2018 Oregon State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

In this annual report, the Oregon Agricultural Experiment Station (OAES) will summarize outputs and outcomes from its six Planned Programs.

Collaboration

The Oregon Agricultural Experiment Station (OAES) during the 2018 year continues its tradition of collaboration across disciplinary and organizational lines. This year, collaborative work has changed as the Station has completed 5 broad collaborative program projects and begun implementing six new research projects to address NIFA program areas. Unfortunately, for the purposes of this report, we continue to have state defined outcomes related to the previous projects as we have not had the ability to update the POW since 2015. Consequently, most outcomes are those associated with the old projects and unrelated to our current efforts. Our new POW will include thematic areas focused on animal production systems, natural resources, and water. Climate change will be a recurring theme across a number of thematic areas.

Funding

One of the Experiment Station's state performance metrics is external funds leveraged per dollar of state funding. In 2017-2018, $30 million in state appropriations were leveraged by faculty to generate $90 million in external fund expenditures, yielding a metric of nearly 3:1.

NIFA Program Areas

Research programs address the six thematic areas defined by the National Institute for Food and Agriculture. Program foci cover Sustainable Energy, Food Energy Water Nexus, Climate Change, Global Food Security, Food Safety, and Obesity. As mentioned previously, our new POW will include thematic areas focused on animal production systems, natural resources, and water.The following are highlights from our existing Planned Programs.

Food Energy Water Nexus

Water shortage and nitrate pollution is mostly attributed to irrigated agriculture. Our long-term goals are to restore 12,300 ha-m of water supply and reduce nitrate in groundwater to < 10 mg L-1. We will be utilizing Hatch and state matching funds to support OSU CAS scientists dedicated to solving water, food, and natural resources problems in Umatilla Basin to reach these goals. Through integrated research, education, extension, and outreach activities, the projct will address systemic challenges to improving water quality and access to water for food production and ecosystem health. In this phase, we will characterize basin hydrology and ecosystem health, and determine source and extent of nitrate pollution. We will apply models to begin formulation of best management practices based on this information. This proposal is submitted in response to Oregon DEQ's declaration of CGA and GWMA in the Umatilla Basin.

Additionally, we have initiated research targeting PV solar generation and traditional cropping practices. Preliminary research suggests that "agrovoltaics" are a possibility; that is, the production of energy and food production need not be mutually exclusive but can be complimentary.

Climate Change

The collaborative project addressing this program area has been completed. Research continues to evaluate new crop varieties that will perform well in a warmer and drier climate. Additionally, improving water use efficiency to reduce consumption and reuse of process water and waste water streams to improve quality of shallow aquifers remains an important focus in this area.

Decision making tools that allow producers to better evaluate planting, cropping, and harvesting strategies for both conventional crops and new crops continues to be a focus of much research and outreach activities.

Faculty members are enhancing existing agricultural and biological models, life cycle models and economic/policy models, and exploring the opportunities and the methods to couple them (formally and informally) to better understand interactions among climate, crop and land use changes, ecological and environmental changes, and policy and economic factors.

Global Food Security and Hunger

Global food security represents access to food at many levels. The health of the animal food sources, as well as plant sources, is important to maintain and expand the nutrition of populations. However, disease is still common in food sources. Many pathogens evolved to survive in the prevailing conditions existing during the course of food production and food conservation may be deficient even in the developed world. Further, if the source of the food is diseased, for example, Johne's disease in cattle or Vibrio tubiashii in seafood or Clostridium perfringens infections in several meat animals (pork, poultry, etc) , the security of food will be compromised. We propose objectives which address aspects associated with food security during food animal production, that is, developing diagnostic tests and vaccines and creating a better understanding of the mechanisms of pathogenesis of many virulent bacteria and viruses.

Creating more resilient crops, including specialty crops is another focus of this research and outreach. A changing climate can accelerate virulence of existing pathogens or allow for the expansion of previously undocumented pathogens. Similarly, introduction of invasive species or inadvertent introduction of new insects can all threaten global food security. Finally, we have focused on training a new cadre of agricultural scientists that recognizes the importance of diversity and inclusion to ensure that all people across the globe have access to a secure food supply.

Food Safety

The implementation of the Food Safety and Modernization Act (FSMA) will have a major impact on agriculture, especially small farms throughout the U.S. A critical need exists for development of a cost effective and simple-to-implement Food Traceability System(FTS) for small producers and processors. OSU researchers will model several small scale food production systems: berries, tree nuts, seafood and meats in order to identify and report both common and unique barriers to FTS implementation. The team will evaluate current technology in the context of how it's able to be implemented and recommend solutions for FTS implementation for small-scale systems.

OSU researchers and extension faculty are actively engaged in efforts to reduce the prevalence of herbicides and pesticides through application of IPM. Faculty members are also seeking new ways to improve food safety from the time the food is harvested until it is delivered to the table. This includes new processing and handling techniques as well as new packaging, storage, and food preparation applications.

Childhood Obesity

Research efforts have lessened during the reporting period due primarily to faculty retirements and transitioning from research to dissemination of findings through outreach and engagement. The project team will apply a social-ecological framework to study how exposure and familiarity with more nutritional foods can increase incorporation of these foods into diets of various populations, as well as increase acceptability. The study will also determine if the greater exposure and familiarity with whole grains, vegetables and fruits increases the selection and incorporation of these foods into typical dietary patterns at home and in school lunches as well as among seniors in residential retirement communities.

Sustainable Energy

While methods to ensure sustainability of the energy resources have been sufficiently well developed, other natural resources such as water and nutrients are not often considered in detail in these frameworks. With the emerging nexus of bioenergy production and water there is a need to develop and validate assessment frameworks that can be used to evaluate the sustainability of energy, water and other natural resources in a unified theoretical framework. This is especially important for water limited U.S.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	193.0	0.0	215.0	0.0
Actual	184.6	0.0	403.0	0.0

II. Merit Review Process

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

- Internal University Panel
- External University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review

2. Brief Explanation

Merit reviews of collaborative proposals are reviewed by the Director, Associate Directors and the Assistant Director prior to project consideration for internal review. Internal reviews were conducted by staff and faculty prior to each proposal being submitted to expert peer review. Peer reviewer comments were incorporated into the final proposals before submission to NIFA for subsequent review. Multi-state project reviews follow the NIFA prescribed process through the Advisory Committee and WAAESD.

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
- Other (cspan)

Brief explanation.

The Director, as well as Associate Directors, Assistant Director and the External Relations Director, traveled throughout the state to interact at formal and informal stakeholder events. Events included field days, special commodity events, County and State fairs, faculty organized conferences and workshops. They also attended events organized by various industry, public and nonprofit entities to interact with stakeholders. Faculty also attended all events.
Reviews of unit leaders and faculty are conducted periodically to assure that personnel are responding appropriately to relevant stakeholders, industry, and consumers.

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
- Other (blogs, fairs, websites,)

Brief explanation.

Extension, Station, and departmental faculty, as well as unit leadership provide information on critical stakeholders and groups. The deans and the External Relations Director also identify important clientele through their many contacts. The Director's advisory group is composed of industry and community leaders. They meet regularly to update the Station administrators about critical issues and developments around the state or in their industry. Every branch station enlists stakeholders to serve as an advisory council for station work planning and research emphasis.

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.

Specific events were scheduled to gather input as well as continually recieving unsolicited input through a variety of public venues open to stakeholders and non-stakeholders alike. The University and College just completed a $1.1 billion dollar capital campaign that generated considerable input from a variety of non-traditional sources. The Strategic Intent process was used to garner input from other University Stakeholders from outside the College to aid with creation of joint mission areas and collaboration that encompasses all entities involved in natural resource management.
Social media via Twitter, Facebook, and hosted web pages also provide a venue for soliciting input and gauging reactions to Station announcements, programs, and published articles. Gathering data on the number of visits and the demographics of those visitors provides valuable insight into stakeholder interest and emerging issues.
Beginning in 2018, the University will begin a new strategic planning exercise and capital campaign that will provide valuable input from stakeholders. This strategic plan (SP 4.0) emphasizes research and AES research will be an important emphasis moving forward.

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
- Other (Strategic Intent)

Brief explanation.

Stakeholder input was used to adapt our curriculum with more experiential learning and incorporation of more agribusiness courses as part of the core. We have also begun to focus more effort on AI and machine learning to address the ongoing labor shortages associated with new immigration policies. Finally, we have adopted more writing intensive courses to improve graduate proficiency in communication of work efforts in their professional fields.

Brief Explanation of what you learned from your Stakeholders

Producers are becoming increasingly aware of the impact trade policies have on agriculture. As developing countries have expanded their middle classes, their is increased global demand for US specialty crops and organic crops. Too often, producers suffer the consequences of reduced international demand because foreign trade policy ignores the impact on agriculture. Secondly, the logistics of transporting goods both nationally and internationally is often overlooked as labor disputes, competition with oil shipments, and changing international political dynamics adversely affect agricultural producers, processors, and consumers.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1441011	0	3671899	0
Actual Matching	1579333	0	38795090	0
Actual All Other	3685480	0	43153132	0
Total Actual Expended	6705824	0	85620121	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	409122	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

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	10%		5%	
111	Conservation and Efficient Use of Water	10%		15%	
112	Watershed Protection and Management	10%		15%	
125	Agroforestry	10%		5%	
131	Alternative Uses of Land	5%		5%	
132	Weather and Climate	5%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
402	Engineering Systems and Equipment	5%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		10%	
511	New and Improved Non-Food Products and Processes	5%		5%	
601	Economics of Agricultural Production and Farm Management	5%		5%	
608	Community Resource Planning and Development	10%		10%	
609	Economic Theory and Methods	5%		5%	
903	Communication, Education, and Information Delivery	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	4.0	0.0
Actual Paid	2.0	0.0	1.0	0.0
Actual Volunteer	619.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
43230	0	421241	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
47379	0	4425785	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
110564	0	1982400	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

In summary:
- Conduct basic and applied research
- Develop models and simulation tools including LCA and LES.
- Develop new culture strains and metabolic engineering tools
- Develop energy saving techniques and recycling of green waste
- Develop products, resources
- Conduct surveys and assessments
- Conduct data analyses
- Conduct workshops
- Lead short course and training seminars
- Provide training
- Partner and engage with community and environmental organizations
- Contribute to trade and peer reviewed journal publications

2. Brief description of the target audience

The target audiences are:

- public sector
- private sector
- economists
- policy makers
- agricultural biotechnology firms
- farmers and agricultural managers
- livestock growers and managers
- energy (including bioenergy/biofuel, hydrogen and fuel cells) industry,
- forest owners and managers
- research community at large
- environmental organizations
- community members

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4424	9395	2865	13227

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

Patent Applications Submitted

Year: 2018

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	15	5	20

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Conduct research to explore the compatibility of PV panels with agricultural production. The expectation is that many existing crops can be grown under newly designed PV panels that will enhance crop production while improving economic returns and energy to the producer.
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improved knowledge about composition and conversion of feedstocks for biofuels, bioenergy, and bioproducts, including co-products (number of new technologies developed, feedstocks (crops or organisms) investigated, residues or invasive species addressed)
2	Improved agricultural or engineering applications to advance production systems for bioenergy, such as, a) new technologies, such as improved water use and quality, optimized photobiological processes to yield higher energy efficiencies, use of waste biomass (such as animal wastes and the organic component of urban wastewater) as feedstock to yield bioenergy and reduce waste and pollution sources, b) improved feedstock logistics c) resource inputs, outputs and quality
3	Enhanced or improved bioeconomy (analyses of the number of new jobs, increased revenues, gallons of biofuels produced or consumed, gallons of fossil fuel displaced), numbers of farms involved in feedstock production)
4	Increased knowledge regarding the use of agricultural crops for energy production (percent increase in knowledge of attendees to workshops, field days and demonstrations)
5	Improved sustainability of alternative energy supply chain, including evaluations of land use changes, biodiversity, acreages and tonnage of feedstocks produced and used, distributed conversion and processing,
6	Increased knowledge regarding the use of forest biomass as an energy source (Percentage increase in knowledge of attendees to workshops, field days, and demonstrations)
7	A framework for the attrbutional LCA based on the ISO standards will be extended to include water use metrics. These metrics will be defined based on source (confined and unconfined aquifers, surface runoff and precipitation), quality, quantity (consumptive and degradative use) and water stress index (volume of withdrawals in the watershed compared to the annual recharge) by adapting several published methods. Metrics for nitrogen and phosphorous utilization will also be developed along similar lines.
8	Biodiesel production from camelina in the Pacific Northwest region will be used as a test case for the methodology developed for water use as an LCA component. Previously developed process models incorporating feedstock handling, pretreatment, transesterification, and coproduct utilization, waste water handling will be further refined to incorporate process efficiency variations. Cellulosic ethanol production from agricultural residues such as wheat straw and grass straw will be used to test the methodology. Algal biofuels production will be modeled based on algae biomass production using dairy waste water as a nutrient source willbe performed. Algae will be used to capture nutrients such as nitrogen and phosphorus and the dried algae biomass will be evaluated as a replacement for peat.
9	Examine idealized cases with LES utilizing simulation modeling compared with theoretical and field work. Construct a model to represent the local topography of an individual farm to investigate the coupled effects of topography, spatial variability in water application and wind turbines
10	Develop an applied policy framework to quantify the direct and indirect impacts of alternative policy options and mandates for a sustainable biofuel system and explicitly address the economic and environmental tradeoffs at multiple scales. This will include a science-based methodology for assessing the tradeoffs (production levels, economic, environmental, social) associated with alternative management practices and technologies and a regional Computable general equilibrium model for assessing the regional impacts of changes in the PNW

11	Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food: to pump water from groundwater or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods. Agriculture is currently the largest user of water at the global level, accounting for 70% of total withdrawal. The food production and supply chain accounts for about 30% of total global energy consumption. There are many synergies and trade-offs between water and energy use and food production. Using water to irrigate crops might promote food production but it can also reduce river flows and hydropower potential. Growing bioenergy crops under irrigated agriculture can increase overall water withdrawals and jeopardize food security. Converting surface irrigation into high efficiency pressurized irrigation may save water but may also result in higher energy use. Recognizing these synergies and balancing these trade-offs is central to jointly ensuring water, energy and food security.

Outcome #1

1. Outcome Measures

Improved knowledge about composition and conversion of feedstocks for biofuels, bioenergy, and bioproducts, including co-products (number of new technologies developed, feedstocks (crops or organisms) investigated, residues or invasive species addressed)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The SGP at OSU continues to evaluate juniper as a potential source for biochar. Juniper encroachment on Western rangelands has decreased carrying capacity for livestock and wildlife. Juniper removal is cost prohibitive without financial incentives associated with juniper as a product.

What has been done
This year, the team developed a pipeline (sequence) of machine learning algorithms (computer processes that allow the computer to ?learn? with data) from remote sensing data to identify and measure juniper from publicly available imagery. Two tested scenarios suggested that positive solutions are highly dependent on the transport distance. Researchers also developed and refined an economic model to calculate the financial performance of hypothetical juniper biochar

enterprises at various scales, and have concluded that a mobile or stationary biochar production system can be profitable with juniper.

Results
Because of the lengthy government shutdown, researchers were unable to provide a report by the regular deadline. Plans for this quarter had included further development of their transport and harvest models; two-day outreach workshops with landholders and producers, including biochar demonstrations; continued monitoring of field trials; and completion of microbial and soil analyses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
609	Economic Theory and Methods
903	Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

Improved agricultural or engineering applications to advance production systems for bioenergy, such as, a) new technologies, such as improved water use and quality, optimized photobiological processes to yield higher energy efficiencies, use of waste biomass (such as animal wastes and the organic component of urban wastewater) as feedstock to yield bioenergy and reduce waste and pollution sources, b) improved feedstock logistics c) resource inputs, outputs and quality

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dairies face major costs both for electricity and for manure disposal. In keeping with a long-term vision of enabling modern large-scale dairy operators to become more environmentally and economically sustainable, Dr. Charles Coronella and his team demonstrated the technical feasibility and cost-effectiveness of hydrothermal carbonization (HTC) for conversion of dairy manure to heat and power, and evaluated production of high-value fuels and fertilizer from aqueous byproducts of carbonization.

What has been done
They converted manure to biocarbon by HTC, prepared pellets, fabricated and put into operation a reactor for continuous HTC, and investigated aqueous sample processing. Outreach revealed diverse concerns of dairy operators and key technological aspects necessary for acceptance and use of the process. Evaluation and implementation included life cycle analysis (LCA), commercialization, and student training.

Results
Important outcomes included a renewed focus on replacing dairy lagoons, which represent significant headaches for dairy operators; development of blended pellets to fuel commercial downdraft gasifiers; determination that some dairy operators may prefer conversion to heat rather than power; and recognition of the importance of controllability of the continuous hydrothermal reactor for long-duration operation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
608	Community Resource Planning and Development
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Enhanced or improved bioeconomy (analyses of the number of new jobs, increased revenues, gallons of biofuels produced or consumed, gallons of fossil fuel displaced), numbers of farms involved in feedstock production)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Oregon's integrated solid waste management plan (ORS11:459A.020) requires the Environmental Quality Commission to prevent waste and increase composting. Currently 50-70% of the material entering landfills is organic waste. As farms have specialized into crop and livestock operations, manure and other organic wastes tend to accumulate where they are generated, potentially threatening water quality. In addition, organic matter on many crop farms has gradually declined where exported crop biomass is not replaced. This trend contributes to reduced soil structure, fertility and biological activity. Some organic waste can be directly land applied, but many organic wastes contain human or plant pathogens, weed seeds and have undesirable physical or chemical characteristics. Composting transforms difficult to manage organic waste into a valuable resource, but can threaten water quality when leachate is poorly managed. To prepare for increased composting of food and other organic waste, Oregon DEQ updated the rules affecting all composting facilities, including those on farms. DEQ now regulates composting at non-CAFO agricultural composting facilities while ODA continues to regulate CAFOs. This new regulatory environment creates uncertainty for agricultural composters. Many leachate management methods, proven to be effective at industrial composting facilities, are uneconomic on farms and promising agricultural methods lack data that demonstrate their efficacy.

What has been done
With WSARE funding, a composting Extension publication and website. From 2004-2009, faculty served on the DEQ Compost Facility Rule Making work group. In this role I represented the interests of small and mid-sized agricultural composters. With funding from the Agricultural Research Foundation, a composting facility at the North Willamette Research and Extension Center in 2009. The facility is used in research and extension projects. I collaborated with Sullivan, DEQ, ODA, Clackamas Soil & Water Conservation District and private composting consultants to lead development of the Agricultural Composting Resources and Education Series (ACRES). This two day, hands-on workshop will be repeated annually through at least 2014. As co-PI with Sullivan, I collaborated with DEQ, ODA, composting consultants and agricultural composters to secure a new (2010-2013) WSARE grant: Protecting Water Quality and Promoting Economic Efficiency at Agricultural Composting Facilities. This project will investigate cost effective methods for protecting water quality at agricultural composting facilities and publish a best management practices guide.

Results

The final DEQ Compost Facility Rule was implemented in September, 2009. It increases the access farms have to different types of organic waste from a variety of sources when they can demonstrate an ability to protect water quality and human health. In 2010 and 2011 a total of 65 people have completed the first two ACRES workshops series. Participants included 28 agricultural professionals. Before the 2010 ACRES workshop, participants evaluated their knowledge of composting at 2.8 out of 7, at the end of the workshop this increased to 5.4. It is too soon to measure impacts from the new WSARE grant.

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
403	Waste Disposal, Recycling, and Reuse
601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

Increased knowledge regarding the use of agricultural crops for energy production (percent increase in knowledge of attendees to workshops, field days and demonstrations)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fertilizers represent about 2-26% of the cost of production for many vegetable crops (i.e. EM8927-8932 and EM8548). Nutrient deficiencies (especially N) are a major cause of reduced yield and crop quality, and farmers have a strong economic incentive to apply high fertilizer rates in order to reduce the risk of production. Increasing fertilizer prices and growing interest in sustainable agriculture enhance grower interest in optimizing application rates. Excessive fertilizer applications are an important source of non-point source water pollution. DEQ is required to

declare ground water management areas (GWMA) when groundwater nitrate levels exceed 7 ppm (ORS468B). For example, Governor Ted Kulongoski declared a GWMA in the South Willamette Valley in 2004. The DEQ is aware of high groundwater nitrate levels in parts of the State where GWMAs have not yet been declared. In addition, there is increasing interest among producers and consumers in farming practices that reduce greenhouse gas emissions and increase carbon sequestration (i.e. Climate Friendly Nurseries Project). Manufacture and use of synthetic fertilizer represents about 29% of agricultural energy use (CRS Report for Congress). In this context I am interested in helping growers optimize fertilizer use efficiency. Non-fertilizer N sources provide an opportunity to reduce application rates, but are difficult to quantify. I am working in partnership with West Multnomah Soil and Water Conservation District, Multnomah County NRCS and area farmers to enhance non-fertilizer N and improve our ability to quantify these sources when making fertilizer decisions. We are also demonstrating the use of cover crops in their commercial vegetable rotations.

What has been done

With contract support from West Multnomah SWCD we are monitoring soil nitrate levels in annual and perennial crops. We are incubating soil samples to estimate N release from soil organic matter and helping growers adapt cover crops to their farming systems. During the project we have collaborated with eleven growers and monitored nitrate levels in more than 90 fields. We have conducted fertilizer rate demonstration trials in 31 fields and various cover crop species have been demonstrated in 16 fields. Cover crops have been planted into bare soil after harvest and relay seeded into late harvested vegetables.

Results

It is too soon to report direct results and impacts from this project. However in a related project, David Brown (Mustard Seed Farm) reported that ?this year I reduced my fertilizer bill about 60% by working with Nick and Dan and still got great yields.? A Multnomah County grower is interested in the project because ?we all put on a lot of nitrogen because we can't afford to skimp. The soil testing is too time consuming and expensive, and it's difficult to interpret. We really can't get much of a handle on N with the testing we do now?.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
608	Community Resource Planning and Development
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Improved sustainability of alternative energy supply chain, including evaluations of land use changes, biodiversity, acreages and tonnage of feedstocks produced and used, distributed conversion and processing,

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Increased knowledge regarding the use of forest biomass as an energy source (Percentage increase in knowledge of attendees to workshops, field days, and demonstrations)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Scientists studying the valuable, but vulnerable, black cottonwood poplar have identified the genetic mechanism responsible for the species? inability to resist a pervasive and deadly disease. The finding, published in the Proceedings of the National Academy of Sciences, could help protect the ecosystem and lead to successful tree growth for increased biofuels and forestry production.

What has been done
A gene that causes susceptibility is widely prevalent across the species range. This degraded resistance and maintained susceptibility could be detrimental to the ecosystem if Septoria is introduced in the Pacific Northwest. Hybrid varieties of the poplars are economically valuable because they can grow up to three times faster than the pure species. If the hybridized poplars survive, they could dramatically increase production of high-value, bio-derived materials, biofuels and forestry products such as pulp and paper, lumber and veneer. Unsuccessful growth of the cottonwood hybrid represents a key barrier to the industry's economic potential and limits companies to slower growing varieties.

Results
To map the genetic behavior of black cottonwood, OSU researchers assessed more than 3,000 individual black cottonwoods using a combination of digital imagery and measurements of disease severity for susceptibility to Septoria canker. The team then searched for links between a dataset of 28 million known mutations and the poplars? genetic profiles to verify which trees lined up with those that were predicted to be resistant or susceptible to Septoria. The results also

identified individual trees that are resistant to the disease and can be used to develop resistant hybrids for commercial production, as well as inform intervention strategies to protect Pacific Northwest ecosystems from the spread of Septoria.

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
403	Waste Disposal, Recycling, and Reuse
608	Community Resource Planning and Development
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

A framework for the attrbutional LCA based on the ISO standards will be extended to include water use metrics. These metrics will be defined based on source (confined and unconfined aquifers, surface runoff and precipitation), quality, quantity (consumptive and degradative use) and water stress index (volume of withdrawals in the watershed compared to the annual recharge) by adapting several published methods. Metrics for nitrogen and phosphorous utilization will also be developed along similar lines.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Groundwater nitrate levels are exceeding actionable levels in the Lower Umatilla Basin. Steps are needed to create a research and extension team to determine sources of nitrate contamination and to create best stewardship practices to reduce the contaminant sources. To help solve the issues at hand, the team is evaluating funding sources, applying for funds, and conducting research and outreach to support the project objectives.

What has been done
I have disseminated findings regarding precision agricultural irrigation (sub-surface drip irrigation) techniques. Results identify parameters to reduce water use and fertilizer leaching. Model

parameters were initiated to visualize irrigation water distribution in the onion root rhizosphere using different flow rates and irrigation onset thresholds. Preliminary data from the research project was leveraged to obtain additional grant funding from the Oregon Department of Agriculture and the Oregon State University Agricultural Research Foundation.
In support of objective #2 (Characterize the LUB hydrologic system to determine suitable sites for aquifer recharge). We have cooperated with the Port of Morrow industrial site and identified and created an aquifer recharge plan of action that was submitted to the Oregon Department of Environmental Quality (ODEQ). Unfortunately, the ODEQ did not approve the recharge plan. The research and Port of Morrow team will revise and re-submit the plan to the ODEQ for the 2019-2020 period.

Results
Methods are being researched which have the potential to reduce water and nitrate leaching in onion production systems in the Lower Umatilla Basin. This research project was implemented in the summer of 2018 and will be conducted for an additional 2 years from funding awarded by the Oregon Department of Agriculture and the Agricultural Research Foundation.
My preliminary research findings from year 1 of research have been disseminated to colleagues and stakeholders at one regional field day and three regional conferences.
The research, funding and dissemination of findings are positive results that are directly related to the objectives of this collaborative project.

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
131	Alternative Uses of Land
132	Weather and Climate
402	Engineering Systems and Equipment

Outcome #8

1. Outcome Measures

Biodiesel production from camelina in the Pacific Northwest region will be used as a test case for the methodology developed for water use as an LCA component. Previously developed process models incorporating feedstock handling, pretreatment, transesterification, and coproduct utilization, waste water handling will be further refined to incorporate process efficiency variations. Cellulosic ethanol production from agricultural residues such as wheat straw and grass straw will be used to test the methodology. Algal biofuels production will be modeled based on algae biomass production using dairy waste water as a nutrient source willbe performed. Algae will be used to capture nutrients such as nitrogen and phosphorus and the dried algae biomass will be evaluated as a replacement for peat.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Examine idealized cases with LES utilizing simulation modeling compared with theoretical and field work. Construct a model to represent the local topography of an individual farm to investigate the coupled effects of topography, spatial variability in water application and wind turbines

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In light of climate change, depletion of major aquifers, urban growth in water-scarce areas, and increasing demand for environmental goods and services, creative approaches are needed for sustainable and efficient use of water resources.

What has been done
This work primarily addresses objective 2 by developing numerical models to examine water-related impacts of climate change. We developed models of the Willamette River catchment and reservoir operations. Model simulations were used to examine the effects of different climate change scenarios, as well as the impacts of aging infrastructure and of modifying reservoir operations to mitigate the effects of climate change.

Results
Results indicated that, for the climate scenarios analyzed, primary operating objectives of flood risk reduction and meeting summer Biological Opinion (BiOp) flow targets were unlikely to be affected. Modest reductions in the ability to fully refill the reservoirs and to meet spring BiOp flow targets were found, particularly under the more severe warming scenario. However, refilling the reservoirs two weeks earlier was effective in reducing the storage deficit introduced by climate change without compromising the ability to meet other operational objectives. Drawdown scenarios for maintenance of aging infrastructure had minimal effect at the system scale. Taken together, results suggested that the hydrologic changes associated with the range climate change examined were not likely to substantially reduce the reliability of the Willamette Project in meeting operational objectives and that, where potential deficiencies emerged, they could largely be mitigated through simple operational changes.

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
131	Alternative Uses of Land
132	Weather and Climate
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

Outcome #10

1. Outcome Measures

Develop an applied policy framework to quantify the direct and indirect impacts of alternative policy options and mandates for a sustainable biofuel system and explicitly address the economic and environmental tradeoffs at multiple scales. This will include a science-based methodology for assessing the tradeoffs (production levels, economic, environmental, social) associated with alternative management practices and technologies and a regional Computable general equilibrium model for assessing the regional impacts of changes in the PNW

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Carinata is an oilseed crop that can be rotated with other Oregon crops. Carinata has superior oil production profiles when compared to other Brassicae species and the meal is valuable as a supplemental feed for livestock and poultry.

What has been done
Identifying of optimal varieties for Oregon diverse climatic regions. The selected locations for the field trials have different soil types, main crops and cropping systems, and rainfall range from 10

inches in the Moro County to around 52 inches in Corvallis (Benton County), and up to 90 inches in some small areas of Benton County. Therefore, we expect that optimal varieties for Moro County will be different from the ones identified for Benton County. The optimal agronomic practices that will be determined for several regions of Oregon. Information on the rotational effects of B. carinata with OR main crops grass seed, potato, and wheat

Results

(1)Economically viable: Incorporation of B. carinata varieties into the traditional for OR grass seed, potato, and winter wheat-fallow rotation are expected to improve economic sustainability of crop and biofuel feedstock production in OR. As B. carinata contains glucosinolates, diversifying potato, wheat and grass seed cropping with B. carinata may improve pest, disease and weed controls, reduce input costs and improve economic viability. Environmentally sound: Besides economics, the integration of winter B. carinata in the winter wheat fallow rotation and in spring crops such as potato, may reduce wind erosion and hence may improve air quality, reduce the loss of soil organic matter because to the reduction of fallow period on millions of acres in the Pacific Northwest (PNW).

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
131	Alternative Uses of Land
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
609	Economic Theory and Methods
903	Communication, Education, and Information Delivery

Outcome #11

1. Outcome Measures

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food: to pump water from groundwater or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods. Agriculture is currently the largest user of water at the global level, accounting for 70% of total withdrawal. The food production and supply chain accounts for about 30% of total global energy consumption. There are many synergies and trade-offs between water and energy use and food production. Using water to irrigate crops might promote food production but it can also reduce river flows and hydropower potential. Growing bioenergy crops under irrigated agriculture can increase overall water withdrawals and jeopardize food security. Converting surface irrigation into high efficiency pressurized irrigation may save water but may also result in higher energy use. Recognizing these synergies and balancing these trade-offs is central to jointly ensuring water, energy and food security.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Disease management is a single component of the larger, multifaceted system used to produce a crop. Resilient agricultural systems will include disease management programs that recognize the challenges faced by agricultural producers and understand the agricultural infrastructure (e.g., center-pivot agriculture vs. agrivoltaic agricultural systems), in which disease management is needed; new management programs must be operationally, technologically, and economically feasible to be adopted by farmers. My research program produces new information to identify the most efficient and environmentally compatible strategies for minimizing disease outbreaks, managing the onset of fungicide resistance, predicting spatial and temporal patterns of disease dispersal, and correctly determining the rates and timing of fungicide or bio-control amendments.

What has been done
My role in this proposed projects would be to monitor pest outbreaks and use epidemiological models to examine how disease risk associated with agrivoltaic production differs from risk associated with current production practices

Results
This project is currently being implemented and will be producing results in the 2019 ARA.

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
131	Alternative Uses of Land
132	Weather and Climate
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

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

Current policies concerning RVOs and refinery waivers, rollbacks of CAFE standards, tariffs, changes to air pollution regulations, and a renewed focus on fossil fuel production, have negatively impacted research related to renewable fuels, and renewable energy. Bioenergy research funding continues to decline as the ability for advanced biofuels to compete with low cost fossil fuels continues to erode investment and interest. This has led to an increased focus on the production of intermediate chemicals as the principal output with biofuels being relegated to a secondary role. Advances in other sectors including fuel cells, novel pre-treatment processes, logistics, and economics have stalled as well, as private investment and federal investment has been reduced.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The production of cellulosic ethanol and advanced renewable diesel continues to be hindered by external factors. Renewable aviation fuels continue to be a bright spot primarily due to international requirements for these blends rather than any national efforts in this area. General resistance remains among the agricultural community toward LCFs and/or RFS and RPS. The results suggest a continued lack of research funds and private investment for this work to continue barring administrative changes.

Key Items of Evaluation

There is considerable debate in Oregon regarding the conversion of farmland to solar power production. Price parity between renewable energy and conventional sources of energy are driving the expansion of solar energy across the country. We have begun the preliminary work to test the notion that solar production and food production need not be mutually exclusive. Solar panels can be designed to produce power while augmenting crop production. We believe this work will show that agricultural production can be increased and farm income increased through the reduced energy demand and the sale of excess power.

V(A). Planned Program (Summary)

Program # 2

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
101	Appraisal of Soil Resources	5%		5%	
102	Soil, Plant, Water, Nutrient Relationships	5%		5%	
103	Management of Saline and Sodic Soils and Salinity	5%		5%	
112	Watershed Protection and Management	5%		5%	
121	Management of Range Resources	5%		0%	
122	Management and Control of Forest and Range Fires	10%		0%	
123	Management and Sustainability of Forest Resources	5%		5%	
125	Agroforestry	5%		5%	
135	Aquatic and Terrestrial Wildlife	5%		5%	
136	Conservation of Biological Diversity	5%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	5%		5%	
212	Pathogens and Nematodes Affecting Plants	5%		5%	
215	Biological Control of Pests Affecting Plants	5%		5%	
302	Nutrient Utilization in Animals	5%		0%	
303	Genetic Improvement of Animals	0%		5%	
311	Animal Diseases	5%		5%	
604	Marketing and Distribution Practices	5%		5%	
605	Natural Resource and Environmental Economics	5%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	5%		5%	
723	Hazards to Human Health and Safety	5%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	10.0	0.0	50.0	0.0
Actual Paid	2.0	0.0	3.3	0.0
Actual Volunteer	621.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
43233	0	681955	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
47383	0	6971512	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
110565	0	7256475	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The program includes studies that focus on development of models of community-level responses to perturbations, population dynamics and habitat management for individual aquatic and terrestrial species, and development of methods for monitoring ecosystem changes. The experimental approaches that will be used to meet the specific objectives of these subprograms include field studies in the Oregon, the Pacific Northwest, the U.S., and abroad. In addition, the experimental approaches will also include controlled laboratory experiments and database/model development.

Theoretical and empirical models will be developed to examine land-use policies and impacts on water quality, wildlife habitat, watershed health, and other ecological indicators. Models will be used to examine how resource and agricultural policy affects major land use and cropping patterns, and how these may affect water quality.

Research is often carried out at field sites in the state, region, nation, or overseas. We will develop and use novel soil-water instrumentation, update and expand the reference evapotranspiration data currently available for Oregon, develop hydrologic models capable of simulating the interactions and processes between surface water and groundwater, conduct laboratory and field observations of physical and biological processes and functions, benthic macroinvertebrate community, numerical and statistical models play critical roles in understanding the driving principles of watershed and river ecosystems and linkages. Watershed and river basin scale resource simulation models and decision tools will be used to examine coupled natural and human systems and trajectories of change under alternative future scenarios.

OSUES's approach to climate change outreach will involve both traditional and non-traditional methods. We will integrate climate change content into existing educational programs, and address climate-related impacts such as drought and adverse storm damage response. Programs will also be developed and delivered, based on current research, which shows mitigation strategies and adaptations that can be accomplished now. For example, our forest geneticists are now developing revised seed zone

maps that account for changing climate. This can assist forest owners and managers who are making planting decision today for forests that will grow for over 50 years and are likely to be under the effects of a different climate 50 years from now.

Other activities will include volunteer-based programs such Climate Masters and Master naturalists, workshops and seminars, consultations and facilitations, web-based instructional programs, web sites, stand alone and web-based videos, publications of all types, mass media, and social networking.

In summary, we will:

- conduct research experiments
- collect data
- conduct assessments
- develop monitoring protocols
- develop products, curriculum resources
- conduct workshops & meetings
- present seminars and professional talks
- provide training
- deliver services
- provide counseling
- partnering
- facilitating

2. Brief description of the target audience

- The general public and those in natural resource-based communities, including growers, ranchers and fishermen
- The research community including scientists working in governmental, industrial, and academic sectors, including biomedical researchers, oceanographers, climatographers, virologists
- Growers, crop consultants, economists, extension faculty and researchers in the agricultural industry
- Ecologists and managers concerned with invasive species
- Salmonid and other fisheries
- State and federal natural resources management and regulatory agencies, including land managers
- Policy makers.
- Citizens in urban settings
- Engineering professionals
- Undergraduate and graduate students

The stakeholder involvement for the collaborative project will be in the form of active participation in the enhanced AgTools^{TM} software to explore the economic potential for both mitigation and adaption strategies, using the existing advisory committees for the CAS and the departments to explore climate change related issues. As mentioned before, the policy and economic dimensions of climate change will be the topic of a forum sponsored by the Center for Agricultural and Environmental Policy (CAEP). The information and materials from this project will also be featured on a project "climate-driven changes in Oregon agriculture" website that is linked from the CAS home page and incorporates other climate science undertaken at OSU by the OCCRI. (http://oregonstate.edu/research/oregon-climate-change-research-institute-occri-0). Production system teams will provide information from the economic studies to their stakeholders at field days and through their online resource systems. Team 1 members plan to provide presentations to local production communities when opportunities arise. This process and format will be studies for its impacts and adopted by the other pilot teams with appropriate modifications. Our intent will be to have biannual forums.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4426	9397	2867	13231

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	18	46	64

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Evaluate the impact of Regional Climate Hubs on stakeholder awareness of the impacts of climate change to producers.
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Developed new or better tools, technologies, practices, and models for understanding and managing water and irrigation systems, soil, food production (crops and animals) systems and land, pests and pathogens, natural resources, and land-use
2	Understand impacts of climate change on and responses of: food systems, land use, watersheds and water systems, species, habitat and ecosystems, genes, pests and pathogens, marine food webs
3	Evaluated resource management strategies and best practices for climate change mitigation, such as: a) chemical control, b) biological control, c) stock assessments, d) fishery management tools, e) nitrogen applications, f) water use efficiency, g) acres planted for carbon sequestration, h) coastal hazards, i) community resilience
4	Understand changes in societal views with regard to the value of habitats and conservation and how to manage these changes
5	Understand changes in ecosystems from carbon management strategies, soil microbial health, natural resource or ecosystem policies
6	New genotypes developed and planted that show enhanced adaptive capacity to climate change
7	Conservation strategies adopted, for example: - Conservation bio-control strategies are implemented differently and active restoration strategies occur. Land owners and managers assess ecosystem services provided by their riparian restorations via a user-friendly web tool - Watershed councils, watershed stewards and Oregon Water Schools implement projects or programs based upon knowledge transmitted - Growers adopt improved, scale-dependent practices selected for various market niches with emphasis on reducing environmental degradation and impact. Commercial small farms will have more diverse and economically viable technologies and production techniques or systems available for their use - Growers implement drip irrigation and produce more marketable yields of onions, potatoes, and poplar trees than with furrow or sprinkler irrigation, and achieve efficient use of soil nitrate and the other available nitrogen sources under drip irrigation. - Generation of the viral vectors for grapevine disease control and functional genomics vectors have a potential for replacing current strategies of using chemical fungicides and bactericides with viral biocontrol strategies.
8	Participants who increase their knowledge of management practices and understanding of climate variability and change (Percentage).
9	Participants in educational programs who improve mitigation strategies for climate, such as reducing greenhouse gas emissions and increasing carbon sequestration in agricultural production and natural resource management systems (Percentage).
10	Clients who employ climate adaptation strategies or incorporate climate-based management practices (Percentage).
11	To assess the aggregate and distributional tradeoffs and consequences of policies, programs, and investments to enhance the adaptive capacity of our managed agroecosystems and thus reduce the downside of exposure and vulnerability to climate change and climate variability, to environmental change, and to changes in economic and policy-based incentives. This includes advancing fundamental knowledge about the flexibility and resilience of agricultural (managed) ecosystems to increased variability in climate -LCA

	and to better understand and expand technologies, innovation and systems that can adapt to increases in uncertainty in environmental conditions and increases in climate variability, regionally and within Oregon
12	To assess the technical and economic potential to engage in mitigation strategies for Oregon agricultural and managed resource sectors while quantifying the costs of alternative mitigation efforts for the agricultural and managed resource sectors in Oregon and the Pacific Northwest (PNW).
13	Farmers in the western United States are increasingly affected by climate change through reduced snowmelt, higher temperatures, and drought (Van Horne et al., 2013). The Oregon Climate Change Research Institute (http://occri.net/) predicts a 50% reduction in summer water availability in Oregon within 50 years (Nolan and Daily, 2006). It is critical for the viability of farms in our region and the security of our food system to increase our knowledge and awareness of drought mitigation tools and strategies for farming with little or no irrigation. The goal of this project is to increase knowledge and awareness of dry farming management practices.

Outcome #1

1. Outcome Measures

Developed new or better tools, technologies, practices, and models for understanding and managing water and irrigation systems, soil, food production (crops and animals) systems and land, pests and pathogens, natural resources, and land-use

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Seafood processing facilities are going through a permit (J permit) renewal with the Oregon Department of Environmental Quality. This permit since the tolerances for wastewater discharge from seafood processing plants into bodies of water. The achievable limits and methods for detection of limits were in dispute.

What has been done

An advisory committee was formed to design an educational workshop that covered seafood processing wastewater treatment, best management practices, design and operation of plants for better compliance and by-product recovery.

Results
The conference was held March 21-23, 2018 featuring over 20 speakers, a tradeshow with 12 booths and 8 mini-talks provided by vendors and agency personnel. It was attended by 90 individuals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
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
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
311	Animal Diseases
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
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

Understand impacts of climate change on and responses of: food systems, land use, watersheds and water systems, species, habitat and ecosystems, genes, pests and pathogens, marine food webs

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Transpiration, the evaporation of water from plant leaves, accounts for more than half of all the global transfer of water from the continents to the atmosphere, but little is known about how much water is transpired across the United States.

What has been done
NSF announced the project as part of its 2018 group of grants made under the agency's MacroSystems Biology and Early National Ecological Observatory Network Science programs. The grants, which shed light on diverse and highly relevant environmental issues, support research that helps understand biosphere processes and their complex interactions with climate, land use and invasive species, from regional to continental scales. Eighty-one sites around the United States constitute the National Ecological Observatory Network (NEON). The network provides a unique combination of air-, ground- and water-based sensors and field sampling with statistical, physical and biological modeling.

Results
The interdisciplinary research team will work with a wide range of NEON-produced data products, with an emphasis on stable isotope ratios of water vapor and carbon dioxide. Isotope ratios provide an integrated measure of physical processes controlling gas exchange between plant leaves and the atmosphere. The suite of NEON sensors provides the first standardized data set enabling isotope-based estimation of transpiration across a diverse range of continental ecosystems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
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
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
311	Animal Diseases
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

Evaluated resource management strategies and best practices for climate change mitigation, such as: a) chemical control, b) biological control, c) stock assessments, d) fishery management tools, e) nitrogen applications, f) water use efficiency, g) acres planted for carbon sequestration, h) coastal hazards, i) community resilience

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Activities were aimed at developing greater understanding of the factors that contribute to resilience to economic and climatic perturbations at regional and farm levels.

What has been done
To this end, we investigated a) the rate at which eroded soil can assimilate soil organic carbon and b) developed a parameter that allows to quantify biogeochemical heterogeneity in soil systems

Results
Research results were published in the journals Geoderma and Plant and Soil:

Remus, R., Kaiser, M., Kleber, M, Augustin, J and M. Sommer. 2017. Demonstration of the rapid incorporation of carbon into protective, mineral-associated organic carbon fractions in an eroded soil from the CarboZALF experimental site. Plant and Soil 430:329-348

Wanzek, T., Keiluweit, M., Nico, P.S., Dragila, M.I., Fiedler, S., Fendorf, S. and M. Kleber. 2018. Parameterizing functional heterogeneity of soil systems at the pore scale. Geoderma, 324:89-97.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #4

1. Outcome Measures

Understand changes in societal views with regard to the value of habitats and conservation and how to manage these changes

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

New research shows that paying communities in Mexico to conserve and manage their jointly-owned property doesn't just benefit the environment it strengthens social relationships and a sense of community within those areas as well. The study is published in the journal Proceedings of the National Academy of Sciences. The findings provide new evidence that payments for environmental services can provide broader social benefits.

What has been done

This is the first analysis of the social capital impacts of a national-scale, globally relevant forest conservation program. It shows that payment programs improve participants' social capital, involvement in assemblies, ability to resolve conflicts, trust between members and community-building efforts, among other things. Conservation of natural resources often relies on voluntary contributions of time and effort, and payments for environmental services policies boost these efforts by providing funding for maintenance of forests and other natural vegetation, Incentive-based conservation programs have been adopted in multiple countries and play a central role in global climate agreements. While these financial incentives help forest management activities compete with other land uses, many conservationists worry that external payments will undermine moral or intrinsic motivation to protect nature.
It is especially noteworthy that the program did not crowd out unpaid contributions to land management or other voluntary community work.

Results

This latest study focused on Mexico's agrarian communities, which are formally recognized structures of local governance that make joint decisions over land management through elected councils and an assembly of members. The researchers found further evidence that the implementation of incentive-based conservation initiatives results in increased land management activities, such as patrolling for illegal activity, building fire breaks and controlling pests. According to this study, social capital and trust are understood to be important drivers of economic development generally, and of collective action to protect the environment. The study noted that Mexico's PES is supporting pro-social behavior in addition to directly incentivizing conservation. Future research will seek to see how PES may impact social capital in other settings globally.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
125	Agroforestry
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Understand changes in ecosystems from carbon management strategies, soil microbial health, natural resource or ecosystem policies

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

New genotypes developed and planted that show enhanced adaptive capacity to climate change

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The climate in eastern Oregon is xeric, with wet and mild winters, dry and hot summers. Precipitation is scarce during the majority of growing season (June, July, August, and September). Unfortunately, this situation will increase as climate change reduces summer precipitation in eastern Oregon. Therefore, irrigation is a normal and necessary agricultural practice with the majority of cash crops and forages. At the same time, reduced snowpack at higher elevations and a rapid snowmelt in the early spring results in reduced stream flows in the summer months. Water scarcity is further exacerbated in eastern Oregon agriculture by competition with other water demand, such as wildlife habitat, creek ecosystems, and municipal demands.

What has been done
In order to adapt to irrigation water limitations, eastern Oregon forage and livestock producers require a renovated forage production system that will conserve water and in the same time produce comparable or higher quantity and quality forages. One direction of this search could be diverse forage species selections. Due to their different growing patterns (early vs late maturity, winter vs. spring annual, annual vs. perennial), drought adaptation mechanisms (drought

avoidance, drought resistance, and water use efficient), and physiological grouping (cool season vs. warm season), different forage species cope with water limitations differently. However, we must answer several questions to support adoption and production of diverse forage species in eastern Oregon. First, which species are the best choices when considering of productivity and quality? New forage cultivars were developed in the last decades to improve their forage production and quality. Second, what kind of irrigation practice is best to produce these forage species, late fall irrigation and/or early spring irrigation? Third, when is the best time to use (haying or grazing) these forage species, early season or late season? Fourth, what kind of regrowth potential for each forage species? Therefore, the research goal is to search and test the best management practices to produce high quantity and quality forages from diverse forage species in eastern Oregon.

Results

1. Valuable information and intensive dataset about monocultures of winter, spring, and summer annual forages, and perennial forage performance under different irrigation treatments in eastern Oregon. Two extension publications were released. Furthermore, the data collected in this study will support study of fertilization levels, irrigation levels and timing, harvest timing, and mixture compositions and diversity to improve forages management protocol.
2. The production and quality of each forage species will be compared with other alternative species; the superior yield indicating the best forage species under the limited and competing water resources in eastern Oregon. It becomes a decision-making tool for livestock producers in this region. The information was used as a guide to select a specific forage species, right irrigation practices, and right seeding time that fit a specific farming and ranching system.
3. Several field tours and talks were organized during this study period; farmers and ranchers were exposed to these research plots. Information was disseminated more quickly and efficiently. Participants were able to ask questions, discuss field results and compare them to their own experiences. These field days are also excellent networking opportunities in which producers come to know each other better, and know the faculty member.
4. As farmers and ranchers in eastern Oregon adopt these improved forage production management practices, they will become more economically and socially stable, as they optimize grazing days, efficient livestock production, improved land use, and conserve water at the same time. Increased in-stream flows can be used for other ecological services, natural resource conservation goals and functions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
201	Plant Genome, Genetics, and Genetic Mechanisms
302	Nutrient Utilization in Animals
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

Conservation strategies adopted, for example: - Conservation bio-control strategies are implemented differently and active restoration strategies occur. Land owners and managers assess ecosystem services provided by their riparian restorations via a user-friendly web tool - Watershed councils, watershed stewards and Oregon Water Schools implement projects or programs based upon knowledge transmitted - Growers adopt improved, scale-dependent practices selected for various market niches with emphasis on reducing environmental degradation and impact. Commercial small farms will have more diverse and economically viable technologies and production techniques or systems available for their use - Growers implement drip irrigation and produce more marketable yields of onions, potatoes, and poplar trees than with furrow or sprinkler irrigation, and achieve efficient use of soil nitrate and the other available nitrogen sources under drip irrigation. - Generation of the viral vectors for grapevine disease control and functional genomics vectors have a potential for replacing current strategies of using chemical fungicides and bactericides with viral biocontrol strategies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change has emerged as one of the key twenty-first century challenges for the management of natural resources, and yet there has been little empirical research conducted by natural resource economists on adaptation to climate change by forest landowners. The economic value of forests can be impacted by adaptation behavior by forest landowners. We use plot-level data to develop an econometric analysis of climate adaptation through private forest management - adjustments in harvest timing and intensity, and through selecting tree species to regenerate. We exploit variation in both climate and timber management choices as the basis for empirical analysis, which is based on the idea that a landowner will adapt to their given climate through selection of harvest and regeneration strategies. We estimate the effects of a set of drivers of a landowner's forest management choices, including timber prices, yields, harvest costs, site productivity, and climate. We also jointly estimate forest management choices along with the likelihood of natural disturbance in a manner that allows management choices to adjust to natural disturbance risk. Estimated plot-level forest management probabilities provide the basis for a landscape simulation of the effects of climate change and carbon price policy on the

composition of forest types across the U.S. forested landscape.

What has been done

Objective 1: Develop a national econometric model of forest management, and use the model to test for the effects of climate on management choices by landowners. We use national plot-level forest management data from the FIA, timber price data from a variety of regional sources, recent estimates of harvest costs, and climate data from PRISM to develop a discrete-choice econometric model of forest management choices.

Objective 2: Use the econometric model as the basis for a landscape simulation to depict the effects of climate change on the state of U.S. forests and the resulting composition of tree species. We use the estimated forest management probabilities as a set of decision rules to simulate future forested landscapes under alternative climate scenarios. The output of this simulation will be shares of each U.S. County in different forest types and in different age classes by 2100. We develop a method to incorporate timber price feedbacks resulting from supply changes.

Objective 3: Examine the effects of multiple carbon price scenarios on the adaptive behavior of forest landowners and the resulting forested landscape. We include land rental values in the econometric model to control for land use decisions, where rental values vary across different tree species choices. This allows us to study the effects of carbon price scenarios on forest landscapes under climate change. Since different tree species sequester different amounts of carbon, a fixed carbon price will differentially affect forest rents for different tree species and alter forest management decisions.

Results

PD Lewis and a collaborator had a paper accepted at an environmental economics journal that examines climate change adaptation in conservation policy. The paper develops an auction mechanism that elicits private information from landowners about their willingness to accept conservation payments, and uses that information to optimally conserve land under climate change.

PD Lewis and a former student finished a draft paper that models climate adaptation in forest management for the Pacific coast states of Washington, Oregon, and California. The paper covers all three objectives of the project in a pilot study for the Pacific states. The methodology is developed and results indicate that landowners are projected to partially shift out of their dominant forest type of Douglas-fir under climate change. A carbon price reinforces the adaptation out of Douglas-fir forests towards hardwoods and ponderosa pine.

PD Lewis and multiple colleagues finished a draft paper that integrates an econometric model of climate adaptation in forest management with detailed wildlife habitat association data for the Pacific coast states of Washington, Oregon, and California. The paper covers all three objectives of the project in a pilot study for the Pacific states. The results indicate that forest wildlife that are specialized to coniferous forests in the Pacific states are likely to see sharp reductions in habitat, while some species specialized to hardwoods and/or ponderosa pine are likely to see increases in habitat under climate change. A carbon price reinforces the habitat losses of coniferous Douglas-fir forests towards hardwoods and ponderosa pine.

PD Lewis and a student have built a national database on stumpage prices that vary across forest types, and constructed county-level estimates of the net economic returns to forestry across the U.S. for 1998 to 2014. The database serves as a foundation for the three project objectives.

PD Lewis and a student have estimated county-tree species specific timber growth functions for the conterminous United States, which serves as a foundational database to build measures of net economic returns to forestry.

PD Lewis and a student have conducted preliminary econometric analysis of the impacts of climate on the net economic returns to forestry using the national database on county net returns.

Preliminary results suggest that climate change scenarios are projected to increase the net economic returns to forestry on average across the United States.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Participants who increase their knowledge of management practices and understanding of climate variability and change (Percentage).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the USDA Economic Research Services, agriculture is the biggest user of water in the United States, accounting for approximately 80% of the Nations consumptive water use and over 90% in many Western States. Demand for water in the inland Northwest is increasing due to population growth, environmental issues concerning salmon and climate change. Finding ways to reduce the need for water in agriculture should be a priority on an international level. One has only to look to neighboring California to see the impact of the most recent drought on their agricultural industries where researchers from the UC Davis Center for Watershed Sciences

estimated that it cost an estimated $2.7 billion and 21,000 jobs were lost.

What has been done
Produced a cuticle supplement that is > 90 um thick. The product is now known as HydroShield. Also looked at individual ingredient properties to determine whether they are attractive or repellants for Spotted Wing Drosophila.

Results
This reduces water usage without affecting plant yield in apples, sweet cherries and wine grapes. Soil moisture has not been adversely affected by reducing water usage by 25% in conjunction with HydroShield. Fruit size of 'Gala' has been increased by 6%. Fruit cracking of 'Utah Giant' cherries was reduced by 19%. Berry size of wine grapes was smaller in the HydroShield plus 50% reduction resulting in better quality grapes with ~1% higher TSS (sugar) than the check.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
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
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
311	Animal Diseases
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #9

1. Outcome Measures

Participants in educational programs who improve mitigation strategies for climate, such as reducing greenhouse gas emissions and increasing carbon sequestration in agricultural production and natural resource management systems (Percentage).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate Change brings new challenges and demands for information and approaches to communication to help natural resource-based communities mitigate and adapt to climate change. Collaboration between researchers, citizen scientists and Extension is a promising approach to meeting this information and communication challenge.

Oregon Season Tracker (OST) aims to broaden discussion and understanding about climate science. OST links natural resource managers, educators, researchers and others in the community to the science they use through collaborative citizen science. OST citizen scientist volunteers gather scientific data on precipitation and seasonal plant changes (phenology) at their home, woodland, farm, ranch or school to share with research partners both locally and nationally. Volunteers contribute to the scientific efforts while learning about climate change which they can apply to management of their property.

What has been done
Our big activity in 2018 was a combined volunteer retreat and teacher training at the HJ Andrews forest in August. About 50 volunteers, teachers researchers gathered for two half days in the field to discuss research activities on the forest about precipitation, air drainage patters, soils, stream flow and aquatic ecosystems. A local author presented an evening journaling workshop. Ten teachers stayed on for another two half-day professional development training in using OST season tracker as a classroom activity.
Following a big training push in 2017, we presented 2 hybrid OST workshops in western OR (Newport, Vernonia), bringing our number of OST trainees up to about 330 spread across 18 counties, who we continued to support through electronic newsletters and web resources.
We also continued to work with teachers in the OST 4-H classroom program. We provided limited classroom support to 5 schools, while another 6 schools used OST curriculum materials independently.
Our staff and volunteers gave several presentations to community groups in 2018.

Results
The OST citizen scientists accounted for 157 unique registered rain gauge stations in 18 counties tracking precipitation with the OST program and the Community Collaborative Rain Hail & Snow Network (CoCoRaHS) national database.

We work with the National Phenology Network (NPN) to track plant phenology observations through their Nature's Notebook (NN) system. OST observers have contributed 50,721 observations (2014 to 2018). In 2018 alone they contributed 20,578 observations.

We did an evaluation following the retreat. Participants were asked four questions and asked to respond on a Likert scale that they agreed strongly (4), agreed (3), disagreed (2) or disagreed strongly (1). We had 31 respondents.
To the statement "I expanded my knowledge about the climate and ecological research being conducted at HJ Andrews" 100% either strongly agreed or agreed (mean response 3.94).
To the statement "leaned about connections between climate and phenology", 100% either strongly agreed or agreed (mean response 3.87).
To the statement "gained a better understanding of the connection between my observations as an OST volunteer, and the research being done at HJA" 94% either strongly agreed or agreed (mean response 3.77).
Asked if the retreat was an effective tool for fostering better communication between citizen scientist and researchers, 97% either strongly agreed or agreed (mean response 3.83).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

Clients who employ climate adaptation strategies or incorporate climate-based management practices (Percentage).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dry farming vegetable crops is not widely known or understood by the maritime Pacific Northwest farming community. Although dry farming is not new, it has not gotten much attention from industry and academia because it is not a yield-maximization strategy. Knowledge, therefore, hasn't been well documented. Dry farming techniques for vegetable crops in the maritime Pacific Northwest have been passed down from farmer to farmer over the past century. In recent decades, very few farmers have experimented with dry farming and even fewer have extensive experience in dry-farming practices.

As the Western United States gets drier, aquifers dry up, and drought is more prevalent, interest in integrating these older techniques with modern agriculture has increased and become relevant to the sustainability of our food system and the future sustainability of many farms.

The Dry Farming Collaborative (DFC) is a group of growers, extension educators, plant breeders, and agricultural professionals partnering to increase knowledge and awareness of dry farming management practices through a hands-on participatory approach. As the DFC expands and interest in dry farming grows throughout the maritime Pacific Northwest and beyond, many questions arise.

What has been done
Since 2015, the OSU Extension Dry Farm Project has focused on small-scale, organic production of spring-planted vegetables such as tomatoes, potatoes, winter squash, zucchini, melons, flour corn, and dry beans; and aims to explore, revive, and expand awareness of dry farming.

Multiple USDA grant-funded research projects engaged the DFC in 2018, addressing some of the questions farmers and researchers have. More than 30 farming trials throughout western Oregon and Washington were conducted. Last winter, the growers involved decided how much area they could allocate to dry farming and chose projects of interest.

Results
Year after year the number of instructional and media contacts for the Dry Farming Project has nearly doubled since 2013, with an estimated 10,000 contacts in 2018.

A resource hub for dry farming was created on the OSU Extension Small Farms website to disseminate reports, handouts, presentations, articles and books. Dry Farming Collaborative Facebook group participation continues to increase with over 550 members as of January 1st, 2019 (27% increase since 2017), and increasingly draws regional, national, and international followers.

Media attention about the OSU Dry Farming Project has been publicized in local, regional, and national publications in 2018 including Capital Ag Press, Growing, Take Root Magazine, and the Furrow (John Deere magazine). The latter two are due to be published in 2019.

All farmers interviewed for the participatory research methods study in 2018 plan to continue to dry farm, and most hope to expand their dry farm plots and intend to experiment with new crops. Most farmers noticed benefits associated with dry farming, and their knowledge about dry farming was greatly enhanced by participation in the DFC.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #11

1. Outcome Measures

To assess the aggregate and distributional tradeoffs and consequences of policies, programs, and investments to enhance the adaptive capacity of our managed agroecosystems and thus reduce the downside of exposure and vulnerability to climate change and climate variability, to environmental change, and to changes in economic and policy-based incentives. This includes advancing fundamental knowledge about the flexibility and resilience of agricultural (managed) ecosystems to increased variability in climate -LCA and to better understand and expand technologies, innovation and systems that can adapt to increases in uncertainty in environmental conditions and increases in climate variability, regionally and within Oregon

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In light of climate change, depletion of major aquifers, urban growth in water-scarce areas, and increasing demand for environmental goods and services, creative approaches are needed for

sustainable and efficient use of water resources.

What has been done
This work primarily addresses objective 2 by developing numerical models to examine water-related impacts of climate change. We developed models of the Willamette River catchment and reservoir operations. Model simulations were used to examine the effects of different climate change scenarios, as well as the impacts of aging infrastructure and of modifying reservoir operations to mitigate the effects of climate change.

Results
Results indicated that, for the climate scenarios analyzed, primary operating objectives of flood risk reduction and meeting summer Biological Opinion (BiOp) flow targets were unlikely to be affected. Modest reductions in the ability to fully refill the reservoirs and to meet spring BiOp flow targets were found, particularly under the more severe warming scenario. However, refilling the reservoirs two weeks earlier was effective in reducing the storage deficit introduced by climate change without compromising the ability to meet other operational objectives. Drawdown scenarios for maintenance of aging infrastructure had minimal effect at the system scale. Taken together, results suggested that the hydrologic changes associated with the range climate change examined were not likely to substantially reduce the reliability of the Willamette Project in meeting operational objectives and that, where potential deficiencies emerged, they could largely be mitigated through simple operational changes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
122	Management and Control of Forest and Range Fires
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #12

1. Outcome Measures

To assess the technical and economic potential to engage in mitigation strategies for Oregon agricultural and managed resource sectors while quantifying the costs of alternative mitigation efforts for the agricultural and managed resource sectors in Oregon and the Pacific Northwest (PNW).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Prior to 2015, ODF Stewardship Foresters would react to requests from individual landowners to conduct individual site visits and perhaps a land management plan at the rate of one to two landowners a year. The Forest Service would conduct a NFMA assessment and NEPA analysis without any consideration or knowledge of private land adjacent to the planning areas. NRCS would react to individual landowners one property at a time. Good work was being accomplished, but the potential was so much greater.

What has been done
Since 2015, the Klamath-Lake Forest Health Partnership (KLFHP) was used as a focal point to overcome barriers by Federal, State, County, and local natural resource management agencies and entities. Through regular meetings, trust and communication was established among participants. Barriers were overcome and the strengths were bolstered and weaknesses shored up. A true team emerged and a common vision and mission was established.

Results
Over the last 2 ½ years, we have mapped and inventoried almost 70,000 private land acres and assisted the development of private land management plans covering almost 40,000 acres. Over 2500 landowners have been contacted, educated, and informed of our efforts to improve forest health, wildlife habitat, fuel loadings, risk mitigation, and safe/effective fire/emergency response. We have improved the social health and well-being as well as the economic health of Lake County and working toward that goal for Klamath. State and Federal agencies have developed agreements (Good Neighbor, Farm Bill, etc) that have vastly improved relationships and the ability to accomplish work on the ground. FS has developed efficiencies in programming and accomplishing work. In Lake County last year, our landscape efforts resulted in the accomplishment of over 20,000 acres of sound, science-based management on public lands, and over 6,000 acres of private lands with two more years funded. We have published a process that works and have inspired many other landscape efforts across Oregon and Washington.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity

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
125	Agroforestry
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
311	Animal Diseases
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #13

1. Outcome Measures

Farmers in the western United States are increasingly affected by climate change through reduced snowmelt, higher temperatures, and drought (Van Horne et al., 2013). The Oregon Climate Change Research Institute (http://occri.net/) predicts a 50% reduction in summer water availability in Oregon within 50 years (Nolan and Daily, 2006). It is critical for the viability of farms in our region and the security of our food system to increase our knowledge and awareness of drought mitigation tools and strategies for farming with little or no irrigation. The goal of this project is to increase knowledge and awareness of dry farming management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The long-term sustainability of wheat-based dryland cropping systems in the Inland Pacific Northwest (IPNW) of the United States depends on how these systems adapt to climate change. Climate models project warming with slight increases in winter precipitation but drier summers for the IPNW. These conditions combined with elevated atmospheric CO2, which promote crop growth and improve transpiration-use efficiency, may be beneficial for cropping systems in the IPNW and may provide regional opportunities for agricultural diversification and intensification.

What has been done
Crop modeling simulation under future climatic conditions showed increased wheat productivity for the IPNW for most of the century. Water use by winter wheat was projected to decrease significantly in higher and intermediate precipitation zones and increase slightly in drier locations, but with winter crops utilizing significantly more water overall than spring crops.

Results
Crop diversification with inclusion of winter crops other than wheat is a possibility depending on agronomic and economic considerations, while substitution of winter for spring crops appeared feasible only in high precipitation areas. Increased weed pressure, higher pest populations, expanded ranges of biotic stressors, and agronomic, plant breeding, economic, technology, and other factors will influence what production systems eventually prevail under future climatic conditions in the region.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
201	Plant Genome, Genetics, and Genetic Mechanisms

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.)
- Other (climatic or environmental conduit)

Brief Explanation

Climate change continues to dominate public discourse and the need for additional research such as that outlined in the state defined outcomes is paramount to adapting to this change. Unfortunately, current administration policies have directed the public and government agencies to deny that climate change is occurring and subsequently research dollars to pursue adaptation approaches has declined and/or been redirected.
We expect large data gaps in the future as government efforts to measure and report on

climate change effects and impacts are restricted if not totally curtailed.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Adaptation to and mitigation of climate change presents unique challenges and begs the question of which approach is most important or at least most efficient. A number of studies conducted over the past year indicate that adaptation that involves changes in crop mixes, rotations, or wholesale changes in land use often require additional mitigation activities. In other words, use of AD liquids for fertilizer may result in increased releases of other GHGs. While the AD removes the methane, other compounds in the liquid are released by soil nitrifying microbes that can further degrade the atmosphere. Likewise, attempts to increase production with some crops in the face of less arable land available for production, increases the environmental cost of via LCA due to increased use of fertilizers that increase GHG production.
Finally, improvements in technology and improved access to that technology has opened new doors for researchers and students to develop remote sensing technologies that can more quickly evaluate and elucidate adaptation and mitigation strategies that are likely to have the greatest impact.

research and improving rather than continuing to degrade the world's soils.

Key Items of Evaluation

THE OPEN-SOURCE PUBLISHED ENVIRONMENTAL SENSING (OPENS) LABORATORY is now operational and has expanded nationally and internationally. OPENS creates a Maker lab space at the OSU and a synergistic forum for environmental sensing technology. The project specifically leverages the confluence of four rapidly developing technologies: 3-Dimensional printing; low-cost solid-state-sensors; low-cost, low-power digital controllers; and open-source publishing. OPENS provided a web-based formal publishing framework wherein global students and scientists can publish novel and evolutionary advancements in environmental sensor systems. This curated and peer-reviewed digital collection includes complete sets of ""printable"" parts and operating computer code for sensing systems. The physical lab also includes all of the machines required to produce these sensing systems. These tools can be addressed in person or virtually, creating a truly global venue for advancement in monitoring earth's environment and agricultural systems. Advancements in sensor technology have yet to be fully deployed for agricultural purposes primarily due to the expense of sensor assemblages and data analytics. This collaborative project is developing and deploying sensors across a broad spectrum of agricultural applications including water and nutrient fate and transport, pathogen and pest detection, yield, abiotic and biotic stresses to commodity crops, specialty crops, small fruits, forage species, and organic production, and to evaluate pesticide and herbicide efficacy and commensurate impacts to the environment.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Global Food Security and Hunger

☑ 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%		5%	
111	Conservation and Efficient Use of Water	5%		5%	
121	Management of Range Resources	5%		0%	
202	Plant Genetic Resources	5%		15%	
204	Plant Product Quality and Utility (Preharvest)	5%		15%	
205	Plant Management Systems	5%		5%	
206	Basic Plant Biology	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
301	Reproductive Performance of Animals	5%		10%	
302	Nutrient Utilization in Animals	5%		5%	
307	Animal Management Systems	5%		10%	
311	Animal Diseases	5%		10%	
501	New and Improved Food Processing Technologies	10%		10%	
502	New and Improved Food Products	10%		0%	
601	Economics of Agricultural Production and Farm Management	5%		0%	
603	Market Economics	5%		0%	
607	Consumer Economics	5%		0%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	5%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890

Plan	60.0	0.0	65.0	0.0
Actual Paid	54.0	0.0	8.1	0.0
Actual Volunteer	16519.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1152808	0	1708360	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1263466	0	18788355	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2948384	0	18244874	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

In Oregon there are over 38,000 farms producing 225 crops on over 16 million acres. Because 36% of Oregon's economy is based on agriculture; successful breeding programs directly influence and affect the success of a good portion of that value. Fruits, nuts, berries, vegetables, seed and specialty crops are produced on over 320,000 acres, and production has been increasing by 12% per year, generating $30-50 million per year. Cereal grains, potatoes and row crops account for over 10% of agricultural farm gate value in a typical year. The Oregon greenhouse and nursery industry typically accounts for approximately 15% of farm gate value annually.

Oregon crops are hosts to a wide variety of pathogens, pests, and stresses for which durable resistance genes are actively sought. At the same time, allelic variation in genes and gene networks associated with plant growth and development are targets for optimization in order to ensure maximum plasticity, productivity, and efficiency.

Organic, value-added, and technological (bio-based, information-centered, robotic, nanotechnology, etc.) approaches complement conventional agriculture. By utilizing contemporary research tools in agronomy, animal or soil science, plant nutrition and pest management, and molecular or genetic techniques, this program will develop improved practices for crop and animal production systems. New or enhanced techniques and information will enhance the potential use of alternative crops, reduce soil erosion, reduce the economic, social, and environmental costs of crop pests, and maintain or increase soil biological, chemical and physical properties. New knowledge will reduce disease, wastes and discharges in animal systems while improving husbandry, productivity and food safety.

In addition, a broad coalition of agricultural, environmental and food groups have coalesced around the need for integrated efforts for sustainable agriculture and food systems information, research, and education. Outcomes include more economically and ecologically sustainable farms and ranches; a more resilient rural economy; stronger bonds between rural, urban, and periurban residents; and a healthier environment for all Oregonians.

AES faculty have been actively engaged in developing new drought and disease cultivars that can improve food security as well as addressing new diseases and pests of both plant and animal production

systems. Additionally, work continues to improve both the yield and nutritional level of foods while simultaneously adapting these products to a changing climate and water regime.

2. Brief description of the target audience

- Professional peers and scientific communities, veterinarians, vaccine producers
- State commodity commissions, grower groups, packers, crop consultants
- Natural resource industry clientele - growers, field representatives, grower co-ops and partnerships, processors and handlers, export companies, importing companies
- County, state and federal agencies - USDA-ARS, Oregon Department of Agriculture, Natural Resources Conservation Service, Bureau of Indian Affairs, Confederated Tribes of the Umatilla Indian Reservation, US Forest Service, and Bureau of Land Management.
- Policy makers, public health officials, and community leaders
- Teachers and students, and other educators
- Genetic companies
- Nutritional consultants
- Nonprofit conservation groups and ecologists
- General public and consumers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	117986	250548	76407	352744

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	424	29	453

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Research projects addressing animal diseases.

Year	Actual
2018	14

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Improved and sustainable plant and animal production systems, including precision systems, cultural practices, conservation and population management strategies, innovations, pest control, organic systems, better fertility and reduced uterine infections in dairy and beef cattle and sheep, as well as better understanding of reproductive genetics and developmental biology
2	Expanded nutrient knowledge in plant and animal systems
3	Improved plant and animal breeding for improved or novel attributes and for human health benefits, including fertility, health, and productivity
4	Develop optimum pest management by identifying factors affecting herbicide activity, controlling weeds in organic and no-till production; learning basic pest biology, registering new herbicides or pesticides, finding application rates, and identifying risks associated with a pest as it becomes established
5	Conduct economic studies to help Producer groups learn about factors shaping global markets and productivity-convergence effects on US agricultural and processed food production and trade
6	Number of growers (commercial, small and fresh market) that adopt new varietals and methods to reduce yield losses and expenses, rejuvenate orchards, achieve better productivity and efficiency, provide environmental benefits (less fungicide applications, etc.), and effectively compete on the world market
7	Number that adopt conservation strategies and practices
8	Number in improved agricultural and fisheries/aquaculture sectors, e.g., commodities
9	Number of policy makers and other stakeholders that are better informed about plant or animal production methods, technologies, and management techniques
10	Improved knowledge of consumer and market conditions and factors that affect business survival and competitiveness such as market conditions, process map, business management, types of consumers and their food choices, motivations for food choice, marketing approaches for local markets and community food systems
11	Improved information about biology, control and resistance of viral, bacterial, fungal diseases, especially disease reproduction, transport and spread; postharvest decay; models to predict risk; and relationships between disease susceptibility and disease resistance
12	Produce the next generation of growers and agricultural eduactors by integrating agricultural education into high school curriculums and community education
13	Number whose consumer business knowledge leads to improved opportunities, and more successful starts, activity, survival, and profitability in food enterprises, as well as new and improved value-added products
14	Study mechanisms of important bacterial diseases affecting food sources in seafood production by enhancing the capacity and sustainability of salmon and trout populations.
15	Develop targeted intervention strategies to prevent pathogen contamination in bivalve rearing systems.

16	To study mechanisms of important bacterial diseases affecting food sources in meat production.
17	To create diagnostic approaches to characterize the genetic difference between bovine herpesvirus type 1 variants and vaccine strains.
18	Develop strategies to increase immunity, including the development of vaccines, against pathogens that impact food sources. Identify the role of mother cow immunization on calf protection agains MAP.
19	Develop new strategies to increase immunity in animals through dietary supplementation of selenium and development of vaccines against influenza.
20	Evaluate the toxicity of various mycotoxins in food.
21	Use molecular breeding tools to develop resistance to abiotic and biotic stressors and to improve traits related to human health and nutrition in cultivars of importance in agriculture systems. a) Conduct a systematic evaluation of germplasm resources to identify sources of genetic variation i. Develop new high throughput markers anchored in genome sequences ii. Map genes/QTLs determining target traits iii. Characterize gene/QTL networks and interactions iv. Measure gene/QTL x environment interaction v. Validate and fine map putative genes/QTLs vi. Transfer identified genes/QTLs into economically useful backgrounds, using accelerated generation advance strategies
22	Improve the nutritional value of important food grains; 2) reduce the impact of wheat storage proteins on human health; and 3) target nutrient development with ripening control. Examples at OSU include barley (Hayes and Ross), wheat (Zemetra, Flowers, and Ross), and grape (Deluc).
23	The mission of the Ornamental Plant Breeding Program is to develop new cultivars that are ecologically sound for producers and consumers as well as economically viable for producers. We seek to develop sterile forms of non-native species, insect and disease resistant cultivars, and low input cultivars that can be grown in nurseries and landscapes with less water or nutrient inputs.
24	Fundamental Research Supporting Multiple Breeding Programs. Two research groups are engaged in fundamental research relevant to multiple breeding programs. These include seed dormancy and germination (Nonogaki) and a systems biology approach to stress tolerance (Jaiswal).
25	Evaluation of wheat cultivars for performance and resistance to stripe rust.
26	Traditional agricultural extension programming has been commodity specific and tends to attract operators of medium to large scale farming businesses that focus on a few commodities and wholesale markets. Small scale farmers with diverse operations who tend to focus on direct marketing are a large but historically underserved audience. Improving access to research based information for small scale diverse farms enhances their chance of developing successful farm businesses.
27	Evaluation of forage crops for improved economics and sustainability of animal production systems.

Outcome #1

1. Outcome Measures

Improved and sustainable plant and animal production systems, including precision systems, cultural practices, conservation and population management strategies, innovations, pest control, organic systems, better fertility and reduced uterine infections in dairy and beef cattle and sheep, as well as better understanding of reproductive genetics and developmental biology

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic growers need new crops, markets, and rotation options supported by varieties that are developed specifically for organic conditions. Our long-term goal is to provide organic gardeners, growers, processors, and consumers with an alternative crop, food, and raw material that will be economically rewarding and sustainable. Currently, organic barley end-uses and markets are stratified due the presence of an adhering hull and grain β-glucan content. We will breed for naked barley and a modest level of β-glucan to create varieties suitable for brewing, feed use, and that will meet FDA guidelines for soluble fiber in human diets. Development, assessment, and participatory breeding of naked multi-use barley will be conducted in five representative regions/states - Pacific Northwest (OR, WA), Upper Midwest (MN, WI) and North East (NY) - using three classes of germplasm: a composite targeted to K-12 students and gardeners, a large diversity panel to apply genetic data to improve barley for organic systems, and a multi-regional trial to identify varieties for release. We will assess germplasm under organic conditions in school and home gardens, university research stations, and on-farm trials.

What has been done
The long-term goals of this multi-region, integrative project are to: (1) provide organic growers, processors, and consumers with a new crop, food, and raw material alternative that will be economically rewarding and sustainable (2) identify and release high-yielding, high-quality, flavorful and nutritious multi-use naked barley varieties for organic systems based on a regional variety testing program anchored in Oregon, Washington, Wisconsin, Minnesota, and New York; (3) characterize key agronomic and food, feed, and malt quality traits in a large, genetically diverse panel of naked barley germplasm grown under organic conditions and maximize the efficiency of selection in this panel via integration of phenotypic and genotypic data; (4) observe,

analyze, and report the results of natural selection and artificial selection on an organically grown naked barley composite population - a vehicle for engaging K-12 students and home gardeners in organic grains and foods; (5) understand the economic and environmental benefits of domestic organic naked barley production, and; (6) educate the public on the uses and production value of naked barley using a number of dissemination techniques.

Results

Goal 1: Growers, processors, and consumers were provided with information about naked organic barley at conferences, field days, through personal communication, and website postings. However, in this first year of the project we have not had much seed to work with. Now that trials have been harvested more information can be provided. Using the limited seed from trials conducted before the start of this grant, we mini-malted 'Buck' and provided malt to two breweries to experiment with. We conducted informal sensory exploration on breads, steamed grain, and biscuits with attendees at conferences and field days.

Goal 2: For our regional variety testing program we grew advanced experimental breeding lines and released varieties in the fall and spring. For our fall trial, 18 advanced naked barley lines were tested at 6 sites in five states: Oregon, Washington, Minnesota, Wisconsin, and New York. For our spring trial, 18 naked barley entries were tested at 9 sites in six states: Oregon, Washington, Minnesota, Wisconsin, Michigan and New York.

Goal 3: For the diversity panel, we assembled 254 spring and facultative naked barley lines from breeding programs and germplasm repositories around the world. These were trialed at 5 spring sites in single or double rows. An additional 130 winter lines were selected and grown out in the greenhouse.

Goal 4: Our outreach to K-12 students is being achieved by assisting teachers in all states with lesson plan development, seed increases, and selection.

Goal 5: Our agriculture economist is generating a literature review on the economic and environmental benefits of naked barley. In addition, he has begun developing questions that will appear on a 2019 grower survey regarding naked barley production and is in the process of developing an economic analysis of the feasibility of developing a small-farm scale integrated organic naked barley operation that includes grain production, malting, brewing, feeding, and culinary dimensions.

Goal 6: Details of the project have been disseminated through email, personal correspondence and communication, field days at all universities, press releases, conferences, and websites. OSU hosted 'Barley Day 2018', which was a day-long field day focused on this project. It was held in conjunction with the annual project meeting and included collaborators from all states who gave presentations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
121	Management of Range Resources
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals

302	Nutrient Utilization in Animals
307	Animal Management Systems
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics

Outcome #2

1. Outcome Measures

Expanded nutrient knowledge in plant and animal systems

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The objective of this study is to determine if supranutritional Se-supplementation of weaned beef calves decreases gastrointestinal parasite load, or the percentage of parasites that are Haemonchus contortus. We hypothesize that Se-enriched alfalfa hay results in high concentrations of whole-blood Se and reduces gastrointestinal parasitism, in particular H. contortus. If true, this would be of tremendous importance to the cattle industry and would alter current parasite control programs. Not only would this strategy slow the development of resistance and prolong the effective use of dewormers in the main herd, but also calves would be eligible for niche markets where drug products such as antibiotics and anthelminthics are not allowed. This strategy may positively impact the ability of the beef producers to control internal parasites.

What has been done
?Cattle, unlike humans, do not receive passive immunity in utero (transfer of antibodies from mother to offspring) as antibodies do not cross the placenta; however, it is known that immunoglobulins in milk colostrum can convey passive immunity in newborn calves in the first 48 hours of life (transfer of antibodies from colostrum in gut to blood stream of calf). The period during which the intestine is permeable to antibodies varies, but is highest immediately after birth and decreases to relatively low levels by 24 hours. Failure of passive transfer predisposes a calf

to infection. Feeding Se-enriched hay to cows for 8 weeks prior to birth leads to significantly increased Se concentrations in colostrum and improves passive transfer leading to higher whole-blood immunoglobulin concentrations in newborn calves.

Results

?Molecular work on cattle blood cells from animals fed Se-fortified hay shows that the role of Se in animal health is based primarily on the functions of Se-containing proteins, many of which have antioxidant activities. The beneficial effects of Se supplementation may result from Se-containing proteins converting harmful and highly reactive oxygen-containing molecules to less reactive molecules, as well as influencing the expression of reduction-oxidation -regulated genes.
?The nasopharyngeal microbiota in cattle plays an important role in overall respiratory health, especially when stresses associated with weaning, transport, and adaptation to a feedlot affect the normal respiratory defenses. Recent evidence suggests that cattle diagnosed with bovine respiratory disease complex have significantly less bacterial diversity. Our work to assess the health effects of feeding Se-fortified alfalfa hay to recently weaned calves shows that weaned beef calves fed Se-biofortified hay tend to have an enriched nasal microbiota. We think that feeding Se-biofortified alfalfa hay to weaned beef calves prior to entering the feedlot is an effective strategy for increasing nasopharyngeal microbial diversity and may improve respiratory defenses in the feedlot.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics

Outcome #3

1. Outcome Measures

Improved plant and animal breeding for improved or novel attributes and for human health benefits, including fertility, health, and productivity

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wheat is Oregon's second largest crop, after alfalfa, valued at $239 million in 2017, with major production regions spread across many climates. While barley production is substantially lower than wheat production ($6.5 million in 2017), it is considered to be an important rotation crop in many parts of the state. Currently, at least five universities, seven private companies, and the USDA have rights to wheat and barley varieties that may have a future in Oregon. While this leads to an abundance of options for growers in the state, it can be difficult for growers to directly compare variety performance in the field. In areas and market classes that are not represented by this variety testing program, this has led to planting decisions being made on the basis of marketing, rather than data. This can lead to growers planting varieties with sub-optimal yields, disease, and quality.

What has been done
In order to provide grower with the information needed to select the best wheat and barley varieties available, we conduct a set of variety trials in twenty locations in Oregon, four locations in Washington, and two locations in California (trials growing regions spanning state borders are often conducted in collaboration with our counterparts in neighboring states). These locations are chosen to cover the wheat and barley growing regions of Oregon, so that variety recommendations can be made based on performance in the target growing conditions. In addition to released varieties, this trial includes advanced experimental lines from public and private breeding programs, to accumulate performance data in the event of a line's release. Trial results are released to growers and seed dealers after harvest through multiple channels, so that they can be used for fall planting decisions.

Results

Results from the variety trial have been received extremely well by growers and stakeholders. Growers regularly express to me how much stock they put in the variety trial results. Mid-Columbia Producers, one of the leading seed dealers in Oregon, features a link to the results at the head of the list of varieties they offer. Similarly, Northwest Grain Growers relies heavily on these results when deciding which varieties to carry, and when recommending varieties to growers.

In addition to helping with planting decisions, the data we collect on experimental lines provides important feedback to plant breeding groups, which helps them to decide which lines to release and market in Oregon, as well as which lines to use as parents for future breeding efforts.

Because leading wheat varieties often differ in yield by 10%, a very conservative estimate of the cumulative effect of this program's impact is a 1% increase in yield of wheat and barley (including assisting growers in planting decisions, and influencing which varieties are released and marketed in Oregon). In 2018, this translates to approximately 516,000 bushels of wheat (at a price of $6 per bushel) and approximately 570 tons of barley (at a price of $150 per ton).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
502	New and Improved Food Products

Outcome #4

1. Outcome Measures

Develop optimum pest management by identifying factors affecting herbicide activity, controlling weeds in organic and no-till production; learning basic pest biology, registering new herbicides or pesticides, finding application rates, and identifying risks associated with a pest as it becomes established

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The United States is the world's leading producer of floriculture products. Horticultural plants are high-value crops of significant worth because of their aesthetic qualities and uses in enhancing personal and community-shared environments. The crown gall and leafy gall diseases caused by Agrobacterium tumefaciens and phytopathogenic Rhodococcus, respectively, are a significant national problem. The symptoms are often grotesque and the abnormal growth phenotypes render diseased plants of no value, resulting in annual losses exceeding a million of dollars for some growers. These pathogens are a particular problem because management is challenging. These pathogens each infect more than a hundred plant species important to the industry. There are few commercially available controls that are effective against these pathogens. Early and accurate diagnosis of disease is difficult for a number of reasons. Their transmission and evolution is poorly understood. There are no rapid and sensitive methods for diagnosing plants. Finally, it can be challenging to train nursery workers in effective management because of the diversity in educational levels and cultural background.

What has been done
The major goal of this proposal is to assist the nursery industry in managing broad host range, gall-causing bacterial pathogens. To address this goal, we have developed trans-disciplinary approaches that rely on expertise in bilingual education, diagnostics, economics, extension, genomics, natural product chemistry, plant pathology, and population genetics.
The specific objectives are:
1)Test and develop control compounds for broad host range and gall forming bacterial pathogens.
2)Determine population structure, migration patterns, and evolution of A. tumefaciens and phytopathogenic Rhodococcus.
3)Develop sensitive and easy-to-use diagnostic kits.
4)Develop a website and database for using molecular data to rapidly identify species and strains of A. tumefaciens and phytopathogenic Rhodococcus.
5)Education outreach to advance in-depth bilingual programs, workshops, and courses focused on managing bacterial diseases, and develop materials to educate and train workers at all levels of the industry.
6)Economic outreach to assess at the levels of the growers, retail and consumer, and community.

Results
We have completed testing the tool-mediated transmission of Rhodococcus and Agrobacterium and are currently writing up the work for publication.
We have completed our evaluation of commercially-available products for controlling Rhodococcus and Agrobacterium and are currently writing up the work for publication. We have identified natural products from two species of plants and one species of bacteria. We have determined the structure for one product. We have demonstrated that the natural product from bacteria controls Agrobacterium in planta. We will be writing up the work for publication over the next year and we have completed the genomic epidemiological survey of nursery plants for Agrobacteria.
We are currently writing up the work on the evolution of agrobacteria and its oncogenic plasmids.

Specific aims 3 and 4 were previously completed. We continue to offer courses on plant health and preventive methods. We learned that for AgBiz Logic to work, that we need to collect more data (see changes/problems).

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics

Outcome #5

1. Outcome Measures

Conduct economic studies to help Producer groups learn about factors shaping global markets and productivity-convergence effects on US agricultural and processed food production and trade

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The continued growth and long-term viability of local food systems depend on public and private investment of financial, political, and social capital. In pursuit of this investment, food system practitioners increasingly are identifying ways to measure and communicate the multifaceted benefits of local food systems (Brown, Goetz, Ahearn, & Chyi-lyi, 2013; Lev, Brewer, & Stephenson, 2003; Sharp, Clark, Davis, Smith, & McCutcheon, 2011). Economic impact in particular is thought to be a critical and convincing metric. While this is relatively easy to measure compared to other impacts of food systems, there is still tension and confusion about how to

measure it accurately. Furthermore, economic impact assessments have little impact themselves if results are not effectively communicated to decision-makers (Druker, 2015). Little research has focused on the effectiveness of communicating these results to decision-makers.

What has been done

For the economic impact assessment, we focused on small to midsized local food producers, both crop and livestock, who primarily, but not exclusively, marketed their products within Central Oregon.

Working together, staff from the three organizations used the USDA Toolkit to design an economic impact study with the following parameters:

?Assess the impact of local food system producers using primary survey data;

?Analyze the impact of two types of local food farms: crop-focused and livestock-focused;

?Measure current direct impact (using 2014 Schedule F tax form data); ?Create two scenarios of potential future impact that considered resource constraints and opportunity costs; and

?Use this study to pilot the use of the Tool-kit in Oregon and evaluate the value of these studies for other regions of the state.

Results

We found the presentation of the results had a stronger and more positive impact among decision-makers in rural counties and the state service providers who work with Regional Solutions. The two urban audiences, Deschutes County and the city of Bend, had lower response rates and responded less positively to the study. Two survey respondents were openly critical of the idea of using public investments to support industry expansion. With just two audiences, our sample of urban decision-makers is small, and while we do not want to overgeneralize from these two responses, it is worthwhile to discuss this opposing viewpoint. This view may be partially explained by differences between the scale of the local food industry and those respondents prior experiences in economic development. However, the responses of urban audiences also illustrate the ongoing challenges in both collecting accurate data from this industry and exclusively relying on economic impact analysis to justify public investment in the local food sector.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #6

1. Outcome Measures

Number of growers (commercial, small and fresh market) that adopt new varietals and methods to reduce yield losses and expenses, rejuvenate orchards, achieve better productivity and efficiency, provide environmental benefits (less fungicide applications, etc.), and effectively compete on the world market

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic food production in the United States is expanding rapidly. The sales of organic food and non-food products in the US reached $39.1 billion in 2014, an increase of 11.3 percent relative to 2013. The sale of organic food accounts for almost 5 % of the total food market in the US. There is an increasing need for graduate training of university students and professionals in Organic Agriculture (OA). Currently in the United States, there is no online master's degree program or graduate certificate in OA, whereas undergraduate programs in OA do exist. The goal of this project is to address this gap by the development and implementation of: online certificate in OA for graduate students and professionals across the nation and abroad.

What has been done
The project's goal is to develop and implement an online graduate certificate program in organic agriculture within the 2-year project period, and then build an online MSc in OA, perhaps in collaboration with another U.S. University, within five years. This project will develop an online Graduate Certificate in OA in several potential areas of specializations: organic whole farm system management, organic livestock management, organic soil management, pest management, perennial berries, fruit crops, vegetables and ornamentals, field crops and forages. This new online graduate certificate will be administered through Oregon State University, consistent with the mission and vision of the institution. This will be achieved through (1)Development of the requirements for the online graduate certificate, (2) Development of new courses, (3) Implementing organic curriculum into some existing courses, and (4) Launching the new online Graduate Certificate at OSU.
Specific objectives that were identified to meet the goal of this project are:
1. To evaluate the Oregon State University E-campus market research study to fully assess target audiences and their needs.
2. To develop the Graduate Certificate in OA via planning meetings with project staff and faculty, as well as administrators of the OSU College of Agricultural Sciences (CAS).
3.To develop the Category 1 Proposal for online Graduate Certificate in OA.
4.To develop and deliver courses for the certificate.
5.To market the new online course offerings and Graduate Certificate to potential students.
6.To evaluate the courses and graduate program outcomes relative to project goals and desired outcomes.

7.To disseminate information and outcomes.

Results

1.A market research study was conducted with the help of OSU's E-campus to assess target audience for the new program and their needs as students. In addition, working with E-campus allowed program faculty and administrators to evaluate projected program costs and the revenue produced by enrollment per course. An analysis was conducted on administrative structure for the new program that would allow the program to be self-sustaining as a permanent addition to OSU Academics.
2.Development of the Organic Ag Certificate was planned in several meetings that included area stakeholders and representatives of international programs in Organic Agriculture, Administrators in the College of Ag Science and Department Heads for all of the Departments/Colleges that will be offering the courses proposed as a part of the new program. These administrators met in group meetings and in individual meetings with the Program Coordinator and the P.I.
3.Following meetings with administrators, the business office (providing a long-term budget), stakeholders and faculty, the Category I Proposal for a new program was formulated and submitted to the University. This proposal has already passed several levels of initial review, and is in the late stages of review before a final approval that will add the new program to the academic catalog.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #7

1. Outcome Measures

Number that adopt conservation strategies and practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The sagebrush ecosystem is currently under threat from landscape scale processes including invasion by annual grasses, an unprecedented rise in wildfire, and encroachment by conifers that have reduced its size by 50% in the past 150 years. Such extensive habitat reduction has led to declines in wildlife species and generated an intense focus on the management of remaining sagebrush habitats. Land managers need to work at large spatial scales to address these ecological threats, but have limited resources to do so.

What has been done
OSU's involvement in the collaborative SageSHARE group, consisting of federal and non-profit partners, led to the creation of the Threat-based Land Management framework, a 9-box conceptual framework focusing on how invasive annual grasses and conifer encroachment affect the sagebrush ecosystem. Partners from OSU, Oregon Department of Fish and Wildlife, The Nature Conservancy, USDA Agricultural Research Service and the US Fish and Wildlife Service have collaborated to develop a common language and decision support framework for diverse stakeholders to communicate about and address shared problems. Threat based Land Management provides a framework that is complex enough to inform management decisions while remaining simple enough for use by all stakeholders.

Results
The manifestation of this framework is the Threat-based Land Management in the Northern Great Basin: A Field Guide. The field guide provides a framework to efficiently identify, discuss, and address landscape-level threats. The illustrated guide takes users step by step through establishing management objectives, understanding the relevant ecology of a large and diverse landscape, assessing threats in order to map simplified ecological states and estimate future trend. The field guide is a decision-support system that directly supports management objectives and conservation practices. The Threat Based Land Management approach and associated Field Guide is currently being applied on over 7 million acres of private and public lands across Oregon, Nevada, Idaho and Wyoming. Over 2,000 copies of the Field Guide have been distributed to an international audience, with requests continuing to come in. This approach supports conservation plans to implement juniper removal, annual grass treatment, improved grazing practices and wildlife conservation on public, state and private land.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
121	Management of Range Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #8

1. Outcome Measures

Number in improved agricultural and fisheries/aquaculture sectors, e.g., commodities

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The city of Astoria in Clatsop County has a diverse fishing industry and is one of the top 10 landing ports in the United States. However, local business leaders, decision-makers and elected officials aren't always aware of the specific impacts this vital industry has on the city, county and region. Local seafood and fishing industry representatives requested Oregon Sea Grant's assistance in developing educational programming to address this knowledge gap and provide opportunities for relationship building.

What has been done
In response, Oregon Sea Grant Extension faculty convened a local steering committee and organized a one-day tour in 2017 of commercial fisheries and seafood-processing operations, focusing on Clatsop County. The tour emphasized the economic impacts of commercial fishing to

the county and to Oregon, highlighting both opportunities and challenges. In 2017, the tour included site visits presentations to seafood processors, a marine construction company and a marine and industrial supply company and presentations on Columbia River and ocean salmon. In 2018, the tour highlighted maritime workforce development, fishing gear technology improvements for increased economic and environmental sustainability, and local port and marina infrastructure maintenance and improvement, and safety equipment and marine support businesses. The tour also included presentations on local fisheries management, the national weather buoy system, and a legislative update from our U.S. Congressional representative's staff. In both 2017 and 2018, the tour concluded with a seafood lunch, featuring an underutilized rockfish species.

The tours have been so successful that the steering committee hopes to make it an annual event.

Results

The 2017 tour drew nearly 100 people and the 2018 tour had over 80 attendees, including representation from state, county, city, and local economic-development offices; local commercial-processing industry leaders, boat services, and fishermen; and the district's U.S. Congressional representative. Attendees noted that the message was positive and emphasized the sustainability of commercial fishing, and they reported increased knowledge about the economic value of commercial fisheries and connections to our community and local businesses, and the current challenges and recent improvements made in fisheries. Nearly 90 percent of attendees reported that they met someone new who they planned to contact in the future, and 98 percent said they would recommend the tour to a colleague.

In a post-tour survey, attendees reported greater increases in knowledge in 2018 compared to 2017 about the economic value, connections between fisheries and other sectors of the economy and other geographic areas, current challenges and sustainability practices. 80 percent of respondents said they met someone new that they might contact in the future, and 100 percent said they would recommend the tour to a colleague.

As a direct result of the tour, Oregon Coast Bank extended a business line of credit to Hyak Marine to assist them in expanding their marine construction business, which employs 15-20 skilled workers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #9

1. Outcome Measures

Number of policy makers and other stakeholders that are better informed about plant or animal production methods, technologies, and management techniques

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Dungeness crab fishery comprises a quarter of Oregon's landed seafood value ($63 million in 2016-17) and is vital to coastal economic resilience. Reports of whale entanglements in Dungeness crab fixed gear have recently increased in west coast waters. A recent lawsuit claims that California's management of the Dungeness crab fishery violated the Endangered Species Act by harming federally listed humpback and blue whales. Potential management changes aimed at reducing impacts on whales could seriously compromise the economic viability of Oregon's Dungeness crab fishery.

What has been done
To ensure an inclusive group and collaborative process, Oregon Sea Grant (OSG) co-organized and -facilitated a west-coast-wide workshop on gear innovation to reduce whale entanglements. We recruited leaders from Oregon's commercial fixed-gear fishing industry to participate in the workshop, and established an Oregon-specific Whale Entanglement (OWE) Working Group. Along with relevant state management agencies, OSG announced OWE to all Oregon Dungeness crab permit holders. We interviewed and recruited gear manufacturers, recreational fishers, NGOs, and whale researchers; OWE membership was finalized through participant feedback.

Results
Oregon Sea Grant partnered with Oregon's Dungeness crab fishery stakeholders including state agencies, fishermen, marine mammal scientists, and gear manufacturers to address potential risk of whale entanglement in crab pots. The newly formed Oregon Whale Entanglement (OWE) Working Group developed a Best Practices Directive, conducted fleet outreach to avoid endangering whales during fishing activity, developed state-level management recommendations, and catalyzed action on this issue by Oregon and Washington fisheries managers. During five

meetings in 2017 and four meeting in 2018, the OWE Working Group advanced short- and long-term solutions to reduce Oregon's whale entanglement risk. In 2017, the group developed a voluntary Best Practices Directive, highlighting gear modifications and practices to reduce risks; distributed the Directive and information on how to report entangled whales; gathered information from managers and technical experts to inform discussions, and proposed potential management options. Recommendations were refined by surveying all Dungeness crab permit holders for their perceptions on whale entanglement risk and feedback on OWE products.
The impacts of the working groups efforts are just beginning to materialize, but include both collaborative research and proposed substantive fisheries policy changes. The California State Legislature passed legislation in early 2018 enshrining the RAMP as a permanent advisory body to CDFW, ensuring continued industry engagement in developing fisheries policy on this issue. In November 2018, both California and Washington announced their intent to file for Section 10 incidental take permits. This is a major policy development, as it will require both states to articulate and analyze how they will minimize their take of endangered large whale species but also will provide regulatory certainty for the Dungeness Crab fleets in both states. It is likely that Oregon will follow suit in seeking a Section 10 permit after they have consulted with the Oregon Fish and Wildlife Commission about their policy proposals in Spring 2019.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #10

1. Outcome Measures

Improved knowledge of consumer and market conditions and factors that affect business survival and competitiveness such as market conditions, process map, business management, types of consumers and their food choices, motivations for food choice, marketing approaches for local markets and community food systems

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small and medium-sized farms urgently need additional market outlets that are profitable. While some farms have succeeded by selling fresh products through farm-direct and intermediated markets, those niches are limited. This project explores whether supplying ingredients and/or processed products to the rapidly-growing specialty food marketplace represents an additional attractive outlet for small and medium-sized farmers and, if so, how sales through this channel can be increased. We examine this proposition from both the perspective of farmers (suppliers) and specialty food manufacturers (buyers) in four broad ingredient categories (dairy, meats, grains, and fruits and vegetables).

What has been done
The project's integrated research and outreach process is guided by an Advisory Committee of farmers, specialty food manufacturers and resource organizations. The three major research elements are: (1) initial exploratory interviews with farmers and manufacturers in three regions: Pacific Northwest
(Oregon, Washington), West (California) and Upper Midwest (Minnesota, Wisconsin); (2) survey of specialty food manufacturers in our product categories across the three regions to gather data about their ingredient sourcing, key attributes for choosing suppliers, interest in purchasing from small and medium-sized farms, and challenges; (3) in-depth interviews with manufacturers and farmers (including some who are also specialty food manufacturers) regarding the nature of business relationships, supply networks and communication strategies. Project outreach events (nine workshops) and products (guides, webinars, and articles) ensure that research insights are used and essential farmer-manufacturer relationships and networks are formed.

Results
n Year 3, we made progress on all three goals. We conducted more than our target of 60 in-depth interviews split among specialty food manufacturers and two types of small and medium sized growers -- those who only produce the farm ingredients and those who are both farmers and specialty food manufacturers. These interviews, in combination with our previous survey results, have been developed into multiple presentations and written outputs that address the three project goals. We continued to provide numerous professional training and outreach activities in Year 3 and made progress on developing our outreach materials .

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics

Outcome #11

1. Outcome Measures

Improved information about biology, control and resistance of viral, bacterial, fungal diseases, especially disease reproduction, transport and spread; postharvest decay; models to predict risk; and relationships between disease susceptibility and disease resistance

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bee pollinators are vital to USA's economy, food security, and environmental health, and hence reports of their declines have raised concerns nationally. For minimizing future losses, bee mortality factors need to be determined. Bees are generalists, and species that pollinate crops are affected by negative factors across the landscape. For instance, recent bee deaths associated with profusely flowering bee attractive linden trees reduced the availability of pollinators for crops in surrounding areas. Impacts of toxic pesticides in nectar have been examined but little is known about naturally occurring toxic compounds. The challenge lies in identification of multiple compounds in low volumes of nectar. However, the emerging field of metabolomics now allows for comprehensive characterization of small molecule metabolites in biological systems. Our goal is to use the metabolomic profiling approach for determining bee toxic compounds in nectar.

What has been done
To identify compounds that are potentially toxic to bees, nectar analysis was expanded to include four additional T. cordata trees known to cause bee mortality. Untargeted analysis was conducted with LC/MS and HPLC (n=10), and a subset (n=6) with was analyzed with an additional technique, nuclear magnetic resonance (NMR). Sugars are the primary energy source for bees, and accurate identification and quantification of sugars in linden nectar is essential. NMR can distinguish between sugar isomers without complex derivatization but requires greater quantities for detection than LC/MS, therefore pairing these techniques is extremely useful. All samples preparation was conducted using the microcapillary pipette and bead-blast tube methods determined in 2016.
Metabolomic analysis of flight muscle was repeated in 2017 with increased sample size and more tightly controlled experimental groups. The length of time between collection and preservation

was reduced by preserving bees with dry ice immediately, which minimized metabolism and preserved differences between cohorts. Bee muscle was analyzed with LC/MS and HPLC (crawling and healthy n=20), and a subset with NMR (crawling n=5, healthy n=4). One hundred and fifteen compounds were detected with LC/MS that matched records in the IROA library and 14 compounds were detected with NMR, including 11 that had not been detected previously. Thirty-three compounds were significantly different between healthy and crawling bees.

Results
Ninety-two compounds detected with LC/MS matched records in the IROA library and an additional eight were identified using NMR, including four previously unidentified compounds. HPLC quantified sugars fructose, sucrose, and glucose, confirming that linden nectar contains sugar levels similar to other bee attractive nectars. Interestingly, principal component analysis shows distinct clustering among samples from individual trees. Again, mannose was not detected. The alkaloid trigonelline detected in initial nectar samples in 2016 was again detected in nectar in 2017. To determine its concentration in nectar for future experiments a targeted search for trigonelline was conducted, and preliminary estimates are approximately nine nanograms of trigonelline in one milliliter of nectar.
Principal component analysis shows clear separation between groups, indicating strong metabolic differences between healthy and crawling bees. We took the analysis one step further by conducting pathway analysis with MetaboAnalyst 4.0. Pathway analysis determined several prominent metabolic pathways that were strongly represented among significant compounds, including the Kreb's cycle, purine metabolism, and the metabolism of several amino acids.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases

Outcome #12

1. Outcome Measures

Produce the next generation of growers and agricultural eduactors by integrating agricultural education into high school curriculums and community education

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Science, technology, engineering and math (STEM) opportunities are a growing interest for Marion County youth. For middle and high school youth, the interest may connect to their long-term goal of studying STEM in college and STEM careers. Many of the Salem-Keizer underserved and low-income youth have a hard time seeing themselves in college, as well as fully understanding what a STEM career may be. These students often do not know which adults in the community do STEM work understand what that may mean for Marion County. Oregon is not alone as underrepresented minorizes hold only 10% of science and engineering jobs despite making up over a quarter of U.S. population age 21 and older. (National Science Foundation, Science and Engineering Indications 2013) Youth in general have a curiosity for STEM education beyond the classroom and in the outdoors to better understand the variety of professional fields and careers the state of Oregon may provide. Across America, 59% of youth would like to have a job related to science when they graduate from school. (4-H Science Youth Engagement, Attitudes and Knowledge (YEAK) Survey 2010) Marion County youth particularly have a strong interest for hands-on, real life application of STEM skills and OSU Extension Service in connection with the Detroit Forest Service and other partners like Bureau of Land Management, Marion-Polk Food Share Youth Farm, City of Salem, NASA, NESSP (Northwest Earth and Space Sciences Pipeline), OSU Robotics Club, Salem-Keizer Education Foundation, and Lewis Design Drones are committed in helping students make that connection to gain confidence and understanding of their career and college pathway.

What has been done
With the help and leadership of Salem-Keizer School District employees from North Salem High School, AP Biology teacher Emily Parent and West Salem High School, Biology and Marine Sciences teacher Valerie Henderson, a partnership with NASA and NEESP were formed to fund a four-day STEM camp in July, 2018. This STEM camp was provided at no cost to underserved youth in grades 9-12 across Salem-Keizer to attract and support underrepresented students who may be new to STEM and 4-H positive youth development programs.

During this STEM Camp, high school students studied and explored the spheres of the earth with STEM professionals in the field. Each day the students traveled to a different site such as the Marion-Polk Food Share Youth Farm, Detroit Lake, Opal Creek, and Salem-Keizer School grounds learning about water, air, habitat, and soils. The STEM camp was held at the OSU Extension Service in Marion County. Students developed hard-skills such as Arduino programming for drones to track air, weather, and temperature for citizen science data collection. Students traveled to the Youth Farm at Chemeketa Community College and tested soil while learning about soil properties for agriculture. At Detroit Lake, students examined the water quality and spoke with a biologist about the recent Toxic Algae Bloom that affected Salem-Keizer?s drinking water in 2018. On the last day, students worked within interest groups on a hike at Opal Creek to study the habitat, including plant species, tree stand health, mapping and team-building activities for data collection. Data was compared between groups at each site and shared with NESSP and NASA.
This STEM camp sparked an interest for many of the youth. For expanded learning opportunities,

students were then invited back to participate in 4-H YES (Youth Enviro Squad) club service-learning field days throughout the summer and into the school year along with existing Teen Teacher programming at Fishermens Bend and BLM lands teaching the public about Native and Invasive species. The core Teen Teacher group then participated in the Caretakers of the Environment International (CEI) program, presenting their YES and Teen Teacher experiences abroad in Austria as the USA Delegation. Students had access to additional opportunities to serve alongside STEM professionals in the field through Oregon State Extension 4-H programming, making STEM more approachable.

Results
Surveys developed by NESSP were given at the end of the four-day STEM camp to all students who participated. 100% of students strongly agreed with the statement "What we learned about during the program can be applied to real life" while 94% agreed with the statement "understood what we were learning about in the program". The real-life application and hands-on study in the field provided opportunities that are not typically available in the academic classroom, connecting students to a greater interest and academic understanding of STEM in general. Because the daily STEM projects connected with citizen science and service-learning, students were able to see the greater purpose of their summer studies and invested their time. Many students had the opportunity to travel to sites across Marion County that they had not been before, creating a deeper interest in outdoor recreation as well. College is a barrier for many limited-income families. Within survey responses, 76% of students agreed with the statement "It gave me confidence that I can study STEM/science in college if I want to." Throughout these camps and field days, hands-on and small group instruction made STEM more approachable and accessible, providing all equipment and instruction at no cost.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Number whose consumer business knowledge leads to improved opportunities, and more successful starts, activity, survival, and profitability in food enterprises, as well as new and improved value-added products

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In 2014, OSU Extension and Gorge Grown Food Network received a grant to purchase semi-commercial home food-preservation equipment. Market analysis highlighted that 98% of food grown in the Gorge is exported to international markets. There was limited value added production despite a glut of fruit. Additionally, new Oregon laws allowed for Farm Direct and Producer Processed foods at local markets. It seemed our region had the potential to create new products, but lacked the knowledge or wherewithal to develop them. The cost of purchasing equipment, renting commercial kitchen space, or certifying one's own home kitchen were large barriers to the development of new products.

What has been done

Our goal was to provide small farmers, orchardists, restauranteurs, home cooks, and other food producers access to food preservation and value added production equipment. This would enable them to experiment with value added products and kitchen equipment to develop and diversify products for sale at markets, increase the proportion of food staying in the local economy, and ultimately increase local food security. A $5,000 grant purchased two semi-commercial dehydrators, high capacity food processors, juicers, cherry pitters, canners, fermentation crocks and other miscellaneous equipment. Equipment is rented out of the Extension office at low or no cost for one-week periods. Extension faculty provide training in the use of equipment and address University liability concerns through waivers and hands-on education.

Results

The program has been running for five years with over 130 rentals completed. We have been able to purchase additional equipment with rental fees. The program has assisted in developing new products, improving home food production, and supporting small businesses in utilizing local foods in their products. A local bakery rents our cherry pitter and dehydrator each year to pit and dry hundreds of pounds of cherries it uses in their scones all year! Other local food businesses have experimented with different pieces of equipment and food preservation processes. Home food preservers have expanded their own skills and caches of food.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #14

1. Outcome Measures

Study mechanisms of important bacterial diseases affecting food sources in seafood production by enhancing the capacity and sustainability of salmon and trout populations.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many Pea/Wheat farmers on the Blue Mountains are century farms but rely heavily of organophosphates for pest control. There is a major need for introducing softer chemistries to these growers while offering incentives to them to move away from hard chemistries. Salmon Safe does exactly this. This program focuses on educating growers and field men and the general public as to the judicious use of pesticides in Pea/Wheat operations.

What has been done
?Presentations to WA/OR Green Pea Association
?Compiled standards for green peas, dry peas, wheat, corn, alfalfa, garbanzo beans, CRP/ pasture, canola
?Co-ordinated Salmon Safe audit for 4 growers
?Wrote a DEQ grant to support this program

Results
?Achieved conditional Salmon Safe certification for all 4 growers
?>12,000 acres are now conditionally Salmon Safe certified
?a 250 acre block of Salmon Safe Barley was produced and processed by Main Stem Malt. The malted barley was used in conjunction with Salmon Safe hops to produce the first truly Salmon Safe beer.

4. Associated Knowledge Areas

KA Code	Knowledge Area

301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management

Outcome #15

1. Outcome Measures

Develop targeted intervention strategies to prevent pathogen contamination in bivalve rearing systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Vibrio coralliilyticus is a gammaproteobacterium that is pathogenic to corals, fish and shellfish. Shellfish hatcheries on the U.S. West Coast have experienced major mortality events associated with V. coralliilyticus in larval oysters and clams. Although there have been no reports of hatchery-associated outbreaks of V. coralliilyticus along the U.S. Atlantic Coast, unexplained high mortality events in these hatcheries have plagued the industry. This study reports V. coralliilyticus-associated outbreaks involving high mortalities of larval Eastern oysters (Crassostrea virginica) at an East Coast hatchery.

What has been done
This hatchery?s production in 2015 was reduced by 97.9% through April, and 34.2% from April through July compared to 2014, causing shortages in seed oysters needed by the commercial shellfish industry. During one outbreak, high mortalities corresponded with the presence of 8.8 × 103 CFU V. coralliilyticus ml-1 of larval tank water. Vibrio coralliilyticus was also detected at low levels in tanks of apparently healthy larvae and in algae used as larval feed. Isolates were confirmed to be V. coralliilyticus by: 16S rRNA gene sequencing, PCR of a zinc-metalloprotease gene (vcpA), and a simple and rapid (15−30 min) dipstick assay for the VcpA enzyme of V. coralliilyticus. Additionally, we showed that four hatchery isolates of V. coralliilyticus were

pathogenic to larval oysters. We conclude that V. coralliilyticus is the likely etiological agent of previously unexplained and sporadic outbreaks of mortality in Atlantic shellfish hatcheries. The dipstick assay could facilitate early, on-site detection of V. coralliilyticus so that hatcheries may better manage and minimize the impact of this pathogen.

Results

This work showed the presence of V. coralliilyticus in a shellfish hatchery on the U.S. East Coast during the spring and summer of 2015 as well as in early 2017. Previously, we showed in small-scale laboratory studies that Eastern oyster larvae, like Pacific oyster larvae, were subject to mass mortalities caused by several strains of V. coralliilyticus (Richards et al. 2015), but it was unclear whether V. coralliilyticus were commonly found in Atlantic waters or in shellfish hatcheries. The current study concluded that V. coralliilyticus: i) was present in an East Coast shellfish hatchery, ii) was associated with high mortalities of larval oysters, iii) on one occasion was a contaminant of algal cultures used to feed the larvae, and iv) could be readily detected and identified by PCR and dipstick assays. Low levels of V. coralliilyticus were observed in healthy larvae, suggesting that low levels may be part of the natural hatchery flora. Early and rapid detection of V. coralliilyticus may allow hatcheries to better monitor and manage this pathogen in order to minimize its impact.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
311	Animal Diseases
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #16

1. Outcome Measures

To study mechanisms of important bacterial diseases affecting food sources in meat production.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Empirical data and modeling studies of diseases caused by pathogens with long-distance dispersal ability will be used to: 1) Determine effects of initial disease prevalence, spatial pattern of initial disease prevalence, and pathogen reproductive capacity on disease spread; 2) Compare the efficacy of reactive ring culling, reactive ring vaccination or chemotherapeutic applications, timing and extent of reactive ring
treatments, and broad-scale population protection for disease control; and 3) Determine the influence of initial disease prevalence and pathogen reproductive capacity on the efficacy of these control tactics. Modeling studies of wheat stripe rust, foot-and-mouth disease, sudden oak death, and arbovirusesof animals will be conducted.

What has been done
Determine the importance of initial disease prevalence, the spatial pattern of initial disease prevalence, and the basic reproduction number on the spread of diseases caused by pathogens with "fat-tailed" dispersal kernels, and the interaction of these biological variables with control practices such as reactive culling, reactive vaccination or chemotherapeutic applications, and broad-scale protective strategies.
1)Use field and modeling studies to determine effects of initial disease prevalence, spatial pattern of initial
disease prevalence, and basic infection number on disease spread of wheat stripe rust, foot-and-mouth disease, sudden oak death, and arboviruses.
2)Compare the efficacy of reactive ring culling, reactive ring vaccination or chemotherapeutic applications, timing and extent of reactive ring treatments, and broad-scale population protection for disease control.
3)Determine the influence of initial disease prevalence and basic infection number on the efficacy of control tactics.
4)Conduct extensive comparative modeling through factorial combinations of models and input data among the different diseases.
5)Develop generalized theory and models to predict "rules-of-thumb" for the control of diseases caused by pathogens with long-distance dispersal.
6)Evaluate data from natural experiments with sudden oak death and foot-and-mouth disease, and manipulative experiments with wheat stripe rust for model validation/verification.

Results
Progress this reporting period: 1) Field studies with wheat stripe rust were conducted to determine effects of initial disease prevalence and basic infection number on the efficacy of culling for epidemic suppression. We found that culling had similar effects regardless of initial disease prevalence and basic infection number. This is consistent with simulation studies that were done in the previous reporting period. 2) Field studies were established to determine effects of cull timing, cull size, and protection in different spatial arrangements on the spread of wheat stripe rust. Plots will be inoculated and treatments applied in spring. 3) We used a previously developed spatial FMD model (Keeling et al. 2001) to simulate hypothetical FMD outbreaks and control strategies in a region with farm demography similar to Cumbira, UK, which was one of the

epidemic hotspots during the 2001 epidemic. Our aim was to explore the possibility of refining the scorched-earth policy to uncover alternative cull-based control strategies that provide equal protection to the scorched-earth policy without as many control causalities. Although we uncovered small reductions in the number of farms culled in the target density strategy compared to the scorched-earth strategy, we think our results demonstrate the potential for more refined and targeted cull strategies to lessen the impact of control measures without compromising control of the epidemic. 4) We have proposed an individual based heterogeneous network model to understand the spreading pattern of the WNV in the USA. We found that a modified fat-tailed dispersal kernel could describe the human incidence data better than general fat-tailed kernel network model. We proposed some control measures for this disease; our simulation suggests that mosquito population reduction in the infected states with its neighboring states is potentially cost-effective. 5) We proposed a novel individual-based interconnected network model that incorporates both insect-vectored and sexual transmission of the Zika virus. We studied the outbreak size with different initial conditions. Our results suggest that although sexual transmission has a relatively low contribution in determining the epidemic size, it plays a role in sustaining the epidemic and creating potential endemic scenarios. 6) We evaluated three filtering approaches to estimate Japanese encephalitis transmission rate and for a forecasting of the disease outbreak. First, we used the ensemble Kalman filter (EnKF) to make a short-term forecast using a constant parameter set. Second, we used a dual state-parameter estimation framework based on ensemble Kalman filter to simultaneously estimate the parameters and states (no of individual in compartment). Finally, we proposed the CPEFF, in which we integrated the concept of kernel density particle filter (KDPF) and ensemble Kalman filter (EnKF). 7) During this fiscal year, we have made significant strides in our participatory modeling work with Oregon stakeholders managing sudden oak death disease spread. We have since analyzed all survey data collected at the first workshop, and have made substantial changes to the epidemiological model, including adding mortality and acquiring finer resolution host and weather data.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
216	Integrated Pest Management Systems
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #17

1. Outcome Measures

To create diagnostic approaches to characterize the genetic difference between bovine herpesvirus type 1 variants and vaccine strains.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The proposed study will investigate how one of the most contagious animal pathogens known to man, foot-and-mouth disease virus (FMDV), overcomes these challenges and persists in isolated populations of its reservoir host, the African buffalo. This study will be one of the first to address this problem head-on, dissecting the contributions of ecological and evolutionary mechanisms to pathogen persistence. Specifically, the study will evaluate (i) whether co-infection by common respiratory pathogens and / or malnutrition during the dry season can trigger FMDV transmission from carrier buffalo; and (ii) the role of viral antigenic shift in limiting host immunity to FMDV at epidemiologically relevant time scales.

What has been done
The centerpiece of the project is a cohort study, in which a captive buffalo herd will be monitored intensively over three years, measuring host-to-host contacts, and tracing FMDV transmission events using viral phylogenetic methods. The investigators will map host contacts onto pathogen transmission, and tease apart the role of behavioral, physiological and immunological drivers in generating heterogeneity in disease transmission among hosts. They will discover whether FMDV transmission from carrier buffalo tends to coincide with secondary pathogenic exposures and / or malnutrition during the dry season - and test whether these associations are causal using a controlled challenge experiment. They will measure rates of viral antigenic evolution directly, and establish the contribution of super-infection by new antigenic variants to FMDV transmission dynamics.

Results
This work revealed that the three southern African FMD viruses have strikingly different transmission dynamics. SAT1 transmits most rapidly during acute infection, balanced with a high rate of conversion to carrier status, long carrier duration, and relatively efficient transmission from carriers to naïve hosts. SAT2 and SAT3 have slower acute infection dynamics (lower R0 than SAT1), as well as lower conversion to carriers and a shorter duration of the carrier status in buffalo. Transmission from SAT3 carriers is much less efficient than in SAT1 (by a factor 3), and transmission from SAT2 carriers was not demonstrated in our experiments. Our models indicate that none of the viruses are likely to persist in buffalo populations by transmission from one susceptible calf cohort to the next alone. Thus, it is likely that SAT1 may be able to persist through epidemic troughs via maintenance of virus, and subsequent transmission from carriers. However, this persistence mechanism is unlikely in SAT2; and less likely in SAT3. We are using our models to characterize the likelihood of FMDV persistence given the parameters we

estimated, and uncertainty in these estimates. If persistence due to carriers is unlikely in SAT2 (and perhaps SAT3), then additional mechanisms, such as antigenic shift, or variable antibody titers over time, may play a role in endemic FMD dynamics. These are hypotheses we are currently investigating, using the viral genetic samples we collected, and through analysis of time series of antibody titers specific to each strain. These hypotheses will be incorporated into our disease dynamic models next.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases

Outcome #18

1. Outcome Measures

Develop strategies to increase immunity, including the development of vaccines, against pathogens that impact food sources. Identify the role of mother cow immunization on calf protection agains MAP.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Mycobacterial diseases of animals are serious program worldwide. In agriculture, Mycobacterium avium subsp paratuberculosis, the cause of Johne's disease, and Mycobacterium bovis, the agent of bovine tuberculosis are associated with significant economic loss and health related issues for animals and humans.

What has been done
During the past 3 years we developed an in vitro cell-based model system for Johne's disease, that is now allowing to answering many questions related to the infection. The model compares quite well with the response of animals to the infection.

Using the model, specific proteins produced by the bovine host, during different phases of infections, have been identified. We also used the model to determine the bacterial proteins involved in the bacterial uptake by the intestinal mucosa. Surface bacterial antigens have been characterized, and are currently being tested for use as vaccines aiming to prevent the infection of the young animal.

In a different project, we recently we have developed an experimental vaccine against M.bovis, which has been shown effective in mice and in going to be tested in cattle.

Results
M.paratuberculosis: The identification of host proteins upon infection of intestinal mucosal epithelial cells and intestinal macrophages would provide important information on how M.paratuberculosis manipulates the host immune responses. Our recent observations confirmed that upon infection od the host cells there is a suppression of the production and secretion of inflammatory cytokines but an increase of anti-inflammatory proteins, while later in the infection the opposite has been observed.

Besides the better understanding of the host response and which bacterial effector proteins are triggering the response, we now have the ability to identify proteins produced by host cells that may be used as biomarkers for early phase of infection.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #19

1. Outcome Measures

Develop new strategies to increase immunity in animals through dietary supplementation of selenium and development of vaccines against influenza.

Not Reporting on this Outcome Measure

Outcome #20

1. Outcome Measures

Evaluate the toxicity of various mycotoxins in food.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many pathogens threaten wild and cultured salmon and trout in the Pacific Northwest. These bacterial, viral and parasitic pathogens occur in both hatcheries, aquaculture and natural ecosystems and in some cases cause severe mortality and serve as limiting factors in production and maintenance of wild fisheries. There is a need to better understand pathogen epidemiology, pathogenic mechanisms and host resistance in order to develop effective control strategies.

What has been done
Our research studies the genetic variation in myxozoan parasites and the development of resistance in the salmonid host. With additional support from BARD funds, we have collaborated with a laboratory in Israel that is helping us to better understand the mechanisms of attachment and invasion of these parasites into their hosts. With collaborators in the USFWS, we are applying molecular epidemiological methods developed for the salmonid virus IHNV to these parasites in order to better understand their evolution and spread. Additionally, as director of the John. L. Fryer Aquatic Animal Health lab, I facilitate collaborations with industries that develop vaccines and feed additives to promote fish health. Currently we are working with a company that is funded by USDA to develop an oral vaccine against the virus IHNV.

Results
We have made significant progress in identification of immune mechanisms and genes involved in resistance against parasitic infections in salmonids. This has been the research focus of three graduate students who have published papers on the pathogenesis of infection and the immune response of the fish host. A current student is looking at the genetics of resistance, using transcriptomic and population genetic methods. Our research on models of disease transmission have resulted in management guidelines that have been implemented in the Klamath River to increase survival of hatchery fish upon their release into the river.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
311	Animal Diseases

501	New and Improved Food Processing Technologies
502	New and Improved Food Products
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #21

1. Outcome Measures

Use molecular breeding tools to develop resistance to abiotic and biotic stressors and to improve traits related to human health and nutrition in cultivars of importance in agriculture systems. a) Conduct a systematic evaluation of germplasm resources to identify sources of genetic variation i. Develop new high throughput markers anchored in genome sequences ii. Map genes/QTLs determining target traits iii. Characterize gene/QTL networks and interactions iv. Measure gene/QTL x environment interaction v. Validate and fine map putative genes/QTLs vi. Transfer identified genes/QTLs into economically useful backgrounds, using accelerated generation advance strategies

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

With the changes in global climate and weather patterns leading to increased temperatures and water deficit in the soil from agrarian lands, we see that the rice crop that feeds 50% of the global population and is an esteemed export crop for US with higher returns, is experiencing sustainability issues. Increased droughts, higher temperatures hypersaline soil condition, and increased threats of fungal and bacterial pests drastically impact the global and US rice production by 30-50% (depending on the severity in a given year). Also if there is a pathogen attack, farmers also need to adopt measures such as fungicides and pesticides. ~70% of US rice crop is grown under pesticide spray. This also impacts the ecology rice growing lands and habitat of the fishes, microbiomes and the water fowls in the US. Therefore, we need to develop rice varieties that are resilient to stress, improve yield by rescuing the current crop and reduce the impact on ecology and habitat. This overall puts our farmers, business and health of the farmland on a sustainability path.

What has been done

We acquired the rice lines with contrasting phenotypes on salinity and drought tolerance from the US germplasm collection and grew them in our greenhouses. Multiplied the seeds, replanted them for phenotype evaluation in the simulated conditions and sampled the tissue for extracting the RNA from a time course experiment and carried out the transcriptome and genetic diversity analysis. Based on our analysis we have narrowed down the region of the rice genome with a handful of candidate genes to test for further analysis by the plant breeders while we continue to perform molecular studies.

A similar study on rice leaf sheath blight was conducted by our collaborator Jim Oard at Louisiana State University (LSU). He conducted the phenotype and sample collection. We performed the transcriptome sequencing and analysis.

Results

Discovered 1000s of contrasting genetic variants across and between the rice lines with contrasting resistant/susceptible phenotypes for drought, salinity and disease stress. Identified differentially expressed genes, their alternate splicing patterns in the mRNA (transcripts). Both data sets were mapped to the reference rice genome and discovery of candidate genes regulating the desired phenotypes is in progress. The genetic markers identified on disease resistance are being tested in rice populations at LSU.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
601	Economics of Agricultural Production and Farm Management

Outcome #22

1. Outcome Measures

Improve the nutritional value of important food grains; 2) reduce the impact of wheat storage proteins on human health; and 3) target nutrient development with ripening control. Examples at OSU include barley (Hayes and Ross), wheat (Zemetra, Flowers, and Ross), and grape (Deluc).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wheat (Triticum aestivum) (ABD) and jointed goatgrass (Aegilops cylindrica) (CD) can cross and produce hybrids that can backcross to either parent. Such backcrosses can result in progeny with chromosomes and/or chromosome segments retained from wheat. Thus, a herbicide resistance gene could migrate from wheat to jointed goatgrass. In theory, the risk of gene migration from herbicide resistant-wheat to jointed goatgrass is more likely if the gene is located on the D-genome and less likely if the gene is located on A or B genome of wheat.

What has been done
BC1 populations (jointed goatgrass as a recurrent parent) were analyzed for chromosome numbers and transgene transmission rates under sprayed and non-sprayed conditions.

Results
Transgene retention in the non-sprayed BC1 generation for the A, B and D genome was 84, 60 and 64%, respectively. In the sprayed populations, the retention was 81, 59, and 74%, respectively. Conclusion: The gene transmission rates were higher than the expected 50% or less under sprayed and non-sprayed conditions possibly due to meiotic chromosome restitution and/or chromosome non-disjunction. Such high transmission rates in the BC1 generation negates the benefits of gene placement for reducing the potential of gene migration from wheat to jointed goatgrass.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems

Outcome #23

1. Outcome Measures

The mission of the Ornamental Plant Breeding Program is to develop new cultivars that are ecologically sound for producers and consumers as well as economically viable for producers. We seek to develop sterile forms of non-native species, insect and disease resistant cultivars, and low input cultivars that can be grown in nurseries and landscapes with less water or nutrient inputs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of this project is to advance the understanding of competition between members of bacterial communities
(microbiome) for resources and their effects on plant health, specifically in regard to Agrobacterium-induced crown gall disease. Agrobacterium spp. carrying a Ti plasmid induce crown gall formation by transferring a segment of DNA (T-DNA) from the Ti plasmid into the plant cell. The T-DNA is able to integrate into the plant genome. The T-DNA contains genes encoding for auxin and cytokinin biosynthesis, which when expressed by the plant causes dysregulation of hormones and results in uncontrolled tissue growth and the formation of galls. Research on crown gall has primarily focused on the mechanisms that mediate the interactions between pathogen and host. Less is known about the bacterial community inhabiting these galls, the interactions between its members, and the effects on plants health.

What has been done
Research on crown gall has primarily focused on the mechanisms that mediate the interactions between pathogen and host. Less is known about the bacterial community inhabiting these galls, the interactions between its members, and the effects on plants health. This gap will be addressed by studying the evolutionary ecology of agrobacteria. It is often difficult to culture pathogenic agrobacterium from some crown galls, as once a gall is established the original bacterial pathogen is not required to maintain growth. It is hypothesized that Agrobacterium is outcompeted by other opine-utilizing bacteria in the gall. This hypothesis is grounded in preliminary data that showed that gall communities are rich and Agrobacterium is not even the most abundant species in the gall, despite the presumed fitness advantage provided by the availability of plant-produced opines (uncommon nutrients able to be catabolized by agrobacteria carrying a Ti-plasmid).
This goal will be met using microbiome sequencing, metabolite profiling, and synthetic bacterial communities to 1) quantify the abundance of agrobacteria within microbial communities in crown galls collected from various agricultural systems, and 2) measure the effects of competition for plant-produced opines on the ability of agrobacteria to persist in crown galls inoculated from synthetic communities of representative bacteria from galls in the natural environment.

Results
As part of progress towards objective 1, I have collected 92 diseased gall and healthy plant tissue samples from nurseries and orchards across Oregon and the pacific northwest. These represent 14 plant host species from nurseries in 4 states and 2 countries. A preliminary

sequencing run on an Illumina HiSeq was performed on DNA from these samples, however microbial DNA was not abundant in the extracted samples and the estimated microbial abundance was extremely low. I am testing multiple DNA extraction protocols from different portions of sampled galls in order to determine if extraction can be improved, or if agrobacteria is located in different portions/regions of the gall. During the course of DNA extraction, galls were surface sterilized, and the center portion of the inner gall was sampled following standard protocol of diagnostics labs. However, agrobacteria may be primarily associated with the surface of the gall on woody plants, and are not found inside the gall tissue itself. Most of the analyzed gall samples were from woody plants such as apple, raspberry, blueberry, and rose. Ongoing experiments include testing multiple regions of the gall (surface-associated, surface tissue, inner gall, etc) for pathogenic agrobacteria, particularly on woody plant hosts. If agrobacteria is found to be primarily gall surface-associated, subsequent experiments will target this tissue for pathogen abundance. Alternatively, other experiments will explore whether the gall itself is the true reservoir of pathogenic agrobacteria.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management
603	Market Economics

Outcome #24

1. Outcome Measures

Fundamental Research Supporting Multiple Breeding Programs. Two research groups are engaged in fundamental research relevant to multiple breeding programs. These include seed dormancy and germination (Nonogaki) and a systems biology approach to stress tolerance (Jaiswal).

Not Reporting on this Outcome Measure

Outcome #25

1. Outcome Measures

Evaluation of wheat cultivars for performance and resistance to stripe rust.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A new barley variety, BSR-27, is a spring-habit hooded barley stemming from the cross of two stripe rust-resistant varieties released by OSU in the early 2000s: Tango, for livestock feed, and Sara, for forage.

What has been done
Results of 2018 trials on four test sites (two each in the Willamette Valley and the Sacramento Valley) show that BSR-27 produced high yields of both seed and forage. BSR-27 had a higher relative feed value (101) than the Haybet, Lavina and Stockford varieties, but lower than the Hays variety (108). BSR-27 is resistant to stripe rust, leaf rust and scald, and tolerant of mildew.

Results
Breeding efforts and trials are continuing and we expect a new variety to be released in 2020.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
601	Economics of Agricultural Production and Farm Management
603	Market Economics
607	Consumer Economics

Outcome #26

1. Outcome Measures

Traditional agricultural extension programming has been commodity specific and tends to attract operators of medium to large scale farming businesses that focus on a few commodities and wholesale markets. Small scale farmers with diverse operations who tend to focus on direct marketing are a large but historically underserved audience. Improving access to research based information for small scale diverse farms enhances their chance of developing successful farm businesses.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In January 2012, the Oregon Farm-Direct Law went into effect. This law allows small farmers to create and sell certain low-risk products from the produce that they grow without a license. Supporters say that the law provides them with a supplemental income source, makes use of excess produce, and adds variety to their offerings. At the same time, there are challenges. Small farmers report that information stating how to interpret the law is unclear, and that there are questions regarding liability, and proper labelling of products.

What has been done
The FCH and Metro Small Farms Program delivered a series of five education and skills-based workshops to small farmers that explained the rules and regulations, and addressed the interpretation and implementation of the Farm Direct Law, and provided hands-on, food preservation labs on High Acid Foods, Acidified Foods, Dried Foods, and Fermented Foods, using approved recipes and following credible and science-based safe practices.

Results
Forty-six participants attended The Essentials workshop and 15 participants (out of the 46) attended at least one Specialty workshop. Ten participants attended at least two, and four participants attended all four Specialty workshops. Attendance was highest at the Dried Foods workshop with 10 participants.
A pre- and post-workshop survey filled out by participants at the Essentials workshop revealed an increase in short-term knowledge and understanding to interpret and apply the Administrative

Rules associated with the Oregon Farm-Direct Law. Participants who attended the Specialty workshops reported an increase in skill and confidence levels to practice credible, and research-based, food preservation techniques.
Thirteen out of the 46 participants who attended The Essentials workshop reported that they were already producing farm-direct products. Those same 46 participants were asked to complete a brief six-month follow-up Qualtrics Survey. The objective of the survey was to measure any changes in numbers of participants who had produced a farm-direct product following the workshop, and to learn the factors that influenced their decision. Fourteen surveys were returned and the results tallied. Those 14 surveys revealed that four participants had produced a farm-direct product prior to the workshop. That number increased to eight at the time of the follow-up survey. In addition, the variety of farm-direct products produced by the participants had expanded from primarily jams & jellies (pre-workshop) to include pickles, salsa, tomato sauce, dried fruit, and sauerkraut and kimchi. Reasons cited for not pursuing a farm-direct product included, "The product that I want to produce is not covered under farm-direct", "I don't grow the produce", "I lack the time and/or capacity to produce a product, in addition to all of my other responsibilities", and/or "I'm just not ready yet".

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
121	Management of Range Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
607	Consumer Economics
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #27

1. Outcome Measures

Evaluation of forage crops for improved economics and sustainability of animal production systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over-utilizing the available forage resource through overstocking and resulting overgrazing often leads to deterioration of grasslands. Estimating the seasonal production potential of improved forage species will facilitate better management of forage-livestock systems and balancing forage production with animal requirements.

What has been done
A grazing project with Fodder Beets has been initiated with Dr. Serkan Ates and a local producer (Cody Wood) who obtained a Western SARE grant to compare fodder beet grazing by weaned calves compared with traditional backgrounding practices.

Results
Results will be obtained and compiled in January of 2019

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
302	Nutrient Utilization in Animals
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management

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 College is well known for its collaborations among state and federal agencies, and the College of Agricultural Sciences encourages low boundaries between disciplines and institutions. Our researchers and Extension faculty work closely with agency partners in EPA, USDA ARS, USGS, US Forest Service, US Navy, and many more.
Regional industries and commodity groups are important partners, too. Oregon's remarkable agricultural diversity--with more than 220 commodities here--means that many commodity groups depend on OSU research and development to improve their varieties and expand their markets. Our plant breeding programs are among the most active, and most diverse, in the nation.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

OSU continues to excel with developing collaborative approaches to livestock production on Western Rangelands that protect ecological services of those lands and promotion of fish and wildlife needs. At the same time, research improves the production efficiency of livestock, addresses animal diseases that can negatively impact the production margins for producers, and improves animal nutrition to promote higher conception rates and postnatal survival.
OSU plant breeding research continues to improve berry and stone fruit production, cereals, pome, and grape production. Research on vegetable and specialty crops continues to provide new varieties that are resistant to disease and better adapted for a changing climate.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 4

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
133	Pollution Prevention and Mitigation	5%		2%	
204	Plant Product Quality and Utility (Preharvest)	5%		10%	
306	Environmental Stress in Animals	0%		5%	
308	Improved Animal Products (Before Harvest)	5%		10%	
311	Animal Diseases	0%		5%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	5%		5%	
501	New and Improved Food Processing Technologies	5%		5%	
502	New and Improved Food Products	5%		5%	
602	Business Management, Finance, and Taxation	0%		3%	
603	Market Economics	0%		5%	
607	Consumer Economics	5%		5%	
701	Nutrient Composition of Food	5%		5%	
702	Requirements and Function of Nutrients and Other Food Components	5%		5%	
703	Nutrition Education and Behavior	10%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	5%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	5%		5%	
723	Hazards to Human Health and Safety	5%		5%	
724	Healthy Lifestyle	20%		5%	
903	Communication, Education, and Information Delivery	10%		5%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	25.0	0.0

Actual Paid	6.0	0.0	3.9	0.0
Actual Volunteer	1858.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
129690	0	558076	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
142139	0	5535130	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
331693	0	13508224	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

This program will result in multiple outputs as a result of the following proposed activities:

- Conducting laboratory, pilot-plant experiments and data collection
- Conducting research experiments
- Developing quality monitoring protocols
- Developing and applying new technology of food processing systems
- Developing products, curriculum, resources
- Developing services
- Presenting seminars and professional talks
- Conducting workshops and training sessions
- Publishing scientific findings
- Partnering
- Providing community education classes
- Maintaining a statewide food safety hotline
- Working with and supervising volunteers to deliver high quality information and programming about food safety topics

2. Brief description of the target audience

There are diverse audiences for the information this program generates. They can be classified into five general groups: (1) the general public and food consumers; (2) state and federal food regulatory agencies; (3) the research community including scientists working in government, industry, and academic sectors; (4) the commercial food processing industry and commodity groups; and (5) professional food handlers in organizations such as schools and other institutions, as well as restaurants.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	13273	28186	8595	39683

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

Patent Applications Submitted

Year: 2018

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	47	38	85

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of people trained to meet requirements of FSMA

Year	Actual
2018	342

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Understand nutritional relationships to health and food safety, such as: a) mechanisms behind the health benefits of fruits and vegetables, b) novel dietary modifications to reduce the incidence of disease, c) role of antioxidants from berries in preventing health disease
2	Improve animal food production systems that impact food safety by a) improving diets to produce safer foods and human benefits, b) enhancing efficacy and safety of vaccination programs, c) developing diagnostic methods
3	Characterize and model pathogens and toxins in food and food systems, including: * agents and mechanisms * toxicity to animals or humans * mechanisms behind immune suppression
4	Improved food handling and regulations, including: * food production and handling practices * intervention strategies reduce bacterial contamination, increase shelf life, and reduce occurrences of food-borne illnesses
5	Improved animal husbandry that reduces food safety issues
6	Number of specialty food and mainstream food processors accessing and applying science based information to produce and distribute safe, nutritious, high-quality foods
7	Number of individuals improving their practices of safe food handling, food preparation, and food preservation
8	Number of technologies and control strategies that improve food safety
9	Ability to detect incidences and trace pathways of food borne illnesses
10	Number of policy makers and managers informed about safe food handling and processing
11	Identify Current traceability practices by small producers and processors
12	Identification of Critical Tracking Events (CTEs) and Key Data Elements (KDEs)
13	Identification of benefits and costs to implementing FTS
14	Training for Stakehoders
15	Apply principals of integrated pest management and integrated crop management to improve food safety and environmental impacts of agricultural production.
16	Reducing dietary carcinogens in food

Outcome #1

1. Outcome Measures

Understand nutritional relationships to health and food safety, such as: a) mechanisms behind the health benefits of fruits and vegetables, b) novel dietary modifications to reduce the incidence of disease, c) role of antioxidants from berries in preventing health disease

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is significant need to further understand the independent and interactive role of nutrients and bioactive food constituents in promoting optimal health. Our goal is to provide a clear understanding of the factors that determine their bioavailability and mechanisms of action. This will establish the foundation for evidence-based dietary recommendations to stakeholders that ultimately affect the health of our nation and the world. The opportunity for our experts to share knowledge, techniques and resources is central to achieving our collective goal in a timely, resource-efficient, and strategic manner. In OR, our particular focus is on bioavailability of nutrients like zinc and milk-based proteins across the lifespan, cardiovascular disease and metabolic syndrome, immune function/inflammation and cancer prevention. Our transdisciplinary approach thereby rapidly advances our understanding of health-promoting dietary approaches having the potential for broader impact on human health, which will be made possible through this multi-state collaboration.

What has been done
The influence of age-related alterations in the microbiome on response to bioactive supplementation and susceptibility to stress will be examined in OR using mouse models (OR). We propose using the zebrafish model to determine if dietary elagitannins, rich in pomegranate and walnuts, improve the efficiency of muscle contraction (as evidenced by lower oxygen cost of physical activity) via the production of specific water-soluble metabolites by the gut microbiome. These studies will involve interrogating the effects of a dietary pomegranate extract on the brain and plasma metabolome, as well as the fecal microbiome, and their association with performance and behavioral phenotypes.
OR researchers are also examining the impact of bioactive compounds derived from cruciferous vegetables on genetic and epigenetic mechanisms leading to suppression of cancer cell growth.

Clinical and biological samples from the clinical trials using broccoli sprout extracts in OR are being used to evaluate the role of cruciferous vegetables and their constitutive bioactive food components (OR) in reducing breast cancer recurrence and prostate cancer risk. In collaboration between OR and OK, we are also examining the impact of zinc status on DNA integrity in populations susceptible to zinc deficiency.
For effects on cardiovascular disease, scientists will use the zebrafish model system to elucidate the physiological determinants of improved efficiency of muscle contraction during exercise caused by dietary nitrate (OR). Additional work in zebrafish is proposed to determine of dietary elagitannins, rich in pomegranate and walnuts, improve efficiency of muscle contraction during exercise via the production of metabolites, such as urolithins, by the gut microbiome.

Results
Preliminary results will be available next year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
306	Environmental Stress in Animals
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

Outcome #2

1. Outcome Measures

Improve animal food production systems that impact food safety by a) improving diets to produce safer foods and human benefits, b) enhancing efficacy and safety of vaccination programs, c) developing diagnostic methods

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The aim of this project is to develop a cost-effective, high performance biosensing technology for rapid detection of histamine and unapproved aquaculture drugs in seafood to enhance food safety. Rather than existing expensive and bulky laboratory analytical equipment, our on-chip biosensors will be made from nature created biological materials --- diatom biosilica. This project will target portable biosensing technique for rapid, reproducible, in-situ detection of multiplex contaminants in seafood, which can also be readily applied to other food testing applications.

What has been done
Our technology will be developed through on-chip chromatography coupled with surface-enhanced Raman scattering (SERS) sensing using diatom biosilica. The objectives are: 1) Synthesis of high density diatom thin film with silver nanoparticles that can function simultaneously as a thin layer chromatography to separate toxic molecules from complex food samples and as ultra-sensitive SERS substrates to probe the signature Raman peaks; 2) Quantitative SERS sensing that can detect trace level of histamine and unapproved aquaculture drugs in seafood; and 3) Demonstration of the nanoplasmonic sensing technology for in-situ seafood safety using portable Raman spectrometers through collaboration with local food industry.

Results
Development of the chip biosensors has been completed and intitial results of the manufacturing of the chips disseminated. Trials will begin in 2019. We will prove that it is feasible to use 780nm portable Raman spectrometers for seafood sensing, but with sacrification in sensitivity. We will further investigate the sensing using 532nm portable Raman spectrometers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
308	Improved Animal Products (Before Harvest)
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
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

Characterize and model pathogens and toxins in food and food systems, including: * agents and mechanisms * toxicity to animals or humans * mechanisms behind immune suppression

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Horticultural nurseries are faced with plant diseases that cause economic losses and may result in quarantines, loss of sales, and crop destruction. For many of these diseases, the pathogen survives in soil from year to year. Until recently, soil fumigants were used to disinfest contaminated soil, but environmental considerations and human health concerns have restricted their use. Alternative methods, including changed cultural practices based on new knowledge about pathogen survival as affected by soil physical and biological factors, will help define Best Management Practices for horticultural nurseries while reducing pesticide use. One example of a changed cultural practice that should lead to a best management practice is soil solarization.

What has been done
Field studies will be conducted in OR, WA, and CA to determine the effectiveness of solarization in reducing soilborne populations of Phytophthora species, and to develop a predictive model for solarization duration and effectiveness based on soil temperature degree-days. Experiments under controlled conditions will contribute to our understanding of soil moisture and its interactions with soil temperature as it affects the survival of Phytophthora species. These studies will lead to development of cultural practices and best management practices for managing pathogen inoculum in soil. Outreach and education of growers will occur through publication in the online Phytophthora course for growers, articles in grower trade journals, field days, and workshops.

Results
This project was initiated in 2018. We have the following outcomes to report on during the next reporting period:
Increase the number of horticultural nurseries that use solarization to disinfest soil contaminated with soilborne pathogens. Develop knowledge that will result in changed cultural practices in

nurseries and implementation of Best Management Practices to reduce soilborne diseases. Develop knowledge about the relationship between the physical and biological environment of soil as they affect the survival and dispersal of soilborne pathogens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
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
724	Healthy Lifestyle

Outcome #4

1. Outcome Measures

Improved food handling and regulations, including: * food production and handling practices * intervention strategies reduce bacterial contamination, increase shelf life, and reduce occurrences of food-borne illnesses

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent foodborne outbreaks and recalls in the Pacific Northwest (PNW) involving strawberries (Escherichia coli O157:H7; Laidler et al., 2013), hazelnuts (Salmonella and E. coli; Harris et al., 2017, Oregon Health Authority, 2017) and basil pesto (FDA, 2017) have emphasized the need to prevent contamination, train farmers, farm managers, and farm workers about food safety in the

fields. To address FSMA-knowledge and resource gaps in the areas of pre- and post-harvest food safety, water testing and sampling, and the development of farm food safety plans, we propose the development and delivery of food safety workshops and resources that will target the main agricultural production and processing systems in PNW. Previous training efforts in the region, such as trainings facilitated by the Western Regional Center to Enhance Food Safety (WRCEFS), have focused on the development of the cadre of trainers that can deliver the Food Safety Preventive Controls Alliance (FSPCA) and Produce Safety Alliance (PSA) curricula.

What has been done

Building upon the food safety outreach program at the Oregon State University (OSU) Food Innovation Center and the North Willamette Research and Extension Center, and through close collaboration with WRCEFS, our project will lead, manage and coordinate regional produce safety trainings targeted at owners and operators of small and medium-sized farms, beginning farmers, socially disadvantaged farmers, small fruit and vegetable processors and merchant wholesalers affected by FSMA-related rules in Oregon. The overall goal will be accomplished through the following specific objectives: 1) Adaptation of PSA curriculum to medium, small and very small growers and produce processors in PNW to include grower engagement, region-specific practices and commodities, and bilingual materials; 2) Delivery of the Western U.S.-adapted PSA curriculum to medium, small, and very small growers and produce processors in Oregon through four workshops; and 3) Evaluation of the impacts of education and training activities. While the short-term goal of this project is to deliver produce safety trainings to growers, the long-term goal is to establish an effective training program and incorporate it into existing food safety extension infrastructure at OSU that will allow continued and sustainable produce safety trainings in the region.

Results

Objective 1. As part of customizing PSA training materials to Oregon, example farm and food safety plans based on the produce operations in the region are currently being developed. To create these example plans, owners/operators of small produce growing or processing operations are being consulted to gather information about common agricultural practices used in the PNW. This information is then compiled into a food safety plan, which will subsequently be included in future workshops and also made available online. We are presently collaborating with two produce growing operation and are developing a farm food safety plan based on their operations. Two model food safety plans are also in preparation for fresh onions and pears, two of the important produce commodities grown in Oregon. Additionally, progress has been made towards compiling add-on materials developed by WRCEFS (n=10), and materials pertaining to "Produce Safety Rule" available through NECAFS Clearinghouse (n=132), PSA Resource page (n=18), and Google Scholar (n=238). Materials collected are currently being evaluated for their relevance to produce production in Oregon.

Objective 2. PI and co-PIs are in the process of obtaining PSA Lead Trainer status. Four courses are tentatively planned in the period from February to May 2019.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
703	Nutrition Education and Behavior

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
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Improved animal husbandry that reduces food safety issues

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The aryl hydrocarbon receptor (AHR) is a conserved ligand-activated transcription factor required for proper vertebrate development and homeostasis. The inappropriate activation of AHR by ubiquitous pollutants can lead to adverse effects on wildlife and human health. The zebrafish is a powerful model system that provides a vertebrate data stream that anchors hypothesis at the genetic and cellular levels to observations at the morphological and behavioral level, in a high-throughput format.

What has been done
In order to investigate the endogenous functions of AHR, we generated an AHR2 (homolog of human AHR)-null zebrafish line (ahr2osu1) using the clustered, regulatory interspaced, short palindromic repeats (CRISPR)- Cas9 precision genome editing method. In zebrafish, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) mediated toxicity requires AHR2. The AHR2-null line was resistant to TCDD- induced toxicity, indicating the line can be used to investigate the biological and toxicological functions of AHR2. The AHR2-null zebrafish exhibited decreased survival and fecundity compared to the wild type line. At 36 weeks, histological evaluations of the AHR2-null ova- ries revealed a reduction of mature follicles when compared to wild type ovaries, suggesting AHR2 regulates follicle growth in zebrafish. AHR2-null adults had malformed cranial skeletal

bones and severely damaged fins.

Results
Our data suggests AHR2 regulates some aspect(s) of neuromuscular and/or sensory system development, with impaired behavioral responses observed in larval and adult AHR2-null zebrafish. This study increases our understanding of the endogenous functions of AHR, which may help foster a better understanding of the tar- get organs and molecular mechanisms involved in AHR-mediated toxicities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals
308	Improved Animal Products (Before Harvest)
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
502	New and Improved Food Products
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #6

1. Outcome Measures

Number of specialty food and mainstream food processors accessing and applying science based information to produce and distribute safe, nutritious, high-quality foods

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

With the resurgence of interest in ?eating local,? many people are acquiring food from their farmers? markets, or growing it themselves, and preserving it at home. Commercial food processors must follow strict government regulations for handling and preserving food. No such rules exist for people who home-can or freeze their garden produce, or meat or fish.

Without up-to-date information and proper equipment, home food preservers risk introducing foodborne pathogens into their foods. Food poisoning is not only potentially deadly, it?s expensive: a single case of botulism?a foodborne pathogen that can lurk in improperly home-canned foods?is estimated to cost between $1.5 and $1.9 million.

What has been done

OSU Extension?s Family and Community Health program (FCH) has long provided research-based information to help people preserve food safely at home. In 2017, FCH faculty, staff and volunteers in Deschutes County conducted food safety/food preservation workshops in Redmond and Warm Springs.

Class leaders taught the relevant research-based background information, explained the food science, and led the class in hands-on food preservation workshops. Participants took home their preserved foods along with tested recipes and important information on proper equipment. FCH also takes research-based food safety/food preservation information into the community through demonstrations and staffed displays at community events and county fairs. Pressure canner dial gauges are tested at county Extension offices, free, for accurate processing.

Results

Post-class surveys showed that participants went away with better knowledge and increased likelihood of practicing safe food-preservation techniques. More than half of the 92 survey respondents said they reviewed their own food-preservation information to see whether it was current. Nearly all respondents reported that they had changed their practices as a result of taking the workshop, and all indicated that they would recommend the class to others. In our area, 18 Master Food Preserver (MFP) volunteers have been trained and supported by Glenda Hyde. Once certified with 44 hours of training and passing a comprehensive written exam, MFPs contribute volunteer hours to promote food safety/preservation to the public. In 2018, Central Oregon MFP volunteers reached 2231 Central Oregonians and contributed 755 hours, a value of $18,640.95 ($24.69/hour).

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
703	Nutrition Education and Behavior
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

724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Number of individuals improving their practices of safe food handling, food preparation, and food preservation

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Interest in home food preservation continues to grow in our state as well as across the nation. The desire to utilize seasonal, local produce; reduce food waste; prepare for emergencies; increased interest in home gardening and locally grown foods; and an increased desire to control ingredients in food have all contributed to the interest. Community assessments reveal widespread interest in food preservation, especially with younger adults and those with health issues.

What has been done
Extension FCH Faculty, volunteer Master Food Preservers (MFP) and Extension office staff cooperate to address local food safety/preservation needs across the state. 17 counties reported active MFP programs, five more faculty reported food preservation classes for community members. Most additional counties report providing information and services related to safe and healthy food preservation such as testing pressure canner gauges.

Results
46,393 Oregonians had direct contact with extension representatives regarding food preservation. 1035 visited their local extension office, 5153 called their local office or the toll-free Food Safety and preservation hotline. Of the 1261 calls to the toll-free hotline, 921 featured a potential food safety issue. 5078 Oregonians attended one of 159 workshops or demonstrations; 27,988 stopped by an information booth. 310 queries came through Ask-an-Expert. 1319 pressure canner gauges were tested for accuracy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
703	Nutrition Education and Behavior
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
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #8

1. Outcome Measures

Number of technologies and control strategies that improve food safety

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Oregon soil, weather and water conditions are perfect for producing some of the best quality produce from farms and gardens so it?s no surprise Oregonians want to grow their own nutritious, tasty foods or get them from local growers. When it comes to food safety and preservation methods, however, creativity or not following directions from up-to-date, tested recipes can cause some very serious food safety risks. You may recall a science textbook with a photo of seven graves, all from the same family. All had eaten improperly processed, canned green beans at a family picnic near Scio, OR. The first death from canned salsa, traditionally only made and eaten fresh, occurred in the Willamette Valley. The first deadly strain of e-coli bacteria, O157:H7 was discovered in southern Oregon.

Oregon State University Extension Home Economists (now called Family and Community Health educators) responded with an effort to build a culture of safe food handling and preservation. The

Master Food Preserver Program was developed in Oregon in 1980 by Dr. Carolyn Raab and Nellie Oehler to help extend the reach of food safety and preservation educators in their respective counties. In cooperation with University of Idaho and Washington State Extension, PNW publications were developed to enhance and clarify recipe directions from the national data base of safe recipes at the USDA National Center for Home Food Preservation. State publications were also developed (SP50-###) to even further clarify safe steps for Oregonians. Since that time, multiple, annual cases of botulism poisoning have dropped to an average of about one per year. We are not done, yet, though. In a study from The Ohio State University in 2015, the costs to Oregonians for foodborne illness were over $668 to $1,099 million. The cost of one case of botulism ranged from $1.4 to $1.8 million. Nearly all of the costs from known sources are preventable.

The education efforts through numerous traditional and contemporary channels continue today to try to reach consumers. New home cooks and food preservers are entering this culture. Social media is flooded with unsafe practices and recipes. Companies are marketing products as safe for pressure canning on late night infomercials, while research exists that denies validity of this claim.

What has been done

The Community Canning Class survey was developed for use by qualified OSU Extension Family and Community Health Food Safety and Preservation Program educators and volunteers who have met the criteria to teach food safety and preservation canning classes. It was sent to IRB and has been identified as Study #8564. Surveys were sent to all units at the beginning of the 2018 food preservation season. A reminder was sent out early in the season. Several emails were sent to get them collected. A Qualtrics survey was created and all data was entered from Deschutes or Linn County offices. Data was analyzed by Glenda Hyde with guidance from Jeanne Brandt, Food Safety and Preservation Program Coordinator.

The Community Canning Class Follow-up survey was developed for 2018 participants of the community canning classes to be administered at the end of the season to judge effectiveness of training one to six months later. It is also part of IRB Study #8564. This survey was entered in Qualtrics. The link and a .pdf copy were sent by email in November to each of the units that reported conducting community canning classes for distribution to their clients. An additional email was sent to remind them about the deadline. Data was analyzed by Glenda Hyde with guidance from Jeanne Brandt, Food Safety and Preservation Program Coordinator.
Food Safety/Preservation Tracking Form is the new tool for documenting activity outside of the classroom. Collecting data from contacts outside of the community canning classes this year was recommended by Food Innovation Center commercial food safety faculty to get a more accurate picture of the consumer food safety practices, interests and needs. IRB recommended that we include this survey in IRB Study #8564. Information about this new project and the .pdf form was sent by email to Food Safety and Preservation faculty and staff, including all office managers (some have had Level 1 training to answer basic questions). The information was collected in the Food Safety and Preservation Tracking Forms by a few faculty, staff and Master Food Preserver volunteers in the first year, 2018.The Food Safety and Preservation Hotline agreed to submit some of their data in the Food Safety and Preservation Tracking Forms since few changes were needed and this gave us a broader statewide picture. A Qualtrics survey was developed so that data could be sorted for analysis. It was labor intensive, and for our dedicated educators, a new system to learn and use but the consumer food safety and preservation story is emerging. Reporters from Clackamas, Columbia, Coos, Deschutes, Douglas (hotline), Lane (hotline), Lincoln, Linn-Benton, Marion-Polk, and Multnomah contributed to the 2018 Tracking Form Report. A Qualtrics survey was created and all data was entered from Deschutes or Linn County offices.

A definition for Botulism risk* was identified and each entry was reviewed and classified for potential Botulism risk* so the classification process was uniform. Data was analyzed by Glenda Hyde with guidance from Jeanne Brandt, Food Safety and Preservation Program Coordinator.

Results

Food safety and preservation education at an OSU Extension community canning class resulted in plans to reduce Botulism risk* for 125 participants. In the Community Canning Class Follow-up survey, one to six months after their workshops, participants in an OSU Extension community canning class maintained safe canning practices and almost all shared what they learned with others.

?The classes made me feel comfortable using the pressure canner and gave me the confidence I needed to do it on my own.? Linn County class participant. ?Bought current books and stopped using my canning book from the 1960?s. The hands-on approach along with the class presentation reinforce the learning.? Deschutes County class participant from Crook County.
Community Canning Class surveys were completed by 328 pressure and boiling water canning workshop participants from 15 counties in Oregon and 3 counties in Washington. Units reporting were Coos, Deschutes, Hood River-Wasco, Linn-Benton, Marion-Polk and Tillamook.
?91% increased or reinforced awareness of equipment necessary for canning foods by very much or a lot.
?94% increased or reinforced confidence to complete all of the steps to safely can foods.
?97% of participants have been or plan to always use up-to-date, research-based home canning instructions (56% increase reported from before the class).
?98% of participants have been or plan to always follow steps for safe use of a boiling water canner (38% increase reported from before the class).
?94% plan to always follow steps for safe use of a pressure canner (44% increase reported from before the class).
?As a result of their class, 187 participants plan to have pressure canner dial gauge tested annually, 195 plan to allow for proper venting of pressure canner, and 204 plan to make altitude adjustments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
703	Nutrition Education and Behavior
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
724	Healthy Lifestyle

Outcome #9

1. Outcome Measures

Ability to detect incidences and trace pathways of food borne illnesses

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Foodborne illness remains a significant public health problem in the United States with an estimated 48 million cases and cost of$89 billion annually. Research conducted under this program will lead to a better understanding of food contamination and will investigate and validate solutions for producing and processing safer foods. Due to the complexity of food products and its desired end use, production and processing interventions will be specific and tailored to individual commodities or categories. Food safety research projects will be varied in their methodology depending on the required research for the commodity or food category. In general, prevalence studies and validation studies will focus on detecting and inactivating Salmonella and other foodborne pathogens.

What has been done
Methods will be diverse and appropriate as necessary for the specific project. Process validation research will be conducted with deference to best practices for the field, including inoculation of food product with a cocktail of the target microorganism(s) of concern. Products will be processed according to the variables and ranges typically used by the industry and boundaried by conservative and liberal processing estimates. Prevalence studies will be designed with suffient sample numbers and timing as estimated by likely contamination rates and levels with power calculation as support. Dissemination of preventive food safety programs will be accomplished using standardized curricula, with deference to PSA and FSPCA materials.

Results
This work will lead to changes in knowledge of the source and spread of pathogens in food systems and evidence to support the impact of processing variables on the inactivation of foodborne pathogens in diverse food systems. Specially, the outcomes will support efforts to enhance the safety of fruits and vegetables, seafood, meat, and poultry products. Workshops will

be developed and delivered to increase food safety risks of regulatory personnel, producers, and processors.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
308	Improved Animal Products (Before Harvest)
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
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
903	Communication, Education, and Information Delivery

Outcome #10

1. Outcome Measures

Number of policy makers and managers informed about safe food handling and processing

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Identify Current traceability practices by small producers and processors

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

Identification of Critical Tracking Events (CTEs) and Key Data Elements (KDEs)

Not Reporting on this Outcome Measure

Outcome #13

1. **Outcome Measures**

Identification of benefits and costs to implementing FTS

Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

Training for Stakehoders

Not Reporting on this Outcome Measure

Outcome #15

1. **Outcome Measures**

Apply principals of integrated pest management and integrated crop management to improve food safety and environmental impacts of agricultural production.

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of this project is to develop and demonstrate ecologically based management plans for field bindweed so that producers transitioning to organic can successfully manage this weed. A second aim is to develop attractants for a biological control agent of field bindweed, and test and demonstrate how the attractants can be used to manipulate the biocontrol agent to enhance herbivory and improve the efficacy of ecologically based control plans. These goals are consistent with the goals of the ORG program because this project will improve the competitiveness of organic crop producers, particularly those that are adopting organic practices. The transition to

organic production is fraught with challenges, and control of perennial weeds during the transition can be a major obstacle to success. If perennial weeds are left unchallenged during the transition period, the results can be catastrophic. Similarly, if the entire transition period is used to control perennial weeds, the results may be unsustainable because of lost income.

What has been done

The focus of this project is management of field bindweed because: 1) this weed is very common and difficult to control in organic sytems, and 2) the biological control agent Tyta luctuosa is a voracious herbivore specific to field bindweed. Pheromone traps have allowed us to document where bindweed moths are distributed. We are now developing attractants that draw male and female moths directly to bindweed growing in crops to improve efficacy of this biological control agent, particularly when integrated with other control methods using flame, organic herbicides, or mulches.

Objectives:

1. Engage producers in developing plans for control of field bindweed, with a focus on successful release, management, and evaluation of Tyta luctuosa for potential to regulate field bindweed in perennial crops.
2. Develop and refine attractants to improve potential of aggregating field bindweed moths onto field bindweed patches in fields that are transitioning to organic.
3.Evaluate integration of cultural and biological control for field bindweed in organic perennial production systems.
4.Report experience and discovery by cooperating producers and researchers as case studies and project summaries through e-Organic and traditional extension platforms and publications.

Results

Gathered pesticide regimes data from growers, in preparation for fall and winter exposure tests of T. luctuosa to insecticides, and the response of field bindweed to herbicides labeled for field bindweed and approved for organic production systems.

Confirmed that benzaldehyde, although detected as part of the field bindweed semiochemical profile, does not attract T.luctuosa, and may in fact support a push/avoidance control strategy.

Continuing to work with a wasp bait as a stimulant to T. luctuosa oviposition.

Four replications of trapping for adult moths to provide longitudinal ground truthing of activity periods of the adults and Growing Degree Day model in a naturalized, non-production agricultural setting.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
607	Consumer Economics
702	Requirements and Function of Nutrients and Other Food Components
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
903	Communication, Education, and Information Delivery

Outcome #16

1. Outcome Measures

Reducing dietary carcinogens in food

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To date food safety with respect to dietary carcinogens is determined from extrapolation of results from high-dose animal studies. Utilizing the exquisite sensitivity (zeptomole-attomole detection) of accelerator mass spectrometry, we can safely dose humans with a known human carcinogen found in food, benzo[a]pyrene (BaP). BaP is a member of the polycyclic aromatic hydrocarbon (PAH) family of environmental carcinogens and is formed from the burning of any organic material (coal, petroleum products, wood, tobacco) and is present in almost all foods. This project has been approved by the NIH, FDA as well as multiple IRBs and is registered at ClinicalTrials.gov. This represents the first such study in humans at environmentally relevant levels of exposure (we use 50 ng and the average daily exposure to a non-smoking adult in the U.S. is 270-750 ng). In rodent models pre-treatment with cruciferous vegetables in the diet or with phytochemicals isolated from crucifers provides protection against PAH-induced cancer. We will provide Brussels sprouts to volunteers daily for a week prior to dosing with BaP. The hypothesis under test is that the addition of Brussels sprouts to the diet will reduce the uptake, metabolic activation (and any DNA binding) and enhance the excretion rate, thus reducing the overall risk.

What has been done
The first study is a dose-response study (25, 50, 100 and 250 ng) with 7 volunteers. Blood and urine is collected over 48 hours for measurement (Lawrence Livermore National Laboratory) of BaP and metabolites. In the NIH-funded proposal, this study is to take place in years 1 and 2. The end of year 1 is November 30, 2018 and we have completed treatments for 4 out of the 7 volunteers. The second study, to be initiated in November, involves dosing with a binary mixture

of benzo[a]pyrene and a second, non-carcinogenic PAH, phenanthrene, commonly found in diet at levels 20-fold higher than BaP. We are testing the Relative Potency Factor (RPF) approach used by EPA and FDA to assess risk from complex PAH mixtures. In this approach, the carcinogenic potency of each individual PAH in the mixture is multiplied by its fractional concentration and the sum is the overall risk. In order for this approach to have validity, each PAH can not impact the uptake, metabolism or excretion of any other PAH. Thus, if we find that co-administration of phenanthrene with BaP alters any of those parameters this would be evidence that the RPF approach may not be valid. The timeline in the NIH grant has this study being completed by the end of year 3 (November 30, 2020). The intervention study with cruciferous vegetables is to take place in years 4 and 5 (completion by November 30, 2022).

Results

Repeated dosing with BaP shows very little intra-individual variation in uptake, metabolism and excretion even with up to a year between dosing. Surprisingly, BaP is metabolized extensively such that it is a minor component in blood even at the earliest time points (we take blood at 0, 0.25, 0.5, 0.75, 1, 1.5, 2, 3, 4, 8, 24 and 48 hours). The BaP metabolite profile varies between individuals and may be related to their genetics. Co-administration of smoked salmon with high levels of multiple PAHs significantly impacted the uptake, metabolism and excretion of BaP but we found that an equal amount of salmon with very low levels of PAHs, had the same impact suggesting that this was a food matrix effect and not due the presence of high levels of a complex PAH mixture (not a true test of the RPF approach to risk assessment).

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
308	Improved Animal Products (Before Harvest)
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
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.)
- Other (Food-borne illness outbreaks)

Brief Explanation

Food safety continues to be an area of concern for producers and consumers. OSU continues to devote considerable resources to exploring options for reducing potential toxins and pathogens in foods, improving pre-harvest and post harvest food safety practices and developing new approaches for food handling, processing, and traceability. Like many research and outreach efforts, reduced federal and state funding greatly impacts our ability to deliver improved technologies associated with detection, prevention and tracking of food borne illnesses.
While producers resist food safety regulations, consumers demand more regulation and transparency concerning food origin, sustainability of production, and safety. As the international economy improves, new consumers are demanding higher quality, more nutritious, and safe food. This has given American producers a competitive advantage over international producers as our food safety system continues to expand and improve.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Future lifestyles will emphasize maintaining health and preventing diseases that now limit human lifespan. As our understanding of the complex relationships between diet and health expands, markets will grow for safe, highly nutritious foods and for functional foods and biopharmaceuticals that have disease prevention and health promotion effects. Our existing strengths in areas such as biotechnology and genomics, agricultural production systems, food processing and food safety, environmental toxicology and agricultural marketing, trade, and economics position the Oregon Agricultural Experiment Station to further understand and develop the agriculture and food system in Oregon and the region. A combination of conventional, organic, and biotechnology-based approaches will provide an array of strategies for sustainable production of nutritionally enhanced crops and food. These agricultural and food products will ensure a range of marketing niches for producers while providing the consumer with robust choices within a safe and secure food system. Research will support producers and marketers in the production of certified organic and health-enhanced foods. Research will also provide analyses of health effects of agricultural and environmental chemicals as well as the use of foods and phytonutrients to maintain well-being. Expanded consumer education about the relationships of food, nutrition, and health will provide U.S. citizens with information for making individual choices among an array of foods and food products.

Key Items of Evaluation

This Planned Program promotes and enhances the scientific discipline of food safety, with an overall aim of protecting consumers from microbial and chemical contaminants that may occur during all stages of the food chain, from production to consumption. This requires an understanding of the interdependencies of human, animal, and ecosystem health as it pertains to food-borne pathogens. The long-term outcome for this program is to reduce food-borne illnesses and deaths by improving the safety of the food supply, which will result in reduced impacts on public health and on our economy.
The Enviornmental and Molecular Toxicology Department at OSU has created a state-of-the-art high throughput zebra fish lab that is beginning to uncover the deleterious effects of natural and man made toxins prevalent in our water and food supply. This important work, coupled with research from the Food Science and Technology Department is discovering ways to reduce exposure to these toxins and developing dietary guidelines that can use foods to ameliorate the intake of some of these toxins.

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
610	Domestic Policy Analysis	5%		5%	
703	Nutrition Education and Behavior	20%		20%	
704	Nutrition and Hunger in the Population	10%		20%	
724	Healthy Lifestyle	20%		20%	
802	Human Development and Family Well-Being	15%		15%	
806	Youth Development	20%		10%	
901	Program and Project Design, and Statistics	5%		0%	
903	Communication, Education, and Information Delivery	5%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	2.0	0.0
Actual Paid	3.0	0.0	0.5	0.0
Actual Volunteer	1032.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
72050	0	166562	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
78966	0	1666686	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
184274	0	1176546	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

We will determine factors that drive the decisions of individuals and householders to adopt and maintain healthy lifestyle choices. Further, we will use a social-ecological framework to study how exposure and familiarity with more nutritional foods can increase incorporation of these foods into diets of various populations, as well as acceptability.

We will also:

• Conduct evidence-based educational programs and activities that are directed at parents, children, professionals, partner agencies, and other audiences.
• Develop or select new 4-H foods curricula that focus on the youth learning to prepare healthy, local foods.
• Develop a curriculum designed to help older youth become local advocates for healthy eating and physical activity in their communities. The curriculum will help young people learn how to conduct community assessments and lead community change efforts that focus on education, system building, and policy development.

In summary, we will:
- Conduct surveys
- Conduct data analyses
- Conduct mixed-methods longitudinal research (interviews,
- Conduct Research Experiments
- Develop models
- Develop Products, Curriculum, Resources
- Provide Training.
- Assessments.
- Partnering
- Partnering.

2. Brief description of the target audience

- children, youth, and families across Oregon
- schools and others youth educators
- elderly residents
- urban and rural residents
- Latino populations
- economists.

- policy makers and agency personnel who work with children and families .

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	7374	15659	4775	22046

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	26	31	57

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of people trained to meet requirements of FSMA

Year	Actual
2018	342

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Conceptual model will guide research to understand the factors & processes that account for physical activity and the associated health outcomes among youth across ethnic and class boundaries in the context of changing communities
2	Knowledge gained to develop strategies for maximizing physical activity and physical and mental health of youths and adults
3	Improved outreach, education, and professional practice to serve the needs of low-income families, including programmatic interventions that reduce physical inactivity and promote the well-being of lower-income and ethnic minority youth across America
4	Develop understanding of human health and nutritional behaviors * obesity intervention strategies * bio-behavioral markers * key parent-child relationships * family interactions * peer interactions * personal choices
5	Improved nutrition * schools offer/encourage healthful foods * more effective programs and student experiences * markers and strategies become the standards of methods and measurement of childhood overweight and resiliency
6	Identify tactics, strategies and factors that provide families, children, and youth access to healthy foods
7	Children practice healthy eating as defined by the current U.S. Dietary Guidelines for Americans (Percent of target audience indicating positive change in measured outcome)
8	Children engage in healthy levels of physical activity as defined by national physical activity guildeines (Percent of target audience indicating positive change in measured outcome)
9	Increases in positive levels of Knowledge, Attittude, Skills and Aspiration (KASA) outcomes, as per Bennett & Rockwell, 1995, related to goals of reducing obesity (Percent of target audience indicating positive change in measured outcome)

Outcome #1

1. Outcome Measures

Conceptual model will guide research to understand the factors & processes that account for physical activity and the associated health outcomes among youth across ethnic and class boundaries in the context of changing communities

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dietary exposure to nitrates and nitrites occurs mainly from vegetable sources and is associated with cardiovascular health benefits and improved athletic performance while, in the context of processed meats consumption, is associated with increased gastrointestinal cancer risk. Dietary nitrite and nitrate can act as reservoirs for nitric oxide (NO) production with its reduction to NO potentiated in acidic or hypoxic areas, such as contracting skeletal muscle. We extend the knowledge in this field with data described in publications below quantifying human exposure to dietary nitrate and nitrite as well as showing data from a zebrafish model informing how dietary nitrate may improve exercise performance by lowering the oxygen cost of physical activity.

What has been done
Analysis of blood and tissue metabolomics data to determine the potential mechanisms through which dietary nitrate and nitrite improve the oxygen cost of exercise, hence endurance, in skeletal muscle and liver in zebrafish.

Results
Preliminary results will be available during the next reporting period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population

724	Healthy Lifestyle
802	Human Development and Family Well-Being
806	Youth Development

Outcome #2

1. Outcome Measures

Knowledge gained to develop strategies for maximizing physical activity and physical and mental health of youths and adults

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aging of the immune system, or immunosenescence, is characterized by a gradual decline in both cellular and humoral immune responses, resulting in increased susceptibility to infectious diseases and compromised vaccination efficacy in the elderly. Aging is also associated with a low-grade, systemic chronic inflammation, which is a significant predictor of morbidity and mortality in aged individuals. The mechanisms leading to age-related chronic inflammation must be resolved in order to develop strategies to improve the health span of older individuals. Increasing evidence indicates that the interaction among gut microbiota, the immune system, and diet contributes to age-related inflammation. Gut microbiota are essential for development and homeostasis of immune function throughout life and changes in its composition are linked to inflammatory disorders. Older individuals have distinct compositions relative to younger individuals; these differences could contribute to age-related changes in both intestinal function and dysregulation of the immune system. In addition, diet has a profound effect on the composition of gut microbiota, and at the same time the gut microbiota also have a significant impact on the metabolism and utilization of nutrients. In particular, the loss of specific nutrients with age may be attributed to alterations in the gut microbiota and may contribute to age-related immune dysfunction.

What has been done
Objective 1: Investigate the effects of aging and zinc status on microbial populations and factors involved in the inflammatory response. The working hypothesis is that age-related microbial alterations and cellular zinc loss contribute to increases in age-related chronic inflammation that

can be overcome with zinc supplementation. We will examine alterations in microbial compositions with age, zinc deficiency and their combination. Secondly, we hypothesize that zinc supplementation will overcome age-related defects in microbial composition and increase zinc status, resulting in decreases in inflammatory responses.
Objective 2: Identify zinc-dependent pathways leading to age-related inflammatory response and investigate the requirement of the microbiome in age-related zinc loss and immune dysregulation. The working hypothesis is that age-related changes in microbial composition and diversity contribute to age-specific zinc deficiency. We expect that age-related decreases in cellular zinc and microbial community alterations cause activation of critical transcription factors such as NFkB, and enhances the inflammatory response. Secondly, utilizing young germ-free mice transplanted with microbiomes derived from old animals, we will define the role of the aging microbiome on zinc status and inflammatory processes without the confound of additional aging effects on the host body.

Results
1. Completion of two mouse feeding studies described in Objective 1.
Due to the limitation in the number of aged mice we can acquire from National Institute of Aging, we have divided the proposed animal study described in Objective 1 into two separate mouse studies.
In the first mouse study (zinc supplementation study), groups of young (2mo) and old (24mo) mice were fed zinc adequate diet (30mg/kg zinc) or zinc supplemented diet (300mg/kg zinc) for 6wks. The feeding study was completed in June 2018, and various tissues and fecal materials were collected for downstream analyses.
In the second mouse study (zinc deficiency study), groups of young (2mo) and old (24mo) mice were fed zinc adequate diet (30mg/kg zinc) or zinc deficient diet (6mg/kg zinc) for 6wks. The feeding study was completed in October 2018, and various tissues and fecal materials were collected for downstream analyses.
2. Determined zinc status in young and old mice in zinc supplementation study.
Serum zinc levels were measured by ICP-OES in mice from the zinc supplementation study. Old mice had significant decrease in serum zinc despite being fed a zinc adequate diet. Zinc supplementation restored their serum zinc levels to those comparable to young mice.
We collected mesenteric and inguinol lymph nodes from individual mouse at the time of necropsy from mice in zinc supplementation study. Zinc supplementation had a significant effect in decreasing age-related increase in memory T cell population, with concomitant increase in naïve T cell populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
802	Human Development and Family Well-Being
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Improved outreach, education, and professional practice to serve the needs of low-income families, including programmatic interventions that reduce physical inactivity and promote the well-being of lower-income and ethnic minority youth across America

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project will use both quantitative and qualitative data to address these two broad objectives:
Objective 1: To conduct extensive higher order analyses in all waves of quantitative and qualitative data to further explore factors that create barriers or enhance the physical and mental health of diverse rural low-income families.
Objective 3: To disseminate findings, based on the proposal analyses, in order to further the empirical knowledge base and increase understanding among family servicing professionals and policy makers regarding factors that contribute to or create barriers to the physical and mental health of diverse rural low-income families.

What has been done
We will address these objectives using three main theoretical frameworks. Based on Bronfenbrenner's (1979) ecological systems perspective, individuals' health and development is influenced by factors from overlapping contexts, including the family (microsystem), the work-family interface (mesoystem), employment (exosystem for children), culture (macrosystem), and time (chronosystem). To advance knowledge on the health of rural families, it is critical to identify the confluence of factors that promote (or hinder) health as well as the mechanisms that explain different rural family health trajectories. This study will pay particular attention to the condition and management of work and family roles and responsibilities and the implications for individual and family health.

Results
To date, the work-family interface has been linked to various psychological and physical health outcomes, but these studies are primarily based on White, middle class, suburban and urban workers. Rural families are not a monolithic entity; therefore, it is important to understand the

types of and reasons for variation in health among rural families. Using a family risk and resilience framework (Walsh, 1996), our goal is to identify risk and protective factors for rural families' health that can be targeted for program or policy intervention. Furthermore, this project is unique by taking a family systems approach (Cox & Paley, 1997) to understand how each family members' unique experiences and health can influence other family members. This approach calls for also understanding how children's health and experiences (school, employment) influence family interactions and health, which will be pursued by this project. Furthermore, this project will aim to study family health as a family systems-level phenomenon, rather than solely examining individual family member's health.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
802	Human Development and Family Well-Being
806	Youth Development
901	Program and Project Design, and Statistics
903	Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

Develop understanding of human health and nutritional behaviors * obesity intervention strategies * bio-behavioral markers * key parent-child relationships * family interactions * peer interactions * personal choices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The prevalence of childhood obesity is steadily increasing in industrialized countries. Evidence suggests that consumption of dairy products, especially milk, might help prevent childhood obesity. The reason for this association is not yet clear. However, the milk may have the capacity to affect obesity by "programming" adipose stem cells. In a recent discovery, microRNAs (miRNAs), which are 18-25 nucleotide endogenous small RNAs involved in post-transcriptional gene silencing, have been found encapsulated in microvesicles (i.e., exosomes) within cow's milk. The miRNAs in milk exosomes appear to be quite stable and maybe horizontally transferred through intestinal absorption even after the postnatal period. If absorbed, miRNAs could affect the differentiation of stem cells, including athe ones responsible for the formation of fat cells. There is a strong potential that if miRNAs in milk exosomes are absorbed following consumption, it will affect adipogenesis via reprogramming of stem cells.

What has been done

Our long-term goal is to determine the nutrigenomic effects of dairy products on human health. Our goal in this proposal is to assess if miRNAs from cow's milk play a role in controlling obesity by affecting ASC. Our central hypothesis is that miRNAs present in raw milk are horizontally transferred and prevent obesity by regulating expression of genes involved in ASC adipogenesis. Our rationale is that the demonstration of absorption and effects of miRNAs from cow's milk on pig ASC will establish a strong scientific framework for future research and, ultimately, clinical trials.

Objective #1: Assess the in vivo effect of milk on the abundance, proliferation, and differentiation capacity of adipose-derived stem cells and size of mature adipocytes. Our working hypothesis is that consumption of cow's milk decreases the number and adipogenesis of porcine ASC in vivo and reduces the size (i.e. lipid accumulation) of mature adipocytes.

Objective #2: Determine if miRNAs present in cow's milk exosomes are horizontally transferred into the blood stream through intestinal absorption and then transported into adipose-derived stem cells. Our working hypothesis, based on recent scientific data, is that miRNAs from cow's milk are horizontally transferred and present in ASC.

Objective #3: Determine the effects of miRNAs present in exosomes of cow's milk have on the transcriptome of adipose-derived stem cells. Our working hypothesis is that miRNAs in exosomes from cow's milk have an effect on the transcriptome of porcine ASC.

Results

Feeding milk had an inconsistent effect on the size of fat tissue and size distribution of fat cells, with a greater size of fat in the first sub-experiment but a better distribution of the size of fat cells while in the second sub-experiment we did not detect any large effect. The ASC isolated from piglets supplemented with milk grew faster in vitro and had a tendency to accumulate less fat when differentiated in mature fat cells. Furthermore, supplementing milk had an effect on the transcriptome of ASC, with potential long-term effect on the ability of these cells to differentiate in fat cells or responding to stimuli. When exosomes size distribution was measured with found a large frequency of exosome with the size of the most abundant exosomes in milk in the blood of milk-fed piglets compared to control, indicating a possible transfer of exosomes from milk to plasma. However, only 3 out of >500 measured miRNA were differentially abundant between the two groups, indicating a small-to-none effect on plasma miRNA.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

802	Human Development and Family Well-Being
806	Youth Development
901	Program and Project Design, and Statistics
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

Improved nutrition * schools offer/encourage healthful foods * more effective programs and student experiences * markers and strategies become the standards of methods and measurement of childhood overweight and resiliency

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Childhood obesity remains at alarmingly high levels despite extensive prevention efforts. The most recent surveys indicate 17.2% of children ages 2 to 19 years are obese (Ogden et al., 2016). In young children, ages 2-5 years, prevalence is estimated at 9.4 %; 17.4% in children 6-11 years of age; and in adolescents, it is 20.6%. The significantly higher rates in older children and adolescents are a predictable consequence of years of poor diet quality and physical inactivity that follow from a pattern established in early childhood (Dubois, Farmer, Manon, & Peterson, 2007; Park, Li, & Birch, 2015). This trajectory underscores the need for early and sustained intervention. Development of obesity by age 5 has been associated with a four-fold increase in obesity risk in adolescence (Cunningham et al., 2014) which is predictive of adult obesity and other chronic disease risk. Moreover, significant disparities in childhood obesity prevalence and risk factors for obesity development have been identified for multiple racial/ethnical minority groups and for children from low-income backgrounds, among other sociodemographic factors (Datar & Chung, 2015; Dixon et al., 2012; Ogden et al., 2016. Evidence suggests these disparities are present by the preschool years (Taveras et al., 2013; Baidal et al., 2016), highlighting the importance of early life experiences for child health.

What has been done
Integrating physical activity habits with healthy eating in young children to reduce the incidence of obesity requires both caregiver and teacher influences, as well as direct education of young

children themselves. Intervention programs designed for young audiences require targeted and structured teaching strategies that match the developmental stage of the child's social, emotional, cognitive and physical abilities. While systematic correlational research confirms the importance of an integrated approach (Musaad et al., 2017), integrated curricula are scarce, and few parents and early care and education providers have the requisite knowledge, training, and support to provide and model quality nutritional choices and developmentally appropriate physical activity for young children. Therefore, the development and dissemination of appropriate integrated curricula for parents/caregivers represent critical needs and a novel approach in the obesity prevention field.

Results
An umbrella review has been undertaken by the research group: Parental/caretaker involvement in diet or physical activity interventions to prevent childhood obesity: an umbrella review. The initial search has been completed, and 1800+ abstracts have been screened by me and another reviewer with a third group member serving to resolve disagreements on inclusion. From the abstracts screened, 112 full-text articles were selected for additional review. Next steps include screening 112 full-text articles, revising the data extraction spreadsheet, and implementing the quality assessment tool. Group members worked on operationalizing AMSTAR 2, a widely recognized, validated quality assessment tool used to evaluate systematic reviews. This work will be completed and results disseminated during the next reporting period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
802	Human Development and Family Well-Being
903	Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

Identify tactics, strategies and factors that provide families, children, and youth access to healthy foods

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Not only are people unhealthy, so are whole communities. Access to nutritious food, good health care and fitness opportunities fell short in four Oregon regions Klamath County, The Dalles, Grants Pass, and the Umpqua region. For example Klamath county has consistently ranks one of the lowest in the state (31 or 32 out of 33 counties).

What has been done
OSU Extension faculty in these counties are participating in the Blue Zones Project, which engages all sectors residents, community, business and civic leaders, together in a commitment to bolster healthy choices, environments and policies.
The Blue Zones approach is inspired by Dan Buettner, a National Geographic Fellow and New York Times best-selling author who identified five regions of the world, Blue Zones with the highest concentration of people living 100 years or older. In Buettner's search for areas of health and longevity, he found residents of Blue Zones sites practice nine healthy lifestyle habits, including a plant-based diet, a sense of purpose, moving as part of daily life and socializing. Other behaviors are attending faith-based services, eating only until stomachs are 80 percent full, moderate wine consumption, developing strategies for less stress, and putting family first.
In addition to need, the four Oregon communities demonstrated readiness to change and commitment from residents, business and government through financial contributions, volunteerism or participation in one or more programs. National Blue Zones staff monitor the process and conduct ongoing research to determine results. Extension faculty in each area facilitate connections in the community, serve on committees, and help various sectors carry out the strategies required to receive final Blue Zones designation.

Results
In Klamath Falls, where the project is three years old, residents have stepped up to volunteer for initiatives such as encouraging healthy food in schools, grocery stores, workplaces and restaurants. Extension helps pull together this community interaction. As a result of Blue Zones, tourism has increased, smoking rates have decreased, parks have been enhanced and bike and walking trails added, and Klamath County won the prestigious Culture of Health Prize from the Robert Wood Johnson Foundation.
Klamath County joins only 39 other counties (including the Dalles) in the nation to receive this award. The award reflects the strides the community and its leaders have made to improve the health and well being of all of its residents. Extension and community leaders have elevated the value of a healthy community, economic vitality and how it intersects with quality of life for its citizens.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis

724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Children practice healthy eating as defined by the current U.S. Dietary Guidelines for Americans (Percent of target audience indicating positive change in measured outcome)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Chiloquin is a small community with a depressed economy, high unemployment rate and limited access to healthy foods. In previous years, research team from GROW Healthy Communities obesity prevention grant collected data on weight status and physical activity of students and inventoried healthy food and physical activity resources in the region. The data supports what many that live in the area already know, youth in Chiloquin are generally in poor health; many are overweight (50% overweight or obese) and the region is a food desert. This project was funded by Phil Knight Cancer Institute to promote healthy eating, cooking and physical activity in the after school program and was completed in cooperation with Klamath Tribes staff and OIT students.

What has been done
A series of eight cooking sessions were designed and delivered to 30 third thru sixth grade students (fall) and 30 K-2nd grade students (spring). They prepared simply recipes, learned cooking skills as well as food safety principles. Each session students received supplies to make recipes at home for their families. Each series ended in a family celebration where students prepared part of the meal that was served. A third week-long class was offered in summer 2018 to kids of all ages. In addition to the classes, kids were given take-home bags of food with all of the ingredients of the meals they learned how to make in that week's class. This enabled the kids to make a healthy meal at home for their family.

Results
Many children said they made the recipes at home that they learned in the program; this was also confirmed by several adults of youth in the program. An observational survey of demonstrated

skills was conducted by Oregon Institute of Technology students for both after school cooking series. The results showed that for both groups, over the 8-week periods mastery of skills went from 60-70% in week 1 to 90-100% in week 8. The skills included hand washing, kitchen safety, knife safety, recipe reading.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle
802	Human Development and Family Well-Being
806	Youth Development
903	Communication, Education, and Information Delivery

Outcome #8

1. Outcome Measures

Children engage in healthy levels of physical activity as defined by national physical activity guildeines (Percent of target audience indicating positive change in measured outcome)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the winter of 2018, the Eastern Oregon Coordinated Care Organization (EOCCO) released their grant application process that included a new incentive measure, to reduce childhood obesity. Inactivity and childhood obesity rates are a growing concern for Lake County youth, especially during summer vacation when there is an increase of unstructured time for school age youth. The Lake County OSU Extension Service developed a diverse, community-wide team to address and increase physical activity of youth through a summer-long program.

What has been done

This committee developed an innovative summer-long program with the goal of increasing physical activity and providing nutrition education while preparing youth for a local triathlon. Each week, instructors from a local group, club, business or agency were scheduled to highlight a new skill for the triathlon or highlight a local recreational opportunity. Youth participants were provided with a magnetic whiteboard friendly physical activity tracker to encourage activity at home between the sessions. Participants who met their goals were provided with incentives such as bike locks, swim goggles and reflect shoe laces.

Results
This program engaged 65 youth participants, 12 Teen Staff members and over 20 community volunteers. On average youth participants attended 5 of the 7 weekly session, engaging an average of 10 hours of direct education. At the completion of the program youth participants parent/guardians were invited to participate in an IRB approved program evaluation.

Responses were collected from one third of youth participant's parents/guardians.

Parents/guardians were prompted to provide narrative feedback their favorite part of your child?s involvement in i Tri, highlighted statements are below:

"Opportunity to hear about healthy eating habits from someone besides myself".
"Socialization and increased physical activity".
"It was a positive experience. It helped to get my kids to really into thinking about their health"
"Her confidence in trying new things".
"It was something she looked forward to each week".
"The chance for them to try new activities and get excited about training for a triathlon".
"Increased activity for the summer and positive programming."

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
802	Human Development and Family Well-Being
806	Youth Development
903	Communication, Education, and Information Delivery

Outcome #9

1. Outcome Measures

Increases in positive levels of Knowledge, Attittude, Skills and Aspiration (KASA) outcomes, as per Bennett & Rockwell, 1995, related to goals of reducing obesity (Percent of target audience indicating positive change in measured outcome)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Preventing and reducing obesity is one of seven priority areas from Oregon"s State Health Improvement Plan as obesity and chronic disease continue to be public health issues within Oregon. According to data from the Oregon Health Authority 2017 Progress Report, in Oregon, obesity prevalence among 2-5 year old's is at 15.6% and 14% among 11th graders. In addition, higher rates of obesity and chronic disease disproportionately affect low-income and minority populations than other populations. According to the 2018 Marion County Community Health Profile, 19% of 11th graders are obese in Marion County, which is 3% above the Healthy People 2020 goal of 16% for teens.

What has been done
The SNAP-Ed program is a chronic disease and obesity prevention program for SNAP-eligible populations. Oregon SNAP-Ed uses the social ecological model to guide multi-level nutrition and physical activity interventions within the community. In FFY2017-2018, Marion County SNAP-Ed focused interventions within five Title-1elementary schools, Mary Eyre, Cesar Chavez, Kennedy and Four Corners and Grant Community School. All five elementary schools have a free and reduced lunch rate above 75% with 3 schools at or above 84%. In addition, all schools have a minority population above 57% with four schools exceeding 67%. Schools are an ideal location for multi-level interventions for a variety of reasons, a few being: schools are typically trusted by the community, schools reach a large group of students, teachers, families and community members, interventions can be multi-level (individual, environment, system and policy) and therefore, have the potential to be more sustainable and have a larger impact.
In FFY2018, the Marion County SNAP-Ed team utilized various intervention strategies to support obesity prevention. They led 23 bi-weekly or monthly nutrition education courses in 1st, 3rd and 4th grades from October to May reaching 540 students. In addition, SNAP-Ed staff regularly utilized additional resources in their lessons to promote good nutrition, food safety and increased physical activity, such as healthy Food Hero recipe tastings, physical activity breaks, and high-speed hand washing. In addition to nutrition education, SNAP-Ed staff conducted eight, whole school cafeteria tastings reaching 1715 students and teachers and attended four school events having 950 contacts with students and parents. Marion County SNAP-Ed staff also led eight lessons using BEPAT physical activities with youth attending summer lunch sites having 65 contacts, and prepared nine, Food Hero Healthy Food Displays, reaching 1,715 students and teachers.

Results

To evaluate efforts, 401 students in 1st, 3rd and 4th grade completed both a pre- and post-survey evaluating increased knowledge and behavior change. Survey results are inclusive of 2017 pre- and post- surveys completed by the students the previous year. Below are the statistically significant changes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle
806	Youth Development
903	Communication, Education, and Information Delivery

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

Childhood obesity has reached epidemic levels in developed as well as in developing countries. Overweight and obesity in childhood are known to have significant impact on both physical and psychological health. Overweight and obese children are likely to stay obese into adulthood and more likely to develop non-communicable diseases like diabetes and cardiovascular diseases at a younger age. The mechanism of obesity development is not fully understood and it is believed to be a disorder with multiple causes. Environmental factors, lifestyle preferences, and cultural environment play pivotal roles in the rising prevalence of obesity worldwide. In general, overweight and obesity are assumed to be the results of an increase in caloric and fat intake. On the other hand, there are supporting evidence that excessive sugar intake by soft drink, increased portion size, and steady decline in physical activity have been playing major roles in the rising rates of obesity all around the world. Childhood obesity can profoundly affect children's physical health, social, and emotional well-being, and self esteem. It is also associated with poor academic performance and a lower quality of life experienced by the child. Many co-morbid conditions like metabolic, cardiovascular, orthopedic, neurological, hepatic, pulmonary, and renal disorders are also seen in association with childhood obesity.
OSU researchers are beginning to expose the causal contributions of micro-nutrients, nitrates and nitrites, and the contribution of the gut microbiome to both obesity and aging. The role that milk plays both in utero and post-natal infant development is also thought to contribute to obesity during the early stages of development.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Obesity is multi-factorial, involving complex interactions between physiological, behavioral, social, and environmental variables. While obesity has been increasing among adults, it is also becoming more prevalent in children. Currently, ~ 32% of children and adolescents aged 2-19 years of age are overweight, while 17% are obese. The increasing number of youth experiencing weight problems is troubling, since it puts them at risk for one or more chronic diseases earlier in life.
Our work continues to explore the linkages between diet and access to healthy foods as well as physical activity level's contribution to obesity. Similarly, meta analyses being conducted on almost 1200 peer reviewed articles seek to establish better linkages between obesity and low income and rural populations.

Key Items of Evaluation

The prevalence of childhood obesity is steadily increasing in industrialized countries. Evidence suggests that consumption of dairy products, especially milk, might help prevent childhood obesity. The reason for this association is not yet clear. However, the milk may have the capacity to affect obesity by "programming" adipose stem cells. In a recent discovery, microRNAs (miRNAs), which are 18-25 nucleotide endogenous small RNAs involved in post-transcriptional gene silencing, have been found encapsulated in microvesicles (i.e., exosomes) within cow's milk. The miRNAs in milk exosomes appear to be quite stable and maybe horizontally transferred through intestinal absorption even after the postnatal period. If absorbed, miRNAs could affect the differentiation of stem cells, including athe ones responsible for the formation of fat cells. There is a strong potential that if miRNAs in milk exosomes are absorbed following consumption, it will affect adipogenesis via reprogramming of stem cells.
Aging of the immune system, or immunosenescence, is characterized by a gradual decline in both cellular and humoral immune responses, resulting in increased susceptibility to infectious diseases and compromised vaccination efficacy in the elderly. Aging is also associated with a low-grade, systemic chronic inflammation, which is a significant predictor of morbidity and mortality in aged individuals. The mechanisms leading to age-related chronic inflammation must be resolved in order to develop strategies to improve the healthspan of older individuals. Increasing evidence indicates that the interaction among gut microbiota, the immune system, and diet contributes to age-related inflammation. Gut microbiota are essential for development and homeostasis of immune function throughout life and changes in its composition are linked to inflammatory disorders. Older individuals have distinct compositions relative to younger individuals; these differences could contribute to age-related changes in both intestinal function and dysregulation of the immune system. In addition, diet has a profound effect on the composition of gut microbiota, and at the same time the gut microbiota also have a significant impact on the metabolism and utilization of nutrients. In particular, the loss of specific nutrients with age may be attributed to alterations in the gut microbiota and may contribute to age-related immune dysfunction.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Food Energy Water Nexus

☑ 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	0%		20%	
112	Watershed Protection and Management	0%		10%	
132	Weather and Climate	0%		10%	
135	Aquatic and Terrestrial Wildlife	0%		5%	
402	Engineering Systems and Equipment	0%		10%	
403	Waste Disposal, Recycling, and Reuse	0%		10%	
405	Drainage and Irrigation Systems and Facilities	0%		20%	
501	New and Improved Food Processing Technologies	0%		15%	
	Total	0%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	5.0	0.0
Actual Paid	0.0	0.0	0.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	135705	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1407622	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	984613	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

CAS AES and Extension faculty will work with stakeholders including large production operations, small farm holders, and urban agriculturalists to improve water use efficiency and to reduce total use. This includes crating understanding among stakeholders of new varieties and cultivars that can reduce water usage while not reducing yields. Similarly, balancing the needs of food production, environmental stewardship, energy, and human health will be analyzed and presented.
A changing climate has revealed new challenges as municipal and agricultural demands create new conflicts between water consumers and threatened and endangered wildlife. More intensive use of groundwater resources has resulted in additional conflicts as groundwater is reduced and concentrations of nitrates, pesticides, and toxins increase.
Oregon hosts a number of food producers that use large volumes of water and this water is often utilized as supplemental irrigation in dry land regions. The impact of water reuse has not been sufficiently studied to determine the impacts of this water that is typically high in nutrients on shallow aquifers that are utilized both for agriculture and human use.
Aging water infrastructure requires inefficient use of energy and water that may or may not be compatible with new irrigation techniques and emerging cropping regimens. Best practices for replacing or rehabilitating this infrastructure must be evaluated and economic analyses conducted that can suggest methods for meeting the needs of 21st century agriculture.

2. Brief description of the target audience

Target audiences include agricultural producers, small farms, nurseries, small fruits producers, irrigation districts, state and federal agencies. Increasingly, CAS research and Extension faculty have become more engaged with state legislators and county officials as concerns over water quality and water quantity increase dramatically..

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2018

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	29	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of producers adopting irrigation practices that reduce nitrate leaching into ground water aquifers.
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase our knowledge and awareness of drought mitigation tools and strategies for farming with reduced or no irrigation water.
2	Investigate opportunities and risks associated with water reuse from a variety of sources including food processing, dairy and municipal sources, and industrial users such as oil and gas producers.
3	Economics and Water
4	Irrigation Efficiency
5	Management and Policy Changes
6	Water quality impairment and agriculture
7	Nutrient-Energy-Water Nexus

Outcome #1

1. Outcome Measures

Increase our knowledge and awareness of drought mitigation tools and strategies for farming with reduced or no irrigation water.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Transpiration, the evaporation of water from plant leaves, accounts for more than half of all the global transfer of water from the continents to the atmosphere, but little is known about how much water is transpired across the United States.

What has been done
Eighty-one sites around the United States constitute the National Ecological Observatory Network (NEON). The network provides a unique combination of air-, ground- and water-based sensors and field sampling with statistical, physical and biological modeling.
The interdisciplinary research team will work with a wide range of NEON-produced data products, with an emphasis on stable isotope ratios of water vapor and carbon dioxide. Isotope ratios provide an integrated measure of physical processes controlling gas exchange between plant leaves and the atmosphere. The suite of NEON sensors provides the first standardized data set enabling isotope-based estimation of transpiration across a diverse range of continental ecosystems.

Results
This project was initiated in 2018. Preliminary results will be disseminated during the next reporting period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

112	Watershed Protection and Management
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
402	Engineering Systems and Equipment
405	Drainage and Irrigation Systems and Facilities

Outcome #2

1. Outcome Measures

Investigate opportunities and risks associated with water reuse from a variety of sources including food processing, dairy and municipal sources, and industrial users such as oil and gas producers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Groundwater nitrate levels are exceeding actionable levels in the Lower Umatilla Basin. Steps are needed to create a research and extension team to determine sources of nitrate contamination and to create best stewardship practices to reduce the contaminant sources. To help solve the issues at hand, the team is conducting research and outreach to support the project objectives. Production water from food processors at the Port of Morrow is used for irrigation in this area and the need exists to reduce nitrate levels in this water and adopt an aquifer recharge plan that can dilute nitrate levels in the aquifer

What has been done
Results have been disseminated on findings regarding precision agricultural irrigation (sub-surface drip irrigation) techniques. Results identify parameters to reduce water use and fertilizer leaching. Model parameters were initiated to visualize irrigation water distribution in the onion root rhizosphere using different flow rates and irrigation onset thresholds. Preliminary data from the research project was leveraged to obtain additional grant funding from the Oregon Department of Agriculture and the Oregon State University Agricultural Research Foundation.

Results
We have cooperated with the Port of Morrow industrial site and identified and created an aquifer

recharge plan of action that was submitted to the Oregon Department of Environmental Quality (ODEQ). Unfortunately, the ODEQ did not approve the recharge plan. The research and Port of Morrow team will revise and re-submit the plan to the ODEQ for the 2019-2020 period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
405	Drainage and Irrigation Systems and Facilities
501	New and Improved Food Processing Technologies

Outcome #3

1. Outcome Measures

Economics and Water

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Economists have found that in the United States, watershed groups have had a positive impact on their local water quality. This is the first empirical evidence that nonprofit organizations can provide public goods. In economics, a public good is a commodity or service that individuals cannot be effectively excluded from using, and where use by one individual does not reduce availability to others. For these reasons, public goods can?t be provided for profit and nonprofits can play an important role.

What has been done
The researchers? analysis combined data on water quality and watershed groups for 2,150 watersheds in the continental United States from 1996 to 2008. The number of watershed groups

across the lower 48 tripled during this period, from 500 to 1,500.
Researchers constructed a model that considered dissolved oxygen deficiency as the measurement of water quality. Dissolved oxygen deficiency is the most common and overarching measure of water quality because dissolved oxygen is critical for many forms of aquatic life that use oxygen in respiration, including fish, invertebrates, bacteria and plants. It was also the water quality measure that had the most data available during the study period.
The researchers used three measures of group activity in a watershed in a given year: total number of active groups, total donations to all groups in the watershed and total expenditures by groups in the watershed.

Results
The model produced some significant results. For example, a nonprofit in a watershed was associated with reduced dissolved oxygen deficiency relative to a watershed in which there were no groups.
Additionally, a $100,000 increase in total donations to nonprofits in a watershed, equivalent to a 10 percent increase to the average, also was associated with reduced dissolved oxygen deficiency. And a $100,000 increase in nonprofit expenditures, a 7 percent increase, was also associated with improved water quality.
The model controlled for additional factors that impact water quality at the watershed level: violations of the U.S. Clean Water Act, spending via federal water quality programs, land use, precipitation, election outcomes, population density, per capita income, educational attainment, ethnicity, home ownership and unemployment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
403	Waste Disposal, Recycling, and Reuse
405	Drainage and Irrigation Systems and Facilities

Outcome #4

1. Outcome Measures

Irrigation Efficiency

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Irrigated agriculture constitutes the greatest consumptive water use globally, so that irrigation efficiency measures are an important part of global efforts to best utilize this limited resource. However, greater irrigation efficiency must be achieved while simultaneously maintaining or increasing crop yields and farming profitability. Incremental water use decisions are made at the local level by farmers under many real world constraints; consequently they face significant risks in operating large and complex irrigation systems. These decisions should be supported by reliable information upon which to base operational plans and irrigation scheduling. Implementing precision irrigation effectively depends upon highly resolved estimates of crop water demand so that application rates match demand precisely both in location and timing. Efficient irrigation planning depends on timely, reliable, and site-specific information in order to anticipate crop water demand, irrigate adequately to prevent drought stress, and maximize yield from the available resource.

Growers and irrigation specialists currently have many resources at their disposal, including regional and satellite based ET estimates, state and local soil mapping, and scientific irrigation planning software. However, these methods do not provide site-specific and real time measurements of actual crop water demand, and farmers do not have reliable means by which to validate the accuracy and precision of these estimates. For this information to be directly useful in irrigation planning, it should be validated by on site measurements. Reliable, local, and real time information is required to realize the full potential of precision agriculture.

What has been done

This project will develop a method to determine the crop water requirement in real time, utilizing existing and affordable instrumentation, such as on-farm weather stations. Artificial neural networks (ANNs), which are used in many complex systems such as airplane flight control and nonlinear hydrologic analysis, will be developed to coordinate and prioritize the required field data. Trained in conjunction with a research grade eddy covariance (EC) system, the ANN will be able to provide a robust, site specific method to determine evapotranspiraton. This solution is proposed to be directly useful by estimating crop water demand without an ongoing need for research grade instruments, thereby providing a robust and low cost information useful to on-farm water management and efficiency measures.

Results

All goals and objectives laid out for the first year of this project have been completed. The Project Director (PD) conducted a series of field experiments in coordination with two participating growers and Oregon State University (OSU) Extension faculty and staff. Experimental design and field studies were conducted at three irrigated sites (one annual crop, one orchard, and over research trials at Extension facility), with a total of more than seven months of data collected. Two additional field experiments were conducted in collaboration with OSU and USDA-ARS staff at vineyard sites, with a total of seven months of data collected. A large scale field study on turbulent transport processes was conducted during the 2017 eclipse, in conjunction with scientists from OSU, Lawrence Livermore National Laboratory, and UC Davis. Several publications are in preparation and results from the study will be available in the 2019 ARA.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
402	Engineering Systems and Equipment

Outcome #5

1. Outcome Measures

Management and Policy Changes

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In light of climate change, depletion of major aquifers, urban growth in water-scarce areas, and increasing demand for environmental goods and services, creative approaches are needed for sustainable and efficient use of water resources.

What has been done
This work primarily addresses the need to develop numerical models to examine water-related impacts of climate change. We developed models of the Willamette River catchment and reservoir operations. Model simulations were used to examine the effects of different climate change scenarios, as well as the impacts of aging infrastructure and of modifying reservoir operations to mitigate the effects of climate change.

Results
Results indicated that, for the climate scenarios analyzed, primary operating objectives of flood risk reduction and meeting summer Biological Opinion (BiOp) flow targets were unlikely to be affected. Modest reductions in the ability to fully refill the reservoirs and to meet spring BiOp flow targets were found, particularly under the more severe warming scenario. However, refilling the

reservoirs two weeks earlier was effective in reducing the storage deficit introduced by climate change without compromising the ability to meet other operational objectives. Drawdown scenarios for maintenance of aging infrastructure had minimal effect at the system scale. Taken together, results suggested that the hydrologic changes associated with the range climate change examined were not likely to substantially reduce the reliability of the Willamette Project in meeting operational objectives and that, where potential deficiencies emerged, they could largely be mitigated through simple operational changes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
402	Engineering Systems and Equipment
405	Drainage and Irrigation Systems and Facilities

Outcome #6

1. Outcome Measures

Water quality impairment and agriculture

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural lands, including dairies, are known contributors to nutrient, microbial, and pharmaceutical pollution to surface- and ground-waters, and as a result, they sometimes receive disproportionate blame for water quality impairment problems. Many agricultural pollutants have multiple sources. For example, sources of nitrate pollution in surface/ground waters include animal agriculture, cropping systems, fertilized lawns, stormwater runoff, treated municipal wastewater effluent, atmospheric deposition, and others. When a pollutant has varied sources,

pinpointing the ultimate driver contributing to water quality impairment can be challenging. Therefore, our goal is to develop the chemical forensics tools that can unequivocally identify pollutant sources from a single water sample.

What has been done

Surface bodies of water are chemical data loggers for watershed processes and contain tens of thousands of chemicals. While some of these chemicals are ubiquitous across watersheds, others are highly specific and are chemical ?fingerprints? of their sources. Therefore, I hypothesize these unique compounds can act as a fingerprint to identify the water origin(s). My aim is to generate a library of the chemicals originating from urban, municipal, and agricultural sources. Using machine-learning classification tools, this library will be used to identify the likelihood that any given water sample originates from one of these sources.

Results

Most of the work accomplished to date has centered on method development. We currently have the capacity to process 48 samples (~215 L of water) at once. We have also developed relationships with regional extension agents who are helping us find partners willing to provide access to surface/groundwaters potentially contaminated by dairy activities. Processing samples within the lab, data acquisition from the mass spectometer, and statistical analysis are fully optimized at this point. Processing the mass spectometry data remains underdeveloped. Nevertheless, we have analyzed >200 samples and preliminary data indicate that we can easily distinguish land cover types (forested, urban, and suburban areas) with a high degree of accuracy based on the chemical composition of the sample. We anticipate full functionality by the spring of 2019.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
135	Aquatic and Terrestrial Wildlife
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
405	Drainage and Irrigation Systems and Facilities

Outcome #7

1. Outcome Measures

Nutrient-Energy-Water Nexus

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Maximizing the yield of a Nutrient-Energy-Water (NEW) Nexus inherently stresses the respective components. Researchers are investigating how to enhance resilience of agricultural soils to applied stresses. The role of organic matter in maintaining a favorable soil water cycle amidst stresses is being investigated in the field and laboratory. Focus is on maintaining or improving soil water retention and redistribution, losses to evaporation and deep drainage.

What has been done
Field and laboratory investigation have been performed to quantify the soil water cycle under low and high organic matter input for the most vulnerable sandy loam soils of central Oregon.

Results
Data shows that the presence of organic matter reduces deep drainage losses, increases retention and maintains a water cycle status commensurate with a finer textured soil. These data indicate that maintenance of the biological soil components are key to improving the resiliency of the soil media.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
405	Drainage and Irrigation Systems and Facilities

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.)
- Other (Funding)

Brief Explanation

Climate change has increased the interest of stakeholders and decision makers regarding water quality and quantity. There is more demand for delineating the the interconnections between food, water, and energy. Changes in the natural hydrograph as a result of reduced winter snow pack, more frequent flooding events due to rain, and drought impacts have renewed interest in improved management of both surface and groundwater. Particular emphasis is being placed on impacts to groundwater quality as a result of agricultural nutrient and pesticide and herbicide applications.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

A key component of the water cycle is transpiration from plants. Prior to research being conducted by OSU scientists, the amount of water involved was poorly understood and poorly quantified. A new model using the NEON array will finally determine the amount from crops as well as other systems. Adoption of drip irrigation systems has been shown to reduce water usage and reduce nitrate leaching into shallow aquifers. This approach coupled with aquifer recharge systems may greatly improve groundwater quantity and quality.
Economists have found that in the United States, watershed groups have had a positive impact on their local water quality. This is the first empirical evidence that nonprofit organizations can provide public goods.
Surface bodies of water are chemical data loggers for watershed processes and contain tens of thousands of chemicals. While some of these chemicals are ubiquitous across watersheds, others are highly specific and are chemical "fingerprints" of their sources. We have shown these unique compounds can act as a fingerprint to identify the water origin(s). The aim is to generate a library of the chemicals originating from urban, municipal, and agricultural sources. Using machine-learning classification tools, this library will be used to identify the likelihood that any given water sample originates from one of these sources.
Maximizing the yield of a Nutrient-Energy-Water (NEW) Nexus inherently stresses the respective components. Researchers are investigating how to enhance resilience of agricultural soils to applied stresses. The role of organic matter in maintaining a favorable soil water cycle amidst stresses is being investigated in the field and laboratory. Focus is on maintaining or improving soil water retention and redistribution, losses to evaporation and

deep drainage.

Key Items of Evaluation

A new project will develop a method to determine the crop water requirement in real time, utilizing existing and affordable instrumentation, such as on-farm weather stations. Artificial neural networks (ANNs), which are used in many complex systems such as airplane flight control and nonlinear hydrologic analysis, will be developed to coordinate and prioritize the required field data. Trained in conjunction with a research grade eddy covariance (EC) system, the ANN will be able to provide a robust, site specific method to determine evapotranspiraton.
New research addresses the need to develop numerical models to examine water-related impacts of climate change. We developed models of the Willamette River catchment and reservoir operations. Model simulations were used to examine the effects of different climate change scenarios, as well as the impacts of aging infrastructure and of modifying reservoir operations to mitigate the effects of climate change.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
4775	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
5	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	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)	
2	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
7	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)	
0	Tons of feedstocks delivered.