, which approved check-off increases worth over \$32 million over the eight years of the increased assessment for support of apple, cherry and pear research and extension. Other support in endowed professorships and research funding has been made available from organizations like the Washington Grain Commission (which has endowed several professorships at WSU and notably also donated over \$5 million dollars to build a grains greenhouse), the Washington Potato Commission, the Washington Hops Commission and the Washington Wine Commission (which donated funding for the Ste. Michelle Wine Estates WSU Wine Science Center). There is a very vibrant relationship between WSU Research and Extension and numerous commodity-based entities in the state and region and we view this as a validation of the value placed on our efforts by our constituents and stakeholders. Our county partners contribute more than \$10 million annually - in cash and kind - to support county Extension operations.

There are numerous societal, environmental and scientific challenges that can be addressed by cutting-edge research and through the application of that research to the practical issues that face the residents of Washington. Every year we assess and evaluate our research portfolio to strategically prioritize our efforts to ensure the greatest impact is derived from both our research and extension programs. As a result, we can continue to deliver important outcomes including economic benefits to agricultural and natural resource-based industries, government entities, communities, and individuals. Additionally, our research and outreach help ensure that the people of Washington State maintain a high quality of life by limiting the negative impacts of chronic disease, addiction, food insecurity, and obesity, and with the goal of eliminating health inequities. Finally, our programs help ensure that the beauty of the state and its natural resources are sustained for future generations. Our annual Report of Accomplishments endeavors to summarize the inputs, outputs, and impacts of our work conducted during the year.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Process	Updates
<p>1. The <u>Merit Review Process</u></p>	<p>Merit evaluation takes place at several levels. Prioritization for specific programs is manifested by allocations of effort and limited funds. In 2017 we implemented a new strategic prioritization of our Hatch capacity funds in order to better align with stakeholder needs and researcher capacity. We organized our research projects into fourteen main collaborative topic areas that were based on organic associations and are reflective of college strengths. Review and evaluation of research projects occurs prior to project submission and on an annual basis through REEport.</p>
<p>2. The <u>Scientific Peer Review Process</u></p>	<p>Individual WSU faculty program plans are developed through statewide planning processes informed by the NIFA Plan of Work, the College of Agricultural, Human and Natural Resource Sciences Strategic Plan, and the WSU Strategic Plan (renewed in 2020). Faculty members are reviewed annually on a set of performance expectations that include: Effective program planning, implementation, and evaluation of impact; scholarly work and creative outreach materials; success with grants and extramural funding; leadership and teamwork; professional development; and service to the public and the institution. Annual merit ratings are assigned based on accomplishment within these categories, which are also the performance expectations considered for tenure and promotion of Extension Faculty. All faculty report at the end of the calendar year into our electronic Activity Insight database which can be accessed quickly at any time during the year that the information is needed. The progress of faculty work is reviewed by Program Directors, Department Chairs, Associate Deans and the Dean as an integral part of the annual performance review process. WSU faculty receive over 60% of their total funding from extramural sources, including USDA grants, grants from other agencies, foundation grants, and commodity commission grants. These funding agencies subject our proposals to expert peer review by scientific panels and by industry professionals and growers. All WSU Extension publications undergo a double-blind peer review. Reviewers include faculty at WSU or other Land Grant Universities, state and federal agencies, or research faculty at non-Land Grant universities.</p>

III. Stakeholder Input

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Stakeholder Input Aspects	Updates
<p>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</p>	<p>Stakeholder involvement is sought through a variety of means, including the following:</p> <ul style="list-style-type: none"> • Relationship building through advisory councils, boards, regular meetings with key partners in local communities and state-wide • Workshops • Presentations at Commodity Commission Board and other state agency board meetings • Field Days hosted statewide • Engagement with Master Gardeners, Master Beekeepers, 4-H • Electronic media (email, listservs, websites, social media platforms, newsletters) • Radio • Direct mail • Telephone contacts • Personal visits • Articles and stories in local, state, and regional periodicals, newspapers, magazines • Electronic surveys (using Qualtrics, Remark or Survey Monkey, and Turning Point software and clicker technology at workshops)
<p>2. Methods to identify individuals and groups and brief explanation.</p>	<p>Annual assessments of general population characteristics, agricultural trends, natural resource- related issues, human health trends, and business dynamics are carried out as needed and are largely based on analysis of data collected by agencies external to the University, such as the US Census Bureau, National Agriculture Statistics Service, Washington Department of Natural Resources, Washington Department of Health, Washington Department of Agriculture, and the Washington Department of Commerce. To meet specific needs, these are supplemented in some cases by focused internal or stakeholder commissioned studies. These data help WSU faculty and staff and the commissioning stakeholders identify target audiences and define specific needs. We then develop appropriate research and outreach to address these needs.</p>
<p>3. Methods for collecting stakeholder input and brief explanation.</p>	<p>The ARC and WSU Extension use local and statewide advisory committees to provide input to the leadership, the faculty, and staff of Washington State University. These include the College of Agricultural, Human and Natural Resource Sciences (CAHNRS) Advisory Council, the Center for Sustaining Agriculture and Natural Resources Advisory Committee, advisory committees at each of the four Research and Extension Centers, and county, departmental, and program- specific advisory committees.</p>
<p>4. A Statement of how the input will be considered and brief explanation of</p>	<p>Input from stakeholders strengthens our ability to assess need and demand, and to identify potential partners, identify emerging issues, and to evaluate the effectiveness of our research and extension programs in addressing these issues and needs as we move forward with Research and Extension</p>

<p>what you learned from your stakeholders.</p>	<p>activities, initiatives and programs. Our programs are directly influenced by stakeholder feedback and input.</p> <p>The highest priority for our stakeholders is to support innovative research and extension outreach that addresses important issues that are critical to profitability, sustainability, and their health and well-being. Many stakeholders prioritize natural resources concerns related to water quality, water quantity, forest health, rangeland health, and stewardship. Local food systems and the desire for community connections with our food supply was another recurring theme, as was the desire to have us investigate new methods and practices for organic food production. Concerns over human health and diet, along with the growing incidence of obesity in our population were clearly stated as priorities and there was a desire to implement educational outreach to change behaviors. Consumer food safety education, positive youth development, and outreach to sustain rural communities were among several other stakeholder-defined issues that are being addressed by our current work. Emerging issues this year include the opioid crisis, access to affordable healthcare, and trust in government.</p>
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IV. Planned Program Table of Contents

No.	Program Name in order of appearance
1.	Sustainability, Security and Resilience
2.	Community and Economic Development
3.	Natural Resources
4.	4-H Youth Development
5.	Fostering A Culture of Health
6.	
7.	

V. Planned Program Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). See Section V of the Guidance for information on what to include in the qualitative outcomes or impact statements. Add additional rows to convey additional accomplishments. You may expand each row as needed.

No.	Title or Activity Description	Outcome/Impact Statement	Planned Program Name/No.
1.	<p>Advancing Soil Health in Washington State</p>	<p>The State of Washington has a storied history of public-private leadership in soil health, including early research defining soil health and substantial early investment in soil conservation. In recent years there has been a growing focus on the need and opportunity to advance the next generation of soil health understanding and implementation in the state. This includes published research focused on assessing the potential environmental benefits of soil management (e.g. carbon sequestration), experimentation on new soil management practices, research on the impact of soil management practices on crop performance and nutrition and potential benefits on animal and human health, development and testing of various soil health diagnostic tools, and significant implementation of new soil conservation and soil building practices throughout the state.</p> <p>Overall Goal: To advance the understanding of soil health in Washington, establish a baseline of current soil health conditions, develop improved management options for improving soil health for a wide range of agro-ecosystems, and support on-farm implementation of soil health practices.</p> <p>Major Activities:</p> <ul style="list-style-type: none"> • Major statewide road-mapping process underway. • A region-wide Soil Health Conference was held in Pendleton in March of 2019, with 151 attendees. • Submitted the Washington Soil Health Initiative as part of the WSU / WSDA / WSCC budget decision packages. Multiple presentations to various agricultural and industry groups. 	<p>Sustainability, Security and Resilience. Planned Program # 1.</p>

		<ul style="list-style-type: none"> • WSU Soil Health Website developed and available at soilhealth.wsu.edu. <p>Results/What Was Accomplished:</p> <ul style="list-style-type: none"> -The Washington Soil Health Initiative was initiated with \$250,000 from the Washington State Legislature. This initiative is an ambitious plan that funds research, extension, and demonstration of soil health best management practices through a network of long-term agroecological research and extension (LTARE) sites across Washington state’s diverse agricultural systems. -The Pendleton “Healthy Soils, Healthy Region” conference extended soil health training to 151 agricultural professionals in the region, with 64% of participants indicating that the conference fully provided the information they hoped to learn regarding soil health, and 39% of participants indicating they had learned some of the information they had hoped to learn. Participants indicated that the most valuable new information learned during the event included the updates in soil health testing, making regional connections, information on soil and root development, and information on dryland cover crops. Participants were inspired to make several changes as a result of this event, including: learn more about soil health, talk with producers about soil health, utilize cover crops, hold field days and step up their collaborations. -The written summary from the Pendleton Soil Health Conference, as well as from the 2018 soil health summit were used to support at least one major grant proposal in 2019 (\$10 million proposal to USDA NIFA, awaiting response). -The potato soil health literature review (completed in 2018 and polished in 2019 into a journal article to be published in the American Journal of Potato research) helped the state’s potato industry in prioritization of soil health research needs, including contributing to support for the commitment to endow a soil health position. -Numerous stakeholders in the region requested information summarizing the potential for cropland agriculture to sequester carbon. A white paper summarizing regionally specific data was produced, was made available to 	
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		<p>these stakeholders. It has also been submitted to the WSU Extension publications system, has undergone peer review, and will be revised and resubmitted in 2020.</p> <p>Peer Reviewed Publications: Hills, K., Collins, H., Yorgey, G., McGuire, A., and Kruger, C. 2020. Improving Soil Health in Pacific Northwest Potato Production: a Review. Am. J. Potato Res. 97:1-22</p> <p>Other Substantial Publications: Yorgey, G.G., S.A. Hall, K.M. Hills, C.E. Kruger, and C.O. Stockle. 2019. White Paper. Carbon Sequestration Potential in Cropland Soils in the Pacific Northwest: Knowledge and Gaps. Center for Sustaining Agriculture and Natural Resources, Washington State University, Mount Vernon, WA.</p> <p>Saari, B.R., Hills, K., Yorgey, G.G., Michel, L., Roesch-McNally, G., Moore-Kucera, J., Finkelnburg, D., Cappellazzi, S., Halpern, A., Wysocki, D., Kruger, C. 2019. Healthy Soils, Healthy Region: A summary of regional vision and priorities for soil health. Healthy Soils, Healthy Region Workshop, Pendleton, OR, March 12-14, 2019. http://csanr.wsu.edu/healthysouils/</p> <p>Blog Posts/Lay Publications: Hills, K. 2019. Soil Health in Potato Production: Oxymoron or Opportunity? Blog post. Perspectives on Sustainability blog. Center for Sustaining Agriculture and Natural Resources, Wenatchee, WA. September 25, 2019.</p> <p>Yorgey, G.G., S.A. Hall, C.E. Kruger, C. Stockle, K. Hills, and M. Donnay. 2019. Carbon Sequestration Potential in Cropland Soils in the Inland Pacific Northwest: A Summary of Existing Knowledge and Gaps. 2019 Dryland Field Day Abstracts: Highlights of Research Progress. Technical Report 19-1. University of Idaho, Oregon State University, and Washington State University. http://s3-us-west-2.amazonaws.com/css.wsu.edu/wp-content/uploads/2012/09/19114614/FDA-2019-Complete.pdf.</p> <p>Yorgey, G.G. 2019. Rapid Evaluation of Winter Wheat Residue Decomposition Potential. CSANR Perspectives on Sustainability blog. Center for Sustaining Agriculture and Natural Resources, Wenatchee, WA. April 10, 2019.</p>	
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<p>2.</p>	<p>Extension Forestry Program</p>	<p>Washington State has 225,000 families and individuals that control 5.9 million acres of forestland, making this the largest rural land use group in the state. Another 3.5 million acres of private land is grazed as open and transitory rangeland. Most landowners manage for multiple objectives, such as timber and livestock production, along with wildlife habitat improvement and a variety of recreation opportunities.</p>	<p>Natural Resources. Planned Program # 3.</p>

		<p>RREA funds (7:1, worth \$500,000) were leveraged to support seven forestry and rangeland specialists, whose combined 101 events were attended by 2,599 owners and managers, representing 156,955 acres. With a focus on forest and rangeland health and stewardship, new management practices were implemented by 2,288 landowners with an estimated economic impact of \$25,740,000 earned or saved. Over 250 youth learned about sustainable natural resource management. WSU Extension and the RREA program have improved the ecological condition and economic well-being of communities in every county in Washington State.</p> <p>In 2019, Extension Forestry measured outcomes of a 10-year outreach and education campaign to improve forest health and wildfire risk mitigation in eastern Washington. The longitudinal evaluation results reveal that Extension Forestry influenced best management practice treatments on at least 247,500 acres. Over 22,000 families accomplished management objectives, reduced risk, and protected their financial investments after participating in one or more of 350 hands-on demonstrations, workshops, field days, and short courses. Goals achieved: improved forest health, improved productivity for growing trees, increased tree cover, improved income prospects, decreased noxious/ invasive weeds, improved habitat, decreased risk of erosion, decreased risks from insects or disease, protected cultural resources and improved recreational opportunities.</p> <p>2019 BY THE NUMBERS</p> <p>101 educational events conducted for forest landowners and managers on the benefits and opportunities of forest stewardship practices.</p> <p>308 forest landowners and managers trained to develop forest stewardship plans.</p> <p>34,202 direct and indirect contacts who increased awareness of the benefits and opportunities of forest stewardship practices.</p> <p>2,547 direct contacts who increased knowledge of the benefits and opportunities of forest stewardship practices.</p> <p>488 forest stewardship plans initiated, supported or developed with Extension support/involvement.</p>	
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2019 Annual Report of Accomplishments and Results (AREERA)

		<p>2,288 forest landowners who implemented at least one new forest stewardship practice. 156,995 acres on which forest management was improved. 5 forest stewardship and health related social media products, web-based products, and communication tools. 5 educational events conducted for rangeland owners and managers on vegetation, water, and animal management on rangelands. 21,020 direct and indirect contacts who increased awareness of vegetation, water, and animal management on rangelands. 216 direct contacts who increased knowledge of vegetation management, water management, and animal management on rangelands. 15,500 acres on which rangeland management was improved. 162 range landowners and managers who implemented at least one new range management practice. 14 rangeland stewardship and health related social media products, web-based products, and communication tools.</p>	
<p>3.</p>	<p>Master Gardener Program</p>	<p>Food security continues to be an issue in American’s lives. Food security means access by all people at all times to enough food for an active, healthy life. According to the USDA, an estimated 11.1% of U.S. households were food insecure in 2018, which is an improvement from 11.8% in 2017 and from a peak of 14.9% in 2011. About 56% of food insecure households participated in one or more of the three largest Federal food and nutrition assistance programs, SNAP, WIC and the National School Lunch Program. Research indicates food banks play a major role in reducing food insecurity, particularly when nutrient rich foods such as fresh fruits and vegetables are available to hungry families. Additionally, families who grow their own food are more likely to eat fresh produce than families who do not.</p>	<p>Sustainability, Security and Resilience. Planned Program # 1.</p>

		<p>The WSU Master Gardener volunteers taught food gardening to communities across the state in an effort to close the food security gap and to support the consumption of healthy food.</p> <ul style="list-style-type: none"> • 4300 adults learned about vegetable gardening, growing small fruits and tree fruits • 1500 youth learned about vegetable gardening, growing small fruits and tree fruits. • Volunteers organized and taught in 68 school gardens • Volunteers organize and teach in 91 community and food bank garden that help feed Washington families • 57500 pounds of produce was donated to local food banks. <p>2019 BY THE NUMBERS</p> <ul style="list-style-type: none"> • 4100 certified volunteers serve Washington State communities • 760 new volunteers trained • 333300 volunteer hours served • 48000 continuing education hours earned • 4500 plant and insect diagnostic clinics served 79500 citizens • 3700 residents learned about water quality and water conservation • 4300 residents learned how to grow their own food • 1300 residents learned about pesticide use and safety • 313600 residents received research based gardening and environmental stewardship education. 	
<p>4.</p>	<p>Food Safety and Preservation</p>	<p>According to the USDA, the Colville Reservation and some parts of Okanogan County are a Food Desert, which means residents in the rural communities have to travel more than 10 miles to get safe, affordable, healthy fresh foods (https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas.aspx). When Reservation and County residents do get fresh fruits and vegetables, safely preserving them allows those nutritious foods to be eaten year-round. Another need that is unique to the Colville Reservation and further justifies the need for food safety and food education is the sheer number of traditional, large gatherings</p>	<p>Fostering a Culture of Health. Planned Program # 5.</p>

		<p>that involve food handling, food preparation, serving food and subsequent food storage. On the Colville Reservation, it is a challenge to educate people that the way grandma and great- grandma traditionally handled and preserved food was more out of necessity, rather than safety.</p> <p>The Colville Reservation and Okanogan County borders Grant County, which had 2 deaths associated with botulism poisoning from home-canned vegetables in February 2016 (https://www.khq.com/news/botulism-believed-to-be-cause-of-two-grant-county-deaths/article_4fbf7c2c-f70e-5aa3-b955-38164008e500.html). In 2019, there was a foodborne botulism outbreak in Okanogan County in the town of Tonasket, WA that linked back to home-canned asparagus (https://jfoodprotection.org/doi/pdf/10.4315/0362-028X.JFP-11-128).</p> <p>Workshop participants completed pre/post retrospective evaluations at the completion of workshops. Participants receive one-year post evaluations annually, participants from 2019 will receive theirs in the winter of 2020. Participants who attend multiple workshops in the same program area are also asked to complete qualitative evaluations.</p> <p>Eleven programs were provided both on the Colville Reservation and in Okanogan County in the program area of Food Safety and Food Preservation. These workshops were: <i>Slice, Chop, Package, Preserve and Store Meat and Fish; Foods Preservation 4-H Judges Training; Canning: Back to Basics</i> (2 workshops); <i>Cooking Under Pressure, Electric Pressure Cooker Workshops</i> (6 workshops) and 4-H Foods Preservation Leader Training.</p> <p>In partnership with the Colville Confederated Tribes (CCT) Food Distribution Program and the CCT Area Agency on Aging Program, I produced and distributed 2000 copies of the 2020 Nutrition and Food Sovereignty Calendar. I am an active member of the WSU Extension Food Safety Team, the National Extension Association of Family & Consumer</p>	
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		<p>Sciences (NEAFCS) Organization and the Washington Extension Association of Family & Consumer Sciences (WEAFCS). In 2019, I served my second year as the vice president of WEAFCs and was voted into the president-elect position at the end of the year. I increased my professional skills in food safety by participating in 6 webinars and 2 in-person conferences/trainings.</p> <p>A total of 4 youth and 95 adults participated in my food safety and preservation workshops. 95% of evaluated participants demonstrated an increase in knowledge and skills relative to key learning objectives (knowledge gain). 74% of evaluated participants either applied or plan to apply at least one practice learned from my workshops in the near future (behavior change).</p> <p>The Electric Pressure Cooker Workshops that I offered this year were new workshops for my clients. Because of the workshops being new and the popularity of electric pressure cookers, like the Instant Pot, these workshops had high attendance numbers. My presentations increased participants' desire to purchase and own an electric pressure cooker, as shown by this participant's evaluation: "I do not yet own an electric pressure cooker but was excited to hear about this class to help me decide if I want one. Kayla did an excellent job presenting the benefits and safety features of the different pots. Based on this class, I plan to purchase an electric pressure cooker. Thank you!" When that participant purchases the appliance, they will know how to use it safely and efficiently in their own home. Another benefit of the workshops was increasing participants' confidence with using the new appliance: "Very good presentation. I had read a lot about the use of the Instant Pot, I just didn't have the confidence to do it. I will now, I promise!" For the participants who already owned an electric pressure cooker, many had received them as gifts and hadn't taken them out of the boxes. For those participants, the workshops infused them with a new excitement and determination to use the</p>	
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		<p>appliance. For example, “I’m way more enthusiastic now [about using an electric pressure cooker], great presentation!”</p> <p>The <i>Slice, Chop, Package, Preserve and Store Meat and Fish</i> workshop was another workshop that I created and delivered for the first time in 2019. The presentation was created in response to a high number of food safety questions being asked about our protein foods- beef, game meet, birds and fish. One of the questions on the pre/post retrospective evaluation asked: <i>Do you feel that the information provided today may result in you changing the way you think about food safety with meat and fish in the future?</i> Every participant reported “yes” to this question. When asked to explain their answers, one participant answered, “very informative RE: bacteria and illnesses.” Another participant responded that s/he, “will be [more] aware consciously of handling fish.” Not only did participants learn new knowledge, as shown by the previous quotes, but participants also learned that some of their habits were incorrect. Here’s an example of that, “I didn’t realize about vacuumed packed fish thawing techniques being hazardous.”</p>	
<p>5.</p>	<p>Forestry Youth Success Program</p>	<p>As a county with 90% forested lands, Skamania County Washington provides a unique opportunity for its residents to connect with the beauty and the function of the forest that surrounds them. Many teens in Skamania County are unaware of the role forests play in their region. Additionally, the lack of opportunities that have resulted from economic changes due to a downturn in the local timber industry create a barrier to obtaining the job experience and real world skills these teens need to be successful. At the same time, a multitude of local agencies lack the manpower to complete projects benefiting the health of the Gifford Pinchot National Forest (GPNF) and other county natural assets.</p> <p>Washington State University Extension, Stevenson-Carson Public Schools, and Mt. Adams Institute partner to provide Forest Youth Success. The</p>	<p>Natural Resources. Planned Program # 3, AND 4-H Youth Development. Planned Program # 4.</p>

		<p>primary goals of the program are to provide opportunities for youth development and employment as well as maintain the health of the local forest. The program provides basic job skills in a paid-work setting focused on environmental stewardship.</p> <p>Community members, program participants, and project partners see enormous value in FYS. FYS participants consistently demonstrate growth in every area measured, with 91% (n=11) indicating an increase in their understanding of forest management practices and 100% (n=12) increasing awareness of the types of careers available in natural resource.</p> <p>FYS Crews provided approximately \$112,200 of direct work value in 2019. On average, more than \$100,000 of direct work value is completed in the forest each year, with a total value estimated at well over one million dollars for the Gifford Pinchot National Forest since the program's inception.</p> <p>One community partner said, "This program provides a great opportunity for young adults to contribute to habitat improvement, provide experience working as a team, raise awareness of environmental issues, earn money, and add to their list of activities should they want to apply to a higher level of education"</p> <p>When asked what the main thing they learned this season is, one teen participant answered, "A better outlook on the forest and new jobs, how to better my financial situation, and how to be a leader."</p>	
<p>6.</p>	<p>4-H Robotics Program in Whitman County and the Blue Mountain Region</p>	<p>During the past five to six years, Whitman County 4-H program has offered an active year-round robotics project. Each summer due to a college intern, they have been able to expand the program and conduct summer robotics camps in three communities across the region: Colfax, Pomeroy</p>	<p>4-H Youth Development, Planned Program # 4.</p>

		<p>and Clarkson. Each camp has a maximum capacity of twelve youth. Thirty-six youth participate each summer through the out-reach STEM workshops.</p> <p>2018 Camp Evaluation responses – youth ages 8 – 12 years old</p> <ul style="list-style-type: none"> • 81% of respondents were first time attendees • 53% like to make things/build robots • 83% said building and programming the robot was the most fun • 49% said programming was challenging • 79% want to learn more about STEM • 86% want to attend college • Most want to pursue STEM careers <p>The Whitman County 4-H Robotics camp is supported by Schweitzer Engineering Laboratories, Inc. (SEL). Each year they make a financial contribution to the program. This past year, SEL donated \$8,200. In addition to SEL, they receive support from the McGregor Company, Digilent, Colfax School District, Pullman School District (use of Lincoln Middle School Shop), Haunted Palouse and several other businesses and individuals. In total the 4-H Robotics project raises about \$20K each year.</p> <p>The FRC team does considerable community outreach, service and presentations. They volunteer at the annual Tom’s Turkey Drive, Lentil Festival, Steptoe Food Booth at the fair, Haunted Palouse, STEM night at the elementary schools in Pullman, Sciber Sprouts STEM activity on campus and several other activities.</p> <p>This past year, Janet distributed a 4-H Robotics Graduate survey to past 4-H project members. Results of the survey were:</p> <ul style="list-style-type: none"> • 100% say area of work/study is related to STEM or work with robotics • 83% say participation in 4-H robotics influenced career path/area of study 	
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		<p>“4-H Robotics made me realize I had an aptitude for engineering, and I should go to college to study it.”</p> <p>“I am currently a junior at the University of Washington studying Computer Science. FRC is the direct reason for choosing my major after programming on FRC 4061 for 2 years. I enjoyed working with robotics and engineers, who showed me I don’t have to know every answer, I just need to work hard and learn to work with other people. I learned how to lead a team while also being humble enough to learn from every member in my team. Overall, working with the volunteers and other students was my most valuable experience.”</p> <p>“4-H Robotics is 100% what made me decide to seek the career I am seeking. I had no intention of going into a STEM related field, but because of robotics I learned that not only was it a possibility for me, but I that could excel at it.”</p>	
<p>7.</p>	<p>Age Friendly Housing Research</p>	<p>A multi-agency project led by CED’s Metropolitan Center and Division of Governmental Studies and Services assessed the Puget Sound area’s projected needs for senior housing. The “Moving Toward Age-Friendly Housing in King County” report found that the number of older adult-led households is on track to outpace the supply of accessible and affordable housing in King County. Half of senior households who rent are already cost-burdened, as are 40% of those with a mortgage. Recommended strategies ranged from updating land use policies to allow cottage clusters and accessory dwelling units to increasing funding for home delivery services. They also recommended building senior housing units near established services to provide for</p>	<p>Community and Economic Development. Planned Program # 2</p>

		daily needs, socialization, and transportation.	
8.	University Emergency Management	<p>For eight years WSU Extension (through the CED unit Division of Governmental Studies and Services) has provided Emergency Management services for the University, with an emphasis on the Pullman campus. This unit provides all phases of emergency management: Planning/Training/Exercises, Mitigation & Preparation, Response, and Recovery support for the greater university community and partners. Notable accomplishments have been the finalization of a joint Comprehensive Emergency Management Plan in partnership with the City and County in which the Pullman campus is located, and most recently the development and administration of a full-scale multi-agency disaster response exercise which met the FAA periodic exercise requirements for the Pullman Airport.</p>	Sustainability, Security and Resilience. Planned Program # 1, AND Community and Economic Development. Planned Program # 2.
9.	Community and Economic Development Centers	<p><i>The WSU Extension Community and Economic Development Program Unit faculty and staff partner with local leaders to improve their communities and grow their economies.</i></p> <ul style="list-style-type: none"> • <i>The Division of Governmental Studies and Services (DGSS)</i> engages faculty and students across the university in applied research, technical assistance and training related to public safety, governance and sustainability and digital initiatives, using that unique project experience to address issues throughout the region. • <i>The Metropolitan Center for Applied Research and Extension</i> puts the people’s university to work for Washington’s cities, bringing WSU’s world-class expertise to help inform data-driven decisions and implement change that works. • <i>The William D. Ruckelshaus Center</i> is a unique joint venture of WSU and the University of Washington with a mission to help parties involved in complex public policy challenges in Washington 	Community and Economic Development. Planned Program # 2.

		<i>state and the Pacific Northwest tap university expertise to develop collaborative, durable, and effective solutions.</i>	
10.	Early Learning Nutrition Education	<p>Once a week during the school year, Extension staff in Skagit County picked-up seasonal produce from the local Skagit farm and delivered to the culinary class at the vocational school to create a snack for kids attending early learning sessions. Most of the students in the culinary class had never tasted the vegetables they were about to cook up -kohlrabi, beets, parsnips. To their delight and amazement, they actually liked the end results. The parsnip snaps baked French Fry style, beet salad mixed with crunchy apples and kohlrabi match sticks with a creamy dipping sauce were new taste sensations for these aspiring teen chefs. The staff then picked up the snacks (following food safety protocols) and delivered to the early learning centers. The parents, teachers and children all had a chance to sample the season snacks. A parent shared that her son could hardly wait to eat the rainbow carrots and kale the family planted after trying them at the center. “He asks me every day, ‘Can I eat it yet?’” Since her son has been exposed to extra fruits and vegetables at the center, he’s more interested in learning about fruits and vegetables and eating them, she said. Even the ProStart students were learning. One student said, “Oh wow, this is good” after trying the parsnip fry snack prepared for the preschoolers.</p>	<p>Fostering a Culture of Health. Planned Program # 5, AND 4-H Youth Development. Planned Program # 4.</p>
11.	4-H Tech Changemakers	<p>More than 24 million people living in the U.S., including 19 million living in rural communities, do not have access to broadband internet—an essential service in today’s economy. Washington is no exception. Limited access to broadband internet, combined with the growing need for digital skills, is impacting access to economic opportunities for youth across the nation.</p> <p>That is why WSU Extension is advancing and promoting the 4-H Tech Changemakers program which empowers 4-H members to lead digital skills trainings, teach the value of digital tools, and find technological</p>	<p>4-H Youth Development. Planned Program # 4, AND Sustainability, Security and Resilience. Planned Program # 1.</p>

		solutions to real world problems. With funding from Microsoft through the National 4-H Council and expert leadership, 4-H Tech Changemakers are making a lasting impact on the communities that need it most.	
12.	Broadband Action Teams	Broadband Action Teams (BATs) are critical networks that increase local engagement by helping to provide broadband access to underserved rural communities. Between 2012 and 2014, the Washington State Broadband Office, with funding from NTIA’s State Broadband Initiative, offered more than a dozen grants to form Local Technology Planning Teams (LTPTs). WSU Extension led or played a key role in over half of the LTPTs. Coupling WSU Extension community engagement expertise and lessons learned from the LTPT efforts, the BAT model was developed and is being facilitated in communities across the state.	Sustainability, Security and Resilience. Planned Program # 1, AND Community and Economic Development. Planned Program # 2.
13.	Agricultural Worker Behavioral Health and Suicide Prevention	In 2018, the Washington State legislature passed legislation to address suicide in the agriculture industry, and WSU Skagit County Extension was selected by the Washington State Department of Health to develop a suicide prevention pilot program for farmers and farmworkers. During the initial stage in 2019, program efforts included collaborating with suicide prevention and behavioral health experts, building institutional capacity, such as bilingual English–Spanish material and website creation, and leveraging the Extension platform. We provide a roadmap for other entities looking to create suicide prevention programs.	Fostering a Culture of Health. Planned Program # 5, AND Sustainability, Security and Resilience. Planned Program # 1.
14.	Women in Agriculture	Women face unique challenges growing viable businesses in farming and ranching. They are often not taken as seriously as men when seeking loans and insurance, may feel unwelcome at farm meetings predominantly attended by men, and often need off-farm income which requires working during the day and farming on evenings and weekends. This statewide program for women involved in agriculture provides risk-management and financial management education, as well as guidance in mitigating problems in running their businesses. Truly a multi-disciplinary program with participating faculty from all three WSU Extension units, the 2020 program reached more than 700	Sustainability, Security and Resilience. Planned Program # 1, AND Community and Economic Development. Planned Program # 2.

		<p>women from six states.</p>	
<p>15.</p>	<p>Molecular Plant Science: Plant Productivity in a Dynamic Environment</p>	<p>The productivity and fitness of crop plants are determined by a multitude of factors, which form a network of highly integrated metabolic pathways that enable plants to dynamically respond to challenging environmental conditions. Understanding these factors becomes highly relevant for society in general and for U.S. agriculture in particular due to global climate change and the need for sustaining food production. An indispensable foundation for improving crops is better knowledge of plants’ fundamental mode of action ranging from nutrient/water usage efficiency, resilience against biotic and abiotic stresses, perception and interpretation of signals from the environment and from inside the plants, conversion of sunlight to primary metabolites, and further to valuable secondary metabolites.</p> <p>The overall goal of the Molecular Plant Science (MPS) umbrella project is to advance our understanding of the molecular basis of plant and crop productivity and to describe the mechanisms of how plants survive and thrive in a challenging, changing, and often unpredictable environment. The project addresses five of the six USDA-NIFA challenge areas: Food Security, Climate Variability and Change, Water, Bioenergy, and Food Safety. By focusing on basic aspects of plant biochemistry, physiology, and molecular biology, this project produces the scientific knowledge for laying the foundation for urgently needed advances in crop productivity, quality, and environmental robustness. The umbrella group focuses on five main areas to achieve a holistic understanding of how plants function in dynamic environments: primary metabolism, secondary metabolism, signals and hormones, stress response, and root functions.</p> <p>The MPS Hatch umbrella group made significant progress in the following areas. <i>Primary metabolism:</i> We uncovered a new role of lipids for photosynthetic energy conversion, and for the integral regulation of starch and photosynthesis. <i>Secondary metabolism:</i> We defined the production limits for healthy high-oleic oils for canola while eliminating non-healthy trans fats. Furthermore, we gained novel insights into the control of fatty acid fluxes that allowed the engineering of these fluxes to increase plant oil production. For the first time, the chemical</p>	<p>Sustainability, Security and Resilience. Planned Program # 1</p>

		<p>composition of pantropical whisk fern was determined by MS and NMR spectroscopy. <i>Signals and hormones:</i> We discovered the unique roles for calcium/calmodulin-mediated signaling in launching and fine-tuning plant immune response and we further defined the dual role of ATP as energy equivalent and danger molecule. <i>Stress response:</i> We generated potato plants with enhanced resistance against soilborne pathogens (e.g., nematodes). We developed a novel method of transferring alien genes from wild relatives to crop plants in a targeted and precise manner that can be used to improve stress response in wheat plants. We advanced our research on the specificity of elicitors for activating antifungal responses in pea. Furthermore, we determined the genetic mechanism for the development of vascular pit membrane in grasses and showed that pit membrane thickness positively correlates with drought survival. <i>Root functions:</i> In collaboration with NASA, we investigated whether symbiotic nitrogen fixation can occur in space and whether these plants no longer need to make as much lignin in the absence of gravity. We engineered strains of soil microorganisms to excrete ammonia, and showed that the ammonia is taken up by crop plants. Finally, we uncovered the role of auxin fluxes in shifting root growth from anisotropic to isotropic.</p>	
<p>16.</p>	<p>Effects of Biodegradable Plastic Mulch on Soil Health</p>	<p>Plastic mulches are an important component of many agricultural production systems, ranging from annual horticultural crops to perennial tree fruits systems. While plastic mulches provide multiple benefits, such as weed suppression, increased soil temperatures, and water savings, the drawback is that these mulches have to be removed from the fields after the growing season or at the end of their use. Contamination with soil hinders recycling, so that the mulches must be disposed of in landfills or stockpiled on-farm. Biodegradable plastic mulches, which are designed to degrade to carbon dioxide and biomass in soil, are a promising alternative, alleviating the disposal issues common to conventional plastic mulches. However, it must be demonstrated that the use of biodegradable plastic mulches does not cause harm to the soil ecosystem.</p> <p>A multi-year collaboration between Washington State University and the University of Tennessee was established involving a transdisciplinary team</p>	<p>Sustainability, Security and Resilience. Planned Program # 1</p>

		<p>of scientists, farmers, industry representatives, and non-profit organizations to address the issues of suitability and sustainability of biodegradable plastic mulches for agriculture, with a focus on annual horticultural vegetable production. Our team specifically focused on evaluating the impacts of biodegradable plastic mulches on soil health. Multi-year field trials were established to compare the performance of biodegradable plastic mulches against conventional plastic mulches in terms of impacts on various soil quality parameters.</p> <p>No differences between conventional and biodegradable plastic mulches were observed in terms of physical, chemical, and biological soil quality parameters. Compared to the no-mulch treatment, the soil-biodegradable plastic mulches and conventional polyethylene mulch increased the soil aggregate stability and water infiltration rate by protecting the soil surface from disturbance. Residual soil nutrients under the plastic mulch after harvest were lower than under no-mulch due to increased yield and associated enhanced nutrient uptake. Accordingly, less leaching of nutrients, especially nitrate, was observed under the plastic mulches. Within the four-year period, the soil-biodegradable plastic mulches had overall positive effects on soil and groundwater quality. However, longer studies are needed to ensure long-term sustainability of biodegradable plastic mulches.</p> <p>Use of agricultural plastic films is expected to increase by 59% from 2018 to 2026. This increase will lead to increased waste and associated pollution of agro-ecosystems with conventional plastics. The results from this project demonstrate that biodegradable plastic mulch films can be a valuable alternative to conventional polyethylene mulch films. Although the cost of biodegradable plastic mulch films is about 3 times higher than that of polyethylene mulch films, the long-term environmental benefit of reducing plastic waste may outweigh the higher initial cost.</p>	
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<p>17.</p>	<p>Determining the Future of Polar Bears in a Warming World— Understanding the Occurrence and Cost-benefit of Terrestrial Foraging and the Implications of Increased Land Use</p>	<p>Global warming of several degrees over the next 100 years is expected to dramatically decrease sea ice during the summer and early fall in many parts of the Arctic. This already has resulted in lengthening the ice-free period and forcing polar bears in many areas to spend more time on land than in the past. The consequences of their reduced use of marine habitats and increased use of terrestrial habitats have included declines in polar bear body condition and reproduction, and catastrophic declines in localized bird populations. Some biologists studying polar bears in Western Hudson Bay have suggested that terrestrial foods are available in sufficient quantities to help offset lost ice-based foraging opportunities, whereas others have countered that terrestrial foods are of insufficient quality, quantity, or distribution to ensure the current widespread distribution of polar bears. Both groups of polar bear researchers have concluded that the only way to test the differing projections of the success of polar bears foraging on land is to do the necessary physiological-based research. Thus, our overall goal is to understand factors constraining the efficient use of terrestrial food resources by polar bears. We propose to 1) quantify the contribution of terrestrial foods to the energetic needs of polar bears while on land in the summer and fall in Western Hudson Bay and 2) thereby provide the definitive information necessary to model and better understand the implications of increasing global warming, sea ice loss, and land use on polar bear well-being and population dynamics across the Arctic.</p> <p>Increasing use of land by polar bears during the annual summer sea ice minimum has become a common response across much of the Arctic. We seek to directly quantify the extent and efficiency to which terrestrial, non-anthropogenic foods are used by polar bears to offset access to seals. We will do this by measuring energy expenditure of polar bears while on land with doubly labeled water (DLW), change in body composition with isotopic water dilution, activity and movement rates with GPS/accelerometer collars, and feeding behavior and foods used with camera collars and stable isotopes. If polar bears can efficiently use</p>	<p>Sustainability, Security and Resilience. Planned Program # 1 , AND Natural Resources. Planned Program # 3</p>
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		<p>terrestrial foods as they spend increasing amounts of time in terrestrial environments, both terrestrial and marine food webs will be impacted as they consume more terrestrial foods and fewer marine foods. If we find that polar bears are limited in their use of terrestrial foods, then the persistence of populations across the Arctic that must come on land will be increasingly restricted as warming occurs.</p> <p>We directly quantified the extent and efficiency to which terrestrial, non-anthropogenic foods are used by polar bears to offset access to seals. We measured energy expenditure of polar bears while on land with doubly labeled water (DLW), change in body composition with isotopic water dilution, activity and movement rates with GPS/accelerometer collars, and we determined feeding behavior and foods consumed with camera collars and stable isotopes. Results from our pilot study suggest that polar bears can efficiently use terrestrial foods as they spend increasing amounts of time in terrestrial environments, thereby impacting both terrestrial and marine food webs as they consume more terrestrial foods and fewer marine foods. Results from our pilot study suggest that polar bears are limited in their use of terrestrial foods; therefore, the persistence of Arctic populations that must come on land will be increasingly restricted as warming occurs.</p> <p>The issue of whether polar bear populations remain abundant as global warming continues is the single most important issue facing polar bear management. Polar bears were declared a threatened species in 2008 under the U.S. Endangered Species Act and are listed as vulnerable on the International Union for Conservation of Nature’s (IUCN) Red List of Threatened Species™ because of the rapid loss of Arctic sea ice. Because polar bears have become the iconic species of global warming, answering these questions about their ability to use terrestrial habitats at a fundamental level has very broad implications for the general public, policy makers world-wide, and ecologists studying Arctic food webs. Thus,</p>	
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		<p>this study provides information that is essential to understanding not only the future of polar bear populations, but also a significant part of Arctic food webs in a warming world.</p>	
<p>18.</p>	<p>WSU Health & Wellness Umbrella Project</p>	<p>While the United States spends more on healthcare than any other country in the world, Americans score lower than average on many health indicators when compared to other countries in the Organisation for Economic Co-operation and Development. To improve the health and wellness of all Americans, evidence-based research and outreach is greatly needed. This collaborative research project, conducted by WSU faculty across disciplines, collectively advanced health-related knowledge and scholarship and translated newly gained knowledge through educational and community-based activities. Our overall goals were: (1) Advance and extend the empirical knowledge base of health and wellness through scholarly activities across a wide range of academic disciplines and, (2) Based on research findings, translate knowledge to outreach, educational, and community-based activities to improve the quality of life of individuals, families, and communities.</p> <p>During the project year of 2018-2019, we expanded our knowledge on factors that create barriers or promote family function in rural, low-income families. We identified informal social support, particularly from grandparents, as being critical for survival of low-income mothers with children. Grandparents—especially grandmothers—provide various types of support including financial, material, housing, food, and childcare. Childcare is essential for mothers with limited resources to obtain and maintain their employment. Our research also revealed that one of the most effective health communication strategies targeting rural, low-income mothers is distribution of culturally appropriate messages that were created with the target population, not for them. Our research into the impact of the Affordable Care Act (ACA) on impoverished families in rural areas found that many families generally appreciated the ACA, but the appreciation was not directly related to easier access to healthcare</p>	<p>Fostering a Culture of Health. Planned Program # 5</p>

		<p>and quality care. Most of the families expressed strong distrust toward the healthcare system, healthcare providers, and policymakers. Specifically, the majority felt their insurance status is tenuous, policymakers do not understand the reality of their situation, and healthcare providers do not listen to their concerns. Accordingly, the families’ first action when a family member becomes sick is to reach out to friends and family members for medical information instead of going to a healthcare provider. Research results were shared with a wider audience through peer-reviewed journal publications and conference presentations. In addition, we created teaching materials for undergraduate students, including a series of animations that illustrate the challenges faced by low-income families in rural areas, based on our interview transcripts. In the 2018-2019 project year, we pilot tested the animations in undergraduate classrooms and revised the animations based on student feedback.</p> <p>During the 2018-2019 project year, our findings and research activities were communicated not only to scholarly audiences such as researchers, educators, and practitioners from a wide range of fields (e.g., family studies, health, nutrition, human development, consumer sciences, apparel, textile, and interior design), but also to lawyers, university faculty, government and business personnel, and APS workers. Collectively, our research findings advance social science knowledge in how to promote overall well-being of rural residents, and this knowledge fosters increased health across the United States.</p>	
<p>19.</p>	<p>Crop Improvement and Sustainable Production Systems</p>	<p>This project sought to enhance sustainability and profitability of production systems for important crops in Washington State, the region, and the nation.</p> <p>Participants pursued a collaborative, multidisciplinary strategy that brought together expertise in plant breeding, crop physiology, and the rapidly-advancing areas of genomics, phenomics, and bioinformatics. We applied our combined disciplinary strengths—including genotyping,</p>	<p>Sustainability, Security and Resilience. Planned Program # 1, AND Community and Economic Development. Planned Program # 2.</p>

		<p>quantitative and statistical genetics, bioinformatics, and physiology—toward plant breeding to support diverse crop improvement programs and maximize our impact on cropping systems, farm profitability, rural livelihoods, and food security. This research was complemented by extension activities in outreach and stakeholder engagement associated with apple, blueberry, grape (juice and wine), pear, potato, raspberry, strawberry, sweet cherry, and wheat.</p> <p>We developed data sets and tools to facilitate basic, translational, and applied research associated with cultivar development by using the selection criteria generated by the computing pipeline. The breeders used DNA-informed techniques to select new genetic material and to evaluate disease resistance (e.g., fire blight in apple). We identified new elite selections/cultivars and showed them to growers at field days and industry meetings. The project helped release for production two Soft White Winter Wheat cultivars (“Devote” and “Stingray CL+”); two Hard Red Winter Wheat cultivars (“Scorpio” and “WA8252”); and one Red Raspberry (WSU 2166’). We also developed specific management of selections/cultivars in the different species to optimize water use, pruning, yield, and product quality.</p> <p>Breeders (target audience) had access to a comprehensive breeding information management system that allowed them to fully manage and analyze data from their programs while also connecting to public data and tools for further analysis. Researchers of Rosaceae species (apple, pear, cherry), pea, lentil, chickpea, and fava bean also had access to curated and integrated data and tools to enable their research. In addition, growers (target audience) had tools and strategies to improve yield and fruit quality in different species. The final beneficiary of all these innovations was the consumer (target audience), who had new genetic resources characterized by higher eating quality.</p>	
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		<p>Our studies produced new genetic material (selections/cultivars) and technical information about the agronomical management of the different species for the growers. The combination of these factors resulted in high quality food production for the consumers.</p>	
<p>20.</p>	<p>Reducing the Impact of Pests and Diseases Affecting Washington Agriculture</p>	<p>According to the Northwest Horticultural Council (www.nwhort.org), sweet cherries are produced on 53,000 acres in the Pacific Northwest (PNW). Washington State leads with 40,000 bearing acres, followed by California and Oregon (USDA-NASS). Approximately 50% of planting stock for new orchard establishments comes from Washington nurseries. One of the primary diseases of sweet cherry in Washington is powdery mildew, caused by <i>Podosphaera cerasi</i>. The disease is managed using intensive fungicide programs. Despite these intensive programs, we have noticed an increase in the amount of control failures. This led to our ongoing research on fungicide resistance in cherry powdery mildew. In 2017 and 2018, our laboratory received multiple reports of control failures in several Washington orchards, some of which had received as many as 12 fungicide applications for mildew control. The PNW cherry industry has long depended on various synthetic fungicide classes: FRAC Group 11 (QoI or strobilurin), FRAC Group 3 (DMI or SBI Class-I), FRAC Group 7 (SDHI), and FRAC Group 13 (quinoline, quinoxifen, Quintec). Many of the 2017 control failures occurred in programs that significantly relied on Group 11 fungicides. Given the documentation of widespread resistance of the grapevine powdery mildew pathogen (<i>Erysiphe necator</i>) in Eastern Washington, and the epidemiological similarities between the powdery mildews of grapes and cherries, we suspected a similar scenario in PNW cherries.</p> <p>In 2019 we collected isolates of <i>P. cerasi</i> from orchards in all PNW production regions. These isolates were subjected to a bioassay that included treatment of sweet cherry foliar tissue with fungicides followed by inoculation.</p>	<p>Sustainability, Security and Resilience. Planned Program # 1, AND Community and Economic Development. Planned Program # 2.</p>

		<p>Powdery mildew grew on foliage where either 1) the fungus was insensitive to the fungicide or 2) the compounds were not designed to be used as protective fungicides and therefore not suited for our bioassay (e.g., Polyoxin-D, an eradicated fungicide). An important result was the growth of some isolates of <i>P. cerasi</i> on foliage treated with Group 11 (QoI or strobilurin) fungicides. These results required additional molecular testing, which confirmed the presence of a mutation in <i>P. cerasi</i> that confers resistance to Group 11 fungicides.</p> <p>Several <i>P. cerasi</i> isolates established colonies under laboratory conditions following treatment of foliar tissue with Group 3 (DMI) fungicides, revealing that they were insensitive to these fungicides when used protectively. Molecular analysis correlated well with some fungicide treatment experiments. By comparing different laboratory experiments, we also found that <i>P. cerasi</i> resistance to DMI fungicides is quantitative in nature. This suggests that the pathogen has developed a spectrum of resistance (sensitive, intermediate resistance, and resistant) owing to the nature of fungicide compounds that target complex cellular processes. Our results confirmed that more than half of the <i>P. cerasi</i> isolates representing different production areas had developed various levels of DMI resistance. Given the quantitative nature of the resistance to Group 3 compounds, we do not yet completely understand the nature of cross-resistance within the group. The complete loss of DMIs would be devastating since several straight Group 3 and premix formulations containing Group 3 would become obsolete. Therefore, further research is needed to preserve and protect this important class of fungicides through aggressive resistance management in production areas where complete resistance is not observed.</p> <p>Cherry production in Washington state and the greater PNW is a major economic driver, and the impacts of fungicide resistance in this industry will be profound. It is the mission of our research program to identify</p>	
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2019 Annual Report of Accomplishments and Results (AREERA)

		fungicide resistance across sites-of-action and to develop new management programs for areas where resistance is a problem.	
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