2015 Washington State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

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 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 in order to enhance their quality of life and to evaluate both short and long term consequences of potential 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 the world to address primary and timely issues in ways that lead to economic development as well as personal, family, and environmental wellbeing. The synergy provided by connecting the problem-solving skills of the research community with the Extension experience gained from working with individuals who sometimes represent different perspectives can be quite powerful and can support valuable contributions to our citizens and society. The WSU ARC and WSU Extension have many natural and structural links. All Washington State University faculty members have responsibilities that include both research and outreach, with many having formal joint appointments. The focus of our joint efforts is to provide for the primary needs of the people of Washington State. As part of this core mission, the ARC has made significant commitments to focus on ten high priority research areas that advance our land-grant mission in discovery and development research. These research areas are (1) advanced molecular plant and animal sciences, (2) animal health, (3) energy-biofuels, (4) food security, safety, quality, and processing, (5) health and wellness, (6) economics, sustainability, and development, (7) plant breeding, (8) conventional and organic production systems, (9) natural resources, and (10) water. And, while significant components of our Extension programs are aligned with the ARC research base, Extension also delivers significant outreach related to natural resource stewardship; food safety; health and wellness; youth and family development; governance and community economic development. The efforts of ARC and Extension are not the only parts of WSU that work to reach these goals, but they are a committed element of a broader set of programs that reside in the many WSU colleges and interdisciplinary centers, including the College of Agricultural, Human and Natural Resource Sciences (CAHNRS); the Voiland College of Engineering and Architecture; the College of Arts and Sciences; the College of Pharmacy; the College of Veterinary Medicine; the Center for Environmental Research, Education and Outreach; and the three outreach centers of the Community and Economic Development program unit: the William D. Ruckelshaus Center (a joint program with the University of Washington), the Division of Governmental Studies and Services, and the new Metropolitan Center for Applied Research and Extension. Additionally, through close partnerships and collaborative agreements, our Extension faculty also extends the research conducted by faculty at other regional centers of expertise, including the University of Washington, Oregon State University, and the University of Idaho. For these and other reasons, we believe the Combined Research

and Extension Annual Report is fundamental to understanding how we make our contributions.
The state of Washington is beautiful, rich in natural resources, and has a highly diverse topography and climate. This diversity is also reflected in our people, communities, industries, and our significant natural resources. For a number of reasons, our agricultural systems are among the most diverse in the nation and the state produces over 300 different crops that are sold domestically or exported, largely to countries in the Pacific Rim. Washington is especially known for its apples, pears, sweet cherries, wheat, potatoes, beef, milk and milk products, and it produces a major share of many specialty crops, like small fruits (e.g. grapes, berries), seeds (e.g., vegetables, alfalfa), pulse legumes, hops, and mint. Most of the state's farm and ranch lands are in Central and Eastern Washington but most of the state's population is located in a coastal zone on the west side of the Cascade Mountains in a corridor that stretches from the Canadian border south to Vancouver, Washington and the Oregon border. Western Washington is characterized by an expanding urban population, which values environmental quality and supports local food systems. As a consequence of the dense population in an area with good agricultural conditions, including a moderate climate, rich alluvial soils, and abundant rainfall, this region of Washington is home to a small but extraordinarily diverse agriculture that focuses on high value production. Eastern Washington is characterized by larger farming operations, especially in the cultivation of wheat, potatoes, legumes, and orchard crops. Our forested lands are in coastal regions, the Cascade Range, and in northwestern and southwestern Washington and they contribute significantly to the state's economy and overall quality of life through economic and recreational opportunities. Washington is also home to two great rivers, the Columbia and the Snake, which provide transportation, electrical power, irrigation, and important fish and wildlife habitat. Other river systems, coastal regions, and the Puget Sound support abundant yet fragile aquatic and marine ecosystems and provide a rich mosaic unique to the Pacific Northwest.
The diversity of Washington doesn't end with its physical features as the state also has continually evolving demographic dynamics, which influence the cultural and political milieu. The state has a significant Native American population with 29 Federally-recognized tribes. There has been almost a tripling of the Hispanic population in the last twenty years, especially in the central and south-central counties, and a virtual doubling of Asian populations in Western Washington during the same period of time. Adding to this overall cultural diversity are the large refugee populations that now call Washington State home; the Seattle metro area is the 5th most popular resettlement area for refugees nationally. Washington now ranks second in the nation for bilingual and migrant education programs at the K-12 level. While this diversity is enriching the tapestry of the state by bringing a multitude of new cultures, foods, and arts, these demographic shifts also strain social services and challenge educational delivery systems. The health and wellness of our youth are also at risk with over 25% of our adult population categorized as obese and almost 30% of our youth categorized as overweight or obese. Our rural communities are struggling with increased poverty and with differential access to technology, health services, and educational opportunities. In such a diverse cultural and environmental landscape, research, technology transfer, and outreach are challenging but essential.
The agricultural industry is a constantly shifting tableau. Weather variability and climate change have had significant impacts on water availability and facilitate migration of new plant and animal diseases and pests into the state. New varieties of crops, both domestically and internationally developed, compete for market share but also provide our growers with new opportunities; constant changes in disease and pest pressure, input costs, and per bushel prices affect how we grow our crops and what we incorporate into our crop rotations; agriculture labor supplies affect the timing and cost of our fruit harvests; and, as importantly, changes in consumer demand and governmental policy shape, and may even dictate, direction. The dynamics of our communities change as the result of changing demographics, changes in transportation, communication, educational and health care opportunities, and the availability and stability of employment locally. As we examine how to adapt to these changes and challenges, we provide the expertise that allow us to take advantage of all potential opportunities. Examples of relatively newly created opportunities include the possibility of growing and processing industrial hemp for oil and fiber, a burgeoning Washington State viticulture and enology enterprise, and the increasing importance of niche legumes in crop rotations. Washington has the second largest wine industry in the United States but there are issues related to local climate, soil, and pest management that need to be resolved in order to exploit

the potential of this crop. The partnership that has developed between the research, Extension, and industry components of the viticulture and enology universe are truly outstanding and a model for future endeavors. Our commercial tree fruit industry has funded several endowed faculty positions that will continue to keep us at the cutting edge of research. We also continue to explore avenues where we have traditionally been a world leader. We have many researchers involved in breeding programs to adapt crops such as wheat and tree fruits to drought and high temperature conditions.

There are also many other challenges to Washington State that impact our citizens. Our natural resources are at risk from land conversion, wildfires, and pollution. Last year in Washington State saw some of the worst wildfires in our state's history. Our faculty in research and extension were mobilized to provide information and support in this critical time. Counties across the state experience severe and emergency drought conditions. This had severe negative impacts on all aspects of life for our citizens but was especially impactful for agriculture. Another issue that is rising to the forefront are pollutants in our environment that are serious concerns for the safety and health of our water systems. Our Washington Stormwater Center was created in 2009 by House Bill 2222 and it is a technical resource center in partnership with the University of Washington and the Washington Department of Ecology to provide tools for storm water management. We are also partners in the State of Washington Water Research Center (it is directed by our faculty) which conducts research on water, fosters education of future water professionals, and serves as a nexus for the academic community, water resource managers, and water stakeholders. As a result of studies on water management for multiple uses, our economists are critically examining current and future water use for urban development, crop production, fisheries, and recreation. Now more than ever it is necessary to develop new ways to meet the demands of climate change and an increasing population.

Our role in dealing with these issues continues to be in both basic discovery research and highly translational applied research that provides information and assistance to our constituents. We use cutting edge technology to develop new processes and solutions and provide this information to our stakeholders. We have strategically prioritized hiring and strengthening research programs in the areas of plant biotechnology and genomics and are leading the nation in several efforts to apply these areas of expertise to issues like cropping systems research and cultivar development for specialty markets. Our biological systems engineers are working on precision systems for delivering water and fertilizer at appropriate times for efficient crop yield and resource management and on remote monitoring to close the loop and measure local effects on a large scale. Our integrated pest management programs are developing genomics as well as management techniques to minimize traditional chemical pesticide use while effectively managing pests across a broad variety of agricultural crops and urban environments. And our energy extension programs are pioneers in areas like building technology and plant operations efficiency.

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. External funding awards to Research and Extension has been uneven over the past several years were $91 million in 2012; $80 million in 2013; and $85 million in 2014, and $81 million in 2015. The Northwest Advanced Renewables Alliance is an important example of a partnership led by WSU with 15 partners ranging from private companies to public research institutions with over 50 principal investigators. This WSU-led consortium is in its 5th year and was a $40 million dollar award. This grant is providing transformational research to make a sustainable aviation biofuels industry a reality. Not included in these figures is future endowment income anticipated as a result of activities of organizations that benefit from and support WSU research and Extension. The largest gift to Washington State University overall is still the Washington Tree Fruit Commission, which approved check-off increases worth an estimated $32 million over the 8 years of the increased assessment for support of apple, cherry and pear research and extension. Other support is available from organizations like the Washington Grain Alliance (which donated over $5 million dollars to build a new grains greenhouse), the Washington Potato Commission, the Washington Hops Commission and the Washington Wine Commission (which donated funding for the new 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.

There are some difficulties in reporting the information about our combined Research and Extension activities through the rubric that is imposed by the reporting structure. One obvious concern is in assigning "credit" to one area when an activity fits partially in more than one area. The two benchmark numbers that are especially affected by this are publications and graduate students. For publications, we have assigned equal "credit" to two Planned Programs when this seemed appropriate. Thus the number of refereed journal article publications reported in a Planned Program might be lower than the number of actual publications making a significant contribution to the area of the planned program. Under state-defined outcomes, we have separately counted refereed Extension publications. For the graduate students, we asked their major department to indicate whether individual students had a significant part of their studies focused on the Planned Program and, when appropriate, allowed them to assign effort to multiple programs to the nearest tenth. The number associated with a Planned Program represents graduate student Full Time Equivalency and a larger number of students may have had partial effort in this Planned Program. For the expenditures in a Planned Program, we asked the administrator with responsibility for each Hatch project to classify the project to Planned Program, and then proportionately allocated total expenditures in this project to the Programs. Individual administrators were given the option of assigning some of the project to "other," to represent an effort that did not fit into the classification scheme, but the dollar amount associated with this choice was small.
There are numerous societal challenges that can be addressed by cutting-edge research and through the application of that research to the practical issues that drive production. Every year we assess and evaluate our research portfolio in order to strategically prioritize our efforts to ensure the greatest impact is derived from both our research and extension programs. As a result, we are able to continue to deliver important outcomes including economic benefits to agricultural and natural resource-based industries, 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, food insecurity, and obesity. Finally, our programs help ensure that the beauty of the state and its natural resources are sustained for future generations. This annual report endeavors to summarize the inputs, outputs, and impacts of our work conducted during the year.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	500.0	0.0	440.0	0.0
Actual	494.0	0.0	656.0	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External University Panel
- External Non-University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel

- Expert Peer Review

2. Brief Explanation

Merit evaluation takes place at several levels. Prioritization for specific programs is manifested by allocations of effort and limited funds. Support for research projects generally begins with discussions between stakeholders, administrators, and researchers. Agricultural Research Center (ARC) project proposals that address these high priority areas are then written by individual faculty members or by faculty teams. These proposals are submitted to the chair of an appropriate academic department, who reviews the proposal, and ascertains that the topic of the research is consistent with the previous discussions. If so, the project proposal is circulated for peer review to internal and/or external reviewers. These reviewers are asked whether the research represents solid science, is directed to topics of current need, will advance the field of study, and whether the research plan is appropriate. Reviewers are asked to offer written suggestions for improvement and to identify the strongest and weakest points of the proposal. After comments are received from the reviewers, the chair assembles the commentary and discusses it with the faculty member who proposed the project. If necessary, the faculty member then revises the project proposal. After examining these changes, the chair submits the project proposal to the ARC where it is proposal is sent to USDA and reviewed by the appropriate National Program Leader. When approval is final, the approved project is entered into our database and into the REEPort system. We also use this system by entering our state projects as a way of tracking most projects that are funded by external funds to track the majority of our research activity in one database. In addition to review of individual projects prior to their establishment, the programs are evaluated on a yearly basis and are reviewed in the context of university and college planning and evaluation priorities. In parallel, proposals for funding that may overlap these projects may be submitted to federal or state agencies or to commodity commissions. As appropriate, we also use the NIFA system that arranges for expert external review teams to examine specific departments or activities.
Individual WSU Extension 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. Extension faculty members are reviewed annually on a set of performance expectations related to the grand challenges recently articulated in the University and College strategic plans. These 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 database called WORQS (WSU Online Reporting and Query System), which can be accessed quickly at any time during the year that the information is needed. The progress of Extension faculty member's work is reviewed by Program Directors, Department Chairs, Associate Deans and the Dean as an integral part of the annual performance review process. WSU Extension 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.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups

- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey specifically with non-traditional groups
- Survey specifically with non-traditional individuals
- Survey of selected individuals from the general public

Brief explanation.

Washington State University has a long and close relationship with its many stakeholders. Not only do we maintain relationships with the local stakeholders through our WSU Extension network of county offices, but we also have established large Research and Extension Centers (R&E Centers) at several locations throughout the state, which are not just farms or research sites but have significant permanently based Research and Extension faculty and staff. They are also centers for graduate student training. Thus, we are able to interact with our primary stakeholders on a daily basis and they develop both personal and professional relationships between those stakeholders and WSU personnel. Major R&E Centers are located in Pullman, Prosser, Wenatchee, Mt. Vernon, and Puyallup. Additionally, many stakeholder groups have research and administrative personnel that have interacted with WSU for a number of years.
In many instances, commodity commissioners or commodity research directors have been appointed as adjunct faculty in appropriate academic units. The agricultural community of Washington is heavily populated with former WSU students who are proud to claim that experience as part of their identity. Stakeholders in Washington have long recognized WSU as a major asset for their industries and activities and are often very forthcoming with suggestions and critiques. Our stakeholders are familiar with our web pages and our phone numbers and are not reluctant to give both formal and informal input to the administrators and scientists in the ARC and WSU Extension and even to contact public officials in their areas to offer suggestions. We make use of all information avenues to connect with the broadest array of stakeholders.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

Many Departments within the College of Agricultural, Human, and Natural Resource Sciences have an advisory board, and there are groups that advise the CAHNRS, ARC and Extension administrations. These advisory councils and committees are kept abreast of activities within their respective units through newsletters, telephone calls, emails, social media, blogs, and direct

meetings. These advisory groups meet at regular intervals both as a unit and with their primary departments. During these meetings, they are briefed about new initiatives, on-going work, and issues related to Research and Extension.
There is a College level advisory committee as well as a smaller college-level food and agricultural council. Both of these interact with the Dean, the ARC Director, the Director of Extension, and other Associate Deans in helping to define priorities, identify emerging research issues, and provide feedback on the quality and relevance of our research and extension activities. Individuals who serve on these advisory panels represent specific knowledge about target audience needs or about specific subject matter that will help advance program design, delivery, and impacts. These individuals are contacted directly by an appropriate person (County Director, Program Director, Associate Dean, Dean, etc.) to invite their participation, often after previous peer contact. Finally, web content delivery and web conferencing is being increasingly used to both communicate

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

Brief explanation.

We prepare and distribute WSU project-related information through our Marketing and Information personnel. While electronic media (email, websites, social media and blogs) are used to solicit information we also recognize that some individuals do not have access to these media, so more traditional approaches are also used. These latter methods include the use of radio, direct mail, telephone contacts, and personal visits, including Spanish language radio (especially in Hispanic communities), local access television, newspapers (English and other languages), newsletters, posted announcements in high volume areas (often in multiple languages), group meetings, and targeted direct mail. As indicated by the target audience or solicitation, we develop materials that are both culturally sensitive and are designed to engage a variety of stakeholder groups and populations. For example, multiple language materials are produced for the nutrition education program. Electronic surveys are increasingly used to capture rapid feedback from program participants, advisors, and the general public. These are generally conducted via media such as Qualtrics.
The use of survey tools allow for rapid assessment which are often critical in the development of projects with short timelines as is often the case when responding to federal, state, and foundation calls for grant proposals or contributing to the analysis of initiatives.
WSU Extension continues to adapt its web capabilities to enabled greater ease of use and access to information. Web conferencing is generally delivered via Zoom, Adobe Connect or Skype. This

allows ARC scientists and Extension educators to communicate broadly with dispersed groups and simultaneously collect feedback from these audiences through online chats and polls.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

Feedback from stakeholders is an extremely important aspect of these events and is especially important in developing new initiatives and outreach programs. One major mechanism of interaction is through various State commodity commissions, which support research and extension at WSU through competitive processes that tend to be biased toward projects that address relatively immediate problems. In addition to researchers, the ARC Director and the Director of Extension or their representative is often present at these sessions to help the groups understand the context of the WSU activity and to get their input into the strategic planning done at WSU related to their industry.

Brief Explanation of what you learned from your Stakeholders

In 2015, the ARC and Extension initiated a new Food and Agricultural Advisory Council. This group is composed of key stakeholders in our agricultural industries and will advise our ARC Director and Director of Extension on areas of focus for research and development and extension. Also in 2015 we had the grand opening of our Grains Greenhouse Complex. This facility was built with funding from our stakeholder partners, the first phase in 1997 and the second phase in 2016. Our partners on this long-term project are the USDA-ARS, the USA Pea and Lentil Council, the Washington Grain Commission, and royalties from WSU grain varieties. This event was attended by all of our key stakeholders, including the President of WSU, and Cathy McMorris Rodgers, our Washington State 5th district representative to the U.S. House of Representatives. Another important event for our research and extension was the grand opening of the new St. Michelle WSU Wine Science Center at the WSU Tri-Cities campus. This state of the art facility was built in partnership with the Washington Wine Advisory Committee, leaders of the Washington State wine and viticulture industry, the Washington Association of Grape Growers, and the Washington State Wine Commission. Finally, we interact very closely with our partners in commercialization activities. Key examples include our work with the Tree Fruit Licensing committee who advise us on commercialization of tree fruit varieties produced by the WSU breeding program. We also worked closely with the Cultivar Release committee which works with us on the release of WSU grain varieties produced by the WSU grains breeding programs.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
4395847	0	4748988	0

Institution Name: Washington State University

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	4539051	0	4278178	0
Actual Matching	4539051	0	4278178	0
Actual All Other	51202184	0	35462824	0
Total Actual Expended	60280286	0	44019180	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Natural Resources Stewardship

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
111	Conservation and Efficient Use of Water	10%		5%	
112	Watershed Protection and Management	10%		5%	
121	Management of Range Resources	8%		5%	
122	Management and Control of Forest and Range Fires	10%		10%	
123	Management and Sustainability of Forest Resources	10%		10%	
124	Urban Forestry	5%		5%	
125	Agroforestry	3%		3%	
133	Pollution Prevention and Mitigation	10%		5%	
135	Aquatic and Terrestrial Wildlife	10%		15%	
136	Conservation of Biological Diversity	0%		5%	
213	Weeds Affecting Plants	5%		5%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	2%		2%	
215	Biological Control of Pests Affecting Plants	5%		12%	
302	Nutrient Utilization in Animals	0%		3%	
403	Waste Disposal, Recycling, and Reuse	5%		5%	
605	Natural Resource and Environmental Economics	2%		5%	
610	Domestic Policy Analysis	5%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	75.0	0.0	25.0	0.0
Actual Paid	76.0	0.0	47.0	0.0

Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
861854	0	243671	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
861854	0	243671	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
6794629	0	3128104	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

WSU scientists will conduct research leading to better understanding of the interaction between human development and terrestrial, aquatic, and atmospheric conditions; genetically improve poplar and black cottonwood species to more effectively sequester carbon, restore riparian areas, and provide wood and fuel using sustainable production practices; develop innovative mechanisms for revegetating mining sites, watersheds, and native prairies; and understand habitat requirements of key species. Extension educators will work with researchers and local communities to develop customized, science- based solutions to local problems and to educate target audiences about new tools to more effectively manage natural resources. This education will in turn lead to behavior change and ultimately to improved condition of the natural resource base in Washington State.
Extension educators will work with researchers and local communities to develop customized, science-based solutions to local problems and to educate target audiences about new tools to more effectively manage natural resources. This education will in turn lead to behavior change and ultimately to an improved condition of the natural resource base in Washington State.

2. Brief description of the target audience

The target audiences include landowners and managers; state, federal, and local natural resource agency personnel; K-12 educators, local and state governments; and the general public, including the scientific disciplines that relate to these issues.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	283122	512154	27730	34963

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	33	44	77

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of extension workshops, demonstrations, field days, and conferences that focus on stewardship of natural resources and environmental protection.

Year	Actual
2015	822

Output #2

Output Measure

- Number of peer-reviewed (official) WSU Extension publications produced on natural resource stewardship topics.

Year	Actual
2015	33

Output #3

Output Measure

- Number of graduate students with a significant professional orientation in the area of Natural Resources stewardship.

Year	Actual
2015	40

Output #4

Output Measure

- The number of WSU Master Gardeners trained during the year to address environmental concerns and natural resource stewardship.

Year	Actual
2015	3649

Output #5

Output Measure

- The number of individuals trained in the safe and proper use of pesticides.

Year	Actual
2015	11045

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of program participants who enhanced their knowledge of natural resource management, environmental protection, water quality, and efficient water use
2	Percentage of participants evaluated who applied their newly acquired information to conserve and use water more efficiently.
3	Number of acres of rangelands and forests receiving application of sustainable management practices as a result of WSU programs or program partnerships.
4	Percentage of pesticide training participants who applied the training received in pesticide safety and proper use.
5	Percentage of participants who applied recommended practices and strategies to protect water quality.

Outcome #1

1. Outcome Measures

Percentage of program participants who enhanced their knowledge of natural resource management, environmental protection, water quality, and efficient water use

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	95

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington?s rivers, lakes and groundwater sources provide water for agricultural, residential and recreational use in addition to providing wildlife habitat. Puget Sound has been rated as unhealthy. Multiple species of salmon are listed as endangered. Runoff from roads, parking lots and rooftops contribute to the decline in water quality in streams, lakes, Puget Sound, and potentially aquifers. Improper pesticide and fertilizer applications; inefficient irrigation systems and water use; and the selection of poorly adapted plants to local climates are major issues. Conversion of private forestlands for urban development continued with little regard for wildlife, water quality and climate change.

What has been done
Water quality education, including proper pesticide use, proper fertilizer use, and integrated pest management are core components of the Master Gardener program. Newer volunteer-based programs, included Rain Gardener Mentors, Stream Stewards, Native Plant Advisors, and Extension Livestock Advisors, taught residents how to improve water quality through workshops focused on changing their behaviors to improve water quality, install rain gardens, and maintain a buffer in riparian areas. The Shore Stewards program teaches shoreline landowners about best management practices to improve water quality. Workshops were held to assist landowners on rain garden installation, fencing to improve grazing management and livestock exclusion, integrated pest management to reduce the use of pesticides, and proper fertilizer applications to reduce nutrient contamination in water. Low impact development certification workshops were held to present the newest methods of green infrastructure to planners, engineers, and agency personnel. A new website: Gardening in Washington State: (http://gardening.wsu.edu/) was developed by a team of faculty and program coordinators to provide relevant and updated information to the public. Master Gardener programs at the county level were updated to provide a greater focus on environmental stewardship. An updated Shore Stewards manual was released

and Shore Stewards TV was introduced (http://ext100.wsu.edu/jefferson/nrs/shorestewards/. An updated WSU Rain Garden website and an updated 12,000 Rain Gardens website, in collaboration with a regional nonprofit, were completed (http://www.stewardshippartners.org/programs/rain-gardens/.

Results

Program volunteers, home gardeners, ranchers, crop producers and environmental agency representatives are gaining a greater understanding of natural resources, stewardship of resources, and protection of water quality. A multi-agency, WSU-led effort continues to make progress toward 12,000 rain gardens in the Puget Sound region by 2017. Research and outreach from the WSU led Washington Stormwater Center continues to develop insight and new approaches to green infrastructure. Based on local research, stormwater standards continued to be modified in Western Washington. The City of Puyallup, a local project partner, installed one city block of pervious concrete for streets and sidewalks with a five-lane pervious pavement road is under construction in the south part of the city. WSU developed a new riparian grazing tool that was taught to ranchers and adopted by the WA Department of Ecology as a best management practice. Conservation District personnel have also been trained to use this tool with clientele for grazing planning. These tools have led to better relationships between ranchers and regulators. Ranchers find economic, workable solutions to maintaining water quality while regulators find softer approaches to meeting the spirit of state and federal regulations. Removal of culverts and dams continued to open traditional areas for fish migration and improved year round flow of streams.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
124	Urban Forestry
125	Agroforestry
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
213	Weeds Affecting Plants
214	Vertebrates, Mollusks, and Other Pests Affecting Plants
215	Biological Control of Pests Affecting Plants
302	Nutrient Utilization in Animals
403	Waste Disposal, Recycling, and Reuse
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #2

1. Outcome Measures

Percentage of participants evaluated who applied their newly acquired information to conserve and use water more efficiently.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	88

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The demand for water continued to increase as the population and industry expand. Changing weather patterns, increased drought, and modified stream flows to accommodate migrating fish have compounded this problem. 2016 was one of the hottest and driest years on record for the state. To provide adequate water for lawns, gardens, agriculture and natural resource uses, residents must learn about and implement water saving strategies.

What has been done
Fields days, workshops, demonstration gardens, applied research, fact sheets and web sites were used to teach and demonstrate water conservation methods. 123 outreach events were conducted across the state. 158 Master Gardeners throughout the Puget Sound region were trained as Rain Garden mentors. These educational opportunities demonstrated water conserving garden practices such as mulching, efficient irrigation, planting drought tolerant plants and xeriscaping are the most cost effective and environmentally sound ways to reduce the demand for our limited water supplies. Rain Garden mentors and demonstration sites demonstrated proper stormwater handling and use of gray water for landscape sustainability. A regional water quality specialist led the WSU Extension Water Quality Team. This included program implementation based on an extensive needs assessment and further development of the website (http://ext100.wsu.edu/water/). It also served as the clearinghouse for drought resources at: http://ext100.wsu.edu/water/2015-drought-2/.

Results
3,649 Master Gardeners in turn taught 5,886 residents how to conserve water and protect water quality. Another 2,350 residents and landscape maintenance personnel and groundskeepers learned how to conserve water and protect water quality. One county held a second micro-irrigation workshop, including irrigation demonstrations and video production. Over 95% of

program participants learned new information about water use and management. Selective follow-up evaluations showed that over 75% of program participants used one or more water conserving methods, including mulches they produced through home composting, using highly efficient irrigation methods, especially drip hoses, and adjusting watering times to take advantage of precipitation and reducing evapotranspiration.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
133	Pollution Prevention and Mitigation

Outcome #3

1. Outcome Measures

Number of acres of rangelands and forests receiving application of sustainable management practices as a result of WSU programs or program partnerships.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	143554

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington has 215,000 people that control 5.8 million acres of forestland, making this the largest rural land use group in the state. The majority of landowners lack the knowledge and skill to properly manage their forest nor do they have a written management plan to provide the biological and physical information necessary to make sound decisions to execute best management practices. Much of this land is at risk due to land-use conversion, landscape fragmentation, poor health, degraded habitat, invasive species, and wildfire.

What has been done
154 forestry events were held, including eight eight-week Coach Forest Stewardship workshop series (138 families) and two major regional field days attended by 1,254 people. Five social media sites and three comprehensive websites were maintained. Approximately 70,359 direct

contacts were made to assist clients through various means. Forestry specialists collaborated with personnel from other natural resource agencies to address the aftermath and recovery from several large wildfire complexes in North Central and Northeastern Washington, the largest wildfires in state history. This is the second consecutive year of record setting wildfires in the state. Five public meetings were held to help landowners and communities understand what is to be expected post-fire, and at the same time improving landowner knowledge regarding the products and services that could assist them to successfully restore their property, to accomplish their land-use needs, and prepare for future wildfires. A workshop attended by 210 absentee forestland owners also discussed wildfire preparation and prevention. These forestland owners typically live in urban western Washington but own land in rural eastern Washington where they would typically never attend an outreach event.

Results

Follow-up evaluations indicate that over 90 percent, or 4,744 people have executed at least two new management practices. In terms of fire risk reduction cost savings alone, this translates to a minimum of $51 million saved by public and private entities, were this land to burn in a wildfire. As a result of the Coached Forest Stewardship classes, 92 Forest Stewardship Plans were prepared. This course includes a one-on-one site visit with a professional forester or wildlife biologist, and landowners stated that this was the most important form of assistance they have ever received. There were 93,000 indirect contacts made with clients via 12 e-newsletters, three email list serves, and direct mailings promoting programs. An estimated 83,700 of these clients benefited from increased awareness of the information. Additionally, 64,753 web clients actively sought information from our statewide website http://forestry.wsu.edu, which contains contact information for educators, downloadable publications, streaming videos for online viewing, resource directories, on-line new letters, and a calendar of events. Forestry faculty were instrumental in helping landowners recover from wildfire, including determining salvageable timber, selecting a knowledgeable consulting forester, selecting a proper grass seeding mix, and determining when to plant. Plans were coordinated with other agencies on management of noxious weeds.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
124	Urban Forestry
125	Agroforestry
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
213	Weeds Affecting Plants
214	Vertebrates, Mollusks, and Other Pests Affecting Plants
215	Biological Control of Pests Affecting Plants
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #4

1. Outcome Measures

Percentage of pesticide training participants who applied the training received in pesticide safety and proper use.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	86

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pesticide use in commercial agriculture, the home garden and around the home is controversial. Improper use can result in crop and ornamental plant damage, illegal pesticide residues, contamination of water, human and animal poisonings, and unintentional death to pollinators, primarily honeybees and bumblebees. The spread of invasive species, including Asian Gypsy Moth, Spotted Wing Drosophila and Brown Marmorated Stink Bug, have resulted in increased monitoring of insects, outreach, and strategies for control. Although neonicotinoid insecticides have been very effective in the control of a wide range of insects, controversy remains on their direct effects on honeybee health.

What has been done
Incorporation of safe pesticide use in core Master Gardener training; introduction of integrated pest management concepts, including biological weed control; major revisions to the PestSense (http://pestsense.cahnrs.wsu.edu/Home/PestsenseHome.aspx) and HortSense (http://hortsense.cahnrs.wsu.edu/Home/HortsenseHome.aspxprograms) websites;
pesticide pre-training and pesticide recertification classes; online pesticide recertification modules; classes on the safe use of pesticides in demonstration gardens. 3,898 residents learned about integrated pest management as a proven system for managing pests in a way that keeps pest damage to a tolerable level for plant health and minimizes threats to non-target animal and plant species, as well as the environment. A new video: Pollination and Protecting Pollinators (https://vimeo.com/146957716) is an outstanding resource for everyone. It has been accessed 2,000 times in less than four months.

Results
Pesticide use on many lands was significantly reduced through the use of biocontrol insects. Land managers released over $267,500 worth of biocontrol agents on 2,675 acres. A multi-year,

comprehensive program impact survey determined the cumulative impacts of the Integrated Weed Control Program. A total of 103 federal, state, county, city, and tribal representatives were invited to participate, and 86 completed the survey, an 83 percent response rate. Respondents reported that 99 percent had learned new information from presentations and 69 percent had made changes. 51% of the attendees indicated their use of biocontrol had increased. Among respondents who use our educational materials, 55% attributed an increase in awareness about the species and 58% agreed or strongly agreed that the educational materials helped them reach a new audience. Herbicide product information and volume estimates provided by those who reported herbicide reductions indicated a savings of $16,600. However, this value does not include the cost of application and is only a small portion of the true reduction. The cost to control the same weed populations using herbicides would be over $1.89 million. Twenty-five percent of respondents noted that the use of biocontrol resulted in decreased use of pesticides. Participants in the pre-license pesticide training have a 99% test passing rate on their pesticide applicator exams. Over 98% of participants in the pesticide recertification training obtained new knowledge and applied this information to their job, business, or consulting practice. Gardeners reported the implementation of simple practices as a way of controlling weeds or insects, including; over 65% used mulches to reduce weed germination; 86% pulled weeds instead of using an herbicide; 92% reported using at least one integrated pest management technique instead of using a pesticide.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
213	Weeds Affecting Plants
214	Vertebrates, Mollusks, and Other Pests Affecting Plants
215	Biological Control of Pests Affecting Plants

Outcome #5

1. Outcome Measures

Percentage of participants who applied recommended practices and strategies to protect water quality.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	95

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rivers, lakes and groundwater sources provide water for agricultural, residential and recreational uses and wildlife habitat. Safe, reliable sources of water must be maintained to meet the needs of our growing population. Water-conserving garden practices, such as mulching, efficient irrigation, planting drought tolerant plants and xeriscaping are the most cost effective and environmentally sound ways to reduce the demand for our limited water supplies. Stormwater has been linked to pollution of drinking water supplies and declining health of wildlife and fish species and has been identified as the number one cause of pollution in the Puget Sound region. Urban gardening best management practices to protect water quality include reducing the use of pesticides and fertilizers, composting, mulching and using groundcovers to reduce erosion, grass cycling and planting rain gardens.

What has been done

New Master Gardener training; Rain Garden Mentor training; Stream Steward training; Beach Watcher training, Master Gardener continuing education classes; e-newsletters; websites; demonstration gardens; plant clinics; online forums; webinars; fact sheets; online modules; Rain Garden installation clinics; Natural Yard Care workshops; sustainable gardening workshops; integrated pest management workshops and livestock grazing in riparian zone; hiring a new LID Stormwater Management specialist that will start August 1, 2015; further development of the Washington Stormwater Center to increase its outreach capabilities.

Results

New Master Gardener trainees passed certifications on core competencies, including integrated pest management, pesticide use and efficient water use in the home garden. Rain Garden Mentors were trained and extending outreach to homeowners. Over 1967 rain gardens were installed in homeowner?s yards to collect roof and sidewalk runoff and officially registered on the rain garden website. Over 95% of program participants enhanced their knowledge of water quality protection and over 90% planned to implement at least one yard or garden practice that would protect water quality. Riparian cattle grazing field research and presentations to Washington policy makers and enforces have resulted in a changed mindset about rangeland grazing, a huge breakthrough for the state.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Problems for research arose during 2015, caused by the largest wildfires in the history of the State of Washington. The wildfires curtailed data collection in various areas, while in other cases research plots and/or collared study animals were lost or forced to move to other areas. Limited state funding has decreased our ability to provide support for graduate student assistantships which has impacted our research because graduate students must now be funded from extramural funding which are also at all time lows with extremely low funding rates.

• Economic: Home gardening continues to increase due to the economy; families interested in having fresh fruits and vegetables, and to know where their produce came from and how they were raised; and increased interest in obesity reduction initiatives.
• Government regulations: New rules restrict the use of traditional fertilizers and pesticides in urban and riparian areas. Alternatives are recommended to maintain or improve water quality. More emphasis has been placed on stormwater management, including keeping stormwater from entering rivers and Puget Sound; retaining rainfall on the property to infiltrate; and pervious pavements.
• Natural disasters: Time was redirected to address post-wildfire areas in North Central and Northeastern Washington, including timber salvage, soil erosion prevention, grass planting, and tree planting. This effort will continue in 2015 as landowners rebuild buildings, fences, and livestock herds.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

As described above, current research being conducted by Natural Resource Sciences faculty in is extremely diverse, ranging from specialized forest ecosystems to grizzly bears to lake restoration and numerous other topics. All of these are critical themes in natural resource stewardship today and pertain directly to stewardship issues. Our peer-reviewed research and extension activities and the graduate students trained are evidence of our success in 2015.
Our evaluation methodologies are designed to assess the amount of learning acquired during our activities and retained at intervals afterword; the degree of application of that learning; and the social, environmental and economic value of these applications. We will use post-program, retrospective, and before and after assessments to document changes in knowledge. We will use survey methods after an appropriate time lag to assess how

much of the new knowledge was actually applied. Finally, we will use research methodologies, industry assessments, and survey responses to determine the social, economic and environmental values derived from the application of new techniques.
Program participants have a greater awareness, increased knowledge, and application of knowledge for management of their yards, forests and ranches. The target audience are utilizing multiple methods for pest control and better choices are being made regarding alternative options. Home gardeners are using more efficient irrigation methods and are using less water overall. Forest owners are implement practices to improve forest health and secure the future of their forest with future generations in mind.

Key Items of Evaluation

Pre- and Post-tests of volunteer-based programs to determine knowledge gain. Follow-up evaluations (telephone call or online surveys) were used for six-month to one year evaluations. Online modules contain tests to determine knowledge gain. End of meeting forms were used for workshops, conferences and demonstration garden events. Regional forest field days were evaluated through personal interview or follow-up online surveys. Pesticide test results are obtained from the Washington State Department of Agriculture.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Agricultural Productivity and Food Security

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	5%		8%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		3%	
111	Conservation and Efficient Use of Water	5%		7%	
112	Watershed Protection and Management	5%		3%	
121	Management of Range Resources	2%		3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		14%	
202	Plant Genetic Resources	5%		8%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		9%	
205	Plant Management Systems	5%		6%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		8%	
212	Pathogens and Nematodes Affecting Plants	12%		9%	
213	Weeds Affecting Plants	10%		3%	
215	Biological Control of Pests Affecting Plants	8%		5%	
216	Integrated Pest Management Systems	10%		4%	
301	Reproductive Performance of Animals	5%		3%	
302	Nutrient Utilization in Animals	5%		3%	
303	Genetic Improvement of Animals	3%		2%	
304	Animal Genome	0%		2%	
307	Animal Management Systems	10%		0%	
604	Marketing and Distribution Practices	5%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	101.0	0.0	290.0	0.0
Actual Paid	122.0	0.0	429.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1432957	0	2867946	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1432957	0	2867946	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
10250465	0	22387358	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The research of most faculty was directed toward increasing agricultural productivity, efficiency, food quality, and global competitiveness. Research activities included: fundamental studies to understand how environmental signals are perceived and translated into plant growth responses; development of data mining tools and resources for genomics to facilitate breeding and the development of new and improved varieties and cultivars that are resistant to pathogens, more efficient in their use of agricultural inputs, and more nutritious; studies in fruit and seed production and biology, with an emphasis on sustainability of production systems; breeding and genetic studies in small grains, tree fruits, small fruits including genomics approaches to identify functional genetic markers for crop improvement; studies of the anatomy and physiology of our cropping systems during growth and development in relation to water use efficiency and overall quality; research emphasizing the use of plant bioregulators to maximize yield and quality of fruits and vegetables; studies related to the interaction of various environmental and production factors influencing yield and quality of potatoes, including retention of postharvest quality and nutritional value; studies of effects of deficit irrigation and partial root zone drying in apple, cherry, and grape; research focusing on the mechanisms of internal and external physiological disorders of apples; development of new potato cultivars and their adaptation to WA and the Pacific Northwest; effects of new clonal rootstocks on scion productivity, growth, and fruit quality in sweet cherry; research focusing on novel management strategies for high density cherry production; the potential for mechanical harvest for fresh market, stemless sweet cherries; high value organic and sustainable vegetable cropping systems including biodegradable mulches, high tunnel production systems, organic farming research, weed management in vineyards, and disease control in fruit orchards of western WA; and the development of automation, sensing, control and information systems for precision agriculture in fruit and vegetable cropping systems.

Breeding programs are developing varieties that increase production and improve end-use quality in the

face of challenges from climate change, evolving pest pressures, use of less-productive land, and the need to produce food while sustaining agroecosystems and the environment. For all of our crops, changing production systems, disease and insect pest problems, market preferences/end-uses, and variable weather patterns all demand a long-term integrated effort to respond to and improve yield potential/protection and quality. Yield limiting biotic (including fungal and viral pathogens, root diseases, and insect pests) and abiotic (including heat, drought, poor fertility, herbicide carryover) stresses impact crop production across the state of Washington. Our research provides genetic solutions to these production limitations in the form of new, high-yielding, pest-resistant, direct and carryover herbicide tolerant, and high-quality varieties. In addition to conventional breeding methods, these programs have developed efficient and effective genotyping and phenotyping selection methods that result in planting and screening of thousands of breeding plots and tens of thousands of head rows. Variety development is also taking advantage of doubled haploid and molecular marker techniques to increase efficiency and desired trait-based selection in wheat. For example, new, higher-yielding wheats with pest resistance and superior end-use quality continue to be released to Pacific Northwest wheat growers and increase spring wheat profitability and sustainability, while decreasing the use of pesticides. In 2015, WSU released two new wheat varieties. WSU released wheat varieties capture nearly 50% of the spring wheat and 35% of the winter wheat acres in Washington State, and an increasing number of acres in Oregon and Idaho. The farmgate value of these lines exceeds $250M annually.

WSU's Animal Sciences faculty contributed to this program by applying and integrating disciplinary approaches (nutrition, environmental impact, reproduction, breeding and genetics, growth and development) to identify mechanisms to enhance production or to increase production efficiency. Research places emphasis on measurement methods by which to address production and production efficiency. Approaches used include actual measurements and modeling approaches. Several projects are focused on defining sustainability of animal systems. This program area also links with Extension activities. Food quality and consistency has been addressed with research projects which include production systems, identifying meat quality markers associated with animal health and meat quality factors (fatty acid - profiles and content). Animal well-being is another area in which animal productivity can be enhanced and is both a research and outreach area in the department.
Many of our entomologists focused on projects that reduced crop losses, enhanced the quality and safety of agricultural products, developed sustainable pest management practices for agricultural production, sought to maintain adequate pollinator levels in agricultural settings or reduced chemical inputs related to entomological challenges. In 2015, Integrated Pest Management (IPM) programs developed by WSU scientists were followed by growers for a number of crops including apples, pears, cherries, hops, mint, alfalfa grown for seed, wine and juice grapes, hybrid poplars, honey bees, small fruits, potatoes, small grains and others. In 2015, faculty continued this updating process through large projects related to improved sustainability of agricultural pest control including projects to enhance tree-fruit IPM decision making and training of growers, to develop management strategies and recommendations for an invasive pest (Spotted Wing Drosophila), to enhance biological control to stabilize Western orchard IPM programs, to assess the impacts of abiotic stress on hops, to investigate interactions between virus and insect vectors in grapes, to reduce pesticide use in potato production and to evaluate possible sub-lethal effects of urban pesticide use on honey bees.
WSU plant pathology and nematology scientists made progress in the epidemiology and management of several potato diseases in the PNW including, black dot, late blight, powdery scab and Verticilium wilt. Disease management efforts extended into important rotation crops for potatoes, like mint. We detected novel strains of potato virus Y in western Washington that cause malformed tubers and began development of diagnostic tests that could identify the strains in seed potato fields. They also developed management tools for onion and other vegetable diseases. Important diseases being studied in onions included trips-transmitted tospoviruses like iris yellow spot virus and bacterial and fungal pathogens that affect yield, quality and storage losses. Characterization and epidemiology of the different bacterial and fungal species causing the onion bulb rot diseases and rhizoctonia root rot have been major emphases. We determined the Rhizoctonia species (AG) causing diseases on both onions and peas. We determined

that there are variety differences between onions in their response to rhizoctonia stunting and thus potential for breeding resistant varieties. Similarly, they identified resistance to bacterial blight in carrot.
A dramatic rise in the incidence of little cherry disease was observed in recent years. In cooperation with a private company a user-friendly assay kit that could be used to detect Little cherry virus 2 was developed.
Vineyard surveys during 2015 season indicated that Grapevine leafroll-associated virus 3 (GLRaV-3), associated with grapevine leafroll disease (GLD), is wide spread in wine grape cultivars, compared to Grapevine red blotch-associated virus (GRBaV), associated with grapevine red blotch disease (GRBD). The two viruses were detected as single infections in majority of samples and mixed infections were observed in a few cultivars. Another outcome of these surveys is that GLD and GRBD have similar, though not identical, symptoms and virus-specific diagnostic assays are necessary for monitoring these two diseases.
Studies were conducted in commercial vineyards to assess impacts of GLD and GRBD on fruit yield and quality. The results indicated that both diseases can cause significant reduction in fruit yield and affect sugar accumulation in red-fruited wine grape cultivars. However, these impacts were found to be variable across wine grape cultivars and geographic locations. Overall, impacts of GRBD on fruit yield and grape quality were found to be more severe than impacts due to GLD. GRBD affects wine quality similar to GLD.
Epidemiological studies have shown continued spread of GLD into newly planted vineyard blocks. The spatial and temporal distribution of symptomatic vines in young plantings suggested primary spread coming from outside sources of infection, especially from heavily infected old blocks adjacent to new plantings. In addition, symptomatic vines in young plantings showed aggregation or clustering indicating secondary spread of GLD between vines due to vine-to-vine movement of vectors. The examined the basic biology of pathogens to identify promising advances in engineering stable disease resistance to important diseases. Analysis of effector proteins delivered into plant cells by cereal rust fungi (Puccinia species) identified genes controlling processes that are essential to the pathogenicity of these organisms. This has been demonstrated by silencing the pathogen genes while the pathogen is infecting plants by expressing interfering RNAs homologous to the pathogen genes. This has resulted in novel methods to engineer resistance in wheat and a better understanding of the pathogenicity of these organisms. Since our experiments have been conducted in transient assays in wheat leaves, we initiated collaboration with UC Davis scientists to make in stable transgenic wheat plants to better demonstrate control methods. To characterize the molecular function of Puccinia effectors we used transient expression assays in tobacco leaf cells. Nine out of 20 effectors tested were able to inhibit R gene-mediated defenses and suppress cell death. We also established that Puccinia striiformis makes small RNAs to moderate gene expression. Some of the small RNAs were predicted to have wheat gene targets, indicating that the Puccinia rusts make small RNA effectors. Other molecular approaches we are using include exploring the role of plant extracellular ATP as an endogenous danger/wounding signal and the plants machinery for recognizing this signal to initiate defense responses.
Plant pathology researchers contributed to sustainable pest control in wheat through genetics analyses of germ plasm and variety testing. Plant Pathology faculty rated wheat varieties for a number of important cereal diseases including Cephalosporium stripe, eye spot, snow molds, soilborne wheat mosaic virus and stripe rust. In addition to rating cultivars, the faculty assist breeders in developing new varieties with strong disease control packages, make varietal recommendations to growers and base other disease management recommendations on the cultivar being grown. In the past year they finished transferring tolerance or resistance to general soil borne pathogens like Rhizoctonia solani from five different synthetic wheat varieties into a spring wheat background and will now conduct multiple root disease assays on these lines. They have also investigated the nature of suppressive soils to Rhizoctonia root rot. They found that different wheat varieties favor different root-associated bacteria and that some of the bacteria that are differentially favored by wheat varieties are disease suppressive. To develop better diagnostic tools we sequence some fungal pathogen genomes to identify sequence-based markers for detection and classification. They sequenced the Botyrtis paeoniae, causing a foliar disease or Peonies, and Tilletia caries which causes flag smut of wheat. We detected an outbreak of sudden oak death, caused by Phytophthora ramorum, in a botanical garden on Bainbridge Island. Several methods are being attempted and tested to prevent the spread of this invasive pathogen.

2. Brief description of the target audience

Target audiences include farmers and ranchers, agricultural consultants, scientists, commodity commissions, educators, state and federal agency professionals, elected officials, food processors, transporters, agricultural chemical producers and applicators, and the general public.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	111715	570422	12733	12683

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: 1

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	32	736	768

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of seminars, workshops, demonstrations, field days, and educational events conducted annually

Year	Actual
2015	2106

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications published

Year	Actual
2015	32

Output #3

Output Measure

- Number of graduate students with a significant professional orientation in the area of agricultural productivity and food security.

Year	Actual
2015	114

Output #4

Output Measure

- Farm Bill Outreach Education Training Workshops

Year	Actual
2015	26

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of evaluated participants who demonstrated increased knowledge and skills relative to one or more key learning objectives for enhancing productivity, efficiency, risk management, or sustainability of crop and livestock production systems.
2	Percentage of evaluated program participants who applied knowledge gained from the program to enhance productivity, efficiency, risk management, or sustainability of crop and livestock systems.
3	Number of acres impacted by WSU research and extension programs that enhanced productivity, efficiency, or sustainability of crop production enterprises.
4	Number of food production animals impacted by WSU research and extension programs that enhanced productivity, efficiency, or sustainability of livestock and dairy production enterprises.
5	Number of food processing facilities or direct marketing enterprises that enhanced processing, marketing, or overall efficiency of food distribution.

Outcome #1

1. Outcome Measures

Percentage of evaluated participants who demonstrated increased knowledge and skills relative to one or more key learning objectives for enhancing productivity, efficiency, risk management, or sustainability of crop and livestock production systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	69

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington State's diverse microclimates produce over 300 crops, including small grains, vegetables, fruits, legumes, and livestock. Washington State University (WSU) conducts research and extension programs focused on increasing the productivity and efficiency of our farms and ranches by reducing plant and animal pests and diseases, developing new genetic resources, and optimizing overall food production practices and strategies.

What has been done
Program implementation utilized local, regional, state-wide, and multistate efforts in a coordinated effort that involved workshops, clinics, seminars, field days, field demonstrations, print and electronic publications, mass media, social networks, and other methods, such as mobile app development, to disseminate research- based knowledge and other relevant information to targeted, diverse audiences

Results
This outcome documents that 69% of program participants increased their knowledge and skill through participation in one or more of over 2,100 educational events focused on enhancing agricultural productivity and food security for the benefit of producers and consumers alike. Participants represented diverse agricultural enterprises, including very large commercial operations, midsize family farms, small farms, and community supported agriculture. Program participants also represented the diverse range of Washington State stakeholders.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
307	Animal Management Systems
604	Marketing and Distribution Practices

Outcome #2

1. Outcome Measures

Percentage of evaluated program participants who applied knowledge gained from the program to enhance productivity, efficiency, risk management, or sustainability of crop and livestock systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	54

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington State's diverse microclimates produce over 300 crops, including small grains, vegetables, fruits, legumes, and livestock. Washington State University (WSU) conducts research and extension programs focused on increasing the productivity and efficiency of our farms and ranches by reducing plant and animal pests and diseases, developing new genetic resources, and optimizing overall food production practices and strategies.

What has been done
Program implementation utilized local, regional, state-wide, and multistate efforts in a coordinated effort that involved workshops, clinics, seminars, field days, field demonstrations, print and electronic publications, mass media, social networks, and other methods, such as mobile apps, to disseminate research-based knowledge and other relevant information to targeted audiences.

Results
This outcome documents that 54% of program participants utilized the research-based information and training provided through this planned program to enhance productivity, efficiency, risk management, or sustainability of crop and livestock systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
307	Animal Management Systems
604	Marketing and Distribution Practices

Outcome #3

1. Outcome Measures

Number of acres impacted by WSU research and extension programs that enhanced productivity, efficiency, or sustainability of crop production enterprises.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10589979

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington State's diverse microclimates produce over 300 crops, including small grains, vegetables, fruits, legumes, and livestock. Washington State University (WSU) conducts research and extension programs focused on increasing the productivity and efficiency of our farms and ranches by reducing plant and animal pests and diseases, developing new genetic resources, and optimizing overall food production practices and strategies.

What has been done
Program implementation utilized local, regional, state-wide, and multistate efforts in a coordinated effort that involved workshops, clinics, seminars, field days, field demonstrations, print and electronic publications, mass media, social networks, and other methods to disseminate research-based knowledge and other relevant information to targeted audiences.

Results
WSU research and extension programs enhanced productivity, efficiency, and sustainability of food production on over 10 million acres of the 15 million acres of agricultural land in the state.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

121	Management of Range Resources
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
307	Animal Management Systems

Outcome #4

1. Outcome Measures

Number of food production animals impacted by WSU research and extension programs that enhanced productivity, efficiency, or sustainability of livestock and dairy production enterprises.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	7218590

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington State's livestock industry includes a diverse mix of dairy, beef, swine, sheep, goat, and poultry enterprises. These enterprises range from small farms to very large cooperate farms with thousands of animals under management. Washington State University?s research and extension programs continue to provide reliable information and training beneficial to the sustainability of these farms and food animal production.

What has been done
Program implementation utilized local, regional, state-wide, and multistate efforts in a coordinated effort that involved workshops, clinics, seminars, field days, field demonstrations, print and electronic publications, mass media, social networks, and other methods to disseminate research-

based knowledge and other relevant information to targeted audiences.

Results
This planned program directly impacted the management of over 7 million food production animals, thought dissemination of research information and training for producers to enhance risk management strategies, animal health, reproductive efficiency, meat quality, feeding management, grazing management, and a variety of other management and animal husbandry practices important for sustainable animal agriculture enterprises.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
121	Management of Range Resources
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
307	Animal Management Systems
604	Marketing and Distribution Practices

Outcome #5

1. Outcome Measures

Number of food processing facilities or direct marketing enterprises that enhanced processing, marketing, or overall efficiency of food distribution.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1404

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food processing and marketing are essential components of a food system and insuring food security. In addition to the importance of large scale food processing operations; on-farm

processing and direct marketing of locally grown food is increasingly in high demand.

What has been done
This work included a series of outreach and training methods that included workshops, clinics, seminars, print and electronic publications, and other methods to disseminate research-based knowledge and other relevant information to targeted audiences. Program offerings were customized for each audience, ranging from midsize, commercial processing plants to farmers market associations and direct farm marketers.

Results
Just over 1,400 small to mid-size enterprises were provided training and assistance resulting in improvements to processing efficiency and improved distribution of locally grown foods.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Although many factors impact the sustainability of agricultural enterprises and food production, our primary goals of providing training and research-based information to target audiences continue to be impacted by reduced or uncertain funding from federal, state, and local sources. This uncertainty directly impacts our decisions on hiring and deployment of human and financial resources. Our work in research and extension is increasingly dependent on securing competitive grants to support our system and drive our programs forward. Ultimately, competing priorities for limited funds and financial resources continue to be our most limiting factor.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

This program encompassed a wide array agricultural enterprises including irrigated and dry-land agronomic crops, high value horticultural crops, fruit orchards, vine crops, grazing lands, livestock and poultry operations, and dairy farms. The overall program evaluation for all events and projects under this program theme was evaluated in terms of "knowledge gained by participants" and "application of this knowledge" to address agricultural productivity and food security. Additionally, we collected data on the acreage of

agricultural land and livestock numbers that directly benefited from our work. We also reported the number food processing facilities, direct marketing enterprises, and food banks that enhanced efficiency of food processing and distribution. Collectively, the results indicate positive impacts to agricultural productivity through the dissemination of research-based information and the application of this knowledge for sustaining agricultural enterprises and food production. Results were collected through a variety of methods including pre and post event evaluations, surveys, agricultural statistics, feedback from stakeholder groups, and other assessments of program participants. The analysis provided the aggregate results indicated below under key items of evaluation.

Key Items of Evaluation

Our scientists were in the top ten for extramural competitive funding from the USDA by congressional district in 2015. This is a trend that we have continued. We are not in the top ten for capacity funds awarded. It is clear that we are using our funds wisely to help fight global hunger and keep our food supply safe and secure. This planned program focused on increasing agricultural productivity, food processing efficiency, and food distribution as a means of enhancing food security though a sustainable system. Our assessments indicated that 69% of program participants increased their knowledge relative to the knowledge areas covered, and 54% indicated application of one or more principles or practices learned from their participation. The aggregate outcomes of this work impacted over 10 million acres for farm land, and over 7 million food animals. This work also supported enhancements to over 1,400 enterprises associated with food processing, direct marketing, and food distribution.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Sustainable Energy

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		5%	
123	Management and Sustainability of Forest Resources	20%		5%	
131	Alternative Uses of Land	10%		5%	
133	Pollution Prevention and Mitigation	10%		2%	
141	Air Resource Protection and Management	5%		3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		15%	
204	Plant Product Quality and Utility (Preharvest)	0%		15%	
205	Plant Management Systems	0%		5%	
206	Basic Plant Biology	0%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		5%	
402	Engineering Systems and Equipment	25%		5%	
403	Waste Disposal, Recycling, and Reuse	15%		10%	
511	New and Improved Non-Food Products and Processes	0%		5%	
601	Economics of Agricultural Production and Farm Management	0%		5%	
603	Market Economics	10%		2%	
605	Natural Resource and Environmental Economics	5%		3%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890

Plan	80.0	0.0	45.0	0.0
Actual Paid	47.0	0.0	62.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
146216	0	385772	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
146216	0	385772	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
11117522	0	2887741	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

WSU scientists contributed to advance the science and technology required to implement a novel biomass economy developing thermo-chemical and biological processes for the production of bio-fuels and bio-chemicals from waste ligno-cellulosic materials. Our scientists have also contributed to the subject areas through participating in one multi-state, multi-disciplinary USDA BRDI project in searching for solutions for increase production of tropical energy crops for biofuel feedstock through improving harvesting efficiency. In 2015, we have conducted a few field data collection and operation-harvester system analysis for finding obstacles and challenges to achieve a high efficiency and sustainable feedstock production.
Our scientists also conducted research in the development of new polymers with which to utilize renewable/sustainable feedstocks (rosin, terpene, soy protein, lignin, etc., were used in this investigation) to potentially replace petroleum based feedstocks. These renewable feedstocks are co-products of biofuels and if value is added, it would decrease overall cost of production and make biofuels economically viable thereby increasing production in WA state (Area 1). If new ways are found to utilize these co-products, an increase in their utilization will be achieved and a new market for these sustainable feedstocks is expected to be created.
Achievements for 2015 included development of the use of partially depolymerized lignin for the preparation of novel thermoset resins which provided improved performance over lignin in its high molecular weight form. Further applications for rosin-derived and fatty acid-derived resins were explored and exhibited overall improved properties of the cured resins. Eugenol and dipentiene were proven to be effective alternatives as curing agents to petroleum based counterparts. Finally, use of rosin, dipentene and oil as feedstocks for preparation of PVC stabilizer is novel and has proven to be better than conventional counterparts as it exhibited improved mixing, a high degree of control of design of structure and is non-toxic and renewable. Progress was made towards developing new functional methods for PLA and other polymers. Overall progress was made towards the long-term objective in developing biobased polymer materials covering a broad range of blends and composites.
An important result in 2015 was the modification of a commercial pyro-probe that is allowing the group to easily study thermochemical reactions. This year our fundamental biomass thermochemical reactions

studies focused on the mechanisms of cellulose and lignin thermochemical reactions and their interactions. This year was also a very productive year on the production, characterization and evaluation of engineered bio-chars.
Progress was made in anaerobic digestion research. In addition to assessing the effectiveness of different treatment methods, two novel processes were developed. The first one was the combination of ozonation and ammonia soaking, and the second one was ammonia based pretreatment integrated with the biogas purification process. In the area of broadening application of anaerobic digestion, we tested the possibility of anaerobic digestion as a way to process microalgae biomass and for fermenting C1-C4 light oxygenated organic compounds. We developed an ASPEN-based model for techno-economic assessment of different anaerobic digestion systems. All these efforts have results in new knowledge and know-how related to anaerobic digestion technology. We further actively engaged in extension and outreach activities to transfer the information generated from the research activities to the scientific communities and the potential users of the technology. A series of extension materials were developed and our scientists conducted workshop and other extension activities to maximize the impact of the research results. Economic analyses were conducted on these various energy systems to assess thresholds for local and regional application of these technologies. Extension programs were developed to teach and demonstrate alternative energy systems such as anaerobic digestion, biomass production, oil seed production, increasing energy efficiency, and utilization of wind and solar energy systems.

2. Brief description of the target audience

The target audiences will include farmers, business owners, homeowners, industry technology providers, project developers, and public agencies and utilities.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1086	23757	32	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	9	155	164

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops, demonstrations, and symposia conducted related to alternative energy and energy efficiency.

Year	Actual
2015	9

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications related to sustainable energy that are published annually.

Year	Actual
2015	9

Output #3

Output Measure

- Number of graduate students with a significant professional orientation in the area of Sustainable Energy.

Year	Actual
2015	56

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of evaluated participants who demonstrated increased knowledge and skills relative to biofuels, energy efficiency, and alternative energy sources.
2	The number of farmers that applied information provided by this program to produce biofuel crops.
3	The number of households and enterprises reporting reduced energy consumption as a result of WSU programs.
4	The number of forest and woodland owners who applied information from this program in the production of wood for biofuels.
5	The acres of forestland and cropland impacted by our programs to advance the production of biofuel feedstocks.

Outcome #1

1. Outcome Measures

Percentage of evaluated participants who demonstrated increased knowledge and skills relative to biofuels, energy efficiency, and alternative energy sources.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	95

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Regional systems for renewable, biomass-based, liquid transportation fuels (i.e. gasoline, diesel, and jet fuel) are needed to support energy independence, reduce net carbon emissions, stabilize fuel prices for consumers, provide new economic opportunities for landowners, and bring jobs and economic development to rural communities. Renewable bio-based chemicals are a stepping stone to biofuels and can provide similar benefits to communities. Advanced Hardwood Biofuels Northwest (AHB) is a USDA-NIFA funded research project to develop a bio-economy in the Pacific Northwest using hybrid poplar. In order for this system to be successful, stakeholders need to be well-informed about the project, understand the opportunities and constraints, and receive technical assistance based on up-to-date research results. These stakeholders include growers, policymakers, Extension personnel, and community members.

What has been done
We hosted the National Energy Extension Summit (NEES) in Seattle April 7 - 10, which drew 95 people. We organized a workshop, ?Poplar farms as a waste water management tool: Planting strategies to align with potential markets,? which had 42 participants. 88 people attended poplar field site tours in four states. In addition, we made presentations (oral and posters) at four national and international meetings and continued a Hardwood Biofuels Webinar Series. We continued building our extensive online presence by updating the project website (http://hardwoodbiofuels.org/) to make information from this project accessible now and after the grant ends. We created 13 professionally-produced videos. We contributed project articles to a variety of local and regional newsletters, continued the quarterly AHB newsletter, and worked with one of our sister-projects (NARA) to publish quarterly policymaker briefing papers. The hardwood biofuel webinar series included six webinars with 139 participants, and 1,080 others viewed recordings of all of the AHB webinars. The project videos have been viewed 2,769 times on YouTube and the AHB newsletter reaches 618 people. The AHB Facebook page reaches over

website had over 4,000 visitors this year.

Results
?Implemented targeted outreach activities for engaging stakeholders and advancing bioenergy literacy to professionals.
?Cataloged activity outcomes and benchmark reports and studies.

End outcomes of this goal are sustainable production of biojet fuel and co-products and rural economic development.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

The number of farmers that applied information provided by this program to produce biofuel crops.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Regional systems for renewable, biomass-based, liquid transportation fuels are needed to support energy independence, reduce net carbon emissions, stabilize fuel prices for consumers, provide new economic opportunities for landowners, and create jobs and economic development to rural communities. Hybrid poplar is one species that may suit this need. In order for this system to be successful, stakeholders need to be well informed about the project, understand the opportunities and constraints, and receive technical assistance based on up-to-date research results.

What has been done

To raise awareness of the project, numerous field tours at plantation demonstration sites, workshops, symposia, and exhibits throughout the four-state region of Washington, Oregon, Idaho, and California. In addition, presentations were made at national, regional, state and local meetings. A Hardwood Biofuels Webinar Series was developed to share information to local, regional, and national audiences

Results

In post-event evaluations, an average of 95% of surveyed field tour participants reported a better understanding of hardwood biofuels, but no farms have applied the information at this stage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
205	Plant Management Systems
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

The number of households and enterprises reporting reduced energy consumption as a result of WSU programs.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

The number of forest and woodland owners who applied information from this program in the production of wood for biofuels.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Northwest Advanced Renewables Alliance (NARA) is a five-year, $40 million project supported by USDA to explore woody biomass as a source of aviation biofuels. The focus is overcoming key obstacles that prevent wood-based jet fuel and petrochemical substitutes from being economically viable. NARA takes a holistic approach to building a supply chain for aviation biofuel with the goal of increasing efficiency in everything from forestry operations to conversion processes. The project includes a broad alliance of private industry and educational institutions from throughout the Northwest.

What has been done
NARA units, research, extension and industry members worked as partners and facilitators with the ultimate goal of empowering the stakeholders to plan and implement the changes needed to build, develop, and sustain a bio-refinery infrastructure. The goal of the outreach team is to promote stakeholder bioenergy literacy and build regional supply chain coalitions for development of a framework of biofuel and co-products production from woody biomass. End outcomes of this goal are sustainable production of bio-jet fuel and co-products and rural economic development.

Results
NARA Outreach and Education Team engaged in western Montana, Northern Idaho panhandle, and Northeast Washington to create a broad forest stakeholder group investigating aviation biofuels development in the region. Washington Clean Energy stakeholders have now formed a Forest Biomass Coordination Group (led by Peter Moulton of the WA Department of Commerce) and are coordinating with a similar group in Oregon as a result of NARA Outreach Team engagement.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
603	Market Economics
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

The acres of forestland and cropland impacted by our programs to advance the production of biofuel feedstocks.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The drop in price of oil from nearly $120 per barrel in 2011 to $33 per barrel in January 2016, slowed the interest in biofuels significantly. Although we demonstrated that these plants can be successfully grown or biomass recovered for biofuel production, the variable costs cannot be currently covered in the market. However, this research will be very important for the future when oil prices rise to 2011 levels.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

In summary, we disseminated research findings and advanced public knowledge regarding conversion of woody biomass into biofuels and co-products. This was done through direct

stakeholder interactions at regional meetings, webinar series, Knowledge Base Portal, and communicating NARA's effort to produce 1000 gallons of bio-jet fuel through an informative timeline. These were essential elements to advance the readiness of the region for eventual development of wood-based biofuel infrastructure. We initiated planning of a national/international conference for May 2016 to engage industry leaders, research community, state agencies, and interested public for advancing the discussion of commercializing wood-based biofuel infrastructure in the PNW (http://nararenewables.org/conference/). Overall, program participants have a greater awareness, increased knowledge, and application of knowledge in their homes and businesses. Farmers have a greater understanding of biofuel crop production but realize that it is not economical at this time.

Key Items of Evaluation

Post-event evaluations of Extension personnel, farmers, agency personnel, and private business were used to determine knowledge gain. End of meeting forms were used for workshops, conferences, and field day events. Major regional field days were evaluated through personal interview or follow-up online surveys. Google Analytics were used for website analysis.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Climate Change

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		5%	
111	Conservation and Efficient Use of Water	5%		5%	
112	Watershed Protection and Management	5%		5%	
122	Management and Control of Forest and Range Fires	5%		5%	
123	Management and Sustainability of Forest Resources	0%		5%	
132	Weather and Climate	5%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		10%	
202	Plant Genetic Resources	5%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%		10%	
205	Plant Management Systems	10%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		10%	
212	Pathogens and Nematodes Affecting Plants	10%		10%	
213	Weeds Affecting Plants	5%		3%	
216	Integrated Pest Management Systems	10%		5%	
404	Instrumentation and Control Systems	5%		2%	
605	Natural Resource and Environmental Economics	5%		5%	
610	Domestic Policy Analysis	5%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	18.0	0.0	65.0	0.0
Actual Paid	22.0	0.0	98.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
179114	0	491860	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
179114	0	491860	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3169690	0	5717900	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research and outreach will be conducted to facilitate conversion of agricultural, forestry, and industrial waste streams into clean energy and stable construction grade materials. This includes development of new products and transfer of associated technology to the private sector. Delivery of information to the general public will continue to be a high priority.
Our plant breeding and molecular biology programs will continue to develop new crop varieties that are able to withstand emerging disease and pest threats associated with climate change. Our integrated pest management programs will continue to develop new techniques to mitigate the effects of introduced pests and range extensions of pests already in the region. We will investigate the possibilities that changed climatic conditions might present opportunities for growing new crops or growing traditional crops in new ways or new areas. These represent a form of mitigation to try to stabilize farm based economies in the face of climate-driven pressures to change.
We will assess climate change related policies and develop research and outreach programs to position Washington's agriculture and forestry industries effectively to increase sequestration of carbon and to benefit from future carbon trading protocols or other greenhouse gas mitigation policy mechanisms.

2. Brief description of the target audience

Owners and managers of crop and range lands, forest resources, and wood products industries; community leaders; and public agencies and organizations.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	15241	54014	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	5	23	28

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops and other educational events delivered on mitigation and adaptation to climate change.

Year	Actual
2015	15

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications referencing climate change mitigation and adaptation published per year.

Year	Actual
2015	1

Output #3

Output Measure

- Number of graduate students with a significant professional orientation in the area of Climate Change.

Year	Actual
2015	36

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	&&Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives on mitigating or adapting to climate change.
2	&&Percentage of evaluated program participants who applied knowledge or technology gained from WSU on mitigating or adapting to climate change.
3	&&Number of farms utilizing WSU-developed crop varieties and/or other technologies to adapt to evolving environmental conditions or newly emerging plant pests and diseases.
4	&&Number of farms employing anaerobic digestion or other methods to reduce GHG emissions or to sequester carbon.

Outcome #1

1. Outcome Measures

&&Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives on mitigating or adapting to climate change.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	21

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The impacts of climate change on Washington State could be significant, with potential changes in irrigation water availability as well as growing conditions for crops statewide. New plant and animal pests and diseases are likely to emerge over time as well. The impacts of climate change on Washington State could be significant, with potential changes in irrigation water availability and seasonal growing conditions for crops statewide. New plant and animal pests and diseases are likely to emerge over time as well. These and other factors will impact communities, agriculture and natural resource management, navigation, and electrical generation in the state. Researching and communicating strategies for mitigating human contributions to greenhouse gases as well as strategies for adapting to such shifts are key roles for us to take.

What has been done
Program implementation utilized local, regional, and statewide efforts that involved anaerobic digester research; 15 outreach educational programs; print and electronic publications; and other methods to disseminate research-based knowledge and other relevant information to target audiences. A team of researchers also investigated how water resources can be better managed in response to climate change induced scarcity and variability of water supply for agriculture.

Results
Program evaluations revealed that an average of 21% of program participants increased their knowledge and awareness of climate change mitigation and/or adaptation practices. This knowledge included basic understanding of climate change and steps to adapt to future changes and mitigate trends that are predicted. The percent of participants gaining knowledge and awareness of climate change mitigation significantly decreased from 75% during the previous year. In outcome narratives, there are other indicators of knowledge gain reported such as resource use which are not captured in the self-reported metric.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
132	Weather and Climate
133	Pollution Prevention and Mitigation
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
404	Instrumentation and Control Systems
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #2

1. Outcome Measures

&&Percentage of evaluated program participants who applied knowledge or technology gained from WSU on mitigating or adapting to climate change.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	13

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The impacts of climate change on Washington State could be significant, with potential changes in irrigation water availability and seasonal growing conditions for crops statewide. New plant and animal pests and diseases are likely to emerge over time as well. These and other factors will impact communities, agriculture and natural resource management, navigation, and electrical generation in the state. Researching and communicating strategies for mitigating human contributions to greenhouse gases as well as strategies for adapting to such shifts are key roles for us to take.

What has been done

Program implementation utilized local, regional, and statewide efforts that involved anaerobic digester research; 15 outreach educational programs; print and electronic publications; and other methods to disseminate research-based knowledge and other relevant information to target audiences. A team of researchers also investigated how water resources can be better managed in response to climate change induced scarcity and variability of water supply for agriculture.

Results

Thirteen percent of program participants indicated and intent to apply the knowledge gained from one or more of the 15 educational events delivered in this program area. This application assessment was significantly lower than the previous year?s evaluation showing a 29% application of knowledge gained. The metric for knowledge gained also decreased from the previous year, it is unclear why the application of this knowledge declined among program participants. This seems to imply that a greater reluctance among program participants to act on the information and recommendations provided, and may be linked to the financial cost of implementation or other considerations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
132	Weather and Climate
133	Pollution Prevention and Mitigation
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
404	Instrumentation and Control Systems

605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #3

1. Outcome Measures

&&Number of farms utilizing WSU-developed crop varieties and/or other technologies to adapt to evolving environmental conditions or newly emerging plant pests and diseases.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The impacts of climate change on Washington State could be significant, with potential changes in irrigation water availability and seasonal growing conditions for crops statewide. New plant and animal pests and diseases are likely to emerge over time as well. These and other factors will impact communities, agriculture and natural resource management, navigation, and electrical generation in the state. Researching and communicating strategies for mitigating human contributions to greenhouse gases as well as strategies for adapting to such shifts are key roles for us to take.

What has been done
Program implementation utilized local, regional, and statewide efforts that involved anaerobic digester research; 15 outreach educational programs; print and electronic publications; and other methods to disseminate research-based knowledge and other relevant information to target audiences. A team of researchers also investigated how water resources can be better managed in response to climate change induced scarcity and variability of water supply for agriculture.

Results
One farm was reported to adopt WSU- technologies to adapt to evolving environmental conditions or newly emerging plant pests and diseases.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
132	Weather and Climate
133	Pollution Prevention and Mitigation
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems
404	Instrumentation and Control Systems
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

Outcome #4

1. Outcome Measures

&&Number of farms employing anaerobic digestion or other methods to reduce GHG emissions or to sequester carbon.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	54

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Livestock are estimated to produce ½ of all greenhouse gas emissions in Washington State. Organic waste estimated to be 17 million tons annually can lead to major unproductive releases of fixed carbon as carbon dioxide and methane. By using anaerobic digestion (AD) to recover some of the energy content of this waste, less fossil fuel is needed and the energy associated with waste disposal is reduced.

What has been done
WSU scientists have conducted extensive research on anaerobic digestion (AD) as a technology to recover methane (energy), stable carbon, and nutrients from organic wastes such as manure, food processing wastes and the organic fraction of municipal solid wastes. We have evaluated the technical and economic performance of commercially available systems, developed improved AD reactors, and commercialized WSU patented nutrient recovery technology.

Results
Fifty-four farms are employing methods to reduce GHG emissions, and 23 commercial farm-based AD projects are now operating in the PNW (WA, OR, ID), processing over 7800 tons of organic waste daily. Four commercial scale nutrient recovery facilities have been installed nationally based on WSU patented technology. Data was collected from survey of project developers and estimates based on existing research.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
133	Pollution Prevention and Mitigation
205	Plant Management Systems
404	Instrumentation and Control Systems
605	Natural Resource and Environmental Economics
610	Domestic Policy Analysis

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)

Brief Explanation

There are numerous factors that influence our work on climate change. In 2015 the state of Washington experienced extreme drought conditions. Overall snow fall and high-elevation snow accumulation were significantly lower than average. This impacted communities, agriculture, and natural resource management. Our priorities related to climate change are to continue to develop crop varieties and crop management strategies to mitigate increasing temperatures and extreme fluctuations in environmental conditions. There is some resistance to the idea of climate change and some of our stakeholders are unwilling to accept this type of research and outreach as valuable or needed. Additionally, as in many of our programs, there were reduced baseline appropriations from the state to support our work. However, the concept of "climate change" as applied to marginal growing conditions has always been important in

Washington State and we have traditionally and much more so recently, sought grants and outside investments that have allowed this program to move forward, in spite of political opposition to the issue of climate change.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Our scientists were successful in procuring extramural research funding to develop crop varieties to deal with climate change. They are also investigating irrigation methods and other crop management methods to deal with the changing climate patterns. Increased knowledge and adoption of improved agricultural systems that support carbon sequestration is a primary focus of our work in climate change. Audiences were receptive to procedures and materials that will allow them to adapt to changing conditions, even as some reject the concept that some of the practice changes are motivated by an evolving climate. Self-reported knowledge increase by 21% of program participants and the intent to apply that knowledge by 13% of participants were the metrics selected to evaluate outcomes achieved through 15 educational events in this planned program. Deployment of anaerobic digesters and other GHG mitigation strategies on 54 farms was another measure of evaluation utilized.

Key Items of Evaluation

Approximately 21% of program participants indicated they acquired increased knowledge and skills relative to key learning objectives of this program. This measure is a calculated average of evaluations across program events where participants reported increased knowledge or skill through their participation.
Thirteen percent of program participants indicated an intention to use or apply one or more principles gained from 15 educational events delivered in this program area.
Fifty-four farms employed anaerobic digestion or other methods to reduce GHG emissions or to sequester carbon.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Childhood Obesity

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
134	Outdoor Recreation	5%		0%	
601	Economics of Agricultural Production and Farm Management	5%		0%	
604	Marketing and Distribution Practices	5%		0%	
607	Consumer Economics	0%		70%	
701	Nutrient Composition of Food	10%		25%	
703	Nutrition Education and Behavior	20%		5%	
704	Nutrition and Hunger in the Population	15%		0%	
724	Healthy Lifestyle	20%		0%	
806	Youth Development	20%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	40.0	0.0	2.0	0.0
Actual Paid	85.0	0.0	0.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
322456	0	13662	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
322456	0	13662	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
7835540	0	6469	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Researchers in the WSU Department of Human Development were funded for a project on "Children's self-regulation and obesity risk" They completed data collection on the 18 month follow-up for about 150 low-income Latina mothers and their children; Continued coding videotapes, analyzing data, and writing papers with this sample, as well as on a previously collected sample of 150 low-income African American and Latina mothers who were observed at three mealtimes; Continued to conduct the RCT study of our feeding intervention (SEEDs). About 75 low-income mothers have participated in the program along with 75 controls; Collected some 6- and 12-month follow-up data; Began work on revising our videos for use with EFNEP mothers to integrate in to an existing curriculum-Eat Smart Being Active.
Educational programming will be delivered to limited resource families through our nutrition education programs, which are funded by SNAP-Ed and EFNEP (Smith-Lever 3-D) programs. Additionally, youth development programs will expand emphasis on physical activity in a number of programs and project areas. Finally, technical assistance will be provided to farmers in the urban fringe to help them produce and effectively market produce to urban residents.

2. Brief description of the target audience

Limited resource families, youth enrolled in 4-H programs, and agricultural producers (generally small producers) operating in the urban fringe.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	145107	217660	162665	325100

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	28	9	37

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of educational programs delivered focused on increasing local food supplies, improving dietary quality, and increasing physical activity.

Year	Actual
2015	5660

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications published per year.

Year	Actual
2015	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.
2	Percentage of participants evaluated who applied acquired knowledge to improve their diet quality, level of physical activity, or production of locally-grown produce.
3	Percentage of participants reporting increased physical activity.
4	Number of communities cooperating with WSU program with farmers' markets and community gardens producing and/or selling locally grown fruits and vegetables.

Outcome #1

1. Outcome Measures

Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	89

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2015, people receiving basic food assistance remained relatively the same. The impact of limited income puts these families at risk for consuming foods of low nutritional quality and getting less physical activity. Consequently, they are at increased risk for nutrition-related health issues, including obesity and chronic disease. Compared to the other groups, low-income families consume fewer fruits, vegetables, and low fat milk and more high fat foods, sweetened beverages and other non-nutritive foods.

A second project, WSU Extension is engaged in focuses on a media literacy project. Television use is a documented risk factor for overweight among children. It is imperative to address children?s and adolescents? response to media messages as a factor in promoting healthy eating and preventing obesity.

What has been done
During 2015, 485 agencies from across 32 counties and 4 Tribes in Washington State partnered with WSU Extension to provide nutrition education to 301,232 individuals.

In the Media Literacy project, a Food Mania curriculum was developed for youth ages 9 to 14 and their parents. The pilot project was delivered in four counties around the state. Thirteen site level educators delivered the five-week program. One hundred and four people completed the pilot program. All participants completed pre and post-tests.

Results

Statewide, SNAP enrollees received an average of 4 lessons in direct education overall and adult series averaging six lessons. Of those adults enrolled in series classes and completed pre/post surveys, 38% and 48% respectively, increased the variety and quantity of fruits consumed, 38% and 50% respectively increased the variety and quantity of vegetables as snacks; 26% reduced the frequency of consuming high-sugar beverages; 56% use My Plate to plan meals more often, 52% use the label when food shopping and 40% shop with a list more often, 29% run out of food less often before the end of the month, and 32% increased the number of days each week they are physically active. Youth evaluations indicated that 40% of the youth ate more fruits and vegetables every day, 30% increased physical activity to 60 minutes most days of the week, and 34% improved skill using food labels to compare nutrition content of foods and 43% report eating breakfast that includes 3 food groups and use MyPlate to select healthful snacks.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
607	Consumer Economics
701	Nutrient Composition of Food
724	Healthy Lifestyle
806	Youth Development

Outcome #2

1. Outcome Measures

Percentage of participants evaluated who applied acquired knowledge to improve their diet quality, level of physical activity, or production of locally-grown produce.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	85

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Through the years, SNAP-Ed has expanded their approach to focus on the conditions, policies and environment. Large groups of individuals can be reached through this expanded approach beyond direct education. Community members, young and old are encouraged through the

physical environment to be more active; have greater knowledge and availability to healthier foods and through policy changes have increased access increasing their ability to make behavior changes.

One in three adults in Washington State have pre-diabetes. People with pre-diabetes are five to fifteen times more likely to develop type 2 diabetes, than those with normal blood glucose and they are at higher risk for developing other serious health problems like heart disease and stroke. The average medical costs for people with diabetes are twice as high as those without.

What has been done
SNAP-Ed trainings were held with partnering schools and community organizations and agencies to improve access and appeal of healthy foods and physical activity where people eat, live, learn, work, play and shop.

In 2015, faculty and staff in nine WSU Extension counties offered the Diabetes Prevention Education program. The program is either a self-pay flat-rate program or some insurance companies reimburse on a fee for performance basis. Performance fees are based on participant enrollment, attendance, and weight loss achievement.

Results
SNAP-Ed partnering schools and community agencies improved the food and physical activity environment, 231 nutrition and 126 physical activity supports were adopted that improved access and appeal of healthy foods and physical activity.

In 2015, participants reduced their cholesterol and blood pressure resulting in a elimination for medication. Participants lost between 5 to 10% of their body weight and reported becoming more physically active.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
604	Marketing and Distribution Practices
607	Consumer Economics
701	Nutrient Composition of Food
724	Healthy Lifestyle
806	Youth Development

Outcome #3

1. Outcome Measures

Percentage of participants reporting increased physical activity.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	72

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Regular physical activity has many benefits. Physical activity helps to prevent many chronic diseases, raises metabolic rates and helps individuals lose weight more easily, reduces stress, anxiety and depression and increases bone density. Overall, physical activity improves your quality of life. Longitudinal research has shown that physically active children become physically active adults.

What has been done
Generating Rural Options for Weight Healthy Kids and Communities (GROW HKC) aims to examine a model the rural obesogenic environment and develop and test an intervention to prevent childhood obesity. WSU Extension served as one of the partnering state with Oregon State University. Faculty worked with four rural communities in Washington. Faculty established community stakeholders, mapped the communities and developed an implementation project based on the community assessments.

Results
Each GROW HKC community project addressed a community environmental feature that supports healthy eating or active living. Port Townsend, WA designed a bike shelter at a Middle School, raised additional funds and built the structure. The covered bike shelter will encourage more youth to ride their bikes to school. Connell, WA built three-raised bed gardens specifically targeted for seniors with mobility challenges at the community garden. Community volunteers recruited and attained additional garden plots and taught individuals about gardening, growing and cooking their fresh vegetables.
The City of Kalama identified broken sidewalk as a hindrance to safe walking/biking between the designated parks and recreational areas. Fairfield Community chose to increase communication networks with a reader board for the town, to support healthy eating and active living messages.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
703	Nutrition Education and Behavior
724	Healthy Lifestyle
806	Youth Development

Outcome #4

1. Outcome Measures

Number of communities cooperating with WSU program with farmers' markets and community gardens producing and/or selling locally grown fruits and vegetables.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	345

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One of the main risk factors for obesity is a poor diet, which could be related to a low consumption of fruits and vegetables. One reason people may not eat many fruits and a vegetable is due to cost.

Research links people?s learning to grow vegetables with improved eating habits and health. The more experience people have with food, the more likely they are to eat it, meaning they eat more fruits and vegetables than non-gardeners eat. Diets high in fresh fruits and vegetables are known to prevent obesity, diabetes and other chronic illnesses. Seniors who garden eat more fruits and vegetables are more physically active and report a higher quality of life than non-gardeners.

What has been done
Over the past four years WSU Extension nutrition and food safety programs have received funding from a variety of sources for farmer market education. In Clark County, the FINI project funded weekly demonstrations focused on uses of the ?produce of the day and ideas for increasing daily produce consumption. Targeted SNAP=Ed audience who used their EBT cards for produce tokens and were given an extra $5 to purchase additional produce.

Results
Farmers Market directors feel that the presence of the WSU Extension display and educational efforts increased the knowledge of the people and encouraged them to purchase new kinds of produce and return on following weeks. Vendors also indicted they saw an increase in purchases from limited resource families using EBT tokens and fresh match tokens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
607	Consumer Economics
701	Nutrient Composition of Food
704	Nutrition and Hunger in the Population

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

WSU Extension Youth and Families have been able to increase our outreach and delivery in the Childhood Obesity program due to the acquisition of numerous competitive grants and contracts. Continued sustainability of these programs will be challenging especially in our rural communities. Washington wildfires impacted communities across Washington. Unhealthy air quality reduced outdoor activities. The treats of evacuation and coordination of support to neighboring communities severely impacted the delivery of educational programs.
Lastly, the access to Snap-Ed finances continues to cause stress throughout the system. The recent switch to an RFP has negatively impacted our program outputs, relationships with partners, and upcoming loss of high quality, talented staff.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Childhood Obesity prevention program measures the percentage of participants who demonstrated increased knowledge and skills relative to key learning objectives; percentage of participants who applied acquired knowledge to improve their diet quality, level of physical activity, or production of locally-grown produce; percentage of participants reporting increased physical activity; and the number of communities cooperating with WSU program with farmers' markets and community gardens producing and/or selling locally grown fruits and vegetables.

Key Items of Evaluation

Our evaluation methodologies were designed to assess the amount of acquired learning, degree of application of learning and the social, environmental and economic value of this application. We used post-program, retrospective and before and after assessments to document changes in knowledge. We used survey methods after an appropriate time lag to assess how much of the new knowledge was actually applied.

For the work with Childhood Obesity and overall health and wellness programs, the Socio-Ecological Model (SEM) provides the overall program and evaluation framework. Educators address individual's attitudes, beliefs, behaviors and choices in addition the environmental conditions in which our participants live.

Through the vast offering of WSU Extension foods and nutrition programs, Washington school age youth gain life skills in selecting healthy foods and learn to increase physical activity. Behavior changes that youth and their families are implementing will improve their health now and into the future.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
307	Animal Management Systems	0%		20%	
315	Animal Welfare/Well-Being and Protection	0%		5%	
504	Home and Commercial Food Service	25%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	15%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	25%		50%	
723	Hazards to Human Health and Safety	35%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	45.0	0.0	13.0	0.0
Actual Paid	26.0	0.0	20.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
231325	0	191537	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
231325	0	191537	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2269073	0	1325893	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research into epidemiology of foodborne diseases, especially in animal herds, and in mechanisms whereby pathogenic organisms reach the consumer. Our scientists also contribute to food safety by developing technologies for sterilization and pasteurization of foods using microwaves and better packaging to improve shelf life.
Major progress was made in the microwave-assisted pasteurization (MAPS) technology development, funded by a five year USDA NIFA CAPs grant (2011-2015, USDA AFRI 2011-68003-20096). A US patent "Method for recording temperature profiles in food packages during microwave heating using a metallic data tracer" (US Patent No. 8,981,270) was granted in March 2015; three new patent applications were made in 2015 to cover IPS. WSU has signed a license agreement to 915 Labs to commercialize microwave-assisted thermal pasteurization technology developed in this project.
Four companies have decided to acquire pilot-scale systems and small production system of MATS for new product development and penetration of new market. Australia Government has allocated millions of new funds to establish a research program, which will benefit USA companies with new knowledge and concepts developed in Australia. Several US companies has initiated internal research programs.
We quantified the influence of conventional and microwave-assisted thermal pasteurization processes on oxygen transmission rates of multilayer polymeric films. X-ray diffraction, thermal, FT-IR and dielectric analyses were used to explain structural and oxygen barrier changes in polymeric films subjected to pasteurization treatments. We developed methodology to determine influence of oxygen and water vapor transmission rates of polymeric packaging on the chemical changes in sterilized foods during storage.
Conferences, workshops, and onsite visits will be conducted. In some counties, volunteers will be trained to engage with the general public to provide training on home food preparation and preservation. Publications and websites will also be maintained as outreach instruments to the food industry and to consumers. A major continuing effort involves the transfer of microwave sterilization technology, which has achieved FDA approval at two levels, into commercial applications.

2. Brief description of the target audience

Food processors, food purveyors, food producers and the general public.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	123817	309542	227569	273082

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	58	193	251

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of conferences, workshops or other training sessions conducted by WSU Extension educators related to food safety.

Year	Actual
2015	394

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications published per year

Year	Actual
2015	8

Output #3

Output Measure

- Number of graduate students with a significant professional orientation in the area of Food

Safety.

Year	Actual
2015	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.
2	Percentage of evaluated participants who applied at least one practice learned from WSU Extension workshops, conferences, or training sessions.
3	Percentage of participants who will institute a HACCP or GAP plan as a result of attending WSU workshops.

Outcome #1

1. Outcome Measures

Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	98

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Whether handling food at home or in a commercial establishment of all sizes and types, knowledge of current food safety standards are critical to maintain the safety of the food supply. WSU Extension faculty and staff are concerned with individuals who process food at home, whether by canning, freezing, or dying. Faculty conduct extensive food safety trainings for food workers, owners and managers of food establishments, focusing on safety knowledge beyond that required to get a food handlers card. WSU Extension Specialists are also concerned about all food processing companies (of all types and sizes) in the Pacific Northwest region. Strong informational needs were recognized for faster development of the new food products, consistent production of the existing products, new ways to differentiate the food products in addition to developing products with extrusion processing.

What has been done
WSU Extension?s food safety outreach for 2015 was extensive and varied. Extension faculty, staff and volunteers conducted face-to-face trainings, workshops at Extension offices, Food Systems conferences and in-school classrooms focused on food safety, food preservation and storage. Informal educational demonstrations were scheduled at weekly farmers? markets, fairs and other community events. Newspaper articles, and electronic media such as blogs, Facebook, list-serves and e-communities were methods used to expand the educational reach. In addition, an online course was adapted from Iowa State University to further outreach.Working with the Washington State Dept. of Health, WSU Extension faculty developed a curriculum and training program called Person In Charge (PIC) designed specifically for food workers, owners and managers in food establishments. Faculty located on Tribal reservations offered classes and workshops as part of the Tribal food sovereignty movement

Results
Extension specialists, faculty, staff, and volunteers delivered 394 workshops, conferences, and teaching activities across Washington State. Tribal members who participated in the food sovereignty workshops, reported a 98% increase in understanding the importance of using tested, reliable recipes when canning and dehydrating foods. 117 food workers from 45 restaurants participated in the program. 98% of the food facilities are locally owned facilitates. Among 47 FIT workshop participants in 2015, increases in high to very high knowledge and potential impacts to their business were observed for the following categories: 95% increase for food ingredients functionality. 98% increase for process and ingredient interactions. 93% increase for ingredient quality and their importance in making consistent food products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #2

1. Outcome Measures

Percentage of evaluated participants who applied at least one practice learned from WSU Extension workshops, conferences, or training sessions.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	92

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

WSU Extension is recognized as a reputable source for information on food safety related to food handling, preservation, and preparation. The number of people growing his or her own food has tripled in the past five years. Food banks are getting more fresh produce from 15+acres dedicated to crops for the food bank. Increased access to local produce has led to more people wanting to know how to select, store and preserve these foods.

What has been done
A new Washington State Consumer Food Safety Specialist was hired to focus on developing a statewide educational approach and increase our educational capacity across the state. 64 4-H program leaders had completed the online training.

Results
Youth and adults that participated in various food safety workshops and trainings across the state replied to post test surveys immediately following the event and many responded to a follow-up survey after an appropriate assessment time.

Families surveyed reported improved some food safety practices such as not leaving food out of refrigerator more than 2 hours and not thawing frozen food on the counter.

Volunteers in Southwest WA tested 96 gauges at 17 clinics. 46% of the gauges were not accurate.

In all food facilitates that participated in the PIC training, all increased their inspection scores in one or two categories and prevented an outbreak of food borne illnesses this past year. Local Health Department inspectors reported they noticed that PIC trained food handlers are using the information learned and changing practices.
One hundred percent of the PIC participants indicated that they will be paying closer attention to their handling practices and those of workers around them. 90% indicated they will be helping educate other food workers

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Percentage of participants who will institute a HACCP or GAP plan as a result of attending WSU workshops.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food borne pathogens cause an estimated 9.4 million illnesses, 55,962 hospitalizations and 1,351 deaths yearly in the U.S. Maintaining a safe food supply requires vigilance from farm to table. Produce foodborne outbreaks decreased consumer confidence and increased buyer demand for third-party certification. The Food Safety modernization Act will impact produce growers as well as food packers and processors. The WSU ? IU food safety team interacted with national and state agencies, such as the Food and Drug Administration Office of the Deputy Director of Foods and Veterinary Medicine and Produce Safety staff, Washington- Oregon and Idaho- State Departments of Agriculture, Washington and Oregon State Departments of Health to address food safety issues in the Pacific Northwest. Performing educational outreach to promote food safety throughout the farm-to-table continuum in the state can reduce foodborne illness prevalence. Producer interest in implementing food safety practices is increasing; however, producers find initiating food safety programs overwhelming. Current on-farm food safety recommendations vary, and producers struggle to discern which are appropriate for their operation. Food safety education and applied research is vital for producers to understand, critically evaluate and manage food safety risks in their daily operations.

What has been done
The Northwest Food Safety and Sanitation Workshop was held to address basic sanitation as well as cutting edge issues related to food sanitation and food safety. Many of the attendees included the line employees of these companies, who are the majority of the people coming in contact with the food that is cleaned or processed and packaged. The workshop helped to train these employees about the basics of food safety, food handling, hand washing, basic microbiology, equipment designing for food safety, process safety and other related topics. This year, topics related to FSMA (Food Safety Modernization Act) was also covered by many speakers at the workshop. Over 475 attendees including the speakers and other invited attendees. The specific collaborating groups of this workshop were, WSDA-Washington State Department of Agriculture ODA ? Oregon Department of Agriculture IDA ? Idaho Department of Agriculture WNWFPA ? North West Food Processors Association OSU ? Oregon State University U of I ? University of Idaho.

Results
Northwest Food Safety and Sanitation Workshop participants reported increases in high to very high knowledge and potential impacts to their business were observed for the following categories: 89% increase for safety plans. 94% increase for basic food plant sanitation. 98%

increase for FSMA regulations. 87% increase for basic food microbiology. 95% increase for role of management in food safety.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
315	Animal Welfare/Well-Being and Protection
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Numerous external factors can impact the success of our extension and research programs. During 2015, Washington State experienced a number of devastating fires across the state. Educational programming was severely affected and the focus turned to survival and basic safe water and food provisions.
A resignation of an Extension Specialist and the delayed hiring of the Consumer Food Safety State Extension Specialist also impacted the extent of the program delivery.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Our Biological Systems Engineering Faculty member Juming Tang was awarded a USDA $4M Center of Excellence grant for his work on microwave sterilization/pasteurization. His work, and the work of others in this area have allowed WSU to showcase its' research accomplishments in this area.
WSU Extension continued to increase it's capacity to meet the ever growing and important need for home, consumer and commercial food safety education through face-to-face, social and print media and an online education program.
During 2015, WSU Extension faculty, specialists, volunteers and staff reached 123,817 adults and 227,569 youth through 394 workshops, demonstrations, fairs, farmers' markets or conferences. Participants increased their knowledge of safe food handling and

preservation or processing practices to minimize the risk of food borne illnesses.
Our Extension Food Safety Specialist developed a self-sustained program on "Value-added processing of the agricultural outputs to create safe and high quality food products". He started two new national level workshops, the Food Ingredient Technology Conference and a Food Extrusion Processing Conference. He led the Annual NW Food Safety and Sanitation Workshop and assisted over 600 small-scale food processors with their product and process development. Lastly, he assisted the WA State Ag Commissions in increasing the markets for their agricultural outputs.

Key Items of Evaluation

WSU Extension specialists, faculty, staff and volunteers continue to utilize evaluation methodologies that are designed to assess the level of acquired learning, degree of application of learning and the social, environmental and economic value of this application. We used post-program, retrospective and before and after assessments to document changes in knowledge. We used survey methods after an appropriate time lag to assess how much of the new knowledge was actually applied.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Youth and Family Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
801	Individual and Family Resource Management	5%		0%	
802	Human Development and Family Well-Being	25%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	15%		30%	
805	Community Institutions, Health, and Social Services	5%		50%	
806	Youth Development	50%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	48.0	0.0	1.0	0.0
Actual Paid	71.0	0.0	0.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
827785	0	83730	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
827785	0	83730	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
5921450	0	9359	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

One grant related to family and community wellbeing was led by Human Development researchers on the Interaction of individual, family, community, and policy contexts on the mental and physical health of diverse rural low-income families. This project was completed preliminary analyses to inform development of case study interview protocols; Identified selection criteria of case study participants; and published journal articles and presented research findings at various conferences.
Research-based programs will be delivered by extension professionals and supervised volunteers. These programs include 4-H club programs, and school and after school youth and family-based programs, such as Strengthening Families, that focus on enhancing preventive mechanisms.

2. Brief description of the target audience

Youth (K-12) throughout the state; military and minority families; urban and rural communities; current and future community and organization leaders; families; and volunteers, teachers and other educators.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	48396	110990	92106	148159

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	20	6	26

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of workshops, demonstrations, and projects developed to foster positive youth, family and community development.

Year	Actual
2015	8650

Output #2

Output Measure

- Number of peer reviewed (official) WSU Extension publications published annually.

Year	Actual
2015	13

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.
2	Percentage of participants evaluated who applied knowledge or skills from WSU programs.
3	Difference in grade point average between former 4-H members and peer students at WSU when they enter as university freshman.
4	High School graduation rates for 4-H members compared to their Peers.
5	Number of participants that reported an increase in family protective factors as a result of WSU programs.

Outcome #1

1. Outcome Measures

Percentage of evaluated participants who demonstrated increased knowledge and skills relative to key learning objectives.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	85

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
oWashington State University Extension?s 4-H Youth Development programs create opportunities and deliver educational programs that advance the situations for young people, families and their communities. Our youth development programs focus on enhancing the capacity of youth in grades K-12. Interventions that these young people receive develop their assets (generally refer to as ?life-skills?). While it has long been accepted that parents, siblings, and local communities make significant impact on a youth?s life and development, young people are increasingly influenced by values, ideas and cultural norms far beyond the borders of any single family or community. Exposure from global media including social media and other technologies have a large and profound influence upon our youth. 4-H Youth Development Programs are planned, intentional educational outreach efforts of sufficient intensity, frequency, duration, and interval to ensure that measureable outcomes are obtained. These intentional educational efforts built not only the life skills of youth but also built the life skills of the adult volunteers who mentor them. Extensive effort is invested in the volunteer mentors, over 5400 of them, to best prepare them to build the capacity of youth for growth and development. Extension adds further value to its work in youth development through its capacity to engage families, and Extension professionals in youth and family development work to ensure that both parents and young people are acquiring the skills that they need to build strong families.

What has been done
In 2015, 4-H life skill educational programs were conducted in all of Washington?s 39 counties and one tribal Extension program. There were over 8,650 distinct 4-H life skill events/activities/programs reaching over 92,106 youth with educational outreach efforts in our three mission mandate areas: mentoring and STEM, citizenship, leadership and healthy living. The life skill events/activities/ programs included but were not limited to: YA4-H!, State 4-H Teen Leadership Conference, District Teen Rallies, 4-H Know Your Government Conference, club and

project work, school enrichment, environmental education and camping and programs.

Results
For many of the statewide events and activities, a pre-post retrospective survey is implemented. Participants identified increases in life skills such as decision making, self-responsibility, understand and see positive oprtion for their future and learning wise use of resources.

Nationally, the Common Measures tool is helping 4-H continually improve programs so that we can reach even more young people with a life-changing 4-H experience. It assesses the impact of 4-H through science, healthy living, citizenship and college/career readiness. These evaluation measurements also assist in cross-program comparison by allowing various programs to be examined on similar outcomes and outputs. Training was provided to Washington 4-H faculty and youth in late 2015. Utilization of this new evaluation tool will begin in 2016.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #2

1. Outcome Measures

Percentage of participants evaluated who applied knowledge or skills from WSU programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	78

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The ConAgra 4-H Food Smart Families Project expands on an existing Youth and Family program through Washington State University, Youth Advocates for Health (YA4-H!) program. YA4-H! trains teens as teachers and advocates for health. They in turn work in partnership with adult leaders to develop county teams to teach youth ages 8-12 nutrition, cooking, budgeting and active living skills using the Choose Health Food Fun and Fitness (CHFFF) curriculum within their communities. The goal was to reach twenty-five hundred youth and their families in thirteen counties across Washington State, in partnership with a variety of community serving agencies. Family events engaged parents and families in experiential activities to expand the learning and increase family knowledge of healthy eating practices. The ConAgra Food Smart Families program aims to support healthy food choices, from point of purchase, to preparation and enjoyment at the family table.

What has been done

Washington State University 4-H Food Smart Families program expanded to thirteen county extension sites. The program focused on developing teens as teachers to deliver nutrition information to younger youth in their communities. Youth Advocates for Health (YA4-H!) Teens as Teacher training was used to train youth-adult partners from each county. The training engaged participants in experiential learning activities to develop youth adult partnerships and train teens in teaching skills and Choose Health Food, Fun and Fitness curriculum. The youth adult partners from each county, in turn recruited and trained additional teens from their counties to participate in the program. A total of fifty-six teens participated in leadership positions, promoting health in their communities. The youth adult partners presented 115 series of the CHFFF lessons, reaching 2,199 younger youth across the state. The CHFFF curriculum includes a nutrition, food preparation and active games in six ninety minute lessons, additional activities incorporating budgeting concepts were developed and included in the program. Family newsletters reinforcing lesson content were sent home with participants to 1,831 families. Thirty-two family events were held across the state. Youth ? adult partners planned events where youth demonstrated what they learned during the lessons, sampled recipes, and participated in games and activities. A total of 2,307 families and 4,081 youth participated in these events. Three counties reaching diverse population, Hispanic Latino, Native American and Military base distributed bags of groceries to participating families at family events. These events included a family meal as well as education events, where youth demonstrated what they learned in the Food Smart Families Program.

Results

Thirty-one teens and adult partners from the thirteen county sites attended a YA4-H! Food Smart Families training April 25- 27. The training team included Co-PIs, three teen leaders, evaluation staff and an additional 4-H Youth Development specialist. Participants were engaged in experiential learning activities to develop youth adult partnerships, teen teaching skills, and curriculum content using YA4-H! Teens as Teachers curriculum and CHFFF lessons. Evaluation of training indicated participants gained knowledge and skills in developing youth adult partnerships, working with groups, teaching the CHFFF curriculum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #3

1. Outcome Measures

Difference in grade point average between former 4-H members and peer students at WSU when they enter as university freshman.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

High School graduation rates for 4-H members compared to their Peers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth who engage in post-secondary education and training far exceed their high school graduation only peers in life-long earning capacity and employment capacity. Some studies has indicated that a Bachelor?s Degree has a value of $1.1M over the lifetime earnings of a high graduate obviously contributing to the overall economic stability of families and communities. US employers say that the inability to find qualified workers is their biggest obstacle to growth. For the first time, young adults risk having lower educational attainment rates than their parents. By 2018, more than 60% of American jobs will require at least an associate?s degree.

What has been done
For the past five years, Washington State 4-H has been conducting an impact survey of 4-H participation reflected as youth engagement in post-secondary education and training called the Graduation Impact Survey. A simple protocol was developed, a series of five questions to be answered by 4-H volunteers for data related to 4-Hers who have ?aged-out? of 4-H. To date data

has been collected from 1701 former 4-H members with 75% of all Washington Counties reporting. IRB approval was completed. Post-secondary programs are defined as certificate programs such as cosmetology school, military, vocational school, formal apprentice programs, community college, 4 year college or university. County educators were recruited to participate. The surveys were completed by club leaders about the graduating 4-Hers in their clubs. The data were sent into a central location where it was summarized for reporting.

Results
Washington 4-H members who have completed the 4-H program by receiving a high school diploma or GED and/or reached the age 19 (too old to be a 4-H member). 38% are attending/enrolled in a post high school education program and are working; 42% are now attending/enrolled in a post high school education program and are working; 17% have a full or part-time job and are not attending/enrolled in a post high school education program; 2% do not have a full or part-time job and are not attending/enrolled in a post high school education program; and 9% are status unknown.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #5

1. Outcome Measures

Number of participants that reported an increase in family protective factors as a result of WSU programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The award-winning Strengthening Families Program for Parents and Youth Aged 10-14, is a parent, youth, and family skills-building curriculum that focuses on strengthening parenting skills, building family strengths, and preventing teen substance abuse and other behavioral problems.

The Strengthening Families Program (SFP) strives to improve parental nurturing and limit-setting skills, improve communication skills for parents and youth, and encourage youth pro-social skills development. The program is important because substance abuse is a serious and costly problem in Washington State and nationwide. In a 2012 survey by the Washington Department of Social and Health Services, 23% of 10th graders in Washington said they had been drunk in the past 30 days, and one in five had driven while drinking.

What has been done
In 2015, over 50 facilitators were trained, and participants represented diverse groups including Latino and African American communities. In 2015, five community sites implemented SFP program in Spanish and one program was composed of African American participants only. In 2015, we received evaluation data from 17 SFP programs, serving 93 families in 7 counties in 2 states. We produced 17 impact reports for agencies that completed the program and submitted evaluation data.

Results
The evaluation consists of validated measures assessing protective factors in the domain of family functioning (e.g. family harmony, parents' rule setting parent-child involvement, and family communication). Four out of five parent measures of these protective factors show significant improvement from pretest to posttest ($p < .001$).

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Numerous external factors can potentially impact the success of our programs. Wild fires that raged across Washington State in 2015, affected our ability to deliver planned programs and workshops. The continually reduced funding has most recently damaged our ability to achieve previous targets, especially because there are fewer peopled employed by Extension in the counties and on the state level.
Changes in political priorities also impact the effectiveness of our work either by changing the availability of resources supporting our programs or by altering the available options for target audiences.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Our evaluation methodologies are designed to assess the amount of acquired learning; degree of application of that learning; and the social, environmental and economic value of this application. We will used post-program, retrospective, and before and after assessments to document changes in knowledge. We used survey methodologies after an appropriate time lag to assess how much of the new knowledge was actually applied. Finally, we will use research methodologies, industry assessments, and survey responses to determine the social economic and environmental values derived from the application of new techniques.

Key Items of Evaluation

Regarding Strengthening Families, facilitators administer evaluations to parents and youths separately on the first and last nights of the program (pretest-posttest). The evaluation consists of validated measures assessing risk and protective measures in the domain of family functioning (e.g. family conflict, parents' rule setting). Four out of five parent measures show significant improvement from pretest to posttest ($p < .001$).
The 4-H Youth Development program's key items of evaluation include all major statewide adult leadership training events and the statewide teen program outreach efforts. Additionally, all age-out 4-H youth were reviewed for their high school graduation attainment and their post-secondary education and training engagement.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Community and Economic Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
604	Marketing and Distribution Practices	10%		0%	
608	Community Resource Planning and Development	50%		0%	
610	Domestic Policy Analysis	20%		0%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	20%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	23.0	0.0	0.0	0.0
Actual Paid	46.0	0.0	0.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Institution Name: Washington State University

Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
537344	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
537344	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3843815	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research-based programs will be delivered by extension professionals. Communities, local/state government agencies, and non-profits will be engaged to collectively analyze situations and recommend mechanisms to enhance public services. CED applied research and education programs will be customized based upon community need and delivered by programs such as Food Processing, the WSU Division of Governmental Studies and Services, the William D. Ruckelshaus Center, and the Composite Materials and Engineering Center. Finally, county-based programs will be delivered that lead to enhanced non-profit capacity.

2. Brief description of the target audience

Community leaders
Local/state government officials, policy-makers and staff
Non-profit leaders and staff
Latino and other small business owners
Special interest groups
Economic development professionals
Private sector leaders in the composite materials and food processing industries
Limited income families

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	32572	162860	2522	8195

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	15	46	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- The number of communities increasing their use of digital technologies.

Year	Actual
2015	46

Output #2

Output Measure

- The number of local governments, state agencies and non-profits assisted.

Year	Actual
2015	2412

Output #3

Output Measure

- The number of existing or new businesses and entrepreneurs assisted.

Year	Actual
2015	1533

Output #4

Output Measure

- The number of people receiving family asset building education.

Year	Actual
2015	635

Output #5

Output Measure

- The number of people/agencies provided information that promote export of Washington products.

Year	Actual
2015	535

Output #6

Output Measure

- The number of scholarly products produced by CED educators.

Year	Actual
2015	103

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of communities enacting processes to increase economic development or the use of digital technologies.
2	Number of local, state, or non-profit entities increasing their capacity to function more effectively.
3	Number of existing or new businesses and entrepreneurs assisted through increased knowledge, including good business practices, food processing safety, composite manufacturing, and exporting.
4	Number of people who initiate family wealth building activities.

Outcome #1

1. Outcome Measures

Number of communities enacting processes to increase economic development or the use of digital technologies.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	107

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recovery in our rural areas continues to lag far behind our metropolitan areas. Seventeen (17) of Washington?s rural counties are suffering unemployment rates of 8% to 10%. Therefore, local economic development and supporting small businesses remain top priorities for our rural decision-makers. Broadband access has become a necessity whether you live in downtown Seattle or rural eastern Washington. For those fortunate enough to have access to this service, training and assistance is often needed to be able to take full advantage of the opportunities: education, economic, health care, and public safety. Many of Washington areas have become more culturally diverse with very significant Latino populations. Latino small businesses bring a new vibrancy to our rural small towns. However, Latino entrepreneurs continue to suffer high failure rates when starting a new small business (up to 50% in the first year of operations and another 35% by the fifth year). Their challenges, in addition to the common ones for any small business owner, include: a lack of awareness of and access to capital, absence of linguistic and cultural appropriate services, and unfamiliarity with regulations and policies governing small businesses. The development of a bio-fuels industry utilizing a wood-based feedstock would contribute to both rural revitalization and the country?s green energy portfolio.

What has been done
WSU Extension?s Community & Economic Development (CED) program continued to partner with leaders in rural areas to foster local economic development, increase small business assistance, and expand broadband deployment. Notable activities included: (1) the development of woody biomass aviation fuel, (2) initiated a local investment network pilot program with the Association of Washington Cities, (3) the development of community structures and capacity to support local rural businesses, including Latino small businesses, (4) assisting rural communities and tribes address broadband access by mounting broadband planning and adoption programs and launching a tribal technology training initiative, and (5) providing technical assistance for Washington State?s FirstNet public safety communications outreach. Additional activities

included conducting extramural fund development, surveys, focus groups, community forums, presentations, training, applied research, and providing information to the public.

Results

o The centerpiece of WSU Extension?s CED efforts in rural development is Washington Rural Pathways to Prosperity Conference. This conference won the national Leadership and Collaboration Award of Excellence from the University Economic Development Association in 2015. https://news.wsu.edu/2015/10/02/extension-program-to-boost-rural-economies-earns-award/ Using digital technology, the conference reached over 300 residents, in 20 rural locations across Washington.

o WSU Extension?s work on woody biomass aviation fuels is taking place through the Northwest Advanced Renewables Alliance (NARA) grant. In its final year, NARA is a five-year, $40 million project supported by USDA to explore woody biomass as a source of aviation bio-fuels. The project includes a broad alliance of private industry and educational institutions from throughout the Northwest. Outcomes to date for the NARA initiative can be found at https://nararenewables.org/.

o In 2015, WSU Extension?s Program for Digital Inclusion had a number of successes:

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
610	Domestic Policy Analysis
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #2

1. Outcome Measures

Number of local, state, or non-profit entities increasing their capacity to function more effectively.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1951

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It can be argued that the success of the United States is the result of its strength in private enterprise and good governance and a healthy non-profit sector. It is through government that we meet the majority of our collective basic needs: safety, healthy environment, and education. In addition, it is through a vigorous non-profit sector that we undertake actions that benefit our communities and/or contribute to our quality of life.

What has been done

WSU Extension?s efforts in local and state government assistance primarily took place through the William D. Ruckelshaus Center (Center) and the Division of Governmental Studies and Services (DGSS). DGSS is devoted to providing high quality research, training, and technical assistance to federal, state, and local government agencies throughout Washington State. http://dgss.wsu.edu/ Of particular note is DGSS?s work with law enforcement agencies and emergency management. Conversely, the Ruckelshaus Center?s mission is to act as a neutral resource for collaborative problem solving in the state of Washington and the greater Pacific Northwest. The Center provides expertise to improve the quality and availability of voluntary collaborative approaches for policy development and multi-party dispute resolution. http://ruckelshauscenter.wsu.edu/ Additionally, both DGSS and the Center provide training targeted to local, state, and federal agency personnel and special interest non-profits. oWSU Extension launched a major initiative, in 2015, to better serve Washington?s metropolitan areas through the development of the WSU?s Metropolitan Center for Applied Research and Extension (Metro Center). The Metro Center puts the people?s university to work for Washington?s cities - utilizing applied research to develop practical knowledge and place-based solutions for urban problems. http://metrocenter.wsu.edu/

Results

oIt is through DGSS that Extension undertakes the majority of its organizational development work with governmental entities. In 2015, DGSS undertook 19 external projects and provided leadership for WSU?s emergency management activities. In addition, DGSS was on point for WSU?s and Extension?s response to the 2015 wildfires in northcentral and northeastern Washington. Additionally, DGSS provided campus leadership for Extension community development efforts in response to the Oso mudslide across State Route 530 that took the lives of 43 people in the Stillaguamish Valley. In recognition of the excellent work of the WSU Extension SR530 Mudslide Project team, they were the recipients of the National Association of Community Development Extension Professionals 2015 NACDEP Excellence in Teamwork Award.

oWSU Extension?s 2015 outcomes in multi-party collaborative public policy development included the efforts of Ruckelshaus Center. Current and past projects can be found at http://ruckelshauscenter.wsu.edu/projects/index.html.
The Center had many outcomes in 2015:
1.Chehalis Basin flood mitigation project wherein the Washington Legislature provided $50 million to undertake an EIS of the proposed recommendations. http://chehalisbasinstrategy.com/
2.the Spokane River Regional Toxics Task Force, a collaborative group of governmental agencies, private industries, and environmental organizations attempting an innovative approach to the reduction of toxic polychlorinated biphenyls (PCBs) within the Spokane River. http://srrttf.org/
3.the Center?s founding Advisory Board Chair, William D. Ruckelshaus received Presidential Medal of Freedom.
http://ruckelshauscenter.wsu.edu/uncategorized/ruckelshaus_medal_of_honor_recipient/

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
610	Domestic Policy Analysis
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #3

1. Outcome Measures

Number of existing or new businesses and entrepreneurs assisted through increased knowledge, including good business practices, food processing safety, composite manufacturing, and exporting.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1361

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The small business sector remains a vital component of most local economies. The health of this sector is fundamental to the sustainability of our communities. This sector of the economy suffered greatly during the last recession and has been slow to recover. Additionally, the supply chain businesses of Washington?s local food systems remain a substantial part of the State?s economy. Lastly, Washington remains both a substantial hub for both exports and imports of goods from Asian markets.

What has been done
Business development and assistance provided through WSU Extension focuses on agriculture, agri-businesses, business in small rural communities, and composite/wood manufacturing. Currently, there is an emphasis on serving small businesses and entrepreneurs in Washington?s growing Latino population. WSU Extension fields a number of different programs:

1.WSU Extension lead the Cascadia Grains Conference. https://cascadiagrains.com/

2.Extension?s Community and Regional Economics program focuses on the analysis of Washington state exports and Regional Economic Modeling.

3.The Composite Materials and Engineering Center (CMEC), develops innovative structural systems to effectively utilize new materials while maintaining economic viability and public safety. http://cmec.wsu.edu/

4.The WSU Food Processing Program focusing on food safety, process improvement, and new product development. http://foodprocessing.wsu.edu/

5.WSU Extension is dedicated to serving the growing number of Latinos small business entrepreneurs. To help these entrepreneurs succeed, Extension supports The Latino Community Studies Program. http://ext100.wsu.edu/latinocommunity/

Results
During 2015, over 1,300 individuals, entrepreneurs and/or businesses were provided information, training and/or technical assistance. There were several outcomes in this program area:

1.The Cascadia Grain Conferences was the largest to date, with 293 attendees,
2.In 2015, CMEC continued to provide direct assistances to manufactures involved in composite materials production or the reuse of waste materials for composites.
3.CED faculty initiated the Local Investment Network pilot project with the Association of Washington Cities in 2015. The pilot took place with seven rural communities seeking to increase local investment in local businesses.
4.In 2015, the Latino Community Study program undertook the new ?Latina Total Well-being? workshop series.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
610	Domestic Policy Analysis
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #4

1. Outcome Measures

Number of people who initiate family wealth building activities.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	549

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is an increasing disparity in the United States between wealth distribution and income classes with more wealth continuing to concentrate at the top. This increasing disparity is also true in Washington. Some of the causes may be inherent to the structure of our economy, while others can be addressed through decisions and actions of the individual.

What has been done
Over the past decade, WSU Extension has mounted efforts to address wealth creation for limited income families. These efforts were commenced with support from the Northwest Area Foundation and, more recently, the Paul G. Allen Family Foundation. Through the support of these Foundations, Extension has undertaken financial literacy education, micro-enterprise development, debt counseling, and capacity-building activities for regional non-profits serving low-income populations. During this same time period, Washington state government all but eliminated its investment in these activities while private foundations have either changed their priorities or re-calibrated who will be the recipients of their support. As a result, and as noted in last year?s report, we are tapering out these efforts in CED and resources have been redirected to other local economic development programs. Thus, the decline in people served during 2015. Going forward, CED?s only substantial effort aimed squarely at poverty issues will be our governmental and non-profits Poverty Simulations.

Results
Extension engaged with 635 individuals in support of family wealth building in 2015. This included eight public entities and their staff who went through ?poverty simulations? to help their organization understand the day-to-day financial difficulties of their limited income clients. This includes both local and statewide groups in health care, emergency management, and school districts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
608	Community Resource Planning and Development
610	Domestic Policy Analysis
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The national economy continues to negatively impact higher education funding at all levels. Once again in 2015, private foundations in the West seemly are remaining on the sideline and were not investing in intermediary organizations such as Extension. While we have excellent staff and well-structured programs with innovative approaches, the lack of available and consistent funding to continue our efforts or implement new ones remains an obstacle.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

In 2015, we continued to see the positive result of WSU Extension's restructuring to three program units. In CED, we increased our efforts with tribal communities and concentrated on assisting the communities of Darrington and Arlington which were impacted by the landslide that killed 43 people. At the same time, the unit also worked with communities, non-profits, and public agencies throughout the state through multi-disciplinary project teams that drew upon faculty from four WSU colleges/schools and the University of Idaho, Portland State University, Montana State University, and the University of Washington. Again, the outcomes of CED faculty work included both helping decision-makers formulate state policy and assisting local communities strengthen their governmental, non-profit, and private sectors.

Key Items of Evaluation

The metrics chosen for WSU Extension's CED work reflects an orientation towards supporting local economic development, better governance, and support for select industrial sectors. A premium is placed on activities that simultaneously move multiple program agendas forward (e.g., our Latino business development work that supports the establishment of community level organizations that assist small businesses and director assistance to small business owners increase the success of their business which in turn contributes to the vitality of the community).
The metrics utilized to evaluate our work consist of the recognized key metrics for success formulated by the communities we serve. Primarily, our economic development assistance is aimed at creating new business and entrepreneurs. These metrics are at the top of list of

our community, state, federal, and private sector partners as well. With regards to our community capacity building efforts, the metrics chosen are indicators that act as surrogates for evaluations, measuring increases in social capital. These include better governance work through informed public policy development (e.g., work done through the William D. Ruckelshaus Center) and improved local and state agencies processes (e.g., work done through the Division of Governmental Studies and Services).

Lastly, our scholarly activities are aimed at contributions to the discipline of Extension and disseminating best practices and new program innovations to those we serve: the residents of Washington state.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
4000	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
170000	Tons of feedstocks delivered.