2016 Oregon State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

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 2013 year continues its tradition of collaboration across disciplinary and organizational lines. This year, collaborative work has been expanded more broadly as the Station has begun implementing six new research projects to address NIFA program areas.

Funding

One of the Experiment Station's state performance metrics is external funds leveraged per dollar of state funding. In 2013-2014, $24.5 million in state appropriations were leveraged by faculty to generate $76.9 million in external fund expenditures, yielding a metric of over 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 (Water and Watersheds), Climate Change, Global Food Security, Food Safety, and Obesity. The following are highlights from these Planned Programs.

Climate Change

An interdisciplinary team of scientists from the College of Agricultural Sciences at OSU is focusing on the adaptation and mitigation impacts of climate change as they relate to key sectors within Oregon, mindful of the regional and global connections. Team 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 maintainand expand the nutritionofpopulations.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 foodconservation 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 inseveral 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 betterunderstanding ofthe mechanismsof pathogenesis of many virulent bacteria and viruses.

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 andunique 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.

Childhood Obesity

The project team will apply a social-ecological fframework 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. Pacific Northwest (PNW) region in the context of global climate change scenarios.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	188.0	0.0	194.0	0.0
Actual	175.0	0.0	148.0	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 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, social mediaa)

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
- Other (social media, electronic media, web sites)

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.

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.

The Station and Extension use this information when establishing budget allocations, proposing capital projects, allocation of research dollars and matching funds, and for priority staffing. The College Strategic Intent document is updated annually as stakeholder input shapes research and extension focus and priorities. Stakeholder input is also important during the faculty and administrator review process to ensure that College personnel are responding to stakeholder needs within budget and staffing limitations.

Brief Explanation of what you learned from your Stakeholders

Public awareness of the impacts of agriculture on health, nutrition, environment and security is demanding broadening of existing research focus while acknowledging the need for additional research and dissemination of that research. Unfortunately, a lack of adequate funding for these programs is constraining the potential positive impacts of new or emerging knowledge. Current stakeholder demand exceeds our ability to staff these needs under current funding.

Stakeholders are demanding more focus on water and water allocation as drought conditions expand across the West. Additionally, food safety appears to be emerging as a contentious issue as food borne pathogen outbreaks occur more frequently within the food supply and the presence of genetically modified materials become more common in the food supply chain.
There is increasing demand for more "urban based" agricultural research particularly for pest management, small farms, farmer's markets, master gardeners, and nursery crops.

Rural areas continue to struggle with declining economies, emigration to areas with better paying jobs, and dramatic changes in landscapes and land ownership as more effluent urban dwellers seek to live at least part time, in rural areas. Issues associated with public lands management, grazing, and endangered species continue to strain relationships between stakeholders and public agencies that are too often driven by litigation rather than science.

Globalization increases the amount of Oregon agricultural products that enter the global market but often creates competition that can suppress prices. Similarly, transportation bottlenecks such as ocean port labor disputes and reduced rail capacity resulting from oil transport continue to hinder market development and expansion. The possibility of new approaches to existing and future trade agreements further garners concern over the loss to foreign markets and reciprocal barriers to trade with existing partners.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
3909333	0	3788594	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1317300	0	3975253	0
Actual Matching	1317300	0	35297820	0
Actual All Other	3774507	0	44370294	0
Total Actual Expended	6409107	0	83643367	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	721231	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	0%		5%	
111	Conservation and Efficient Use of Water	0%		15%	
112	Watershed Protection and Management	0%		15%	
125	Agroforestry	10%		5%	
131	Alternative Uses of Land	0%		5%	
132	Weather and Climate	0%		5%	
133	Pollution Prevention and Mitigation	0%		5%	
402	Engineering Systems and Equipment	0%		5%	
403	Waste Disposal, Recycling, and Reuse	40%		10%	
511	New and Improved Non-Food Products and Processes	0%		5%	
601	Economics of Agricultural Production and Farm Management	20%		5%	
608	Community Resource Planning and Development	20%		10%	
609	Economic Theory and Methods	0%		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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	3.0	0.0
Actual Paid	2.0	0.0	5.0	0.0
Actual Volunteer	73.0	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**
39519	0	387497	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
39519	0	3437771	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
113235	0	1328322	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	13304	5716	155	295

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

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	5	8	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total grant dollars received by Collaborative Project Members

Year	Actual
2016	1748000

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	Increased knowledge of wave energy, particularly by coastal stakeholders (Percent increase in knowledge of attendees to workshops, field days, and demonstrations)
8	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.
9	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.
10	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
11	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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Third generation biofuels produced from algae are of growing interest due to high energy yields per unit area, use of carbon dioxide and other available resources for growth, and minimal competition with the food industry. The interest in algae for commercial applications such as biofuel production (Hu et al., 2008), hydrogen production (Melis and Happe, 2001) and pharmaceutical applications (Vo et al., 2012) is growing substantially. The use of algae has also been explored for production of high value nutraceutical compounds such as polysaccharides, sterols and polyunsaturated fatty acids (Barrow and Shahidi, 2007). Algae are capable of producing important products by utilizing inexpensive inputs such as light and carbon dioxide. Algae-derived products such as hydrogen, triacylglycerols, starch, and methane could serve as potential feedstock for biofuels (Hu et al., 2008; Melis and Happe, 2001). Biofuel production from microalgae has captured interest of researchers due to its high biomass yield and ability to synthesize and accumulate large quantities of lipid. Microalgae are composed of membrane lipids, cell wall carbohydrates and proteins and accumulate lipids or starch under nutrient or environmental stress conditions. For example Chlamydomonas reinhardtii, a green eukaryotic algae, can accumulate large amount of starch under nitrogen stress.

What has been done
In the present study, in silico genome scale metabolic model of Chlorella variabilis has been constructed. Chlorella sp. is of interest in applications such as biofuels (Xu et al., 2006), CO2 sequestering (Ramanan et al., 2010), waste water treatment (González et al., 1997) and pharmaceuticals (Morimoto et al., 1995). C. variabilis NC64A is a green unicellular photosynthetic

alga from the genus Chlorella and is a model system for studying algal/virus interac- tions (Blanc et al., 2010) and a potential feedstock for biofuel (Misra et al., 2013).

While the genome for C. variabilis, NC64A was recently sequenced (Blanc et al., 2010), there are no genome scale metabolic models reported in literature for this strain representing a knowledge gap for this important algal species. This study focuses on bridging this knowledge gap by reconstruction of a compartmentalized genome scale metabolic network for C. vari- abilis (isolated strain) to offer insight into various metabolic potentials from this alga.

Results
A compartmentalized genome scale model was reconstructed and validated for autotrophic growth conditions. The recon- structed genome scale model reliably captured the growth of C. variabilis NC64A under three light sources. There were some differences in the measured and the observed growth rates, which can be attributed to the inability of the model to capture growth kinetics and photoinhibition. C. variabilis was observed to grow well in the presence of red and blue light. Similar observations were made from the model (details in Supplementary Material), where higher stoichiometry of red and blue light wavelengths"
"predicted higher growth rates."

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
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
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This study concerns the development of a new bioenergy supply chain for the aviation sector of the Pacific Northwest region of the United States. The focus is on the policies and price signals necessary to induce a new market channel to develop, and on the implications for the efficiency of resource allocation. A general equilibrium economic model with explicit representation of key sectors is developed and applied to aviation fuel made from oilseeds such as camelina. It can be processed into a high grade bio-based jet fuel for military and commercial purposes using approaches such as a Hydroprocessed Esters and Fatty Acids (HEFA) process (Bauen et al. [1], Shonnard et al. [2], IATA [3], and Natelson et al. [4]).

Despite the theoretical potential and technical plausibility of this alternative supply chain, the economics of how the market might work are less clear. There are public good aspects to the problem, meaning that the private sector, by itself, may not make the necessary investments. Interactions up and down the supply chain must be considered, including the incentives of a range of different economic agents who may have competing interests. Farmers, for example, are incentivized by a high price for camelina, while refiners are incentivized by a low price. Whether prices can be found that satisfy all supply chain participants, simultaneously, is an empirical question that can be addressed in part by economic modeling.

What has been done

To shed light on this problem, a general equilibrium economic model is developed in this study that simultaneously accounts for a number of sectors key to the analysis. This general type of model is part of a venerable tradition in economics, and has been used to study biofuel energy policy (Cansino et al. [10]). It combines mathematical representation of the incentives and constraints faced by all of the economic actors in the system. To make the model useful for policy, it must be made to replicate, that is, its parameters must be calibrated such that the model can reproduce baseline data for the region in an appropriate recent time period. Parameters of the model are calibrated primarily using highly detailed IMPLAN [11] data for the Pacific Northwest region (Oregon, Washington, and Idaho) of the United States. These data account for trade and transfers between hundreds of economic sectors within the region, including between the aviation, processing, and farming sectors.

Once parameterized and validated, the model is used to illustrate the mechanisms that could make this new bioenergy supply chain economically feasible. These include non-policy as well as policy instruments such as subsidies and taxes, including a tax-cum-subsidy approach. A suitably motivated government could conceivably take the estimates of this study and use them to guide policies that would facilitate the emergence of an aviation biofuel supply chain in the Pacific Northwest.

Results
Under current oil prices, a significant government intervention would be required. Three scenarios offer the best choice for creating a market for camellia for use as a commercial aviation biofuel. Three alternatives include:

?17 percent subsidy on camelina crop production;
?20 percent tax on conventional jet fuel;
?A combination 9 percent subsidy on the alternative fuel and 9 percent tax on the conventional fuel.

Camelina would also be a practical alternative if airline passengers voluntarily elect to pay more to travel if they perceive an environmental benefit to using the oilseed, he said, allowing airlines to use the proceeds to offset the higher cost.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The transition from conventional energy to bioenergy-based solutions presents a numerous challenges in the traditional and competitive energy market. Ongoing research and innovation is pursuing technological and research breakthroughs for bio-refinery capital cost reduction and process scale-up for commercialization. Most forest harvest residues (FHRs) are underutilized due to logistical challenges, such as high collection, transportation, and storage costs, as well as low market values. Challenges have also been reported in the literature due to the nature of the bioenergy supply chain (SC). A major drawback of bioenergy is network uncertainties within the biomass-to- bioenergy supply chain (B2BSC), including uncertainty in supply, logistics, production and yield, and demand and distribution. In order to overcome the existing challenges and fill the gaps in B2BSC, development of robust and reliable SCs that incorporates knowledge of the sources of uncertainty is crucial."

What has been done

The overarching objective of the research presented here is to ensure energy security in the dynamic and competitive energy market by producing a competitive bioenergy from forest-based biomass resources. B2BSCs have three main segments: upstream, midstream, and downstream. The focus of this study is on upstream and midstream segments of B2BSC, which contain harvesting, collection, transportation, pre-treatment, conversion, and short term storage. Conversion process converts biomass into denser energy carriers (e.g., bio-oil and biochar) that ease handling, transportation, and storing. A multi-criteria decision making method is developed to simultaneously evaluate the objectives of cost, quality, and availability along with assessing the role of network uncertainties and transportable bio-refineries to support broader bioenergy commercialization. The proposed decision making method integrates two quantitative methods: support vector machine method and stochastic optimization model.

Results

The results of proposed model for a case study using data from Oregon, USA demonstrate that the proposed multi-criteria decision making method offers a promising approach to incorporate uncertainties in logistics and SC planning. In particular, the results indicate that incorporating quality and availability uncertainty in the model can aid in selecting appropriate harvesting sites to collect highest quality biomass and reduce collection costs. This will provide more reliable, robust, and sustainable B2BSC networks. Future research should expand the SC network by considering the downstream segment, as well as considering the production of other bio-products, such as bio-char, which can lead to additional revenue streams and environmental impact reductions (e.g., carbon pollution).

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
125	Agroforestry
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes
601	Economics of Agricultural Production and Farm Management
608	Community Resource Planning and Development
609	Economic Theory and Methods
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

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,

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The call to decrease reliance on fossil fuels to reduce impacts on the environment and improve energy independence has created new duties and responsibilities within society. As one approach, mobile bio-oil reﬁneries have been developed to facilitate the production of bio-oil near the source of underutilized forest harvest residues. These mobile reﬁneries are expected to improve the robustness of woody biomass to bio-oil supply chains by reducing overall supply chain costs and environmental impacts. The use of mobile reﬁneries in combination with large-scale non-mobile reﬁneries, however, must be examined to better understand the potential economic and environmental beneﬁts and drawbacks of such a supply chain. The research presented herein develops a mathematical model capable of helping decision makers in determining the optimal combination and location of ﬁxed reﬁneries and mobile reﬁneries for a known quantity of woody biomass and a given set of harvesting locations by considering capital, operational, and transportation costs. A hypothetical case for northwest Oregon, USA is applied to verify the mathematical model.

What has been done
The research herein is motivated by the premise that bio-oil can be considered an economically and technically feasible alternative for fossil fuel-based applications. Current bio-oil output is not sufﬁcient to meet societal demand, however, due to high costs of transportation.

The MILP model presented in this research is developed to minimize WB to bio-oil SC cost. Operation of each fixed and mobile refinery in a predetermined population to define the SC network is facilitated using a binary variable in the mathematical model. The major cost elements of the model include transportation cost, refinery operational and capital costs, and storage cost. Since the focus of the model is on the optimal number of fixed and mobile refineries needed

to process a known amount of WB, the model considers the supply side, rather than the demand side of the SC, i.e., it is assumed that all bio-oil will be utilized in existing markets.

The objective of the proposed MILP model is to minimize the overall cost of a mixed-mode biomass SC by considering two major cost elements. First, the transportation activities involved in the network consist of delivering WB from the forest to the mobile or FR using both in-forest and main roads, as well as delivering bio-oil from the MR to the bio-oil storage at an FR location. Second, costs account for establishing and operating the FRs and MRs, and for the bio-oil and biomass storage facilities adjacent to the FRs.

Results
Earlier studies focused on upstream biomass to bioenergy SC cost considered harvesting/collection, logistics, and storage, while pretreatment was not investigated. Mirkouei et al. (under review) reviewed the literature in detail by examining the conventional upstream segment biomass-to-bioenergy SCs structure. The work presented here addresses two limitations of modeling and opti- mization of bio-energy SCs. First, while previous studies have focused on optimizing the SCs for producing other types of forest fuels, the cost model developed is the ﬁrst reported that focuses on SC optimization for the use of in-forest WB for bio-oil production. Second, the mathematical model developed in this study is the ﬁrst reported that optimizes an integrated SC for a combination of ﬁxed and mobile bio-oil reﬁneries. Finally, it is the ﬁrst known study to simultaneously investigate economic and environmental impact measures for the bio-oil SC as indicators of sustainability

4. Associated Knowledge Areas

KA Code	Knowledge Area
125	Agroforestry
131	Alternative Uses of Land
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

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

Increased knowledge of wave energy, particularly by coastal stakeholders (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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wave energy is viewed as a potential threat to the crab fishermen of Oregon's coast. Extension agents have worked to develop a level of trust between fishermen and wave energy researchers from OSU.

What has been done
A recent accident involving a wave energy data collection device resulted in the device and all of its data being separated from its mooring cable. The device was a danger to crab fishermen and the loss of data and the device a large financial impact to the research. Crab fishermen were enlisted to locate and retrieve the device.

Results
The device was located and retrieved by local crab fishermen. Due to trust developed by OSU extension between the fishermen and researchers, the accident actually proved that researchers and fishermen could work together for their mutual benefit.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
903	Communication, Education, and Information Delivery

Outcome #8

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Making beer takes water. And the water that doesn?t end up as part of the brew ends up as a slurry of leftover malted grains and yeast. That can mean high clean-up costs, as well as wasted water.

What has been done
OSU has developed an improved technology that harnesses the power of microbes to produce electricity directly from wastewater. The technology could create waste treatment plants that power themselves. Microbial fuel cells use microbes to oxidize organic matter in wastewater, which in turn produces electrons. These electrons transfer energy flow from the fuel cell?s anode to its cathode, creating an electrical current. The new microbial fuel cell has reduced the anodecathode spacing and uses proprietary separator and electrode materials to increase the amount of energy produced from the organic matter. As a result, the new fuel cell?using organic matter from grass straw, animal waste, or byproducts from food and beverage industries?produces electricity more efficiently than do anaerobic digesters and treats wastewater more effectively.

Results
These new developments in fuel cell technology could save food and beverage companies millions of dollars in water treatment costs. This technology can aid developing nations where access to electricity and sewage treatment is lacking. Microbial fuel cells could provide an efficient, low-cost way of treating wastewater while providing off-the-grid communities with electricity for lights or charging cell phones.

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
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

Outcome #9

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.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
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
609	Economic Theory and Methods
903	Communication, Education, and Information Delivery

Outcome #10

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

Not Reporting on this Outcome Measure

Outcome #11

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
We examine the effects of biofuel mandates and subsidies on prices of crops,food, and energy, and on consumer welfare in a general equilibrium framework. Our framework has three desirable features. First, instead of treating biofuel mandates and subsidies separately, we focus on their

interactions. We show that the price and welfare effects of bio- fuel subsidies, to a large effect, depend on the level of biofuel mandates. Second, we model both the direct and indirect effects of biofuel subsidies and mandates on food and energy markets. Economists have long recognized that taxes or subsidies can generate distortional costs by driving a wedge between marginal benefits and marginal costs (Harberger 1964). Finally, we derive the conditions under which a biofuel subsidy has a positive or negative effect on the prices of crops, food and energy and consumer welfare. These conditions allow us to identify the key factors determining the domestic price and welfare effects of biofuel policies.

What has been done

This research develops a general equilibrium model to analyze the interactions and to evalua price and welfare effect of biofuel mandates and subsidies. The general equilibrium model developed by Goulder and Williams (2003) was adapted to analyze the impact of biofuel policies on food and energy prices. The model is particularly suitable for the analysis because it was developed with the explicit purpose of capturing the interaction between various markets. For our purpose, we assume there are two types of markets (consumption goods markets, intermediate goods markets) and four types of agents (consumers, producers of consumption goods, producers of intermediate goods, governments).

Results

Results suggest that biofuel mandates are a primary cause of some of the major concerns associated with crop-based biofuel production, including higher food prices and lower consumer welfare. The price and welfare effects of biofuel subsidies depend on the level of the biofuel mandate. When the mandate is weak or not binding, a biofuel subsidy becomes a transfer from consumers to biofuel producers, which tends to reduce food and fuel prices because of the negative income effect. However, with a strong mandate, a biofuel subsidy will increase the prices of crops, food, and fuel when crops account for a large share of production cost and when the supply of crops is inelastic. Using parameter values consistent with empirical evidence found in the U.S., we calculated the price and welfare effects of the biofuel mandates and subsidies specified in the Energy Independence and Security Act of 2007. Results suggest that the biofuel mandates and subsidies increased the price of corn by 25?40 %, increased the price of food by 1.5?2.5 %, and lowered the price of gasoline by 5?10 %. Overall, the biofuel policies had only a small effect on consumer utility.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
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

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

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.
Efforts continue to pursue innovative uses of biomass for biopower in conventional fossil fuel plants through both pyrolysis and torrefaction. The advantage of this approach is the production of biochar as a byproduct of the conversion process that can then be used as a soil amendment in depleted soils or as an amendment for rangeland restoration and improvements.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

We have made significant progress evaluating the limitations of biomass (particularly forest residues) due to logistical concerns. Mobile refineries couple with fixed refineries can address many of these issues although the spatial arrangement of the refineries with respect to the source of biomass remains to be optimized. Transportation infrastructure and transportation equipment will need to be improved to make these products cost competitive with fossil fuel sources.
Fuel cells represent an excellent opportunity for treating wastewater from any number of industrial, agricultural, and municipal sources. These fuel cells can make the water available for other uses and provide decentralized energy production.
Traditional oilseed crops like canola and camelina provide an excellent feedstock for the production of aviation fuel. Barring significant policy and financial incentives, these feedstocks cannot compete with conventional jet fuel.

Key Items of Evaluation

Significant cost barriers continue to constrain the use of biomass for bioenergy production. This is particularly true for the "up stream" costs of harvesting, aggregating, transporting and storing biomass prior to pre-treatment at the refinery. Mobile refineries may show promise under precise scenarios designed around fixed refineries and location of the

biomass

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	8%		5%	
103	Management of Saline and Sodic Soils and Salinity	4%		5%	
112	Watershed Protection and Management	8%		5%	
121	Management of Range Resources	5%		0%	
122	Management and Control of Forest and Range Fires	5%		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	8%		5%	
212	Pathogens and Nematodes Affecting Plants	5%		5%	
215	Biological Control of Pests Affecting Plants	5%		5%	
302	Nutrient Utilization in Animals	4%		0%	
303	Genetic Improvement of Animals	5%		5%	
311	Animal Diseases	4%		5%	
604	Marketing and Distribution Practices	4%		5%	
605	Natural Resource and Environmental Economics	5%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%		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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	10.0	0.0	50.0	0.0
Actual Paid	2.0	0.0	19.0	0.0
Actual Volunteer	201.0	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
39519	0	1063430	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
39519	0	9421157	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
113235	0	10320912	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2208	1749	512	1431

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

Patent Applications Submitted

Year: 2016

Actual: 2

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	4	51	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total grant dollars for collaborative project

Year	Actual
2016	23160000

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	Understand the role of international trade as a vehicle by which adaptations in global climate change can be made, such as: a) Key relationships that tie climate change to the distribution of crop yields, comparative advantage, geography, and international trade; and b) Numerical estimates regarding how climate change will affect crop prices, production costs, and the economic welfare of producers, consumers, and society at large.
8	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.
9	Participants who increase their knowledge of management practices and understanding of climate variability and change (Percentage).
10	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).
11	Clients who employ climate adaptation strategies or incorporate climate-based management practices (Percentage).

12	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
13	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).
14	To provide educational opportunities for undergraduate students, graduate students, and stakeholders in the areas of climate change, risk, agroecosystem technologies, and interdisciplinary policy analysis. We will also enhance partnerships with industry and stakeholders for innovative and more resilient technologies, practices, policies and management strategies.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Temperature-based methods may be particularly prone to error when extrapolated into the future to assess the effects of greenhouse-gas driven warming on PET (Milly and Dunne, 2011). Such biases are derived from the fact that increasing temperature by increasing solar radiation would likely cause a greater increase in PET than would increasing temperature by increasing greenhouse gases, because radiation provides the energy driving evapotranspiration (Scheff and Frierson, 2014). Thus, projections of future drought severity and its effects on vegetation may be

overestimated by the use of temperature-based estimates of PET derived from historical climate data. One such example of this potential for bias involves the future rate of woody encroachment of grasslands, which we consider here.

What has been done

To assess the threat of woody encroachment in the Northern Great Plains, USA (NGP), we have used the dynamic vegetation model MC1 (Bachelet et al., 2001), which calculates monthly water balance and plant growth as limited by water and other factors. In the standard version of MC1, these calculations are based on PET determined with Linacre?s (1977) algorithm, which is derived from the Penman equation, but uses semi-empirical temperature relations to estimate net radiation. This approach makes future PET estimates susceptible to bias. We therefore derived a method that reduces the potential bias in estimating net radiation from temperature alone by linking it to extraterrestrial radiation, as calculated from site latitude and time of year. We calibrated the new PET algorithm with radiation data from the NGP to assess the likelihood of woody encroachment of NGP grasslands as inﬂuenced by future climate and land management practices.

Results

We developed a new PET algorithm that links surface shortwave insolation to extraterrestrial radiation via the atmospheric transmittance and then calculates net radiation as a function of shortwave insolation, temperature, and transmittance. This new estimate of net radiation was then used in place of an estimate based solely on temperature in the Penman equation for PET. Simulation results showed that projected woody expansion across the NGP was substantially increased by this improved calculation of PET.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change adaptation and mitigation options can include land use and management change. Land managers could use a parcel to 1) adapt to climate change by altering the crop mix to improve yields and revenues or 2) mitigate climate change by increasing carbon sequestration in the soils and biomass by planting trees, for example. Such actions are clearly competitive and substitute for land use (Ingham et al. 2013). Therefore, research focusing on adaptation potential should also consider possible resource use for adaptation and vice versa with mitigation actions affecting the capacity to adapt (Klein et al. 2007).

What has been done
In this study, we investigate the interrelationships between adaptation and mitigation that involve AF lands. The interrelationships are investigated in the context of independent and joint implementation of 1) crop management adaptation and 2) responses to a carbon dioxide price (CO_2) incentive for net emissions reduction for two climate change projections. Adaptation and mitigation in the forms of land use and land management change are driven by profit maximizing behavior in the AF sectors, thus we use the Forest and Agricultural Optimization Model with Greenhouse Gases (FASOMGHG) as described in Adams et al. (2005) and Beach et al. (2010) to simulate the interrelationships.

Results
By itself, we find adaptation results in increasing GHG emission and small reductions in total AF welfare. Mitigation by itself effectively reduces GHG emissions and increases total welfare

due to the exogenous funding of the carbon offsets. When both strategies are pursued, the effects of crop management adaptation are dominated by the effects of mitigation. Therefore, it is important to consider both adaptation and mitigation policies together as they may work at cross-purposes (Ingham et al. 2013). The latter point is important in the context of the temporal reality that adaptation is necessary in the short term while mitigation can reduce impacts in the longer term (Wang and McCarl 2013). A balance between adaptation and mitigation policy in the U.S. is needed to avoid mitigation dominating adaptation and/or shifting GHG emissions to another country in the case of leakage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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
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
723	Hazards to Human Health and Safety

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The sagebrush steppe is among the largest ecosystems in the North America, and is critically endangered due to the impacts of invasive species, land cover change, altered ﬁre regimes, live- stock grazing, and a changing climate (Noss et al. 1995, Knick 1999, Brooks et al. 2004, Chambers
et al. 2014a). These threats often interact to modify ecosystem structure and function (Brooks and Pyke 2000, Davies et al. 2009). It is estimated that one-third of the presettlement sagebrush biome has already been converted to other land uses or has been highly degraded (McIver et al. 2010). Few studies have examined post-ﬁre succession in sites where domestic livestock were eliminated as a central part of the land management approach for ecosystem recovery. The overarching objective of this research was to compare burned and unburned vegetation composition 17 years after ﬁre in Wyoming big sagebrush ecosystems, with emphasis on native and invasive species dynamics in historical ﬁre and control (no ﬁre on record; at least 50 yr) plots.

What has been done
In this study, we quantiﬁed vegetation composition prior to prescribed burning, 1 year following ﬁre, and 17 years after ﬁre in a native-dominated Wyoming big sagebrush ecosystem at Hart Mountain National Antelope Refuge, Oregon, United States.

Results
Seventeen years following ﬁre, the ecosystem was dominated by native herbaceous vegetation, with 8.3% cover of broad-leaved forbs and bunchgrasses in the understory, compared to just 3.8% cover of native herbaceous vegetation in unburned controls. Invasive annual grass cover ranged from 0.2% to 8.4% across all treatments and years (P = 0.56). One year following ﬁre, the distance from a randomly located point and the nearest mature sagebrush was 16.6 m, but by 17 years after the ﬁre, that distance had decreased to 2.5 m. Seventeen years after ﬁres, shrub cover was 0.4?4% in burned plots compared to 13?24% in unburned controls. Collectively, these data demonstrate that good condition ungrazed Wyoming big sagebrush plant communities exhibited resilience following ﬁre and maintained a native-dominated mosaic of shrubs, bunchgrasses, and forbs. Further, unburned control plots were dominated by woody vegetation and exhibited losses in herbaceous understory, possibly indicating that they are outside of their natural ﬁre return interval. Our results illustrate that management of all habitat components, including natural disturbance and a mosaic of successional stages, is important for persistent resilience and that suppression of all ﬁres

in the sagebrush steppe may create long-term losses of heterogeneity in good condition Wyoming big sagebrush ecosystems.

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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although most studies that have considered the combined effects of land use and climate change have focused on range shifts at the edges of species distributions, it is likely that many responses to both land use and climate change occur well within these edges, with changes in population demography that precede detectable changes in species distributions. Although several studies have addressed how population demography is affected by climate change, land use, or their combined effects, few studies have focused on disentangling the underlying mechanisms explaining these changes. Within the range of a species, it is reasonable to expect increased variation in local environmental conditions initially, with more homogeneous and coherent changes manifested as the effects of land use and climate change intensify. Accordingly, local variability in environmental conditions may play a key role for understanding emerging responses

to land use and climate change, but it has yet to be fully explored. In the context of land use and climate change, an improved understanding of such local variability can provide critical insights into processes behind observed changes in species distribution and abundance.

What has been done
We applied an individual-based model of fish population dynamics to evaluate the role of local stream variability in modifying responses of Coastal Cutthroat Trout (Oncorhynchus clarkii clarkii) to scenarios simulating identical changes in temperature and stream flows linked to forest harvest, climate change, and their combined effects over six decades. We parameterized the model for four neighboring streams located in a forested headwater catchment in northwestern Oregon, USA with multi-year, daily measurements of stream temperature, flow, and turbidity (2007? 2011), and field measurements of both instream habitat structure and three years of annualtrout population estimates.

Results
Model simulations revealed that variability in habitat conditions among streams (depth, available habitat) mediated the effects of forest harvest and climate change. Net effects for most simulated trout responses were different from or less than the sum of their separate scenarios. In some cases, forest harvest countered the effects of climate change through increased summer flow. Climate change most strongly influenced trout (earlier fry emergence, reductions in biomass of older trout, increased biomass of young-of-year), but these changes did not consistently translate into reductions in biomass over time. Forest harvest, in contrast, produced fewer and less consistent responses in trout. Earlier fry emergence driven by climate change was the most consistent simulated response, whereas survival, growth, and biomass were inconsistent. Overall our findings indicate a host of local processes can strongly influence how populations respond to broad scale effects of land use and climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Anaerobic digesters represent a promising strategy to reduce methane and nitrous oxide emissions
released by conventional animal manure treatment. We know little about how effectively soil nitrification transforms the concentrated ammoniacal component of digester liquids applied to fodder crops across a range of soil temperature and water regimes. Two fundamentally different types of soil microbes (Archaea and Bacteria) are responsible for soil nitrification and their relative contributions are affected by soil temperature and ammonium availability. Both types of nitrifiers produce N2O as a side product of ammonia oxidation, but the soil and climatic factors affecting their respective N2O contributions in the field are unknown.

What has been done
Our proposal consists of a will examine the influence series of objectives that include laboratory and field experiments that of soil temperature, water content, and level of digester N on the relative contributions of Archaea and Bacteria to soil nitrification and N2O derived from nitrification. The second objective examines the influence of digester N on Archaeal and Bacterial nitrification under field conditions, and the effect of different phenological stages of fodder crop growth on N fate. The third objective evaluates how soil temperature affects the imbalance between nitrite production and consumption during nitrification, its recovery, and impact on N2O production. The research fits the ANRCVC program and Climate and Microbial Processes program area. It is focused upon the role of microbial nitrifier communities on GHG emissions from digester N applied to croplands across seasons where soil temperature and water availability range considerably.

Results
During the first year of our project we have made significant progress on objective 1. Dairymen have been recruited as collaborators and we have sampled soil from their fields where fodder crops are grown. Sources of manure digestate for our experiments have been identified, samples obtained, and characterization of the digestates is being completed. Laboratory based experiments are underway to examine the response of soil nitrification to different rates and sources of digestate and to evaluate the interaction of digestate and soil temperature with contributions of bacteria and archaea to nitrification, and to evaluate the magnitude and extent of nitrification uncoupling/recoupling and its impact on NOx production.

4. Associated Knowledge Areas

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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Potatoes are an important agricultural industry to the Pacific Northwest (PNW). Production from this region supplies approximately half of all USA potatoes and provides the majority of exports. Farm gate value is roughly $1.7 billion and considering 60% of the PNW is processed, finished value exceeds $3.0 billion and contributes about $1.0 billion of USA exports. A comparison of production and acreage reveals that the PNW is one of the most efficient potato producing regions in the nation and indeed worldwide. However, production efficiency must improve to offset rising input, transportation, and processing costs to keep the PNW potato industry competitive with ever increasing foreign imports.

What has been done
OSU researchers are principal investigators for on-going field research that includes: potato variety development, pest management, and cultural management practices to improve potato

production efficiencies at OSU-KBREC and an active member of the Tri-State Potato Breeding and Variety Development team. This team includes research and Extension faculty from OSU, WSU, U of I, and the USDA/ARS in Aberdeen, ID and Prosser, WA. Variety improvement is the best strategy available to address issues of food supply, climate change, nutrition, and impact of agriculture on the environment.

Results

Selected varieties from the NWPVD Program have been evaluated for nitrogen (N) use efficiency relative to the industry standard, Russet Burbank. Yield responses of Alpine Russet, Alturas, Classic Russet, Clearwater Russet, Premier Russet and Umatilla Russet to N rates were used to develop N fertilizer requirements based on specific yield goals. Alturas required about 40% less N than Russet Burbank for a given yield goal, while Classic Russet, Clearwater Russet, Premier Russet and Umatilla Russet required about 20-25% less N. Alpine Russet was slightly less efficient than the top four varieties but still required 17% less N than Russet Burbank for a given level of production. Production of Umatilla Russet, Alturas and Premier Russet in ID, OR, and WA was about 48,000 acres in 2011, potentially reducing the amount of N applied to the soil by 4.8 million pounds compared with the same acreage planted to Russet Burbank. In 2011, the potential economic savings to NW growers was over $3.1 million. The reduced use of N should also significantly reduce the potential for nitrate-contaminated ground water in the region. Hence, the potential for improving the efficiency of N use through more efficient varieties is substantial. Reducing fertilizer applications by 20-40% per unit of yield produced would not only provide a considerable economic benefit to growers but would also provide environmental benefits and contribute significantly to the sustainability of potato production systems. As improved varieties are adopted, quality and production efficiency will continue to improve, fertilizer and pesticide inputs will decrease, and environmental impact will be lessened.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #7

1. Outcome Measures

Understand the role of international trade as a vehicle by which adaptations in global climate change can be made, such as: a) Key relationships that tie climate change to the distribution of crop yields, comparative advantage, geography, and international trade; and b) Numerical estimates regarding how climate change will affect crop prices, production costs, and the economic welfare of producers, consumers, and society at large.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The design of socially responsible public policy requires a comprehensive, rigorous, and timely assessment of its economic, environmental and social impacts. With the growing deficit and national debt, funding for farm commodity and safety net programs is facing increasing scrutiny for fiscal prudence, environmental performance and congruence with national goals. These policies will likely be targeted for overhaul in the next Farm Bill. At the same time food policy and agricultural and environmental policies are also being reviewed for their effectiveness. A comprehensive effort is needed to assess the impacts of these potentially substantial policy changes o agricultural economies, rural communities, the environment, and consumer access to healthy, affordable food and nutrition.

What has been done
By linking a spatially-explicit land use modeling system to the TOA-MD 5.0 model and the Multi-Regional Input-Output (MRIO), we evaluated the effect of the trend towards high commodity prices and alternative designs of commodity, conservation, income safety net policies on land use and its economic and environmental consequences. 2. Distributional Impacts on Rural & Urban Households & Economies of Overhauling Commodity, Farm Safety Net, & Conservation Programs.By coupling the TOA-MD model with a regional CGE and the Multi-Regional Input-Output Models (MRIO), we evaluated the distributional impacts on rural and urban households and economies of farm policy reforms, including distributional impacts of alternative targeting criteria for the Conservation Reserve Programs. 3. Risk Management for Specialty Crops.Using the farm-level weather and crop suitability data by county, crop and policy option, we now better understand insurance choices of specialty crop producers. These data will allow policy makers and stakeholders to better understand how program characteristics affect growers, industries, consumers and taxpayers. 4.The Impacts of Reformed Commodity Support & Food Policy on Consumers, Food & Nutrition. Policy-specific expertise of project partners was used to explore such questions as the effect of dairy supply management on food consumption and nutrition or the effects of expanded crop insurance for vegetables on nutrition outcomes.

Results
Research, Publication and Capacity Building: All the data collection and model development tasks specified in the proposal have been completed. These efforts have greatly enhanced our capacity to provide objective, high-quality economic analysisof critical public policy issues concerning agricultural economies, rural communities, the environment, and consumer accessto healthy, affordable food and nutrition. Based on the research efforts, the team authored or coauthored 40

journal articles, 41 other publications, and 13 book chapters during the project period. The team members also gave (or will soon give) 53 presentations in professional meetings. Our team has written 14 issue/policy briefs. These publications and presentation address a number of important policy issues in our emphasis areas.
Extension and Outreach: The research team's efforts have reached a large targeted audience. Our listserv for issues briefs includes more than 2000 individuals and organizations, including federal and state government officials, farmers and farm organizations, environmental groups, researchers and the general public. These stakeholders were also well represented inour conferences and workshop. Our well-designed website is also expected to reach a wide-range of audiences. Our team presented (or will soon present) 53 times during the project period.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

Outcome #8

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

THE OPEN-SOURCE PUBLISHED ENVIRONMENTAL SENSING (OPENS) LABORATORY is proposed. OPENS will create 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 will provide 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 will include complete sets of ""printable"" parts and operating computer code for sensing systems. The physical lab will include 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 will seek to develop and deploy 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.

What has been done

The presence of branch experiment stations (BES) in each of the eco-agricultural zones of Oregon will provide faculty and students with a unique opportunity to evaluate sensors for a broad range of crops and agricultural problems. Oregon's BES provide access to virtually every crop grown in Oregon and their facilities, including on campus greenhouses and farming operations, and allow for testing innovator's abilities to determine difference in yield, water and nutrient fate, pests and pathogens, varietal differences, environmental impacts of pesticides and herbicides, grazing management, rangeland restoration, and impacts of weeds and other invasives. One of the problems currently facing precision agriculture is to have focused most technological development on unmanned aerial vehicles (UAV) without a contemporaneous focus on sensor platforms that can inform agricultural decision-making and environmental sensing. The OPENS lab will allow horticulturalists, weed specialists, agronomists, entomologists, viticulturalists, soil scientists, hydrologists, and engineers to develop ideas for sensor development that can address any number of agricultural production problems and improve agricultural economics and environmental sustainability.

Results

The OPENS project proposes the development of a Maker Lab specialized in Environmental Sensing and for deployment of Precision Agriculture across working landscapes for all members of the research and educational communities of Oregon State University. Further, it will be also accessible to researcher and students worldwide via a curated open-archived publication process (led by OSU Libraries) to develop evolving collaborative designs. The OPENS project will give professionally supervised access to 3-D printer(s), laser/plasma cutters, computer controlled milling machines (CNC Routers and controllers), and to a wide range of electronic devices (e.g. Arduino, Adafruits, Beagle Bone, Raspberry Pi). It will include traditional hand tools and facilities such as workbench stations, soldering irons, oscilloscopes, Computer Aided Design CAD software, lathe, milling machine, sheet metal shop all currently maintained by the Department of Biological and Ecological Engineering. On-line and on-campus classes, as well as presentations and workshops, will be given to teach skills needed to make effective use of the sophisticated

tools. Remote participants will be supported in their 3-D printing and equipment production on a pay-per-piece basis, so long as their designs are open-published in the Environmental Sensing instrumentation catalog.

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 #9

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although climate change related research is extensive in the OSU College of Forestry and elsewhere, Extension efforts addressing the intersection of climate change and forest management are not widespread. There are several reasons, for example: few practical applications that are relevant for the family forest owner/stand level scale are ready for implementation; and there are perceived political risks associated with discussing climate change with an audience who may be largely skeptical.

What has been done
Climate, Forest and Woodlands Community of Practice. An eXtension Community of Practice (CoP) is a multi-state group of Extension faculty who collaborate to develop and curate peer-reviewed material on a particular topic area to be published on eXtension.org. Extension personnel joined the Climate, Forests and Woodlands CoP as a contributing member and accepted an invitation to join the CoP?s Core Leadership Team (CLT). The CLT acts like an editorial board, making decisions about the overall direction of the content, soliciting authors and reviewing new content. The CoP subsequently underwent an extensive reorganization with new content added and re-launched in 2014.

Results
?Out of our needs assessment we developed a series of three professional development webinars for Extension colleagues. The webinars covered communication strategies, basic climate science, and climate models. There were 191 participants in the webinars from at least 15 states, and 95% of those that responded to a short survey reported the webinars as providing information useful to them.
?The Climate, Forests and Woodlands CoP site has averaged about 1,600 page views per month since its 2011 launch (per eXtension analytics).
?75% of the CoCoRaHS training attendees report that participating in CoCoRaHS has influenced other aspects of their life, such as gardening practices, land management, or thinking about weather and climate.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
125	Agroforestry
136	Conservation of Biological Diversity

605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #10

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project works to establish a partnership between Extension, the HJ Andrews Long-term Ecological Research program and PRISM, to develop collaborative climate change-related research and educational activities to the mutual benefit of Extension and HJA. The project is meant to:
?generate data of interest to national and local teams studying ecology and climate change
?strengthen the connections between researchers, educators, natural resource managers and the public
?Bring scientific depth to Extension?s effo

What has been done
In 2016 we presented 14 educational events to a wide group of people in several counties. We held 7 volunteer training workshops, 3 teacher workshops (4-12th grade), and 4 community presentations, for a total of 158 individual participants trained, including many couple teams taking on the project at their home site. We also worked with teachers in 6 schools in the OST 4-H classroom program where we engaged 156 k-12 students.

Results
The OST citizen scientists accounted for 65 unique registered rain gauge stations 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. We show 57 unique

phenology observers contributing over 12,000 observations in the time period 2014-15.

In our 2015 evaluation, 100% of responses reported improved understanding of variation in precipitation and plant phenological processes across both landscapes and time. 95% of responses agreed or strongly agreed that OST program contribute to a better scientific understanding of climate and weather. The survey also tells us something about people?s motivations. We found participants are interested in the scientific effort, in contributing to local knowledge and want to generate information that will be used by the scientific community. This fits with the project?s objective of continued learning and engagement of Citizen Science volunteers with the research community.

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
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
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #11

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

2016 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Developing increased awareness and skills regarding forest stewardship opportunities, technical and financial resources, as well as the benefits of goal-setting and plan writing will ensure family woodlands in Central Oregon continue to provide multiple benefits, including timber production, wildlife habitat, high water quality, resilience to fire, insects and disease and climate change. The Stewardship Series will also serve to increase camaraderie and community in counties that have not had a strong Extension education or woodland owner community component for some time.

What has been done

An informative brochure with return postcard was mailed to 3,800 landowners, with a copy of the regional FNR Life on the Dry Side Newsletter on year later. Monthly email updates supplemented quarterly newsletters. 17 workshops were offered to 398 landowners and management professionals in coordination with OSU FNR Extension partners, including topics such as mentored management planning, wildlife habitat enhancement, management techniques to increase resilience to insects, disease and climate change, juniper ecology and management, forest tax and business considerations.

Results

The Forest Stewardship Series was successful in raising awareness of forestry educational, financial, and technical support available in Central Oregon. Based on responses to the brochure, needs assessment postcard and newsletter we were able to create a database that can be used to announce upcoming workshops, tours, and other relevant information. Future educational efforts are being planned using needs assessment results. Close to 400 family forestland owners contacted Central Oregon Forestry and Natural Resources Extension to learn about upcoming events and to attend programs. 13 landowners plan to implement at least one new stewardship practice on 4,892 acres of private forest and rangeland. In addition to increasing technical knowledge and skills, courses such as Mentored Management Planning provide crucial social networking and peer learning opportunities. Through carefully planned programs, landowners get to know each other and learn from each other, eventually becoming friends. These long-term relationships will strengthen efforts to keep working forests and farms in this land use amid pressure to develop land for other uses.

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
123	Management and Sustainability of Forest Resources
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 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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The total value of the United States (U.S.) strawberry production in 2014 was $2.4 billion and surpassed that of the fresh apple industry for the ﬁrst time in 2010 (AgMRC, 2013). Strawberries are the fourth most valuable fruit produced in the U.S. and the total pro- duction of strawberry has been reported by the United States Department of Agriculture (USDA) as 1.4 million tonne in 2014 (USDA, 2015). Increasingly, producers, food retailers and consumers are becoming conscious of the environmental impacts of the products they produce, sell and/or consume. Therefore, assessing environmental impacts of strawberry production is essential to enable more sustainable production practices and to inform consumers of their choices. Communicating environmental impact information to stakeholders in an easy-to-understand format is critical for the move towards more sustainable production practices (Peano et al., 2015).

What has been done

The goal of this study was to develop a cradle to farm gate life cycle inventory and assess the environmental impacts of strawberry production in four major strawberry producing states of the United States: California, Florida, North Carolina and Oregon, representing 99% of the United States strawberry production. Life cycle environmental impacts depend strongly on geographic location and production practices. Data for California and North Carolina strawberry production were collected in collaboration with agricultural economists from those states using the ?LCA Extended Enterprise Budget? Excel sheet (version 4.11). Data for Florida strawberry production

were collected from the state's existing enterprise budget (a detailed accounting of production costs and returns which estimates proﬁability of an enterprise). Data related to Oregon strawberry production were obtained through interviews with straw- berry producers. OpenLCA software was used to conduct life cycle assessment for strawberry production. Missing unit processes for production of agricultural machinery, pesticides, fertilizers and materials were modeled based on existing literature. In order to better assess the sustainability of strawberry production, three metrics encompassing nitrogen productivity, phosphorous productivity and fossil energy productivity were introduced.

Results

The use of modiﬁed enterprise budget sheets for collecting LCI data, while a worthy concept, was not very effective due to differences in production methods,which is reﬂected in differences in the format of enterprise budgets in different regions. Strawberry production varies greatly among geographic regions, and reliable LCAs for strawberry production can be performed only using datasets that are speciﬁc to a particular location. GWPs for strawberry production in California, Florida, North California and Oregon were 1.75, 2.50, 5.48 and 2.21 kg CO2-eq/kg, respectively. GWP for North Carolina strawberry was the highest even in comparison with GWPs for strawberry production in other countries. Materials and fuels were the main contributors to GWP in strawberry production in all the states. Additionally, potassium sulfate was the primary contributor to most environmental burdens. Incorporating characterization factors for agricultural chemicals into existing life cycle impact-assessment methods is necessary to perform objective LCIA for agricultural commodities.

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
122	Management and Control of Forest and Range Fires
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #13

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The valuation of ecosystem goods and services are essential inputs to decision-making and policy development that balances sustainable economic growth, environmental quality, and natural resouce use and conservation to enhance societal well-being. Advances in economic methods, applications of new or existing methods, and syntheses of past research outcomes are important to expanding and understanding the accumulated body of knowledge associated with environmental and natural resource-related policies and decision-making. This project, in collaboration with several institutions, helps meet the needs for economic information and processing. Outcomes from this project are anticipated to improve decision-making and policy assessments that benefit society for the long-term.

What has been done
The primary methods include primary data collection via surveys of stakeholders, development of valuation instruments, systematic collection and review of research outcomes from the literature, and regression-based methods of analysis. The majority of the research outcomes will be policy-relevant and evaluated within that context. Efforts to disseminate knowledge gained will include classroom instruction, outreach activities, and publication of results and methods. Successful completion of this project will be measured according to outputs such as number of publications, presentations, workshops, and number of people affected.

Results
This project was initiated in 2016. No results are available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
605	Natural Resource and Environmental Economics
723	Hazards to Human Health and Safety

Outcome #14

1. Outcome Measures

To provide educational opportunities for undergraduate students, graduate students, and stakeholders in the areas of climate change, risk, agroecosystem technologies, and interdisciplinary policy analysis. We will also enhance partnerships with industry and stakeholders for innovative and more resilient technologies, practices, policies and management strategies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change has resulted in more frequent and severe droughts in both Western and Eastern Oregon. This project seeks to evaluate the efficacy of dryland vegetable production (production without irrigation) in Western Oregon and using biochar to improve soil organic matter and moisture retention in drylands wheat production in Eastern Oregon.

What has been done
Several trials were conducted across Oregon with vegetables commonly produced under irrigation. Trials evaluated yield and consumer preference for irrigated and non-irrigated vegetables.

Trials were conducted with several wheat varieties utilizing the application of biochar to increase soil organic matter and water retention as compared to the same varieties under normal growing conditions.

Results
Vegetables grown without irrigation were smaller and had lower yields than irrigated vegetables but stakeholders and consumers preferred the taste and texture of dry land vegetables over irrigated vegetables. Economics of yield differences to improved consumer preference have not yet been evaluated.

Biochar contains miniscule crooks and crannies where water collects and microbes hole up and gnaw on plant residue, releasing nutrients. Researchers have found that one application of less than 10 tons per acre?one percent by volume?is all that?s needed to adequately increase water- and nutrient-holding capacity and increase crop yields. The additional moisture in the soil may allow farmers to plant every year, which boosts organic matter and crop yield.

Biochar has drawbacks. Because of limited supply, the price is steep, but higher yields could eventually offset expense. Researchers tell farmers to think of biochar as a capital investment ?like buying a tractor, only one that could last forever.?

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
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics

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 condit)

Brief Explanation

We met our goals for this planned program. Space limitations do not allow us to share all information gained, but significant progress was made on all state defined outcomes. Remote sensing, irrigation and reuse of water, rethinking the use of irrigation for vegetable crop production, economic analyses that evaluate grower responses to a changing climate, and educating stakeholders and producers about the potential impacts of climate change largely successful.
The changing political climate regarding climate change and climate change research is much more troubling. Failure to acknowledge climate impacts to agricultural production

and food security is deceiving and at cross purposes with feeding an increasing population. More research - not - less will be required to rethink how water is used in production agriculture and how we can increase production through new breeding and genomic research and improving rather than continuing to degrade the world's soils.

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.

Key Items of Evaluation

THE OPEN-SOURCE PUBLISHED ENVIRONMENTAL SENSING (OPENS) LABORATORY is proposed. OPENS will create 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 will provide 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 will include complete sets of ""printable"" parts and operating computer code for sensing systems. The physical lab will include 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 will seek to develop and deploy 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	8%		5%	
111	Conservation and Efficient Use of Water	8%		5%	
121	Management of Range Resources	8%		0%	
202	Plant Genetic Resources	0%		15%	
204	Plant Product Quality and Utility (Preharvest)	5%		15%	
205	Plant Management Systems	15%		5%	
206	Basic Plant Biology	0%		5%	
216	Integrated Pest Management Systems	15%		5%	
301	Reproductive Performance of Animals	0%		10%	
307	Animal Management Systems	15%		0%	
311	Animal Diseases	10%		15%	
502	New and Improved Food Products	0%		10%	
601	Economics of Agricultural Production and Farm Management	5%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	5%		0%	
903	Communication, Education, and Information Delivery	6%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	60.0	0.0	65.0	0.0
Actual Paid	56.0	0.0	36.0	0.0
Actual Volunteer	2395.0	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**
1053840	0	1718156	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1053840	0	15271844	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3019607	0	26361145	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

In Oregon there are over 38,000 farms producing crops on over 16 million acres. Because 25% 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. 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).

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.

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.

Research and extension will also look at key areas of various social changes in the marketplace impacting producers, retailers and consumers. The research aims to determine (1) how technology impacts producers/retailers/consumers in the market place; (2) how society impacts consumer demand for goods and services with a goal of improving the well-being of consumers; and (3) how to develop economic linkages among producers, retailers, and consumers for the community development.

In addition, a broad coalition of agricultural, environmental and food groups has 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.

- Conduct Research Experiments
- Conduct surveys
- Conduct Workshops, Meetings
- Deliver Services
- Develop Products, Curriculum, Resources
- Provide Training
- Provide Demonstrations
- Provide Counseling
- Assessments
- Work with Media
- Partnering
- Facilitating

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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4714	775	2711	5246

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

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	19	73	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total grant dollars for collaborative project

Year	Actual
2016	33000000

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.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overall goal is to provide a comprehensive innovative training in systems biology of animal nutrition, health and well-being to 3 outstanding multicultural graduate students. The theme of the proposed doctoral training program is "training the next generation of scientists for the systems biology era in animal production." The proposed research program will provide novel scientific information through application of holistic (i.e., systems biology) approach to nutritional studies. To achieve these goals, the fellows will be given a vigorous training that entails course work in traditional nutrition, molecular and cell biology, bioinformatics, laboratory rotations, experiential learning, peer-based learning, teaching, internships, externships and outreach. This will equip the NNF fellows to solve challenges associated with efficient animal production, food security, and hunger. Outcome and measurable target of this training include, a) three broadly trained multicultural Ph.D. Fellows, b) peer-reviewed manuscripts and presentations, c) a program for recruitment, retention and graduation of multicultural students, and d) increased placement of multicultural graduate students in academia, industry, and government. Students completing this NNF will: 1) establish an independent research career with a holistic (i.e. systems biology) approach to science, 2) communicate effectively with scientists across disciplines, and 3) translate science-based information to the public and producers. Through this program, we will be able to provide workforce-ready and globally competitive future leaders in TESA of animal agriculture.

What has been done
This program has just been initiated and three new multicultural PhD students have been recruited.

Results
No results to report at this time

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
301	Reproductive Performance of Animals
307	Animal Management Systems

502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plant-like phytoplankton are the foundation of the ocean?s food web. They are abundant, especially in springtime in high latitudes, where their populations explode into blooms. For decades, scientists have attributed these blooms to increases in sunlight and warming temperatures. Yet satellite images show phytoplankton concentrations starting to increase in midwinter, when the ocean?s upper waters are stirred by strong winds and cold surface waters sink. It seems these physical forces deepen the upper mixing layers, giving phytoplankton room to slowly spread out and escape being eaten. In this way, phytoplankton out-multiply the grazers, and then stay ahead of the grazers as their photosynthesis continues to accelerate toward a spring bloom climax.

What has been done
2016 marked the first of four sea expeditions planned for the 5-year study, each to catch a different critical moment in the annual cycle of the North Atlantic plankton. November is the point of least bloom activity, and this is when a OSU?s team deployed a breadcrumb trail of drifting, bobbing sensors that will collect ocean data for the next several years.

Onboard ship, researchers collected information on everything from the types of organisms present to the airborne aerosols linked to plankton activity. Meanwhile, a C-130 Hercules aircraft took measurements of aerosols, clouds, and trace gases in the atmosphere. And above that, satellites provided large-scale observations of plankton populations by measuring shifts in ocean color.

Results
This is NASA?s North Atlantic Aerosols and Marine Ecosystems Study (NAAMES). Information collected at sea, in the air, and from space could potentially change our understanding of how the atmosphere is connected to life in the ocean. OSU will investigate the annual cycles of ocean plankton and address two basic questions. First, what processes allow the plankton blooms to be recreated each year? And second, how do blooms impact atmospheric aerosols and clouds.

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
307	Animal Management Systems
502	New and Improved Food Products
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic production is rapidly growing, but growers lack access to certified-organic seed and vegetable varieties adapted to organic production. Most available varieties have been bred in and for conventional production systems. An organic system is a different growing environment from

conventional systems, and for optimal productivity, a variety should be adapted to the target environment. To obtain optimally adapted varieties, one needs to breed in the target environment. Our long-term goals are to enhance organically managed agriculture and increase compliance with National Organic Program (NOP) requirement for certified-organic seed. We seek to increase the number of organically adapted vegetable varieties through farmer-participatory trialing and breeding in organic farmers' fields. Our research objectives are to breed and to trial varieties for organic systems, and to evaluate the potential of broad and narrow selection to develop organically adapted varieties. Breeding will be conducted for late-blight resistant, good-tasting tomatoes, high quality, cold-tolerant OP cabbage, high-quality, early-maturity sweet corn, early, good tasting and high-yielding peppers, and high-quality, short-season winter squash. Variety trialing and evaluation of material at various stages of development will provide key information regarding adaptability and will be ideal for soliciting regional participant grower input regarding their evaluation of the suitability of the vegetables to their needs and guidance for further improvement toward cultivar development.

What has been done

Our overall goal is to increase the proportion of US agriculture that is managed organically. Growers are limited by the lack of vegetable varieties that have the best performance potential in organic systems over a wide seasonal window. Organic growers will increase market share with improved vegetable varieties that are adapted specifically to organic systems and combine the needs for extended market presence, disease resistance, nutritional and flavor quality, and contemporary productivity traits that are crucial to success in modern markets.

Another long term goal is to enhance compliance with the National Organic Program (NOP) requirement for use of certified organic seed. There is still too little certified organic seed available to close the loophole that allows a grower to use untreated conventional seed when organic seed of an equivalent variety is unavailable.

Results

Variety trials of tomatoes, sweet corn, sweet peppers, winter squash and cabbage were completed during the 2015 growing season and new trials of those crops were initiated in 2016. Trials were conducted in a mother-daughter design in Oregon (9 farms), Washington (6 farms), Wisconsin (5 farms) and New York. In 2015, the trial set was provided to Colorado State University, who grew the trial on certified organic land on the CSU research farm near Ft. Collins. In 2016, the trial entries were again provided to CSU and a subset of materials were grown near Polson, MT. In Wisconsin, in addition to the 5 daughter farm trials, the NOVIC variety trials were grown at the UW agricultural research station in pooner WI. Data from the trials has been compiled and is being formatted for inclusion in the Organic Variety Trial Database.

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
502	New and Improved Food Products

601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Improving IPM practices can have economic and environmental benefits by reducing unnecessary pesticide use while maintaining crop quality and yields. Fundamental to IPM is identification of pests, the losses they cause, and costs of control.

What has been done
A team of extension specialists from OSU, Washington State University and the University of Idaho developed a series of ?Train-the-Trainer? workshops to increase IPM knowledge throughout the Pacific Northwest. Another team from OSU and the University of Arizona developed an onion crop loss assessment so crop consultants and growers could better understand the impact of different pests and the effectiveness of their management programs.

Results
Impact: Our ?Train-the-Trainer? workshop series has trained over 100 crop consultants in insect, weed and disease identification and management. As part of the program, trainees help further disseminate information by training others in their organizations. Our onion crop loss project is aiding growers and crop consultants in understanding how damaging different pests are

and how cost-effective current management practices are. Improved pest identification and understanding of the economics of IPM allow growers and their consultants to make more informed decisions on their crop production.

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
903	Communication, Education, and Information Delivery

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 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Conventional and organic farmers utilizing organic waste products and cover crops as fertilizers only had access to general published estimates of N mineralization. Organic fertilizers are also expensive and contain different nutrient ratios. This made it difficult for farmers to match organic fertilizer rates with soil requirements and identify the most cost-effective fertilizer program. Total N content and plant-available N (PAN) content of cover crops is difficult to estimate in the field. Growers also lacked tools to compare the cost of cover cropping to the cost of fertilizers when developing nutrient management plans. Researchers at OSU are developing methods and tools for growers to estimate PAN from cover crops and organic fertilizers and to identify balanced and cost effective nutrient management plans.

What has been done

Most recently a UI Soil Scientist secured funding to develop a similar N mineralization calculator for cover crops in Idaho, and a team In 2012 NRCS and Oregon Tilth were awarded a WSARE PDP grant to teach conservationists in the PNW to use the OSU calculator. With funding from this grant, researchers have been teaching nutrient management workshops for agricultural professionals in California, Oregon, Washington. In 2008 we developed and launched the OSU Organic Fertilizer Calculator. It allowed growers to determine the most cost effective and balanced fertilizer program for all nutrients and integrated an existing PAN model for organic fertilizers (Sullivan). With grant funding from WSARE, we compared field methods for estimating total N content of cover crops. OSU also proved the concept that total N analysis of a sample with a mixture of cover crop species could be used to estimate cover crop PAN. With funding from an OSU Special Grant, researchers validated a published PAN model for crop residues with laboratory and field trials. OSU economists developed an economic spreadsheet to estimate the cost of using cover crops. The cover crop PAN model and economic spreadsheet were combined with the original fertilizer calculator to develop the OSU Organic Fertilizer and Cover Crop Calculator. The website also includes cover crop field sampling instructions. In 2015 a 1000ft2 version of the calculator was developed for small farms and gardens.

Results

The original Organic Fertilizer Calculator was launched in 2008 and extended to cover crops in 2010. From 2008-2010 it had over 1600 registered users. From 2010-2015 more than 840 additional people from 47 countries have registered to use the expanded Organic Fertilizer and Cover Crop Calculator. More than 540 were in the U.S. with Oregon (149), Washington (83) and California (49) having the most registered users. Over 160,000 acres are managed by people registered to use the calculator. If 25% of the registered users save $50/acre/year on reduced fertilizer costs or increased yields, the estimated annual economic impact of the new calculator is more than $2 million. Most registrants identified themselves as farmers (291 or 36%) or other agricultural professionals (318 or 39%). 137 students (17%) and 60 gardeners (7%) also registered.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
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
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The berry processing industry in Oregon goes back well over a hundred years, and during much of that time there?s been a dynamic relationship with USDA and OSU working together with growers and nurserymen, all building the highest quality industry. Historically, Oregon berries have been used primarily in processing, but recently there?s been a shift toward fresh markets and new cultivars adapted to organic systems. It?s a global market, whether fresh or processed.

What has been done
The partnership of horticulturist and plant breeder allows OSU to have larger plots of advanced selections grown to industry standards at the North Willamette Research and Extension Center. There, we can evaluate selections based on yield and fruit quality, and also on labor costs, end uses, and economics. Industry input and financial support from the various berry commissions are critical to the program?s success.

The berry breeding program benefits from a tremendous amount of collaboration, in horticulture, plant pathology, food science, and industry support. OSU works with state and federal scientists in breeding programs in Washington and Canada. There?s no other program like this in the world.

Results
The biggest challenge to breeding new cultivars for all these crops is meeting constantly increasing standards for a variety of industries. For example, blackberry growers have long wanted a thornless, cold-hardy berry that can be machine-harvested and tastes as good as Marion. OSU just released Columbia Star, which seems to satisfy all those criteria. In the case of strawberries, OSU is working to expand markets with cultivars that ripen over a longer season

and that are more efficient to pick, because labor can be expensive with berry crops.

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
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Management of private lands in urban and rural areas as well as in the Wildland-Urban Interface (WUI) is an important community issue in Southern Oregon as it is throughout the United States. In Southern Oregon?s Jackson County, WUI owners number in the thousands and collectively manage significant areas of forest, woodland, range, and other ?unimproved? land. As a result they have a significant influence on wildfire risk, the spread of noxious weeds, water conservation, and many other natural resource concerns. Yet many WUI and rural landowners

are new to the area and lack experience in rural living. The award-winning Land Steward program stimulates WUI owners to adopt best management practices by teaching them about land management in a holistic, multi-disciplinary way and then guiding them through a planning and technical assistance process. The program both educates and builds social support to help land owners successfully adopt best management practices for their natural resources.

What has been done

Over the 11-week Land Steward training, participants are introduced to locally appropriate best management practices for woodland management, fire hazard reduction, pasture management, biomass utilization, riparian management, noxious weeds, wildlife habitat, and more. Instruction is provided by professionals who serve as disciplinary experts, working alongside experienced landowners who host the classes and serve as peer instructors and advisers. Participants are required to create and implement an action plan for their property that addresses at least one natural resource concern, with technical assistance provided through cooperating agencies, and site visits provided by L.S. mentors. The innovative L.S. mentoring program incorporates property visits, verbal and written peer-to-peer feedback, and ongoing support through the Land Steward community. The program hosts a one-day land owner conference which Land Steward volunteers help to plan and implement. Volunteers also participate in committees to help plan stewardship-focused community education classes throughout the year and other community building events such as potluck gatherings with a stewardship topic theme.

Results

The LS program is effective at reaching new and inexperienced owners: Upon registration, approximately 60% of 2015-16 program participants had owned their land for 2 years or less.

The LS program facilitates participant contact with agencies and organizations that provide follow-up technical and financial assistance. As a direct result of the LS training, within a year of beginning their training, 68% of respondents reported contacting one or more of 14 different agencies and organizations such as the Jackson Soil and Water Conservation District, to the Oregon Department of Forestry, watershed councils and other organizations. This was a total of 73 contacts, including 19 phone/email consultations, 18 site visits, 12 sets of technical assistance recommendations, and 1 instances of participation in a cost-share program.

The LS program stimulates participants to improve stewardship of their property.
?Of 154 improved management practices reported by land owners, 85% were impacted positively by participating in the Land Steward program:
o41% of projects were initiated as a direct result of the training, with most initiating multiple projects
oAn additional 48% of these were reported as already planned prior to the training, but improved as a result of the training.
?An average of 8 projects initiated per respondent.

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
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aquaculture of marine fish is limited by production of the larval stages. Typically, larval mortalities are high and large proportions of surviving larvae show abnormalities. The overall objective of this project is to compare two types of microparticles (liposomes and wax spray-beads) to improve the nutritional value of rotifers. Optimal microparticle types and methods to enrich rotifers will be developed and the best method will be used to enrich rotifers to feed to fish larvae. Growth and survival of fish larvae fed on enriched rotifers will be compared with the performance of larvae fed on unenriched rotifers. Improved growth and survival of marine fish larvae will reduce husbandry obstacles to seed production for the aquaculture industry.

What has been done
Our overall hypothesis is that wax beads and liposomes can improve growth and survival of marine fish larvae by efficiently enriching live prey with water-soluble nutrients. We will address this hypothesis via the following research objectives: 1) Evaluate and compare inclusion and retention efficiencies of water-soluble nutrients by wax spray beads and liposomes; 2) Compare

the effectiveness of wax spray beads and liposomes in enriching rotifers with water-soluble nutrients; 3) Determine uptake of fluorescent markers by larval fish fed enriched rotifers; 4) Compare the effects of enriching rotifers with micronutrients contained in wax spray beads or liposomes on the growth and survival of larval fish.

Results

Our results indicated that wax spray beads produced from beeswax showed the highest retention of the water-soluble fluorescent compound, sodium fluorescein. In the second phase of trials, we measured the retention of the water-soluble nutrient, taurine, by beeswax WSB and liposomes. We found that wax spray beads and liposomes retained high concentrations of taurine when suspended in seawater, with approximately 40% and 90% retention of taurine after 1 h, respectively. The higher retention of taurine, by liposomes, may explain why liposome enrichments obtained much higher taurine concentrations (on a dry weight basis) in live prey when compared to WSB.

We have conducted feeding trials with two species of marine fish, northern rock sole (Lepidopsetta polyxystra) and California yellowtail (Seriola lalandi). Our results indicated that both species grew and developed at higher rates in response to microparticle- enriched live prey. Furthermore, we found that marine fish larvae fed taurine-microparticle (wax spray beads or liposomes) enriched live prey showed elevated body taurine concentrations when compared to larvae fed unenriched live prey. These results suggest that wax spray bead- and liposome-encapsulated substances were biologically available to marine fish larvae.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
601	Economics of Agricultural Production and Farm Management

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As wolves migrated into Oregon in 2009 after the 1995-96 reintroduction in Idaho they settled in Wallowa County first. Today's population is more than 84 in Oregon. As populations have grown, so has predation on livestock. Wallowa County?s economy is strongly tied to beef production where wolves have dominated the livestock producer's awareness since their arrival. Wolves have begun to migrate to other counties in Eastern Oregon. Target counties must be prepared to respond effectively to this presence in their livestock and in their communities.

What has been done
A collaborative group developed GPS collars that continuously track cattle and wolves. They began to research the Effects of Wolves on Cattle Production Systems. As part of that group and current PI, faculty delivered 12 trainings on wolf cattle interactions to a variety of audiences including; 4 to college classes and 2 radio interviews, 6 to cattleman across 3. A tour of Oregon politicians laid out the major issues facing producers. A paper was published in the OCA Beef Producer Magazine.-- A Case Study of Wolf use of a Mountainous Idaho

Results
?Decision makers understand the rules under the Endangered Species Act, whether federally listed or not and the rules that their citizens must comply with.
?95 % of ranchers in areas of known wolf activity are better prepared to deal with wolves through management practice.
?Ranchers and hunters understand how to detect whether a carcass was attacked by a wolf or some other predator.
?More than 50% of ranchers in Northern California prepared to appropriately report incidents, protect the evidence, and participate in the investigation of a suspected depredation.
?30% of ranchers in areas that wolves are just moving into are better prepared to deal with wolves through management practice.
?The data set is changing the perception that cattlemen are not proactive. Instead, their support of and contribution to the research indicates that they are partners with the University.
?The community of ranchers is better prepared to deal with wolves through management practice.
?Decision makers understand the rules under the Endangered Species Act, whether federally listed or not and the rules that their citizens must comply with.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Phytophthora ramorum is one of the most destructive and devastating diseases currently affecting US horticulture and forests. State, national, and international quarantines have been imposed on all host plant species and require eradication of affected nursery stock. Consequently, nurseries across the US have lost tens of millions of dollars from destruction of infected stock and suffer further from lost markets. In addition, the high mortality of dominant oak species and foliar blight of understory shrubs has caused a profound impact on our natural forests, permanently altering natural forest ecosystems in the Western US. Natural forests throughout the US are now at risk and nursery crops offer a very effective means of dispersing the pathogen across the country. This has happened twice with shipments of infected camellias from California that resulted in 1.6 million potentially infected plants detected in 175 infested sites in over 20 states. Despite broad regulatory and eradication protocols have been implemented, new introductions of P. ramorum and contamination of nursery stock continues to occur. Intensive research efforts to understand the mechanism of spread and origin of the pathogen have lead to a large number of studies examining the molecular epidemiology of this pathogen. Unfortunately, molecular techniques are challenged by low genetic variability of this recently introduced, clonal athogen, such that whole-genome sequencing is an ideal approach to provide the power necessary to decipher these patterns.

What has been done
The long-term goal is to limit the harmful effects of P. ramorum by expanding our knowledge of the adaptation and microevolution of the pathogen, how it is spread in forests and horticultural systems, and how evolutionary changes within populations affect disease dynamics and prevalence. The objectives here are to explore the genomes of 92 P. ramorum isolates strategically sampled from a worldwide collection to characterize migration patterns in fine detail

and conduct whole- transcriptome sequencing of each clonal lineage to characterize microevolutionary adaptation. The outcome of this project will be the complete genome sequences and analysis of 92 P. ramorum isolates and transcriptome sequence/analysis of each of the clonal lineages; thus, this work will represent a comprehensive characterization of the migration, origin, and evolution of P. ramorum. Collectively, this information is important for the development of improved management techniques and effective mitigation strategies, thus enabling improved forest health and security and increasing nationwide competitiveness and sustainability of the US nursery industry."

Results
Genome sequencing was done using the Illumina HiSeq 2000 (Illumina Inc) at Canada's Michael Smith Genome Sciences Centre or GSC (Vancouver Canada). For sequencing, 100bp paired-end tagged (PET) reads were prepared. Twelve individuals were pooled per lane. Thus far, a total of 80 isolates have been sequenced with 12 samples with sequence pending. The average coverage depth of the isolates sequenced thus far ranges from 29.5 to 87.7x coverage, which is more than is required for subsequent population genetic analyses."

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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Minorities are traditionally least represented in Agricultural and Veterinary Sciences. Therefore, there is a pressing need for recruiting, retaining, mentoring, and training outstanding Multicultural Scholars to address the changing demographics of the nation and meet national needs for multicultural scientists and professionals in Agricultural and Veterinary Sciences. Our overall goal is to provide a comprehensive innovative training in Animal and Rangeland Sciences to five multicultural undergraduate students (target audience). The training program will be called Multicultural Young Scholars Training in Animal and Rangeland Sciences (MYSTARS). Traditional undergraduate studies in Animal Sciences are discipline-based and emphasize general knowledge of animal production systems. We propose to provide a novel training which will integrate traditional Animal Sciences course work, multicultural education, laboratory experiential learning, communication training, and internships for multicultural students. Such training will provide students 21st century skills and tools to successful transition to their professional career and achieve leadership positions in academia, industry, and government. This will lead to competitiveness and success of U.S. agriculture on the global market.

What has been done

Three students have been recruited and mentored to improve retention. Students have presented the program to many area high schools to recruit minorities into the Animal Science program at OSU.

Results

The next step will be to transition these three students to professional careers and/or graduate school. Students have agreed to mentor future students as the program proceeds over the coming years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
301	Reproductive Performance of Animals
307	Animal Management Systems
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The locavore movement continues to thrive and grow in Oregon. Initially only attracting fresh food enthusiasts about 8 years ago, now, a robust food preservation interest is taking root. While consumers know that they want to eat healthier, year-round and support local, sustainable systems to get the food that they want, they and some small producers-sellers frequently don?t have the food preparation, safety or preservation knowledge, skills or practice to ensure safe, healthy home food preparation or preservation methods. The Cooperative Extension Service has been providing food preservation information, training and resources for over 100 years here in Central Oregon, yet, our lifestyles have recently changed so dramatically that nearly two generations don?t know how to cook (Manore, M. 2010, FCH Conference).

What has been done
In Central Oregon, our mission has been to make our public aware that OSU Extension, present in every county in Oregon, and on-line, can provide information, training and resources for food safety and preservation at home. We want to make sure they have the education and information that will help them make good decisions.

Not everyone is interested, willing or available to participate in a public workshop. For this reason, direct education is also important because it can lead to multilevel interventions that reach a diverse audience of community members. Public Workshop participants develop a skill set to extend our reach to those that cannot participate in direct education opportunities. Resources and promotions supply families, neighbors and friends with tips and information that can be shared. We have developed some important community collaborations to provide information quickly when needed for our larger audience, the community.

Results
Family/Friend Resource Sharing.
Food Safety/ Preservation Hotline promoted when it is open, verbally and in print.
News releases (15) about public workshops, free dial gauge testing, Clear Jel TM availability, and food safety updates about raw milk and raw milk soft cheeses, flavored oils, and pesto to 24 media outlets and 800+ contacts.
Web page with our food preservation resources, volunteer program, on-line class.
Food Safety/ Preservation Hotline Bookmark with Central Oregon public workshop dates and link to all our free resources. Handed out at public workshop, displays, and coalition and community meetings and on ?brochure wall? in 5 Extension offices (Crook, Deschutes, Jefferson, Warm

Springs and Wheeler).
OSU Extension/Deschutes County web pages on food preservation, food safety and food storage. Public workshops, resources, MFP program and Preserve @ Home are featured. Upon recommendation by Dairy Specialist, realrawmilkfacts.org is featured under food safety.
State Food Preservation Publications web page referenced in many Facebook and Ask an Expert posts.

Community Collaborations.
Exchanges and support between Deschutes County Health Services Sanitarian for united messages. Reviewer for food borne illness news releases from DPHS.
Exchanges and support between Oregon Department of Agriculture Food Safety Specialist for united messages.
Raise awareness and provide support for food editors when inaccurate, unsafe information is published.
Deschutes County Sheriff?s 1st Responder - Cascadia Coordination meeting.
Deschutes Public Library System bookplates to raise awareness of possibly unsafe recipes in books that can be checked out (in process).
Serve as a consultant for free-lance food reporters.

Direct Education and Family/Friend Resource Sharing.
OSU Extension Food Preservation Facebook page ? regular administrator contributor (40+ posts).
Direct contact from MFPs at public workshops and in their sphere of influence.
Direct contact from happy customers at public workshops and in their sphere of influence.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
206	Basic Plant Biology
502	New and Improved Food Products
601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The size at which organisms reach sexual maturity is one of the most important life-history traits affecting fitness (Stearns, 1992; Roff, 2001). Delayed maturation increases body size, which in turn increases fecundity, but decreases the probability of survival to reproduction. Hence, there is a trade-off between future growth and survival. In salmonids, there is no single optimal age or size at maturity. In some species, males mature 1 year earlier than the youngest females and can be as much as 50% younger and 30% smaller than other males in the population (Gross, 1985).

What has been done
Major histocompatibility complex (MHC) and immune-relevant gene markers were used to evaluate differences in reproductive success (RS) among naturally spawning coho salmon Oncorhynchus kisutch mate pairs involving an alternative male reproductive phenotype, known as jacks. These mate pairs included both hatchery-reared and wild origin fish such that three classes were evaluated in two consecutive years (2005 and 2006) using a previously constructed multigenerational genetic pedigree: wild × wild (W × W), hatchery × hatchery (H × H) and wild × hatchery (W × H). Oncorhynchus kisutch jack mate pairs mated randomly based on immune-relevant genotype in both years; a result consistent with the opportunistic mating strategy of jacks. An association between greater number of alleles shared at three immune-relevant gene markers and increased RS was found for: W × H mate pairs in 2005 (BHMS429), W × H pairs in 2006 (SsalR016TKU) and W × W pairs"

Results
No correlation between immune gene diversity and RS was found for H × H pairs in either year. The results suggest that the influence of immune-relevant genotype on mating success may be different for jacks when compared with previous studies of large adult male O. kisutch.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Researchers at OSU continue to expand bivalve breeding research to improve the culture, production, and harvest of Pacific Oysters. The Northwest oyster industry has been going strong for more than a century. Most farmed oysters are Pacific oysters, imported from Japan in the early 20th century after heavy harvesting nearly wiped out the Northwest?s native Olympia oysters. Pacific oysters vary widely in survival, growth, and disease resistance. They also vary in shell size, color, and shape, all of which affect the market price for oysters and the efficiency of harvesting and shucking.

What has been done
Researchers started this broodstock improvement by collecting 600 Pacific oysters from different areas along the West Coast. Working at a pilot-scale hatchery at the Hatfield Marine Science Center, they began the long process of selection and crossing to develop pedigreed lines. The offspring were reared in the Hatfield Center?s pilot hatchery and then planted them out at study sites all along the Pacific Coast, from California?s Tomales Bay to Alaska?s Prince William Sound. After the oysters reached spawning age, they identified the ones with the best survival and growth, and crossed and recrossed them systematically until they started to see improvements.

To ramp up production to a commercial scale, researchers crossed the top-performing families to produce genetically distinct ?pods? of offspring. The pod-production was now ready for hand-off to the industry. A group of partners from the seafood industry have scaled up pod-production and are helping to fund ongoing rearing of larvae and spat.

Results

The project has paid off in plumper, faster-growing, sweeter-tasting, easier-to-shuck oysters. Broodstock improvement has also achieved more-uniform size and shape, which makes harvesting, sorting, and shucking oysters much easier.

Another improvement was resistance to disease pathogens and pathogens that impact human health. Breeding will continue to improve oyster resistance to both pathogens and new breeding is occurring to address shell formation in increasingly acidic oceans.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The persistence of rapidly transmitting, acute pathogens in their natural host populations represents one of the fundamental puzzles in disease ecology: highly contagious pathogens tend to reduce the pool of susceptible hosts to very low numbers, increasing their own risk of extinction during epidemic troughs. This vulnerability constrains the range of pathogen life histories that result in viable population dynamics; nonetheless, highly transmissible pathogens do occur - despite causing rapid host immunity or death. The 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
We used empirical data to from our cohort (Aim 2) and experimental (Aim 3) studies to parameterize a stochastic, individual-based mathematical model of acute FMD transmission. During an experimental infection FMD was transmitted readily from acutely infected animals to naïve hosts, and recovery occurred within 4-6 days, resulting in estimates for R0 of 15.9 (SAT3), 23.8 (SAT2), and 42.3 (SAT1). Using our longitudinal cohort study, we determined that births occurred predominantly between November and March, giving an inter-birth interval of 5 months. We also have found that the time at which maternal antibodies wane below protective levels varies between individuals and have incorporated this into our model framework. Our models using these data show that FMDV is unlikely to persist in buffalo populations with calf-to-calf transmission alone. A manuscript on these findings in currently in preparation.

Antibody dynamics appear much more complex than anticipated based on the FMD literature, which suggests that high antibody titers are maintained essentially life-long, after initial FMDV exposure. By contrast, our longitudinal data tracking antibody titers in individual animals over time show that titers are very variable, with pronounced seasonal patterns in the maintenance of antibody titers - and perhaps, protective immunity to FMD.

Results
? We conducted a series of FMDV transmission experiments, covering transmission from acutely infected and carrier "buffalo, for all three SAT strains, during the reporting period.
? Acute transmission extremely efficient (100%), and R0 was high for all strains (see Aim 1).
? We were able to demonstrate prompt transmission of SAT 1 and SAT 3 from carrier to naïve buffalo in an experimental setting. This was unexpected, because previous (published) experiments had typically failed to demonstrate transmission from carrier buffalo. We hypothesize that one reason we succeeded is that transmission requires direct and close contact, and previous experiments used cattle as their naïve animal with buffalo as the carrier animal -but the buffalo and cattle avoid each other even in a small enclosure. Additionally we have not ruled out the impact of co-infection by other respiratory pathogens.
? There were conspicuous differences among viral strains in their ability to transmit from carrier hosts to naïve individuals. This suggests that mechanisms for persistence may differ among FMDV strains.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
311	Animal Diseases
502	New and Improved Food Products
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The project was developed to investigate a herpesvirus infection in cattle, BHV-1. Bovine herpesvirus type 1 (BHV-1) is the causing agent of Infectious bovine rhinotracheitis (commonly called IBR or red nose). BHV-1 infection is the leading cause of acute respiratory disease, abortion, or occasionally encephalitis in cattle, and is often the trigger of "Shipping Fever" or Bovine Respiratory Complex. As a consequence of the pathogenic potential of BHV-1, the cattle industry suffers more than $500,000,000/year in losses.

What has been done
Although modified-live multivalent vaccines, such as PregGuard GOLD and Bovi-Shield Gold, have been used routinely in both beef and dairy cattle in the US, abortion and respiratory diseases still occasionally occur following vaccination. To determine whether the antibody induced by the multivalent vaccine can recognize BHV-1 isolates from aborted animals, BHV-1 antibody titer was evaluated with two isolates from abortion cases and two vaccine BHV-1 viruses. Cattle serum was collected from a dairy herd that was vaccinated annually with Bovi-Shield Gold 5 vaccine.

Results
Among the 28 cattle tested, no statistical significant difference in serum neutralization titer was observed when test virus was either vaccine virus or clinical isolates. It suggests that the BHV-1 antibody from the vaccinated cattle can recognize both the vaccine virus and clinical isolates. However, it is noticed that cows at 5 years old or older had a significantly lower BHV-1 antibody titer on average than the average of SN titer in 3 year-old cows. Similarly, cows at 5 years or older had a significantly lower BVDV antibody titer than cows at about 2 years of age. In addition, cattle vaccinated within 0-2 months had a significantly higher BHV-1 titer than those that received vaccination 6 months or greater prior to titer measurement. In contrast, cattle that received a

vaccination 6 months prior had a significantly higher anti-BVDV antibody titer than those vaccinated within 1-2 months. The BVDV antibody titers remained relatively unchanged between 6 months and 1 year post-vaccination. Our study suggests little antigenic variation exists between BHV-1 disease isolates and BHV-1 of the multivalent vaccines. In addition, BHV-1 antibody titer is relatively lower at 6 months post vaccination in those tested animals. However, the BVDV antibody titer remained relatively high after 6 months from time of vaccination..

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems
311	Animal Diseases
601	Economics of Agricultural Production and Farm Management

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
2016	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. Extensive comparative modeling will be conducted through factorial combinations of models and input data among the different diseases. Generalized theory and models will be developed to predict "rules-of-thumb" for the control of diseases caused by pathogens with long-distance dispersal. Data from field observations of sudden oak death and foot-and-mouth disease, and manipulative experiments with wheat stripe rust, will be used for model validation/verification. The project will determine the importance of initial disease prevalence, the spatial pattern of initial disease prevalence, and pathogen reproductive capacity 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. The work is fundamental to our understanding of disease spread, and is crucial to predicting the spread of epidemic invasions and designing disease control strategies. The work is potentially transformative as it will provide a rare opportunity to test such hypotheses in natural and controlled field experiments, and because the applicability of a broad diversity of plant, animal, and human pathogens with fat-tailed dispersal kernels will be rigorously evaluated via the interdisciplinary modeling efforts.

What has been done

1) Used 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) Compared 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) Determined the influence of initial disease prevalence and basic infection number on the efficacy of control tactics.
4) Conducted extensive comparative modeling through factorial combinations of models and input data among the different diseases.
5) Developed generalized theory and models to predict "rules-of-thumb" for the control of diseases caused by pathogens with long-distance dispersal.
6) Evaluated 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

Large field studies were established to determine effects of initial disease prevalence, spatial pattern of initial disease prevalence, and basic infection number on spread of wheat stripe rust. Models based on wheat stripe rust showed that ring cull size has no impact on subsequent epidemic spread, while time of initiation of the cull had a very strong effect. We are currently attempting to dermine whether this is true for the other diseases as well.
An individual-level network model for a hypothetical outbreak of Japanese Encephalitis (JE) was developed for a selected scenario in the US. Simulation analysis suggested two important mitigation strategies: for low mosquito vectorial capacity, insecticidal spraying of infected areas reduces transmission and limits the outbreak to a single geographic area. Alternatively, in high mosquito vectorial capacity areas, birds rather than mosquitoes need to be removed/controlled.
Stochastic models were developed to study the spread of foot-and-mouth disease using actual farm number and farm sizes for the states of Oregon, Pennsylvania, and Texas. Results showed important effects, and that relationships differ substantially among the states. Preliminary results indicate the following:
a. Varying the level of initial prevalence had a larger effect on epidemic expansion in Texas than in Pennsylania or Oregon.
b. It appears that the farm size of the initial infections does not have a big impact in OR or PA, but does increase epidemic size and duration somewhat in TX.

c. Increased homogeneity of farm size increased epidemic severity in Texas and Pennsylvania, but not Oregon.
A new, tangible geosptial modeling framework was developed for studying the spread of sudden oak death in heterogeneous landscapesand was applied to collaboratively managing disease spread. The following conclusions were drawn for the state of California: "". . . despite extensive cryptic (i.e., presymptomatic) infection and frequent long-range transmission, effective exclusion of the pathogen from large parts of the state could, in principle, have been possible were it to have been started by 2002. This is the approximate date by which sufficient knowledge of P. ramorum epidemiology had accumulated for large-scale management to be realistic. The necessary expenditure would have been very large, but could have been greatly reduced by optimizing the radius within which infected sites are treated and careful selection of sites to treat. In particular, we find that a dynamic strategy treating sites on the epidemic wave front leads to optimal performance. We also find that "front loading" the budget, that is, treating very heavily at the start of the management program, would greatly improve control.

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
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
903	Communication, Education, and Information Delivery

Outcome #19

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Bovine respiratory disease (BRD) is the most common and costly disease of feeder cattle in the US. Preconditioning programs that include vaccination against BRD pathogens are one of the most effective management methods that mitigate the incidence of this disease. Management to mitigate BRD is becoming of even greater importance due to recent regulations regarding antibiotic use in beef/feedlot systems. In typical western US beef operations that adopt preconditioning programs, calves receive vaccination against BRD pathogens at weaning and booster 30 days later at feedlot entry. However, weaning and feedlot entry are two of the most stressful situations encountered by feeder cattle, and vaccine efficacy can be reduced if administered to highly-stressed animals. In addition, vaccination against BRD pathogens elicits innate immune responses known to impair cattle performance, particularly during feedlot receiving. Hence, altering the time of vaccination/booster against BRD pathogens has been considered as an approach to concurrently enhance vaccine efficacy, immunity to BRD, and cattle performance. Research that delayed vaccination by 2 weeks after feedlot arrival reported increased seroconversion to a BRD pathogen during feedlot receiving. However, the majority of BRD cases occur within the first 14 days upon feedlot arrival, and delaying vaccination/booster by 2 weeks may not provide full immunological protection against BRD pathogens to newly-received feeder calves.

What has been done

Two hundred and fifty Angus × Hereford calves (125 steers and 125 heifers) will be assigned to the experiment. All calves will be vaccinated against clostridial diseases (Clostrishield 7; Novartis Animal Health; Bucyrus, KS) and bovine virus diarrhea complex (Virashield 6 + Somnus; Novartis Animal Health) at 45 days of age. Calves will be reared on semi-arid rangeland pastures (Ganskopp and Bohnert, 2009) with their respective dams until weaning at 7 months of age (day 0 of the experiment). Fifteen days before weaning (day -15 of the experiment), calves will be ranked by sex, dam's parity, body weight, and age, and assigned to 1 of 3 treatments as in Lippolis et al. (2016).

Results

The sample size planned for this experiment is adequate to result in statistical significances for all measurements proposed, according to the G*power 3 software (Faul et al., 2007) and our preliminary research (Lippolis et al., 2016). Data will be analyzed with the MIXED procedure of SAS using calf as the experimental unit, and treatment comparisons will be made on an equivalent post-vaccination day basis when appropriate (Lippolis et al., 2016). For all measurements, the model statement will contain the effects of treatment, in addition to time the resultant interaction when appropriate. Initial results will be provided in the 2017 Annual Report of Accomplishments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of 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 #20

1. Outcome Measures

Evaluate the toxicity of various mycotoxins in food.

Not Reporting on this Outcome Measure

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of this project is to advance the understanding of the evolution of bacterial virulence by characterizing phytopathogenic bacteria Rhodococcus fascians using a combination of bioinformatics analyses, genetic complementation, comparative metabolomics, and transcriptome profiling. R. fascians is of economic importance to the plant production industry, has a wide host

range, and is genetically diverse. It utilizes a unique infection strategy to exploit cytokinin signaling, a hormone common to all plants, to cause disease. In addition, R. fascians is a member of the Gram-positive plant pathogen group. Relative to the extensive knowledge that exists for their Gram-negative counterparts, the evolution and mechanisms of virulence of Gram- positive plant pathogens are not well understood. We hypothesize that R. fascians is a genetically diverse group of bacteria in which members have independently evolved virulence towards plants through a process of co-option of housekeeping genes and horizontal gene transfer acquisition of common key virulence genes. We further suggest that members of R. fascians have undergone refinement via nonorthologous gene displacement of the linear plasmid, a key acquisition that actualized plant adaptation. Our collection of R. fascians isolates, including isolates that are geographically-, temporally-, and pathogenetically- diverse, enables us to test this hypothesis with the goal o shedding light on both the mechanisms that R. fascians uses to cause disease as well as evolution of bacterial virulence.

What has been done

Using R. fascians isolates that vary in both their virulence gene complements and their behaviors on plants, the goal of this proposal is to use a genome-enabled approach coupled with comparative metabolomics and transcriptomics to characterize "the evolution of virulence in R. fascians. The proposed objectives are:

1. Profile cytokinin production using comparative metabolomics for 5 R. fascians isolates exhibiting different virulence phenotypes.
2. Identify and characterize genes that enable isolate A21d2 to cause disease in a fas-independent manner.
3. Profile gene expression i R. fascians isolates to determine contributions of known virulence operons att and fas and identify novel virulence genes."

Results

In the first year of study, we leveraged genomic resources to develop hypotheses about the virulence loci of R. fascia's and their contributions to its ability to cause disease on plants. In the second year of this project, we made significant advancements in developing methods to test these hypotheses. We adapted methods developed for other Gram-positive bacteria and set up a robust system for making clean, single gene deletions in R. fascians. These represent a key change in knowledge allowing us to systematically knock out individual genes that are predicted to play a role in disease and assess their contributions.

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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Barley is one of the world?s oldest cultivated crops, and yet it has slipped off the table as a major source of food in many parts of the world, including the United States, where barley is currently grown primarily for feed and malt purposes. The Oregon State Barley Project is attempting to raise awareness for barley as a source of human food and promote delicious ways to prepare barley- from a simple brown rice substitute to using barley flour in baked goods.

What has been done
The OSU barley project has initiated research on 7 varieties that represent a spectrum of food barleys, as well as a feed and malt variety. We are in the process of characterizing these 7 lines for a number of different traits. This research is being done with the collaboration of several different labs on and off campus. T

Results
Pearled barley: Pearling involves mechanical abrasion to remove the hull. Since most barley varieties - bred for malting or feed - have adhering hulls, much of the pearled food barley that is currently available is made from varieties that have hulls. The hull is insoluble dietary fiber. Pearled barley is not considered a whole grain. The advantage of pearling is that it shortens cooking time. Furthermore, the soluble dietary fiber component grain beta glucan content is not reduced by pearling since the beta glucan occurs in all cell walls of the barley seed.

Whole grain without hulls: With a naked barley, at harvest the hulls separate from the seed - just like in wheat. Therefore, a hull-less barley grain is just like wheat grain - it can be milled into flour, flaked, steamed, or added to soups. Like wheat berries, barley berries will be crunchy if prepared directly. Cooking time can be reduced - and a fluffy rice-like consistency achieved - by light

pearling (buffing) or cracking the grain. Buffing is easily done at home by running one cup of grain, on high, in a blender for 30 seconds. This will lightly pearl the barley.

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

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.

Not Reporting on this Outcome Measure

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).

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

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
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
903	Communication, Education, and Information Delivery

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The development of resistance to multiple fungicide classes is currently limiting disease management options for many pathogens, while the discovery of new fungicide classes may become less frequent. In light of this, more research is needed to quantify virulence trade-offs of fungicide resistance in order to more fully understand the implications of fungicide resistance on pathogen fitness.

What has been done
The purpose of this study was to measure the virulence of azoxystrobin-resistant and -sensitive Zymoseptoria tritici populations collected from North and South Willamette Valley, Oregon, in 2012 and 2015. Inoculum mixtures of known fungicide-resistant pheno- types were used to simulate natural field conditions, where multiple genotypes exist and interact in close proximity. Six greenhouse inoculations were conducted over 2 years, and virulence of the isolate mixtures was evaluated in planta. We considered virulence to be ?the degree of pathology caused by the organism? and visually estimated the percent area of leaf necrosis as a measure of virulence.

Results
In greenhouse conditions, a consistent association of reduced virulence with azoxystrobin-resistant Z. tritici isolate mixtures was observed. North Willamette Valley and South Willamette Valley populations did not differ in virulence.

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

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 demands for research on food security far outstrip the resources available for funding this research. Oregon produces 226 different crops that are all related to food production via direct production for human consumption or as food for animals that are produced for

human consumption. Unlike many LGUs, OSU also conducts research on shell fish and ocean species that are important food production systems. The lack of research dollars to meet research demands creates a serious gap in our ability to feed an ever expanding population across the globe.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

- Expanding access to agricultural sciences to multi-cultural students
- The role of ocean phytoplankton in global moisture cycles
- Adopting new agronomic practices for organic production
- Breeding new cultivars for changing industry and consumer needs
- Providing new landowners with land stewardship and conservation training
- Improving the nutritional value of rotifers for feeding aquaculture larvae
- Improving the nutritional value of potatoes
- Applying genomic approaches to eradicating Sudden Oak Death

Key Items of Evaluation

OSU research and extension scientists continue to expand knowledge and agronomic principles for over 226 crops and livestock production systems. New genomic methods of cultivar improvement and for addressing pathogens will continue to improve yields and economic vitality for Oregon producers.

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
204	Plant Product Quality and Utility (Preharvest)	0%		5%	
306	Environmental Stress in Animals	0%		5%	
308	Improved Animal Products (Before Harvest)	0%		5%	
311	Animal Diseases	2%		10%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%		10%	
501	New and Improved Food Processing Technologies	12%		5%	
502	New and Improved Food Products	11%		5%	
701	Nutrient Composition of Food	12%		10%	
702	Requirements and Function of Nutrients and Other Food Components	0%		10%	
703	Nutrition Education and Behavior	15%		10%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	12%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	10%		10%	
723	Hazards to Human Health and Safety	10%		10%	
724	Healthy Lifestyle	8%		0%	
903	Communication, Education, and Information Delivery	8%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	25.0	0.0
Actual Paid	6.0	0.0	16.0	0.0
Actual Volunteer	595.0	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**
118557	0	559212	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
118557	0	4982736	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
339705	0	3635556	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2269	1553	1135	3072

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

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	35	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total grant dollars for collaborative project

Year	Actual
2016	18000000

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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nationally there is expanding interest in the organic and locally grown food movement, leading to an increase in home gardening and home food preservation. The traditional practice of home food preservation, especially canning, has enjoyed a surge of popularity over the last decade with a new generation interested in preserving locally grown fruits and vegetables and ensuring food safety. Recent surveys indicate that up to 1 in 5 U.S. households preserve their own food. Unfortunately, many of these households are accessing food preservation resources that are outdated, or that have not been properly tested. The National Center for Home Food Preservation revealed in their 2005 survey that a high number of home food preservers are using high risk practices that put them at risk for foodborne illness and economic losses due to food spoilage. The survey further noted a significant percentage of home food preservers use practices that put them at risk for botulism. The Oregon State University Extension Master Food Preserver and food preservation programs have become the most reliable resources for providing education and awareness about food safety and safe practices for home food preserving for Oregonians. These programs are addressing an important public health issue by providing Oregonians with an increased awareness of safe harvesting, handling, and preserving the health benefits of healthy foods.

What has been done

Provided 7 sessions on food preservation/safety as well as helped facilitate online Preserve@Home course. Supported volunteers as they contributed to community education events. Answered 60+ phone calls, Ask Expert & drop ins to address food safety questions and/or test guages. Classes taught include: Preserve@Home Lab, Dehydrating/Pressure Canning, Fermenting, Pickling, Water Bath Canning/Salsa, Cheesemaking, Intro to Food Preservation for

Klamath Tribes.

Results

Based on written post class surveys (n=59), 100% of participants reported the class helped them to learn food preservation skills they needed (?a lot? or ?very much?). 100% said they planned to use skills/knowledge learned in class. Before class 26% reported they ?never? used up to date instructions compared to 0% after the class. 100% of participants would recommend these classes to someone else. When MFPs were surveyed at end of year (n=5), 100% reported they had made changes in their own food preservation practices as a result of volunteering.

In 2015, 125 new and 271 veteran Master Food Preserver/Family Food Education volunteers contributed over 26,494 hours of time. Over 41,468 contacts were made by volunteers, faculty and Extension staff, with 3386 of these from callers receiving assistance from the Food Safety/Preservation Hotline. In addition, an estimated 149,930 Oregonians were reached by our faculty and volunteers through radio and television broadcasts, social media sites, and newspaper articles related to food safety and food preservation topics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This research will provide valuable information to hatchery personnel aimed at guiding disease prevention and management decisions, thus helping to create a more stable economic climate for producers in the aquaculture industry.

What has been done
We have initiated frequent sampling during the spawning season of the microbial communities at two separate oyster larvae hatcheries on the Pacific Coast. Sampling was initiated during the late summer of 2015 at the end of typical spawning seasons, in order to develop a better idea of how microbial communities are distributed across the hatchery environment. Specifically, our sampling was focused on defining how the microbial community in water flowing through aquaculture facilities changes as a function of different hatchery water treatments protocols or different water incubation conditions. "we have collected over 200 Vibrio isolates from the hatcheries we have sampled over the last year. We are now working on testing for pathogenic phenotypes in these organisms to answer the question of whether pathogens are present in this environment despite the non-occurrence of disease outbreaks. We have already sequenced 12 of these isolates in order to perform a comparative genomics study of these strains along with several published strains. The goals of this study will be to define key genetic and metabolic indicators of pathogenic lifestyles across these organisms.

Results
Sampling of the hatchery was conducted every other day from late July to late August and less frequently from late June to early July to track community changes as larvae developed.
As our sampling period has just finished, we will now begin to process these samples in order to extract and sequence the DNA of these communities. Unfortunately (for us, but not the hatchery, of course), no disease events were observed over the entire sampling period. An alternative experiment has been designed in collaboration with Chris Langdon's g oup at Oregon State to test the effect of increased carbon dioxide (CO2) levels on larval-associated microbial communities. S"

4. Associated Knowledge Areas

KA Code	Knowledge Area
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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Driven by major scientiﬁc advances in analytical methods, biomonitoring, computation, and a newly articulated vision for a greater impact in public health, the ﬁeld of exposure science is undergoing a rapid transition from a ﬁeld of observation to a ﬁeld of prediction. Deployment of an organizational and predictive framework for exposure science analogous to the ?systems approaches? used in the biological sciences is a necessary step in this evolution. Here we propose the aggregate exposure pathway (AEP) concept as the natural and complementary companion in the exposure sciences to the adverse outcome pathway (AOP) concept in the toxicological sciences."

What has been done
Aggregate exposure pathways oﬀer an intuitive framework to organize exposure data within individual units of prediction common to the ﬁeld, setting the stage for exposure forecasting. Looking farther ahead, we envision direct linkages between aggregate exposure pathways and adverse outcome pathways, completing the source to outcome continuum for more meaningful integration of exposure assessment and hazard identiﬁcation. Together, the two frameworks form and inform a decision-making framework with the ﬂexibility for risk-based, hazard-based, or exposure-based decision making.

Results
Completing the source to outcome continuum by joining the AEP and AOP networks sets the stage for more eﬃcient integration of toxicity testing information and exposure information, creating opportunities for development and deployment of novel computational tools that enable more comprehensive, more rapid exposure-based, hazard-based, and risk-based decision making.3"

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agriculture is a knowledge intensive activity and producers are continually faced with new emerging issues, both positive and negative. Agricultural producers need up-to-date information that is accurate and reliable to address emerging problems, comply with changing government regulations and take advantages of new opportunities and technologies to improve their operations. Among the most critical regulatory issues that emerged in 2013 were the Food Safety Modernization Act (FSMA) and its proposed water quality standards that could restrict the use of irrigation water in the Treasure Valley of eastern Oregon and southwest Idaho and consequently devastate the area?s critical onion industry.

What has been done

In addition to applied research, the extension program focuses on educational programming to address the needs of agriculture in Malheur County and the surrounding region, and promote and improve it. In 2013, faculty assisted in organizing two workshops in Ontario that featured officials from the FDA, Oregon State University, Washington State University, ODA and ISDA, and were designed to help the public understand and comment on the new proposed FSMA rules. After the workshop, faculty assisted area growers in making comments to the FDA and drafted the comments submitted to the FDA by the Malheur County Onion Growers Association and the Idaho Onion Growers Association that provided science-based information on the safety of onion production and shipping practices.

In 2014, OSU faculty and Western Laboratories, Parma, ID, to conduct research on understanding the potential for microbial contamination of onions and remediation methods to reduce bacterial levels in irrigation water, using available technologies and currently registered pesticides.

Results

The FSMA workshops were attended by over 360 people and gave FDA officials the opportunity to learn about onion production practices from a tour of onion farms. Partly in response to these events, FDA announced revisions the standards for Growing, Harvesting, Packing, and Holding of Produce for Human Consumption that would be more favorable for onion production in the Treasure Valley.

Our recent research has demonstrated that bacteria from irrigation water are not likely to be contaminating onion bulbs at the time of harvest. Our remediation research has shown there are ?off-the-shelf? techniques growers could employ to reduce bacterial loads in irrigation water if that is ultimately required by FDA in the final FSMA rules.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
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 #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
2016	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. Different than existing expensive and bulky laboratory analytical equipment, our on-chip biosensors will be made from nature created biological materials --- diatom biosilica. The research objectives are: 1) Synthesis of high density diatom thin film with silver nanoparticles that can simultaneously perform on-chip separation and sensing; 2) Quantitative detection of trace level of histamine and unapproved aquaculture drugs in seafood; and 3) Demonstration of the biosensing technology for in-situ seafood safety through collaboration with local seafood industry.

What has been done
Our central hypothesis is that diatoms, which are a group of single-celled photosynthetic algae that use natural biochemical pathways to bio-mineralize and self-assemble amorphous photonic crystal biosilica nano-structures, can function simultaneously as a thin layer chromatography (TLC) to separate toxic molecules from complex food samples and as ultra- sensitive SERS substrates to probe the signature Raman peaks, which enables multiplex sensing with high specificity. When used with commercial portable or handheld Raman spectrometers, it can enable rapid, in-situ sensing of food contaminants with very low cost. We have formulated this hypothesis based on our strong preliminary data as described in Section 2.4. Our rationale for this project is that its successful completion would accelerate the transition of SERS sensing from a well-established bench-top analysis technology into a portable, in-situ sensing technology to enhance food safety. It would also increase our understanding of how bio-enabled nanotechnology would be employed to separate and identify trace amount of chemicals in complex food samples at chip scale, which ould potentially be applicable to water and environmental protection, and therefore potentially offer wide-ranging applications.

Results
The outcome of this proposed research comes from the rapid, portable, in-situ TLC + SERS sensing technology with great accessibility and low expenses that cannot be readily complemented by conventional bench-top analysis methods. From the commercial standpoint, the market of global food safety testing is forecasted to reach $14 billion by 2018. The successful completion of this proposed project would provide the regulatory agencies and seafood industry with a simple, user-friendly and cost-effective means to detect histamine and unapproved aquaculture drugs in seafood, and will be ready for many more food contaminants through extended research efforts. Equally important, this research will transcend a bioenabled

nanotechnology from basic research stage into real food sensing application with significant engineering and commercial potentials. Both seafood consumers and the seafood industry will benefit tremendously from the outcomes of this project.

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
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Our goal is to support recruiting, retaining, mentoring and training in food and agricultural sciences for undergraduate students with a Multicultural Scholars Program (MSP) grant. We will use continuing MSP funding within the research-based BioResource Research (BRR) interdisciplinary sciences major in the College of Agricultural Sciences at Oregon State University

(OSU). In BRR, undergraduate students undertake a mentored research project on a topic related to agriculture, natural resources, food science or human health and nutrition. This program provides strong faculty/peer mentoring, personalized advising, innovative and flexible integrated training, exceptional opportunities for research and professional development. BRR has a demonstrated history of successful education of students from diverse cultural backgrounds. Multiple programs provide excellent academic, professional, and mentoring services to underr presented students, and have a history of serving Latino, Native American, African American, and other minority students.

What has been done
The negative effect of poor socialization is diminished by peer interaction for minority students and for science students in general. Early participation in research improves students' academic performance and persistence to graduation, gives them a greater sense of integration into the academic community, and raises the likelihood of enrollment in graduate and professional school. The BRR program closely follows recommendations of the National Academy of Sciences to provide strong academic and professional training. BRR is a challenging science and research program that prepares students for placement into jobs and graduate programs in traditional STEM disciplines, food and agricultural sciences, and globally important new interdisciplinary agricultural fields: bioproducts, bioenergy, genomics, the impact of climate change on agriculture, and water resources. BRR's interdisciplinary approach follows current research in science and education. BRR's 13 options undergo frequent review; new options, including Genomics/ Bioinformatics, Water Resources, Bioproducts and Bioenergy, and Climate and Biosystems Modeling, have been recently developed in response to these reviews and with input from faculty and representatives from agriculture, forestry and industry. Along with strong academics, BRR's two-year research project provides training in transferable skills (e.g., communication, teamwork, and management) and exposes students to a variety of jobs.

Results
Students in OSU MANRRS and SACNAS organizations hosted numerous professional development speakers (i.e. Career Services, Graduate School, Weyerhaeuser, Monsanto, Crop Protection Services, etc.) As well as special topic presentations including: The U.N. Right to Food, Cuisine as Cultural Heritage and Reflections on Globalization and Food Security by Dr. Lisa Price, How to use Social Networking for Professional and Research Benefits by Dr. Sidlauskas, and The Value of Undergraduate Research and How to Prepare and Find on- and off- Campus Opportunities, by Wanda Crannell. Students in these organizations served as peer-mentors during campus visitations by HS students in the fall and spring terms. Community service activities included: Ag. Day, Earth Day Native Plant Sale fundraiser for Avivara (raised $700 for education in Guatamala), Career Wardrobe MakeOver Event (raised over $1000 to support student attendance at National Conference), and Mi Familia Weekend, a bilingual (English/Spanish) program to connect Hispanic/Latino families to the OSU campus.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
701	Nutrient Composition of Food
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With the remote location of Curry County and the real threat of natural disaster striking, training in food preservation and emergency preparedness are highly sought out. Training for community volunteers in the Master Food Preserver Program had not been available in Curry County for over 5 years. These classes were requested by the community.

What has been done
In 2016, we hosted an 8 week Master Food Preserver Volunteer training in Curry County. Training consisted of classroom instruction, hands-on labs and a series of homework assignments. Lectures were taught by Margie House (Curry County MFP Volunteer Coordinator) with support from veteran volunteers from Curry County, Coos County MFP Volunteer Program Assistant and neighboring county volunteers from Douglas, Lane and Coos counties.

Results
A total of 11 new volunteers participated in the training and all 11 were certified as OSU Master Food Preservers after completing the final exam. The class conducted a year end workshop (Gifts from the Kitchen) in November 2016 and invited the public to attend. Registration for the event sold out quickly with 28 community members signing up. Our post training survey indicated that 100% of our new volunteers want to ?share my knowledge with others?. We plan to offer community classes in 2017 and will be looking for new ways to reach the community as well at

Farmers Markets and other public events (ie. Agness Tomato Festival). Volunteers will also help with the planning and implementing of our 2017 Volunteer Training. Effectiveness of this training is evident not only in the forward momentum of volunteer driven events, but also in the feedback we received on our year end survey.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
701	Nutrient Composition of Food
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New industrial processes have enabled the development of pesticide nanoformulations that are active longer against pests than the same active ingredient with a conventional formulation. These processes include creating tiny pesticide particles, which have an outer layer designed to protect the pesticide from environmental breakdown and make it easier to mix with water. The

properties of the nanolayer may increase the ability of the pesticide to control pests, and there are many of these new pesticide formations already on the market. However, pesticide particles and dusts are already known to be collected by bees, build up in the pollen they collect, and pose a risk to their colonies. Additionally, making pesticides more soluble in water could possibly affect their ability to move into lakes and streams. Our goal is to research whether nanoformulated pesticides stick to bees more than conventional pesticides, and whether they are more toxic, or toxic longer. We will also examine the toxicity of nanoformulated pesticides to zebrafish in the laboratory. To understand whether nanoformulated pesticide particles can move through the environment differently than conventional pesticides, we will investigate whether bees carry more into their colonies with pollen, and how they may accumulate in and affect plants, insects, and fish in aquatic microcosms, which are aquatic communities we can observe in the laboratory. These data will help us understand whether nanoformulated pesticides behave differently in the environment, and whether we should be more concerned about their potential effects on vulnerable organisms than conventional pesticide formulations.

What has been done
We measured multiple parameters of a selection of multiple pesticide formulations including insecticides, fungicides,and herbicides. Using Scanning Electron Microscopy and hydrodynamic diameter, we found an astonishina wide range of particle sizes, beginning as small as 20 nm and approaching 10 mm. Particles shapes vary widely and may be spherical, rodshaped, irregular flakes, or other shapes. They may agglomerate without considerable dilution. Formulations may be extremely homogeneous, or a complex mix of particulates that vary in size, shape and composition.
We investigated how pH and ionic strength affect the hydrodynamic diameter(HDD) and zeta potential of encapsulated lambda-cyhalothrin and how those changes affect the subsequent exposure and toxicity to Daphnia magna under a range of environmentally relevant conditions. We found that HDD and zeta potential could be predicted as a function of pH and ionic strength (IS). The concentration of encapsulated lambda-cyhalothrin was influenced by incubation time and exposure conditions, and HDD or stability of particles. The central composite design (CCD) in this investigation provides a template for investigating and predicting NBP behavior in aquatic systems.

Results
We continued to investigate the transfer of NBP particles from foliage to bees. After probing multiple methods for this investigation, we adapted standard protocols for quantifiying residual toxicity. We applied the NBP products to intact hazelnut leave, and placed these leaves in a large petri dish, together within honey bees. After 24 hours, we prepared both leaves and bees for examination by SEM. Rovral, has little apparent potential to transfer from foliage to bees. This is interesting, given that we and others find the active ingredient in large concentrations in bee-collected almond pollen, and has been found to impact colony development in our studies. In contrast, we found that Beleaf particles can transfer from leaf to bee. The Sagili lab has analyzed bees, pollen, and other bee hive matrices during carrot pollination, and found that the active ingredient of Beleaf, flonicamid, transfers from carrot plants to honey bee colonyies and negative effects on bee development are associated with this exposure. In the case of Rovral, it is possible that the particles adhere to pollen, which is brought into the colony, while Beleaf may transfer directly to bees. These findings indicate that better understanding of NBPs may help reveal important properties th t contribute to bee and colony exposure and toxicity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Last fall, OSU was selected to administer the $1.2 million USDA Western Regional Food Safety Center, one of four in the US, to provide technical assistance, training, and outreach to help small and mid-size farms, processors, and wholesalers understand and comply with the new regulations including the FSMA.

What has been done
By spring 2017, the center?a partnership with fellow land-grant universities in 13 western states and two Pacific island territories?will have two dozen lead trainers and, later, 200 certified trainers. This network of educators, including farm and processing facility employees and Extension staff, will fan out to conduct trainings on FSMA?s produce safety and preventive controls.

The center will also draw on expertise and current food safety science at the various universities to create customized training materials and add-ons for regional specialty crops. Oregon alone has around 220 commodities, everything from hazelnuts and grapes to potatoes and blueberries, a staggering diversity that is a blessing and a challenge, says McGorrin. ?Each of these crops

has different food chemistry and food safety requirements.?

Results
As an established leader in food safety research, including work with shellfish, microbial and chemical contamination, and traceability of pathogens, OSU was an attractive candidate for the regional hub, says McGorrin. And already, researchers here are helping farmers and processors make sense of the new regulations and the practical challenges they pose.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #10

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Eastern Oregon has been working on community food systems development for a number of years but the programs have not been sustainable. By bringing together individuals and organizations that would like to strengthen our food system we can develop a more stable working group to encourage greater production and sales for local consumption, as well as

strengthening food security in our region.

What has been done
Partnering with Oregon Food Bank, OSU Extension coordinated a Gathering event for Eastern Oregon which welcomed over 50 people in a discussion of the community food system in our region. The group talked about food production, food security, food access and marketing. Participants included farmers, food bank managers, OSU Extension SNAP Ed, Crops and Small Farms agents, farm to school representatives, farmers market managers, and community gardeners.

Results
Several counties expressed an interest in developing better linkages between small and mid-scale producers and restaurants and retailers to keep more locally grown products in the region. We talked about current partnerships within the counties and ways to strengthen them. Food policy councils, community food collaboratives, and greater outreach to low income families to ensure a more health and consistent food supply are all goals for future future food systems work.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
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 #11

1. Outcome Measures

Identify Current traceability practices by small producers and processors

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The albacore tuna fishery is a sustainable fishery in which the tuna are caught one at a time on hook and line. More than most seafood, albacore needs special handling. It?s imperative to chill the flesh quickly?otherwise it develops a toxin that can cause a severe histamine reaction. This toxin has not been a problem in Oregon-caught albacore, Northwest albacore fishermen are well aware of the danger and are diligent about icing or freezing their catch immediately.

Recently, OSU food scientists found themselves in the middle of a dispute between fishermen and federal regulators over a new interpretation of a seafood-processing rule. Regulators were calling for detailed onboard recordkeeping of catch times and fish and water temperatures. They wanted documentation that the catch had been handled safely.

What has been done
Such a system is appropriate for trawlers, seiners, and large processing ships that process fish in bulk quantities. Unfortunately, Oregon's albacore fleet catches fish by hook and line, one at a time,? and the fish are typically iced or frozen within minutes.

The new rule called for a separate record for every single fish. OSU faculty members met with the fishermen and listened to their concerns. Then they traveled to Washington, D.C. and spoke to regulators at the FDA?s Office of Seafood Safety. Scientists told FDA how fish are caught here, and discussed how we could design a record-keeping system that would not be over-laborious to the fishermen.

Results
The new rule called for a separate record for every single fish. Faculty met with the fishermen and listened to their concerns and then traveled to Washington, D.C. and spoke to regulators at the FDA?s Office of Seafood Safety. They discussed how they could design a record-keeping system that would not be over-laborious to the fishermen.

Listening to both regulators and fishermen, OSU drafted a set of handling guidelines that fulfilled the intent of the new rule. She devised a simple log sheet for noting catch periods, type and effectiveness of chilling, and other pertinent records.

?We demystified the record-keeping so that we could get buy-in from the fishermen,? says DeWitt.

The economic payoff of effective regulations may be hard to quantify, says DeWitt, but it?s real. Without the simpler system, ?each vessel might have needed an additional crew member to handle the monitoring and record-keeping,? she says. ?That would clearly have been a financial burden.?

The system hasn?t been formally blessed by regulators, but they?re happy with the process used to develop it, DeWitt says. And the processors and restaurants that buy the fish?and that are ultimately answerable for its safety?are happy with the added accountability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 #12

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Expanded Food and Nutrition Education Program (EFNEP) provides practical, skill-based nutrition education to low-income families with young children. Through discussions and hands-on experiences, adult EFNEP participants learn how to improve the nutritional quality of the meals they serve their families. They participate in a series of small group sessions led by an EFNEP educator. Classes emphasizes nutrition, food shopping, and food safety while engaging participants in group discussions, cooking demonstrations, food tasting, fun physical activities, and other hands-on learning. Cost effectiveness studies in a number of states have shown that for every dollar spent on EFNEP, $3 to $10 were saved on lower health care costs and increased productivity.

What has been done

The EFNEP Las Comidas Latinas a language and specific nutrition education program serving low-income families in Linn and Benton County. Education provides immigrant families the needed support to develop life skills, including budgeting, shopping, food safety, food preparation, and basic nutrition. During 2016, 2 series of classes were held in Benton County and 5 in Linn County. An English language year round series was also implemented with Albany DHS. The series of classes is centered on the evidence based curriculum ?Eat Smart and Be Active?. Two outreach events were conducted through the Albany and Corvallis Farmer?s Market.

Results

During 2016, EFNEP reached a total of 86 adult participants, with a total reach of 339 family members.

84% of adults improved in food resource management practices
35% adults increased their daily physical activity
48% ate more vegetables
65% adults ate more fruit
95% adults improved in nutrition practices
84% improved in food safety practices
87% of participants completed their EFNEP nutrition class series

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
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
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

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

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

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 AFRI Challenge Area 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.
In 2015-16, Food Preservation programming was reported in 30 counties. There are 15 active Master Food Preserve/Family Food Education programs at this time. Most of those encompass more than one county. 382 new and veteran MFP/FFE volunteers contributed over 25,524 hours of time in 21 counties, including: Central Oregon (Deschutes, Crook, Jefferson), Clackamas, Coos/Curry, Douglas, Hood River/Wasco, Jackson/Josephine, Klamath, Lane, Linn/Benton, Marion/Polk/Yamhill, Tillamook, Wallowa and

Washington/Multnomah. They educated the public about safe food handling and preservation over the phone, at workshops, and at exhibits and demonstrations at sites such as farmers' markets and county fairs. Over 41,000 contacts were made by volunteers, faculty and Extension staff in throughout Oregon, with 3,041 of these from callers throughout Oregon receiving assistance from the Food Safety/Preservation Hotline. The Hotline is operated with volunteer assistance during the food preservation and holiday season. In addition, over 260,000 Oregonians were reached by our faculty and volunteers through radio and television broadcasts, social media sites, and newspaper articles related to food safety and food preservation topics.

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	0%		5%	
703	Nutrition Education and Behavior	30%		20%	
704	Nutrition and Hunger in the Population	10%		20%	
724	Healthy Lifestyle	10%		20%	
802	Human Development and Family Well-Being	5%		15%	
806	Youth Development	20%		10%	
901	Program and Project Design, and Statistics	10%		0%	
903	Communication, Education, and Information Delivery	15%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	6.0	0.0	2.0	0.0
Actual Paid	4.0	0.0	2.5	0.0
Actual Volunteer	1266.0	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**
65865	0	246958	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
65865	0	2184312	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
188725	0	2724359	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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	10079	7951	6082	13973

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	24	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Total grant dollars for collaborative project

Year	Actual
2016	10100000

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)
10	Develop new treatments for regulating obesity

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Oregon?s Expanded Food & Nutrition Education Program (EFNEP) assists low income families in acquiring the knowledge, skills, attitudes and changed behaviors necessary for nutritionally sound diets. Oregon currently has the 36th highest obesity rate in the nation, putting thousands of Oregonians at risk of serious health problems, such as heart disease and diabetes. National obesity rates are higher among low-income families and minorities, particularly Blacks and Latinos. This is of particular concern in the Portland Area where the Hispanic population continues to increase (3.66% in 1990 to 12.92% in 2010).

What has been done
During FY 2015 the Metro Hispanic Nutrition Education Program (Lynn Steele, Faculty and Lucy Lores and Yolanda De La Cruz, EPAs) worked with community partners to reach a total of 189 mostly Hispanic adults (during 18 groups and 147 classes), with a total reach of 1,395 family members; and 323 youth (during 14 groups and 110 classes) with a long series of culturally appropriate food and nutrition education classes in Multnomah and Clackamas Counties. Classes were provided in community centers, health department clinics, family resource centers, churches, limited income housing community centers and schools.

Results
EFNEP participants completed behavior checklists and 24-hour food trackers (adults only) at the beginning and end of the class series.

Adult Program results revealed that:

?88% of adults improved their food resource management practices
?92% improved their nutritional practices
?85% improved their food safety practices
?60% increased their daily physical activity
?51% ate more vegetables.

Youth Program series resulting revealed that:
?82% of the youth improved their diet
?48% are more physically active
?51% improved their food safety

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obesity is a major public health issue. Research shows that regular physical activity can help people maintain and lose weight, as well as help prevent, delay and control many chronic

conditions. Walking is an especially beneficial form of physical activity because it is easy to do, does not require special equipment, and is accessible. Many times, individuals are more motivated to walk if they have others to walk with them, as well as have safe, accessible, and pleasant areas to walk.

What has been done
A second year of funding was secured to continue the expansion and sustainability of Just Walk Salem Keizer? a grassroots, neighborhood-centric walking initiative in Salem Keizer. Walks offered throughout Salem Keizer were scheduled and promoted through community partners and social media. The JWSK Steering Committee strengthened relationships and assisted in establishing additional partnerships to help sustain JWSK after the grant funds end.

Results
In 2016, there were 13 weekly walking groups in Salem and Keizer led by 23 active, trained leaders; and more than 2200 individual walks were recorded.

In December, a survey was sent out to Just Walk Salem Keizer (JWSK) followers via Facebook and eNews. Fifty two people responded. Respondents reported walking an average of 38 minutes each day. Three quarters (77%) of the respondents reported that they felt more connected to the community as a result of JWSK, and 39% reported walking more. Nearly all (95%) of the respondents reported that they planned to continue walking with JWSK.

Additionally, partnerships were built to continue to foster a culture of walking. These spawned a new collaborative project to create neighborhood-centric Points of Health Wander Walk maps. Mini grant funds were also secured to complete an intergenerational walking project, whereby middle school students and older adults will work together to create at least 2 walking routes and subsequent Walkable America ?walk audit?. The routes will be included in a Points of Health WanderWalks neighborhood map. The walk audit will help raise awareness of walkability issues in NE Salem, which will hopefully lead to safer, more accessible walking infrastructure in Salem.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
724	Healthy Lifestyle
802	Human Development and Family Well-Being
806	Youth Development
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The rate of childhood obesity in Wasco County exceeds both the state and national levels. More than one in three children in our county are clinically overweight or obese, meaning they have a body mass index, or BMI, greater than the 85% percentile. Perhaps for the first time in our county's history, our children will not have a healthier life than their parents nor will they likely live as long. This Oregon Solutions project team is dedicated to reducing childhood obesity in Wasco County. The project team commits to creating a healthier built environment for our children's sake; educating and informing our community to change community norms around the importance of proper nutrition and being active; and working collectively and collaboratively to change the things we can within our own organizations and within the community to reduce the likelihood of childhood obesity. Our Oregon Solutions (OS) project team, represents a large cross-section of our community.

What has been done
his OS project team is part of ongoing efforts to reduce childhood obesity in Wasco County. Initial work began in 2013 with the measurement of percentile BMIs of children in one public elementary school in The Dalles. Higher than state average overweight and obesity rates were noted, which prompted additional inquiry. A Columbia Gorge Health Council (CCO) transformation grant was obtained through Pacific Source Community Solutions, to study the BMI percentiles of the 3 largest elementary schools in The Dalles. Those results again showed higher than state and national averages of overweight and obese children. The grant proposal was then revised from implementing a specific intervention aimed at parental education and increasing physical activity, to a much broader attempt to inform local leaders of the scope and intensity of the problem, and development of a coalition. The Oregon Solutions project team was charged to "create a community action plan that enables public sector, private sector, and non-profit organizations to agree on shared outcomes and coordinate team members' specific activities." The community action plan to reduce childhood obesity will ultimately involve actions making an impact at three levels: culture, policy and regulation.

Results
Since the DoC signing ceremony in 2015, a number of successes have occurred including: the development of a social media campaign tracking all Fit in Wasco activities on Facebook and Twitter; receipt of two grants from the Knight Cancer Foundation to support walking groups for youth and adults and healthy corner store initiatives in The Dalles; a Drink Fit program which

supports local restaurants with reduced licensing fees for agreeing to discontinue free-refills of sugary drinks and proportional pricing (the first of its kind in the nation); exploration and application to Blue Zones for the City of The Dalles; receipt of grants to fund sidewalks in the city of Mosier; receipt of the Robert Wood Johnson Foundation Culture of Health Prize; the Dalles Youth Center kicking off their capital campaign and raising $225,000 in the first two months. OSU Extension staff under my direction began the Community Meal & Cooking Class in direct response to these needs for greater nutrition education. A further success was the elevating of the Food Hero campaign among many partner agencies and the institutionalization of the 5-2-1-0 campaign to promote consumption of 5 servings of fruits and vegetables, limiting screen time to no more than 2 hours, 1 hour of physical activity, and 0 sugary drinks. In the spring of 2017 the BMI studies will be repeated to see what effect this panoply of efforts has had on the local community.

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
2016	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 th t if miRNAs in milk exosomes are absorbed following consumption, it will affect adipogenesis via reprogramming of stem cells.

What has been done

To test this we will run three separate experiments Experiment 1, ten weaned pigs (5 weeks of age) will be randomly assigned to receive whole cow milk (750 mL/day) or liquid sucrose in addition to the normal diet for 3 months. At the end of 3 months, pigs will be euthanized and stem cells from
the fat tissue will be harvested to see the capacity to become fat cells and the whole transcriptome sequencing. For Experiment 2, one dairy cow will be infused intravenously with a saline solution containing an isotope tracer (13C-glycine) for 12h between two milkings. Milk from the cow will be fed to three piglets and used to isolate exosomes. Whole blood from the piglets will be collected at 1, 3, and 6h after feeding and exosomes isolated. miRNAs will be extracted from exosomes. Stem cells from the fat tissue will be isolated 12h after feeding to extract miRNAs. The horizontal transfer of miRNAs containing the isotpe from milk, blood, and stem cells will be assessed by measuring isotope enrichment in samples using liquid chromatography-tandem mass spectrometry. For Experiment 3 milk from the experiment 1 will be collected monthly to isolate exosomes and extract RNA. Whole blood from the pigs will be collected and exosomes isolated to extract RNA. The extracted RNA will be used to measure type of miRNA . To infer effects of isolated miRNAs on transcriptome of stem cells from the fat tissue, data from Experiment 3 will be combined with data from Experiment 1 using bioinformatics approaches. To determine direct effect of milk miRNAs on stem cells from the fat tissue, stem cells will be cultivated with exosomes isolated from the milk for 6h and transcriptome measured and the formation of fat cells assessed.

Results

This project has just been initiated and initial results will be available in 2017.

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

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Schools are well-suited to play a critical role in childhood obesity prevention by providing opportunities for students to learn healthy eating and physical activity behaviors, and by providing a supportive environment in which to practice these behaviors. The School Physical Activity and Nutrition Environment Tool (SPAN-ET) was developed and pilot-tested to assess school resources and readiness to improve nutrition and physical activity environmental factors (policy, built, and situational). This integrated postdoctoral project addresses the program area of food safety, nutrition, and health and the challenge area of childhood obesity prevention. The project goal is to enhance our capacity to evaluate school-level factors that facilitate healthy lifestyle habits among elementary school-age children.

What has been done
The project objectives are to: 1) evaluate the reliability, validity, and utility of the SPAN-ET nutrition component; 2) develop resources to enhance the utility of the SPAN-ET for schools and stakeholders; 3) create training modules to improve adoption and implementation of the SPAN-ET; and 4) design a graduate-level course on policy, systems, and environmental influences on children's healthy eating and physical activity behaviors. Mentorship and professional development activities will facilitate the project director's transition to career independence by advancing skills in research design and analysis, project management, novel course design, and translation of obesity prevention research into practice."

Results
This project was just recently initiated. Results will be presented in 2017.

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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The health of Oregon?s South Coast puts residents at serious risk for chronic disease. Coos and Curry counties rank 28th and 29th respectively out of 32 Oregon counties (2013 County Health Rankings). Mortality and morbidity rates are higher in both counties than Oregon state rates or the National benchmarks. Nearly 60% of the population is aged 18 to 64, 22% over age 65, 10% over 75, and 3% over 85 years. With the median age of 47.4 years, 95% of Coos and Curry county residents are adults who are at risk for chronic disease.

According to the CDC, about half the US adults (47%) have at least one risk factor for chronic disease and 90% consume too much sodium from processed foods. The economic costs associated with chronic disease are immense. Greater than 86% of health care spending is used for treatment of adults with chronic disease. The fact that Coos and Curry counties? rates are

higher than national rates is even more alarming. But the CDC also notes that heart disease, stroke, cancer, diabetes, obesity and arthritis are all preventable forms of chronic disease. Lifestyle, and particularly diet, can have a serious impact on either causing or preventing these conditions.

What has been done

Project LEAP (Lifestyle, Eating, Activity & Progress) is a 30-day community-based lifestyle medicine program. It was modeled after the gold standard, CHIP (Complete Health Improvement Program), and was designed to lower risk factors for chronic disease using whole food. CHIP, created by Dr Hans Diehl of Loma Linda Lifestyle Medicine Institute, has demonstrated clear reversal of chronic disease with diet and activity using 30 years of data including pre and post blood labs and other metrics.

LEAP is similar in design to CHIP, including plant-based meals, nutrition education sessions and pre/post health screens. Where LEAP differs from CHIP is that it includes a series of hands-on activities to help participants adopt the plant-based lifestyle. Where CHIP education sessions are prerecorded, LEAP sessions are live and interactive. Participants engage in nightly meal preparation and food demonstrations. They prepare book and video reviews which they present to their classmates and they practice their skills with case studies, games and discussions.

Results

Every one of the 19 participants showed improvement in at least one parameter from pre to post health screenings. The average weight loss was 5.6 pounds with variation from 0 pounds lost to 2 participants losing 12.4 pounds. Waist circumference also varied from 0 inches to 5? lost. Moderate reductions in systolic/diastolic blood pressure were noted. The average cholesterol dropped 15 points, with LDL and VLDL also dropping. HDL raised slightly with is a desirable effect. Triglycerides lowered by an average of 14 points and blood sugars went down an average of 9.5 ml/dl.

For each factor, we compare the post-pre difference yielded by LEAP with that by CHIP. For 8 out of the 9 factors considered, the data suggests no significant difference between LEAP and CHIP in their average effects. For blood sugars, however, CHIP shows a borderline significant advantage over LEAP. This demonstrates that an Extension version of a lifestyle medicine program can be as effective as the model, CHIP. In addition, Extension FCH was able to offer the program at a cost 46% less than CHIP, increasing opportunity for lower-income, or fixed-income participants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
703	Nutrition Education and Behavior
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Washington County has higher than average chronic health incidence of obesity in youth, according to the last Community Health Assessment. Reducing childhood obesity through community health interventions is one strategy used presently in public health, and one of interest to OSU students who must obtain internships during the senior year in public health/exercise science/community health. Local partners have standing outreach to locate youth mentors to serve youth during summer.

What has been done
Community partners constructed a set of summer program experiences which would engage students in addressing local needs for both more access to food for youth during the summer months and regularly staffed opportunities for physical activity. Partners included City of Hillsboro Parks and Recreation, Boys & Girls Club. Four OSU seniors in public health staffed nine weeks of summer feeding programs and physical activity programs in two Hillsboro Parks and the Inukai Boys & Girls Club. Students used evidence-based interventions and created activities using best practices to engage parents and students during park and club hours. Activities included Super Hero training (regular physical activity), assisting with summer lunches and science exploration, as well as food tastings of nutrient-dense recipes for park guests. Students maximized their internships by identifying public health staff from sanitarians to epidemiologists to interview, reviewing current practices for work with youth, and checking the health statistics and goals in the Community Health Improvement Plan.

Results
Interns contributed over 1400 hours of support to the health of Hillsboro residents. The Outpost at Shute Park and Shadywood Park contacts were the most popular, with daily physical activity

offerings. College of Public Health and Human Sciences feedback indicated that these joint placements were beneficial to students, as a model at variance with single placements. Follow-up with partners confirmed all want to offer this joint programming again in 2016.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Early adolescents consume 63%?65% of their daily calories at home , making the home and family environment an important target for interventions to improve diet quality and prevent obesity. Parental behaviors forming part of the home and family environmental sphere of influence within the Socio-Ecological Model include practices, such as making healthy foods available, establishing expectations for healthful food consumption, and setting a good example. These practices have been positively associated with overall diet quality of youth. A similar set of parenting practices has been identified regarding influence on youth physical activity behaviors including modeling, providing support for physical activity in the home environment, and establishing rules or expectations for physical activity. A review of physical activity parenting practices for early adolescents was beyond the scope of the current review, which was focused primarily on eating behaviors.

What has been done

This review (1) characterizes early adolescent eating behavior by describing eating occasions with respect to frequency, intake (energy, nutrients, foods and beverages), and eating context

(location, time of day, who is present) with an emphasis on independent occasions; (2) describes the influence of parenting practices on eating behaviors in general and as it pertains to independent eating occasions; and (3) suggests future research needs to inform parenting interventions targeting obesity prevention among early adolescents focusing on independent eating occasions.

Results
Implementation of food-related parenting practices during occasions when parents are present and during independent eating occasions may be reliant on parent and household demographic factors including race/ethnicity and degree of acculturation. For example, the availability of healthy or unhealthy foods in the home could vary based on diet transitions to more Western foods and fewer traditional foods after immigration. Analysis of food sources of calcium showed differences among foreign-born versus USA-born Asian or Hispanic parents and early adolescent children. These findings indicate that some families may prefer to retain aspects of their culture-of-origin identity, with implications for implementation of food-related parenting practices. Several studies have found differences in home availability of healthful and less healthful foods between race/ethnic groups. However, few studies have examined differences in frequency of other parenting practices such as role modeling or setting expectations/rules and none during independent eating occasions.

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 #10

1. Outcome Measures

Develop new treatments for regulating obesity

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

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 if 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. The project team is applying 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 is also determining 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. The project has examined what environmental and social factors predict how groups (e.g. communities, schools, families) and/or individuals (e.g. mothers, family food providers, etc.) make long-term positive changes in dietary patterns, healthy eating and physical activity (PA) behaviors for obesity prevention and reduction of chronic disease risk. Finally, we determining the impact of diet (types of foods) and levels of PA intensity on appetite, food selection and weight management.

Key Items of Evaluation

Research is needed to determine strategies to increase taste preference or liking for low energy dense foods, especially vegetables and whole grains. Decreased rates of home meal consumption and cooking, and increased popularity of non-vegetable snacks, sweetened beverages, and processed grains have diminished the incorporation of these healthy foods into our diets. In addition, children's lack of exposure or familiarity with these foods, limited opportunity to gain experience in developing likeness, and an unwillingness to try healthy food options also reduce intake. Encouraging these foods will require increasing awareness of preparation that meets time and cost limitations of families, is culturally acceptable, and that can be readily incorporated into meals and snacks. This includes having healthy foods consumption role modeled within households and among peers, and

having access and availability of those foods in the household and at school.
Families also live in communities, where the opportunities to be active and grow and select healthy foods are important. Rural communities provide an excellent context in which to examine the fruit and vegetable consumption patterns of youth at risk while also engaging youth in productive work within their own communities. By engaging low-income youth in the construction and maintenance of gardens and in harvesting and marketing organically grown produce, we have found that youth not only consume more produce, but they also become more visible and engaged in their communities. Although youth garden projects initially may not produce enough vegetables to provide a living wage for more than one or two youth, the Producing for the Future Project has found that the increased visibility of the youth participants at the local farmers market can lead to other economic opportunities for youth. Further, mentorship from supportive adults within their own community can encourage youth at risk to stay in school and may even open avenues to higher education.
Community youth gardens may be both a strategy for developing collaborations in rural communities while also providing exposure to produce, nutrient dense foods that can serve to prevent the development of overweight and obese in our youth. Familiarity with the process of growing vegetables potentially increases the consumption of such items. Developing gardens that target low-income youth within communities has the

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
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)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.