

2009 Washington State University Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

This was both a challenging and a productive year for the scientists in the Washington State University (WSU) Agricultural Research Center (ARC), the Agriculture Experiment Station of Washington State University. Once again, ARC faculty and staff as a group have the largest amount of research grant expenditures for an organized group at WSU, \$30.3 million, obtained from various federal sources, state sources, crop commissions, industry, etc.. These funds cover work in a myriad of subject areas and the individual projects approach the work from a variety of perspectives. Washington state agriculture is more diverse than that of many other states, partly as the result of the different climate and soil conditions found in the state, partly because of its emphasis on meeting agricultural needs of both domestic and export markets. This report outlines a few of our major successes and documents the adaptation of the ARC and CAHNRS in response to constraints and opportunities.

The most significant of the constraints has been a decreased state budget. At one point, we were projecting a cut of approximately 20% but the final cut was buffered by a substantial tuition increase and was about 9%, with more to come in 2010. Although research was spared the larger cut, the saving justification that researchers are important in the teaching missions of WSU is likely to mean over the long term that our research faculty will ultimately have a larger fraction of their appointments in instruction. The budget issues led to the transfer of the Statistics faculty in the College of Agriculture, Human and Natural Resource Sciences (CAHNRS) to the College of Sciences, plans to eliminate the Department of Community and Rural Sociology in July, 2010, and decreased allocation of resources to selected programs within CAHNRS. As a consequence of previous cuts, WSU Extension was moved back into CAHNRS and reworking of the integration of Research and Extension is underway.

Researchers on the Pullman campus, at the WSU Research and Extension Centers and at field locations throughout Washington State are engaged in over 300 projects that address the needs of Washingtonians and the nation. Our goal is to develop and leverage basic science to ensure that our farms and industries can compete in the global economy with quality products, to protect the security of our food production, processing and distribution systems, to keep our population healthy and well nourished, to protect our natural resources and environment, and to enhance economic opportunity for individuals, businesses and communities. Our work is of high quality; WSU was listed among the top 25 schools in the world on the basis of citation impact in agricultural science by Science Watch newsletters and various plant and animal science WSU programs based primarily in CAHNRS were highly ranked in a 2007 survey published in the Chronicle for Higher Education.

At another level, WSU scientists secured almost 20% of the funds allocated under the 2009 USDA Specialty Crop Research Initiative and participated in grants that were awarded over 40% of the funds. Because the SCRI competition is structured to favor projects with substantial industry support and well integrated Research and Extension activities, we take this funding as evidence that we have research programs that are directed toward the needs of our stakeholders, at least in these areas of production agriculture. This has been especially rewarding to the tree fruit industry, which has invested heavily in the development of increased capabilities in Horticulture over the last several years. Also notable was the hiring of two new wheat breeders to replace accomplished breeders who had taken administrative positions. The combination of their capabilities gives us an unusually deep team in a area where we had become overextended.

Washington State has been a leader in developing practices to support sustainable agriculture, including low erosion cultivation techniques, ways to minimize pesticide and herbicide use, and breeding for disease and pest resistance. The state has also been innovative in supporting scientific research in organic production techniques and in implementing value added marketing based on organic and limited input production systems. While some of this work has been carried out under the umbrella of the Center for Sustainable Agriculture and Natural Resources, much of it is integrated into our routine research goals. An example of this is the WSU Decision Aids system for making real time integrated pest management decisions for the tree fruit industries that is based on an expert system model developed by our scientists that integrates weather and other local data with insect growth rate and pesticide properties to advise whether or when to apply materials (<http://entomology.tfrec.wsu.edu/das/>). One test of our capabilities in this area is on the horizon, with the sighting of the spotted wing Drosophila in Washington State (sanjuan.wsu.edu/Documents/SWD11.09.pdf). This fly can oviposit on intact developing fruit, like berries and cherries, making it a potential threat to major local industries.

Researchers have adapted their programs to focus more on aspects of biofuels, biomass, and bioproducts research of particular relevance to the state. These include projects to add value to straw and other waste products, to improve the yield and stability of crops like poplars that have been identified as a potential energy crops well suited to this region and produce useful materials from various waste streams associated with food and fiber production. However, Washington is unlikely to be a major biofuels contributor in the future by growing crops for ethanol production, since this use probably will not compete

well with the value of the specialty crops that are grown in the state, according to a team led by Jon Yoder (see <http://wsm.wsu.edu/2009/Spring/biofuels-strategy.php>) which makes the point that the state's current major ethanol crop, wine grapes, is worth much more as wine than as fuel. This study, commissioned by the state legislature, focused on the fit between various public policy objectives related to energy use and availability. By stepping back and separating longer term goals from the short-term fluctuations in the energy and agriculture markets, their report is likely to be useful in setting up incentives for lower energy use. Our contributions to bioenergy are more likely to be in areas like pyrolysis of mixed lignocellulose feedstocks or anaerobic fermentation, which are foci WSU Center for Bioproducts and Bioenergy. In addition to the scientists now being recruited to the Center in Richland, considerable expertise exists at the main campus in Pullman. Another focus has been in the generation of higher value biofuels, such as those needed for aircraft. These fuels must be more energy dense than ethanol and their generation from plant materials will require plants to produce more lipids, terpenes and phenylpropanoids, areas of metabolism that are represented by strong programs in the Institute of Biological Chemistry. The Composite Materials Engineering laboratory is studying how to use carbohydrate and polyalkanoate biopolymers in fabricating plastics and coatings.

The buildings being constructed on the WSU main campus and at field stations contribute to the excitement in research. The Vogel Plant Biosciences Building was opened in 2007. Funded by the state legislature, the 93,000 square foot, four story structure is located next to several older buildings in the CAHNRS precinct of the WSU Pullman campus and it contains many facilities, like climate controlled rooms and high tech laboratories, which were difficult to install in the older buildings. Space in Vogel was allocated by the need for these new facilities and not by departmental unit and there has been a secondary but important effect of mixing faculty from different areas. Vogel is the first of a planned complex of seven interconnected buildings devoted to the Life Sciences. A second building opened in summer, 2009, and houses the School of Molecular Biosciences from the College of Sciences. Funds are being identified for a second plant sciences building, especially to increase the facilities available to federal scientists. The objective is to bring state and federal scientists with both fundamental and applied research orientations closer to each other physically in order to promote collaboration in various areas of life sciences research.

The reports in the Planned Program areas reflect an overview of some of the activities in 2009. However, the reporting vehicle is not well suited to describing major changes in the Plan of Work for these areas and the Program directors were advised to try to make the configuration of the report reflect the current situation rather than simply to fill in the boxes. In particular, this affects the Program in Food Science, which is merging with the Food Science department at the University of Idaho located just across the state border. This integrated department has so far been unsuccessful in finding a new chair, at least in part because the search was suspended during a recent hiring freeze. This search is in progress and we hope to move forward in this area in 2010.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	479.9	0.0
Actual	0.0	0.0	452.2	0.0

II. Merit Review Process

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

- Internal University Panel
- External University Panel
- Expert Peer Review
- Other (individual external peer reviewers from within or without the university)

2. Brief Explanation

Agricultural Research Center (ARC) project proposals are written by individual faculty members or faculty teams and these proposals are submitted first to their department chairs. The department chair reviews the submission and ascertains whether the topic of the research is consistent with departmental and College goals and, if so, sends the project proposal to internal and/or external reviewers. These reviewers are asked whether

the research represents solid science, is directed to topics of current interest, will advance the field of study, and whether the research plan is appropriate. Reviewers are invited to offer written suggestions for improvement and asked to identify the strongest and weakest points of the proposal. After comments are received from the reviewers, the chair assembles the commentary and submits it to the faculty member. If necessary, the faculty member then revises the project proposal. After examining these changes, the Chair submits the project proposal to the Agricultural Research Center where it is reviewed by either the Director or the Associate Director. After this review, the proposal is sent to USDA CSREES and reviewed by the appropriate National Program Leader. When approval is final, the approved project is entered into our database and into the CRIS system. In parallel, proposals for funding that may overlap these projects may be submitted to federal or state agencies or to commodity commissions. These proposals are reviewed and input, especially from the commissions, is often used in refocusing and in setting future research directions.

In 2008, CAHNRS participated in the university-wide Academic Affairs Program Prioritization process. While this activity focused primarily on graduate and undergraduate education, these are linked through the participation of our researchers in student training. This A2P2 process was used as a context for the budget cuts implemented in 2009 and the recommendations from this process were re-examined in detail to yield the final budgeting priorities. The overall result of these processes was a serious examination of all departments and programs and included examination of their research priorities and capabilities.

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

Brief explanation.

Stakeholders in the State recognize WSU as a major asset in their industries and are often very forthcoming with suggestions and critiques. We have web pages, our phone numbers are in plain sight and our stakeholders are used to giving both formal and informal input to the leaders of the Planned Programs and to the ARC administration. One major mechanism of interaction is through various State commodity commissions, which support research at WSU through competitive processes that tend to be biased toward projects that address relatively immediate problems. In addition to researchers, the ARC Director or his representative is often present at these sessions to help the groups understand the context of the research and to get their input into the strategic planning done at WSU related to their industry. Stakeholder input is also received by the use of various advisory committees to advise departments, centers, and programs. There is College level advisory committee as well as a college level agricultural kitchen cabinet. Both of these interact with the dean, the experiment station director, and other associate deans helping to define priorities, emerging research issues, and provide feedback on the quality and relevance of our research activities.

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

Brief explanation.

Established industries tend to have formal bodies that we have worked with through the years and many of our interactions with these industries are through these constituent groups. The situation is more complex in interacting with emerging groups, particularly if these are not organized with a component that includes research support. Often the contacts with these groups are made through specific issues, like carrying out the research to certify a pesticide for a minor crop, dealing with a land use issue that is peculiar to their industry, or determining methods that can be used locally to establish sustainable production. Much of what is done in these cases is to identify what

capabilities we have that can be useful and in trying to develop a plan to obtain or allocate resources. For various reasons, the ARC has relatively little funding or personnel that can be redirected rapidly so, especially for minor crops, it is important to see areas where resources can be shared through coalition building, often with other stakeholders or other universities.

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

Brief explanation.

We go to meetings. We answer phones and read email. We listen. Established industries tend to have formal bodies that we have worked with through the years and many of our interactions with these industries are through these constituent groups. It is more complex to interact with emerging groups, particularly if these are not organized with a component that includes research support. Contacts with these groups are often made through specific issues, like carrying out the research to certify a pesticide for a minor crop, dealing with a land use or production issue that is peculiar to their industry, or determining methods that can be used locally to establish sustainable production. In these cases we try to identify capabilities we have that might be useful and often try to develop a plan to obtain, allocate or reallocate resources. The ARC has relatively little funding or personnel that can be rapidly redirected so, especially for minor crops, it is important to see areas where resources can be shared through coalition building, often with other stakeholders or other universities. As a State institution, we also have stakeholders referred to us by the legislature or by State and county executives.

3. A statement of how the input will be considered

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

Brief explanation.

The input from stakeholders enters our research programs at several levels. Through direct funding decisions and the participation of the ARC administrators or their delegates in the funding process, we see stakeholders state their priorities and often allocate their own money to research at WSU and elsewhere. Sometimes a project may be structured to separate objectives that are more easily supported by the ARC from those that are supported by the stakeholders. The ARC takes stakeholder prioritization into account in allocating resources, such as space or positions, and we communicate our limitations to groups that often are better placed to obtain additional resources. As a State group, we are charged with responding to those who look to us for help, in so far as we can with the resources we have been allocated. In 2007, we began an internal grants program to direct resources toward Emerging Issues in Agriculture (<http://arc.wsu.edu/info/eri/index.html>). The priorities of this program were articulated with stakeholder input and stakeholders participate in the review process. In addition to the research accomplishments of the teams, the team building and preliminary data generated through this process were able to leverage considerable outside funding. Generally, this kind of project expansion pleased the stakeholders.

Brief Explanation of what you learned from your Stakeholders

The overwhelming message is that stakeholders want more help in research and its applications. Especially because Washington State agriculture is so diverse and has so many minor crops, the research capability at WSU can be a key to bringing new crops to profitability under local conditions. Historically, this has meant breeding more productive wheat varieties, developing methods for controlled atmosphere storage, choosing wine cultivars suited to particular sites, and developing procedures for organic and sustainable agriculture. Conflict can arise when this

broad need meets the limited resources available. Specifically with regard to programs like SCRI, our stakeholders whose industries were able to obtain funding through the SCRI matching mechanism were pleased with the growth of their investment in research. There are two other categories of stakeholders, those who invest in research but did not receive substantial leverage and those who do not invest much in research. The first is pressuring our researchers to do better,; the second may be considering more research investment because they now see themselves at a competitive disadvantage.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	3889358	0

2. Totaled Actual dollars from Planned Programs Inputs				
Extension			Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	3826516	0
Actual Matching	0	0	29803495	0
Actual All Other	0	0	28490165	0
Total Actual Expended	0	0	62120176	0

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

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Program in Animal Science
2	Program in School of Food Science
3	The IMPACT Center
4	Western Regional Plant Introduction Station (W-006)
5	Program in Plant Pathology
6	Program in Economic Sciences
7	Program in Statistics
8	Program in Community and Rural Sociology
9	Program in Agricultural Animal Health
10	Program in Fruit and Vegetable Development, Production and Management
11	Program in the Post Harvest Quality of Fruits and Vegetables
12	Program in Environmental Horticulture
13	Program in Entomology
14	Program in Natural Resource Sciences
15	Composite Materials and Engineering Center (formerly Wood Materials Eng. Lab)
16	Program in Biological Systems Engineering
17	Institute of Biological Chemistry
18	Program in Crop Genetics and Breeding
19	Program in Sustainable Crop and Soil Management
20	Global Food Security and Hunger
21	Climate Change
22	Sustainable Energy
23	Childhood Obesity
24	Food Safety

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Program in Animal Science

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation			5%	
301	Reproductive Performance of Animals			25%	
302	Nutrient Utilization in Animals			15%	
303	Genetic Improvement of Animals			5%	
304	Animal Genome			10%	
305	Animal Physiological Processes			10%	
307	Animal Management Systems			5%	
308	Improved Animal Products (Before Harvest)			10%	
311	Animal Diseases			5%	
701	Nutrient Composition of Food			5%	
722	Zoonotic Diseases and Parasites Affecting Humans			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	0.0	12.0	0.0
Actual	0.0	0.0	17.2	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	89922	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	2217312	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	435420	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

We have: (1) Evaluated nutritional, physiological and genetic mechanisms for differences in the use of dietary energy for growth, lactation and animal maintenance, (2) Evaluated sources of feedstuffs and methods of processing for enhanced rumen function and productivity in animals, (3) Searched for candidate genes and DNA markers for improved quality and yield of meat in beef cattle, (4) Searched for candidate genes and DNA markers for enhanced reproduction and nutrient utilization in dairy and beef cattle and for susceptibility or tolerance to animal disease, (5) Developed new approaches and investigate the molecular and biological regulation of germ and somatic cells in mammalian spermatogenesis, (6) Defined the underlying mechanisms responsible for the hormonal regulation of somatic tissue growth and development in rainbow trout and other species. (7) Developed mathematical models to better understand and evaluate factors related to metabolism in the lactating dairy cow, (8) Obtained gaseous and particulate emissions data from cattle feedlots and provide credible scientific information for making air quality policy decisions, and (10) Determined the basic molecular mechanisms regulating skeletal muscle growth and differentiation.

2. Brief description of the target audience

In general, the target audience for the program includes consumers of food products produced by the livestock industry. However, the pathway of information from our research program includes commercial and seed stock producers in the dairy, beef, swine and sheep industries. It also includes companies that produce feeds, pharmaceuticals, and consulting to these industries. A significant biomedical component exists where fundamental research conducted in the basic science areas especially have application to human medicine and its allied industries. Government agencies are also a target audience as research outcomes can and have been used to establish public policy and regulatory actions involving livestock production.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	2300	4500	1200	2200
Actual	2300	4500	1200	2200

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

Patent Applications Submitted

Year: 2009

Plan: 1

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	4	23	
Actual	5	32	37

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	23	35

Output #2

Output Measure

- Graduate Students supported by Agricultural Research Center and other grant funds

Year	Target	Actual
2009	5	7

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Enhanced understanding of nutrient utilization and mechanisms of nutrient use by animals.
2	Enhanced food quality, food safety, consumer acceptance of foods from animal sources and issues of animal and human health.
3	Identification of strategies to decrease the environmental footprint from livestock systems.
4	Enhanced reproductive efficiency of livestock.
5	Enhanced understanding of mechanisms associated with growth and differentiation of muscle cells and adipocytes.

Outcome #1**1. Outcome Measures**

Enhanced understanding of nutrient utilization and mechanisms of nutrient use by animals.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	3	6

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Identifying ways to increase the efficiency of nutrient utilization will enhance the sustainability of livestock operations from financial and environmental perspectives. Projects contributing new information to understanding genetic links associated with nutrient use in animals are valued by the animal production and allied industries. Work in this area is also currently supported by external competitive grants.

What has been done

Projects are implementing techniques to study metabolic activity and regulation at the subcellular level. As an example, gene expression techniques are being used to study lipolysis and lipogenesis in lactating cows and mitochondrial energy expenditures in beef cattle at various stages of production.

Results

4 refereed journal articles, 1 presentation at international conferences, graduate student training.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
701	Nutrient Composition of Food

Outcome #2**1. Outcome Measures**

Enhanced food quality, food safety, consumer acceptance of foods from animal sources and issues of animal and human health.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	11	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Projects are of immediate importance to consumers and producers as they impact food safety, food quality, and animal and human health issues. Results are used and valued by commercial beef industry in prevention of beef measles, by leaders in livestock production using genomic technologies for breeding and selection decisions, and by consumers making informed decisions about the quality and safety of the meat they consume. External support for this work further identifies its relevance to industry.

What has been done

Methodology to quantify fatty acids associated with meat quality has been developed and is currently evaluated for commercial applications. Identification of genetic markers that are associated with meat quality traits and animal health are being investigated. Management strategies to reduce the incidence of a costly feedlot parasite are being defined.

Results

8 refereed publications, graduate student training.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals
304	Animal Genome
308	Improved Animal Products (Before Harvest)
722	Zoonotic Diseases and Parasites Affecting Humans

Outcome #3

1. Outcome Measures

Identification of strategies to decrease the environmental footprint from livestock systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	3	4

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

The ability to quantify and monitor inputs and outputs of livestock systems is essential for sustainable production. The impact of livestock systems on water and air quality are being addressed in several projects having direct impact on the production systems as well as social impact to the community. Projects are also supported with competitive external federal funds. New IGERT grant focusing on nitrogen will enable expansion of efforts and graduate student training.

What has been done

Novel techniques to measure emissions from livestock units have been developed and results are being used in establishing federal and international regulatory guidelines. Precision feeding strategies have been designed to meet animal nutrient requirements while minimizing excretion of minerals. Education tools available to mass audiences nationally, are being developed to aid producers in whole farm nutrient balance practices.

Results

3 refereed publications, input to state and national policies,

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
302	Nutrient Utilization in Animals

Outcome #4**1. Outcome Measures**

Enhanced reproductive efficiency of livestock.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	6

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Reproductive performance and efficiency has many impacts on sustainable livestock production. Projects are designed to identify factors stimulating and mechanisms associated with both male and female germ cell differentiation. Impacts of this work may influence the breeding practices and reproductive performance in livestock operations producing meat and milk. Other work is designed to identify ways to manage reproduction, which has immediate impact to the cattle feedlot industry as well as domestic animals, pets and wild species animal industries. This work is also funded by external grants and industry support.

What has been done

Bovine testis xenografts have been successfully used to identify factors stimulating germ cell differentiation. In vitro culture requirements for porcine and bovine uterine and testicular fibroblasts were identified and will provide necessary information for future work. A vaccine has been developed that effectively controls the reproductive hormone cycle and thus prevents pregnancy. New faculty studying early pregnancy recognition and implantation has gotten off to fast and funded start. New strength to this area.

Results

5 refereed publications., graduate training.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
303	Genetic Improvement of Animals
304	Animal Genome

Outcome #5

1. Outcome Measures

Enhanced understanding of mechanisms associated with growth and differentiation of muscle cells and adipocytes.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	4	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endocrine control and cellular mechanisms regulating growth of muscle and adipose cells provide important new information relevant to animals and humans. One project is designed to study the role of myostatin in regulating muscle growth in rainbow trout. Another project studies the regulation and differentiation of adipocytes in the study of fat accretion in domestic species. Projects in this area have potential to make important contributions to human growth and development as well. Work in this project area is also supported with external competitive grants and industry support.

What has been done

Mechanisms of action and regulation have been identified leading to more complete understanding of muscle growth and development and adipogenesis

Results

8 peer reviewed publications, graduate training

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals

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

Brief Explanation

There are many factors that will affect the outcome of our expected research program, but the most important is the availability of funding primarily at the federal level, and to some extent from companies that are interested in utilizing or marketing results of our research program. We are not expecting support from state government except for facilities and salaries for research technicians, graduate students, and secretarial support. We would like to receive more financial support from our commodity stakeholders. This support, which has not been strong in the past, could enhance our research efforts. Facility upgrades are very important to the conduct of our research. A new 400-cow dairy has been discussed which would greatly enhance our ability to conduct large-scale trials in this important industry in Washington State. This discussion has been stalled given current budget challenges at state and university levels. We also are being encroached upon by other university entities at our beef cattle feeding and reproduction research facilities on the campus. These facilities along with our feed mill and farm shop need to be moved to Tula Young Hastings farm to be with our other animal facilities.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)
- Other (See below)

Evaluation Results

Research programs will be continuously evaluated to determine their effectiveness and probability of reaching the stated objectives. The evaluation will include annual written progress reports, quality and quantity of publications and evaluation of continued funding resources.

Key Items of Evaluation

There is an accounting of grants submitted, grants funded, and peer review publications. The faculty are reviewed on their annual accomplishments reports, and their department summaries.

V(A). Planned Program (Summary)**Program # 2****1. Name of the Planned Program**

Program in School of Food Science

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
501	New and Improved Food Processing Technologies			25%	
502	New and Improved Food Products			14%	
503	Quality Maintenance in Storing and Marketing Food Products			11%	
702	Requirements and Function of Nutrients and Other Food Components			25%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			25%	
Total				100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	23.0	0.0
Actual	0.0	0.0	23.3	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	71532	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1595803	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	868874	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

In recent years, the cost of production and competition from international players in conventional agricultural commodities has increased. Washington producers, because of logistics, cost of production, and increasing environmental and regulatory requirements, are becoming less competitive in many commodity markets. The School of Food Science is providing scientific and

technical information that will assist producers and processors to develop profitable new foods and new markets for healthy foods. Health-promoting functional foods will include foods that can reduce the risk of cancer and provide healthy food choices. Furthermore, the College of Agricultural, Human and Natural Resources Sciences is poised to provide this assistance to the state agricultural community by building upon existing strengths within the College regarding the production, processing and utilization of a variety of important food products as well as in the area of sustainable organic agriculture and consumer education. The presence of WSU Extension throughout the state and its programmatic emphasis on safe foods and public health will bolster community outreach aspects of the food science program.

2. Brief description of the target audience

Food producers, processors, packers, peers, professionals, industry, and consumers.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	5	3	0	0
Actual	5	5	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 4

Actual: 2

Patents listed

A novel enrichment broth to improve detection and isolation of *Enterobacter sakazakii* from infant formula.

Peptone for bacterial growth from fish hydrolysate.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	4	30	
Actual	3	34	37

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal publications

Year	Target	Actual
2009	24	34

Output #2

Output Measure

- Graduate students supported by experiment station funding and grants

Year	Target	Actual
2009	12	13

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Investigation of rapid detection systems for food contamination.
2	Investigation of novel food processing and storage methods
3	Scientists and companies would use the information we have published to further their research and food production practices
4	Rapid detection systems move to a pilot plant testing phase.
5	Information in published research is incorporated into production practices thus improving the safety of the food supply.
6	Novel rapid detection methods for food pathogens become available to the food and processing industries improving the safety of the food supply

Outcome #1

1. Outcome Measures

Investigation of rapid detection systems for food contamination.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Food industries and food safety issues affect everyone.

What has been done

Development of a rapid method of detection for food contamination.

Results

Using the new methods we can save more than 23 hours in measuring E. coli numbers in foods. We are working to establish a more stable procedure, however, the current method is very promising and helpful for both food safety and quality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #2

1. Outcome Measures

Investigation of novel food processing and storage methods

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The food industry to improve food quality and safety.

What has been done

Effect of microwave radiofrequency, ultrahigh pressure and pulsed electric fields on food safety and quality.

Results

Improve safety of produced food products for the consumer.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #3

1. Outcome Measures

Scientists and companies would use the information we have published to further their research and food production practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	10	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Improving the safety and quality of food. Encourage foreign governments to improve food safety and defense programs and to assist them to comply with provisions of international law.

What has been done

Improve instrumental methods for detection and quantitation of food constituents and prediction of food quality; including physiological factors that impact productive competence. Assess the effects of processing and packaging treatments on microbial survival in food during storage. Study regulatory and market forces that impact the production of safe food and trade, particularly factors involving food defense and food security.

Results

This is the first research group in the world to spectroscopically characterize microbes in the injured state and be able to differentiate the type of damage sustained by microbes from heat, pH shock, chemical treatments, and stress from changes in ionic strength. This is also the first to use spectroscopic techniques to monitor changes in reproductive status of fish by measuring changes in plasma hormone levels and lipid transport proteins. This work is the basis for international collaborations. New strategies have been developed for microbial control in minimally processed foods.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #4

1. Outcome Measures

Rapid detection systems move to a pilot plant testing phase.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Development of a new rapid method for the estimation of Escherichia coli in foods. The detection methods developed are very useful for the food industry to prevent contamination and results can be determined much faster.

What has been done

Evaluated a unique enzyme of E. coli for rapid monitoring of the microorganism in food. Determined specifics of certain enzymes formed by residual chymosin during ripening of semi hard cheese. Further investigation

continues to determine newer more novel and faster methods.

Results

Continue to work on developing a 10-15 minute rapid method to enumerate E. coli in foods. Elucidation of peptidase activities on casein derived bitter peptides may allow specific manipulations of lactic acid bacteria resulting in decreased ripening times and increased quality of cheese.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #5

1. Outcome Measures

Information in published research is incorporated into production practices thus improving the safety of the food supply.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The food industry in Washington State, the US and all consumers.

What has been done

Training in Hazard Analysis Critical Control Points, safe quality foods, food sanitation and Good Agricultural Practices (GAPs). Research on food microbiology is included into these programs.

Results

Safer food production which translates to a safe food supply for consumers. Changes in food handling and packaging processes in the industry to prevent foodborne illness.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #6**1. Outcome Measures**

Novel rapid detection methods for food pathogens become available to the food and processing industries improving the safety of the food supply

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	2

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Development of a new rapid method for the estimation of Escherichia coli in foods. The detection methods developed are very useful for the food industry to prevent contamination during processing and results can be determined much faster and not slow down production.

What has been done

Evaluated a unique enzyme of E.coli for rapid monitoring of the microorganism in food. With conventional methods it took about 24 hours measuring E.coli numbers in food.

Results

Using these new methods, 23 hours of time can be saved in the measurement of E. coli in food. This will be very helpful for food safety and quality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

With federal grant funding on the decline and commodity commission funding down, limiting resources affected not only our research programs and ability to recruit new graduate students, but also our ability to carry out our ongoing research. A hiring freeze, including the failure to complete the search for a new Director of the WSU-UI School of Food Science, has prevented the school from moving forward and determining the areas of research most important to the state, nation and internationally. Current cutbacks to our programs will also affect how we determine strategies for the school to remain competitive in dealing with current research issues. Several of our senior faculty will be retiring in the next couple of years and we are concerned that cutbacks will affect our ability to fill these positions and that we will be forced to limit our research efforts in order to concentrate on teaching our courses. Resolution of these issues will determine the future direction of our Program.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- null

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

The IMPACT Center

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
501	New and Improved Food Processing Technologies				
502	New and Improved Food Products				
603	Market Economics				
604	Marketing and Distribution Practices				
606	International Trade and Development				
607	Consumer Economics				
609	Economic Theory and Methods				
610	Domestic Policy Analysis				
611	Foreign Policy and Programs				
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins				
Total					

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	15.3	0.0
Actual	0.0	0.0	0.0	0.0

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

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

V(D). Planned Program (Activity)**1. Brief description of the Activity**

The IMPACT Center has merged in with the School of Economic Sciences and hence no longer exists. We will not be reporting on this planned program separately from the Program in Economic Sciences..

2. Brief description of the target audience**V(E). Planned Program (Outputs)****1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	1500	2000	0	0
Actual	0	0	0	0

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

Year: 2009

Plan: 1

Actual: 0

Patents listed**3. Publications (Standard General Output Measure)****Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	5	20	
Actual	0	0	0

V(F). State Defined Outputs**Output Target****Output #1****Output Measure**

- Peer reviewed journal articles

Year	Target	Actual
2009	20	0

Output #2**Output Measure**

- Graduate students supported by experiment station and grant funding

Year	Target	Actual
2009	6	0

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Scientific Publications
2	Graduate students and post-docs trained
3	Research Support increased in percent.
4	Developmental Research Advanced (percent).
5	Improved research Quality in percent.

Outcome #1

1. Outcome Measures

Scientific Publications

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Graduate students and post-docs trained

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Research Support increased in percent.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Developmental Research Advanced (percent).

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Improved research Quality in percent.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- During (during program)
- Comparisons between program participants (individuals, group, organizations) and non-participants

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 4****1. Name of the Planned Program**

Western Regional Plant Introduction Station (W-006)

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			5%	
202	Plant Genetic Resources			75%	
206	Basic Plant Biology			5%	
211	Insects, Mites, and Other Arthropods Affecting Plants			5%	
212	Pathogens and Nematodes Affecting Plants			5%	
215	Biological Control of Pests Affecting Plants			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.5	0.0
Actual	0.0	0.0	5.6	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	449881	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	25544	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	21448	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

We shall acquire and conserve specific germplasm, and manage associated information. The outcome is the continued provision of quality germplasm of the species maintained by W-006 and deliver it to researchers. From the utilization of this germplasm both basic and applied research will result. This includes new cultivars, production of genetic maps, analyses of diversity, new medicinal plants and ornamentals. We shall characterize germplasm, using morphological and molecular markers to enhance

conservation management, increase utilization of collections, and incorporate the genetic data into public databases. We shall reduce genetic drift in heterogenetic accessions, through sampling procedures that maximize effective population. This information will be applied to regeneration programs to provide cost effective methodology to maximize effective population size during regeneration of species and accessions. We shall genotype germplasm collections for diversity analysis and duplication. Results will provide the basic information needed to characterize germplasm collections. It will be useful to scientists interested in the interaction between marker systems and DNA sampling. Characterization data will be made available to the public on GRIN. We shall characterize and enhance Kentucky bluegrass germplasm for seed production in alternative residue management systems. An enhanced understanding of turf quality and yield will provide an understanding if yield can be improved without detrimental effects to turf quality. This should assist the plant breeding community in cultivar development. We shall apply co-dominant markers, cross-taxa and species markers, and the development of parallel methods to elucidate allelic diversity across legume germplasm. This research will result in the identification of unique germplasm in each food legume taxa readily available for basic research and applied plant breeding programs. We shall conduct research on selected germplasm collections for response to close organismal associates such as microorganisms, pathogens, saprophytes, and significant insect pests and disease vectors. Completion of entomology research will identify sources of insect-resistant germplasm for use by breeding programs. We shall detect, identify and control microorganisms which are agents of plant disease or which induce disease in humans or animals consuming such plants. The exploitation of microbial symbionts or saprophytes for enhancement of desirable germplasm properties or resistance to pests & diseases. The use of targeted microbial and plant germplasm for breeding of pest-resistant crops. We shall transfer technology in the form of plant germplasm propagules (seed/clones), research publications and other associated information to scientists. Quality germplasm is distributed, to plant researchers. Plant Introduction material is and will continue to be utilized in the development of superior cultivars. Enhanced productivity, nutritional value and alternate use of plant material will result. By incorporating relevant research at this station and others, optimum efficiency in conserving the widest possible genetic base for each taxa will be achieved.

2. Brief description of the target audience

The target audience for this program is plant researchers.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	30	1500	100	100
Actual	43	1500	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	3	10	
Actual	0	15	15

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	10	15

Output #2

Output Measure

- Graduate students supported on Agricultural Research Center or other grant funds

Year	Target	Actual
2009	1	1

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Completion and publication of our work in peer reviewed journals
2	Continued distribution of valuable germplasm and information
3	Development of valuable germplasm
4	Continued distribution of valuable germplasm
5	Development of new collaborative projects with state federal and international research scientists
6	Continued provision of quality germplasm of the species maintained at the Pullman site and delivered to researchers worldwide
7	Basic and applied research resulting from the sharing of germplasm--production of genetic maps, analyses of diversity, new medicinal plants, ornamentals,etc.
8	Restoration and re-patriotization of germplasm to seed banks in countries of origin. [This is difficult to predict.]

Outcome #1

1. Outcome Measures

Completion and publication of our work in peer reviewed journals

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	10	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Peer-reviewed publications on plant genetic resources are valuable resources to the scientific community.

What has been done

Fifteen peer-reviewed publications from this research effort appeared in print in 2009.

Results

The results of these studies are available to scientists, worldwide.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants

Outcome #2

1. Outcome Measures

Continued distribution of valuable germplasm and information

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	18000	36000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Scientists and breeders around the world depend on plant germplasm in both fundamental and applied research in plant sciences.

What has been done

In 2009, we shipped 36,704 packets of seed samples to researchers in 42 different countries.

Results

Valuable germplasm has been distributed to scientists worldwide.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology

Outcome #3

1. Outcome Measures

Development of valuable germplasm

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Fall sown safflower will provide important management alternatives and higher yield potential.

What has been done

The W6 project developed safflower breeding lines that showed yield advantage of 66% in Pendleton OR, 48% in Pullman, WA and 83% in Central Ferry, WA when it is fall sown.

Results

These breeding lines will have the potential to be further developed into a new crop for growers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology

Outcome #4

1. Outcome Measures

Continued distribution of valuable germplasm

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	18000	2939

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Plant breeders depend on available germplasm to contribute favorable alleles to new varieties with increase productivity, which is a necessity for food security for the expanding world population.

What has been done

In 2009 we acquired 2,939 new accessions of various species and brought our holdings to 83,566 accessions belonging to 3,631 plant species in 799 genera.

Results

The germplasm introduced increased the genetic diversity of the WRPIS collection.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology

Outcome #5

1. Outcome Measures

Development of new collaborative projects with state federal and international research scientists

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	3	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It is very important to re-vegetate rapidly the national forest land after disturbances such as fire.

What has been done

Collaborated with Forest service and BLM, we developed adaptive seed zones for Mountain brome and other native plant species for the Blue Mountains of southeast Washington and northeast Oregon.

Results

Provided a useful tool for guiding revegetation and restoration on more than two million ha of US forest land.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology

Outcome #6**1. Outcome Measures**

Continued provision of quality germplasm of the species maintained at the Pullman site and delivered to researchers worldwide

Not Reporting on this Outcome Measure

Outcome #7**1. Outcome Measures**

Basic and applied research resulting from the sharing of germplasm--production of genetic maps, analyses of diversity, new medicinal plants, ornamentals, etc.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	12	21

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Phenotypic data of the accessions will add useful value to the accessions.

What has been done

W6 scientists, together with our collaborators, observed and recorded 125 descriptors of 21 crops.

Results

A total of 26,988 observation data records were added to the GRIN database.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

Outcome #8**1. Outcome Measures**

Restoration and re-patriotization of germplasm to seed banks in countries of origin. [This is difficult to predict.]

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Long-term preservation of genetic resources is important to world agriculture.

What has been done

we regenerated 952 accessions and sent 958 samples to the National Center for Genetic Resources Preservation (NCGRP) in Fort Collins, Colorado and 327 accessions to the Svalbard Global Seed Vault, Longyearbyen, Svalbard for secured backup.

Results

More valuable germplasm samples are securely preserved.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources

V(H). Planned Program (External Factors)**External factors which affected outcomes**

- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities

Brief Explanation**V(I). Planned Program (Evaluation Studies and Data Collection)**

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 5****1. Name of the Planned Program**

Program in Plant Pathology

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
206	Basic Plant Biology			10%	
212	Pathogens and Nematodes Affecting Plants			60%	
216	Integrated Pest Management Systems			10%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	67.8	0.0
Actual	0.0	0.0	63.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	555615	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	3566985	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	3288653	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Grant proposals will be written. Experiments will be designed. Applied and basic research will be conducted in laboratories, greenhouses, and in field plots. Results of these studies will be summarized, and analyzed statistically. Results of studies will be disseminated to producers in the State, to the lay public, and to other scientists in the discipline and in other disciplines through oral presentations at meetings, field plot tours, extension bulletins, scientific publications, newsletters, and electronically through websites. Peer-reviewed scientific papers, popular press articles, and book chapters will be published. Data will be provided to

support registration of crop protection chemicals. Graduate students will be trained to conduct and disseminate research.

2. Brief description of the target audience

Targeted audience: 1) Primary producers of and dealers involved with trade of agricultural, forestry, horticultural, seed, and nursery commodities produced in the state; Homeowners and policy makers with need for plant health information; and 2) other scientists conducting related research. Extension specialists and teachers involved in transmitting information to the public and students.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	12	24	0	0
Actual	12	24	0	0

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

Patent Applications Submitted

Year: 2009
 Plan: 0
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	28	59	
Actual	25	65	90

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	59	66

Output #2

Output Measure

- Graduate students supported by experiment station funds

Year	Target	Actual
2009	28	32

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Increased numbers of publications
2	Increased graduate student enrollment
3	Reduced Fungicide Use

Outcome #1

1. Outcome Measures

Increased numbers of publications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	59	66

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Plant diseases cause significant losses to both quality and yield of several important commodities such as cereals, tree fruits, vegetables, ornamentals in the state.

What has been done

Research into understanding of the biology, etiology, epidemiology, plant-pathogen interactions addressing various pathogen groups (bacteria, fungi, nematodes, viruses, and viroids) was carried out.

Results

Improved understanding of the etiology and biology of various pathogens affecting crops in the state, development and implementation of disease management strategies, improved disease diagnostics, increased understanding of the genetic diversity of plant pathogens and plant-pathogen interactions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #2

1. Outcome Measures

Increased graduate student enrollment

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	28	36

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Graduate education and training is critical in ensuring the future supply of highly trained plant pathologists.

What has been done

Increased recruitment efforts to attract high-caliber graduate students into the department.

Results

The stated goal of graduate student enrollment was exceeded.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

Reduced Fungicide Use

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes
- Public Policy changes
- Competing Public priorities

Brief Explanation

Reduced budget allocations resulted in reduction in allocations for support staff in the unit.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)
- Other (After)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 6****1. Name of the Planned Program**

Program in Economic Sciences

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
601	Economics of Agricultural Production and Farm Management			15%	
602	Business Management, Finance, and Taxation			5%	
603	Market Economics			15%	
604	Marketing and Distribution Practices			10%	
605	Natural Resource and Environmental Economics			15%	
606	International Trade and Development			10%	
607	Consumer Economics			10%	
609	Economic Theory and Methods			5%	
610	Domestic Policy Analysis			10%	
901	Program and Project Design, and Statistics			5%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	21.4	0.0
Actual	0.0	0.0	28.5	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	225392	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1893217	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1781853	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The outputs from these research efforts address each of the preceding priority subject areas to varying degrees, and focus on economic analyses that delineate costs, benefits, sustainability, and/or impacts on societal welfare of various policies and decisions made by farmers, ranchers, agribusinesses, government officials, and general public at large that impact the agricultural and natural resource sectors. The output occurs in a number of different formats. One format is the publication of high quality refereed journal articles, which will validate the scientific merit of the research performed under the previously listed priority subject areas and will stand as long term contributions to the inventory of knowledge in the respective areas of inquiry. Output also occurs in the form of a number of peer-reviewed and other research bulletins, research reports, and both peer-reviewed and invited research presentations disseminating the results of the research that will be delivered to appropriate clientele by faculty analysts themselves. In addition to outreach efforts by research faculty, which is an expectation of all faculty in the School of Economic Sciences, the research results are translated into outreach and engagement efforts through collaboration with extension faculty. Timely and relevant deliverables in this regard include extension bulletins, workshops, downloadable data, tables, and reports, and other outreach and engagement activities with appropriate clientele. The knowledge is disseminated through the aforementioned mechanisms to appropriate clientele and decision makers in various segments of the agricultural and natural resources sector, government, and in the general society to generate an appropriately informed decision environment. The goal is to present sufficient insights into the economic and societal consequences of decisions so that actual outcomes will enhance the sustainability of the agricultural and natural resources sector, balance the need for uses and preservation of natural resources, and further good stewardship of the environment.

2. Brief description of the target audience

The target audience of the School of Economic Sciences is multifaceted. It encompasses decision makers in various segments of the agricultural, food and natural resources sectors; federal, state and local governments; and the greater society at large. It also includes foundations, NGOs and other organizations with interests in general societal welfare, including issues relating to the environment. Particular clientele includes farmers and ranchers, agribusiness managers, and government legislators and their staff. It also involves the general population, and relates to their purchasing decisions and their health and welfare. The research produced by the School will also influence the thinking of economists in academia, nationally and internationally as well as add to the theory and methodology used by the profession..

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	750	1000	0	0
Actual	900	2000	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	9	22	
Actual	10	19	29

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	22	27

Output #2

Output Measure

- Graduate students supported by experiment station and grant funds

Year	Target	Actual
2009	40	44

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number and Quality/reputation of refereed journal publications (mid-tier economics journals and above)
2	Number and quality of other research bulletins, reports and presentations at major conferences
3	Degree of contribution of fundamental knowledge within the fields researched (percent increase)
4	Number and value of external grants in support of the research program (units are dollars)
5	Contribution to improved/new research methods/tools (percent of output)
6	Relevant knowledge generated for use by policy and decision makers (percent of output)
7	Number of graduate students trained and placed in the job market
8	Degree to which overall research funding is increased (percent)
9	Number of additional institutionally funded and externally funded GRAs that are studying and researching in the School

Outcome #1

1. Outcome Measures

Number and Quality/reputation of refereed journal publications (mid-tier economics journals and above)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	22	27

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Addresses a variety of priority issues relating to the indicated USDA knowledge areas and that were also listed previously as being addressed as part of SES's Research Program.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
606	International Trade and Development
607	Consumer Economics
609	Economic Theory and Methods
610	Domestic Policy Analysis
901	Program and Project Design, and Statistics

Outcome #2

1. Outcome Measures

Number and quality of other research bulletins, reports and presentations at major conferences

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	28	42

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Addresses a variety of priority issues relating to the indicated USDA knowledge areas and that were also listed previously as being addressed as part of SES's Research Program.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
606	International Trade and Development
607	Consumer Economics
609	Economic Theory and Methods
610	Domestic Policy Analysis
901	Program and Project Design, and Statistics

Outcome #3

1. Outcome Measures

Degree of contribution of fundamental knowledge within the fields researched (percent increase)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
------	---------------------	--------

2009

5

3

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

This represents the estimated proportion of published and presented research output generated by faculty that contributes to the advancement of economic theory for use in applied economic research.

What has been done

Contributions to the economic theory-based conceptualizations of models of economic behavior that underly analyses of consumer, producer, and agribusiness decision making.

Results**4. Associated Knowledge Areas**

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
603	Market Economics
607	Consumer Economics
609	Economic Theory and Methods

Outcome #4**1. Outcome Measures**

Number and value of external grants in support of the research program (units are dollars)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	950000	5800000

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

This represents the amount of new extramural funding for which faculty have been associated as either a PI, Co-PI, or collaborator.

What has been done**Results****4. Associated Knowledge Areas**

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
603	Market Economics
605	Natural Resource and Environmental Economics
606	International Trade and Development
607	Consumer Economics
609	Economic Theory and Methods
610	Domestic Policy Analysis
901	Program and Project Design, and Statistics

Outcome #5

1. Outcome Measures

Contribution to improved/new research methods/tools (percent of output)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	5	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This represents the estimated proportion of published and presented research output generated by faculty that contributes to the advancement of statistical/econometric theory and methods for use in applied quantitative economic research.

What has been done

Research on new or improved statistical and econometric methods that underlie quantitative economic analyses of consumer, producer, and agribusiness decision making was completed, and papers on the results were presented and published.

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
901	Program and Project Design, and Statistics

Outcome #6

1. Outcome Measures

Relevant knowledge generated for use by policy and decision makers (percent of output)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	10	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This represents the estimated proportion of published and presented research output generated by faculty that addresses priority issues in the Agricultural and Natural Resource sectors and that contributes to informing policy and decision makers as to the benefits, costs, societal welfare, and overall economic consequences of decision outcomes.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
606	International Trade and Development
607	Consumer Economics
610	Domestic Policy Analysis

Outcome #7

1. Outcome Measures

Number of graduate students trained and placed in the job market

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	13	19

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This represents the number of Masters (10) and PhD (9) students who have successfully completed the graduate program and who have been placed in positions relevant to their training.

What has been done

Graduated and gainfully employed in their field.

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
606	International Trade and Development
607	Consumer Economics

Outcome #8

1. Outcome Measures

Degree to which overall research funding is increased (percent)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	10	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Substantial increase in the amount of research funding has been derived from increased success in securing extramural funding by the program's faculty.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
603	Market Economics
605	Natural Resource and Environmental Economics
607	Consumer Economics
610	Domestic Policy Analysis

Outcome #9

1. Outcome Measures

Number of additional institutionally funded and externally funded GRAs that are studying and researching in the School

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Additional net funding of graduate students made possible through extramural funding obtained by faculty.

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
607	Consumer Economics

V(H). Planned Program (External Factors)**External factors which affected outcomes**

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

There has been some reduction in the number of faculty in the School whose principal research focus is on traditional agricultural sector issues. Because of an unprecedented number of faculty retirements, there has also been a substantial demographic change in the unit, with more than half of the faculty being assistant professors and on the faculty for 3.5 years or less. These factors combined to exert a notable negative influence on the overall research productivity of the unit in critical areas relevant to the types of output produced and tracked in this report.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 7****1. Name of the Planned Program**

Program in Statistics

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
901	Program and Project Design, and Statistics			100%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.3	0.0	0.8	0.0
Actual	0.0	0.0	0.4	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	0	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	77961	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	566	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

It is expected that the results obtained from each project will be disseminated to other scientists at professional meetings through contributed or invited presentations as well as through peer reviewed publications resulting from the research conducted.

2. Brief description of the target audience

The target audience is other academic statisticians, biologists and scientists of other disciplines who are consumers of knowledge.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	20	40	0	0
Actual	60	40	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	1	
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed publications

Year	Target	Actual
2009	1	0

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Immediate dissemination of knowledge gained from research projects through talks presented and peer reviewed publications
2	Number of peer reviewed journal and proceedings papers, number of talks given.
3	Implementation of statistical methodologies and procedures derived from individual research projects in our department by other scientists.
4	Number of citations for articles published which are based on individual research projects.

Outcome #1

1. Outcome Measures

Immediate dissemination of knowledge gained from research projects through talks presented and peer reviewed publications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Other academic and applied statisticians as well as other scientists in other disciplines who are consumers of knowledge concerning statistical methodologies.

What has been done

Methods of allocation were compared in one project whereas the second project determined the most powerful methodology for analyzing binary data obtained from completely randomized block design.

Results

Results of first project provide a better understanding for wildlife biologists on how to allocate natural resources which results from project two provides information on the best statistical methods available for analyzing binary data obtained from completely randomized block designs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
901	Program and Project Design, and Statistics

Outcome #2

1. Outcome Measures

Number of peer reviewed journal and proceedings papers, number of talks given.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Implementation of statistical methodologies and procedures derived from individual research projects in our department by other scientists.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of citations for articles published which are based on individual research projects.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (See below)

Brief Explanation

Both of these projects are ending because the Department of Statistics has moved to a new college.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 8****1. Name of the Planned Program**

Program in Community and Rural Sociology

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
608	Community Resource Planning and Development			30%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities			40%	
805	Community Institutions, Health, and Social Services			30%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.9	0.0
Actual	0.0	0.0	2.2	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	8553	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	392203	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	12440	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

In 2009, research projects were carried out on the way on how to improve community support for, and positive community impacts of, agri-food production systems in Washington State. Additional research was conducted on the links between agricultural and community sustainability, including the role of women and minorities in agri-food systems, and how the role of such stakeholders is crucial to enhancing the sustainability of rural communities. In addition, an extensive amount of research was conducted on improving the conduct of survey research methods, with direct applicability to improving the quality of the upcoming U.S. decennial census in 2010.

2. Brief description of the target audience

The target audience includes other social scientists, persons interested in sustainable agriculture, communities, agri-businesses, demographers, policy makers, and employees of the federal government.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	1500	9000	0	0
Actual	1500	9000	0	0

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

Patent Applications Submitted

Year: 2009
 Plan: 0
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	5	7	
Actual	4	10	14

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	7	10

Output #2

Output Measure

- Graduate students supported by Agricultural Research Center funds including grants

Year	Target	Actual
2009	3	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Steady increase in the number of state residents accessing bulletins and other stakeholder directed publications via the department website.
2	Steady increase in number of state residents accessing survey results via the department website.

Outcome #1

1. Outcome Measures

Steady increase in the number of state residents accessing bulletins and other stakeholder directed publications via the department website.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	9000	9000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The department chair is working with Extension staff to ensure that public access to department bulletins and publications that remain relevant to the public will continue to be made available to the public via the world wide web after the formal closure of the department in June, 2010.

What has been done

More than likely, more than 9000 residents accessed departmental bulletins and other publications. However, as all department staff were eliminated in 2009, it is now impossible to develop an accurate assessment.

Results

More than likely, more than 9000 residents accessed departmental bulletins and other publications. However, as all department staff were eliminated in 2009, it is now impossible to develop an accurate assessment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

Outcome #2

1. Outcome Measures

Steady increase in number of state residents accessing survey results via the department website.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1000	1000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Several departmental faculty have been transferred to other units in the University and will continue to have a direct impact on the lives of Washington residents through those units.

Results

It is assumed that more than 1000 contacts were made, but this is impossible to measure as several faculty were transferred to other units and staff no longer exists to compile data on direct contacts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities

Brief Explanation

Due to severe State budget cutbacks to the University, the Department in Community and Rural Sociology, which is directly aligned with this Program, at Washington State University is being eliminated. Most faculty have already been transferred to other units. Formal closure will take place in June, 2010.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- During (during program)
- Comparisons between program participants (individuals, group, organizations) and non-participants

Evaluation Results

Due to the elimination of all departmental staff positions, and the transfer of most faculty out of the program, it is no longer possible to evaluate recent past results effectively.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Program in Agricultural Animal Health

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
307	Animal Management Systems			10%	
308	Improved Animal Products (Before Harvest)			10%	
311	Animal Diseases			10%	
312	External Parasites and Pests of Animals			10%	
313	Internal Parasites in Animals			10%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals			10%	
403	Waste Disposal, Recycling, and Reuse			10%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			10%	
722	Zoonotic Diseases and Parasites Affecting Humans			10%	
Total				100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual	0.0	0.0	2.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c 0	1890 Extension 0	Hatch 5809	Evans-Allen 0
1862 Matching 0	1890 Matching 0	1862 Matching 307839	1890 Matching 0
1862 All Other 0	1890 All Other 0	1862 All Other 48376	1890 All Other 0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

The following are the project studies planned for the next five years. Information will be disseminated in the form of manuscripts in research journals, lay press, and extension bulletins. Investigate the epidemiology and ecology of *Salmonella enterica* in and around farms. The ultimate goal is to develop strategies to prevent entry of infection to the farm and to mitigate zoonotic risk. Through molecular epidemiology, determine the antibiotic resistance elements of microbes associated with livestock, either as commensally associated flora or disease agents. Conduct bovine mastitis research to identify transmission factors for *Staphylococcus aureus* and *Mycoplasma* spp, the epidemiology, and immune responses to these agents. Develop milk tests to better diagnose these mastitis agents and improve management of dairy teat chapping and milking time hygiene. Identify plant toxicities, describing previously uncharacterized problems, and developing strategies for reduction of problems, including studies on pasture/animal disease interactions. Identify the determinants for regional and on-farm variation in risk for lupine-induced arthrogryposis (crooked calf disorder) in range cattle.

2. Brief description of the target audience

Our target audience includes academicians, clinicians, microbiologists, public health authorities, practicing veterinarians, farmers and the general public.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	90	4000	50	100
Actual	160	4000	50	100

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

Year: 2009

Plan: 0

Actual: 0

Patents listed**3. Publications (Standard General Output Measure)****Number of Peer Reviewed Publications**

2009	Extension	Research	Total
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Plan	2	15	
Actual	1	4	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	15	5

Output #2

Output Measure

- Graduate students supported on agricultural research center funds and grants

Year	Target	Actual
2009	6	6

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Define natural occurrence and shedding patterns of E. coli O157:H7
2	Determine the extent of Salmonella typhimurium DT 104 as an emerging and zoonotic pathogen
3	Develop PCR test for mycoplasma mastitis in milk samples
4	Assess Epidemiology of mycoplasma mastitis
5	Research support in dollars for the project on E. coli O157:H7

Outcome #1**1. Outcome Measures**

Define natural occurrence and shedding patterns of E. coli O157:H7

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

The Escherichia coli O157H7 bacterium may affect more than 70,000 US citizens a year. As few as 10-100 colony forming units of this pathogen can make a person ill. Thus the shedding patterns of this pathogen from cattle can have a significant impact on human health.

What has been done

Escherichia coli O157H7 strain differences exist. Some strains that have specificity for one host have less specificity for another, and vice-versa. This is true for Escherichia coli O157H7. In fact, 2 strains have been found that seem to be more infectious in humans than the many other strains of Escherichia coli O157H7 in cattle. Genotyping Escherichia coli O157H7 strains that cause mastitis has been done.

Results

Five candidate strains associated with Escherichia coli O157H7 human illness have been identified. These strains are being studied further to determine genotypes and virulence factors unique to these strains.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)
311	Animal Diseases
403	Waste Disposal, Recycling, and Reuse
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

Outcome #2**1. Outcome Measures**

Determine the extent of Salmonella typhimurium DT 104 as an emerging and zoonotic pathogen

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

The challenge to U.S. and global food and fiber animal agricultural systems is to balance the imperative to produce a safe, affordable, and wholesome food with the economic need to sustain the producer and the societal pressure to develop sustainable systems. The issues that must be addressed include: food safety, which includes not only residues and pathogens but the use of genetically modified material; economics of agricultural systems; intensive versus extensive agricultural systems and the application of new technology.

What has been done

Research evaluating the ecology of salmonella in a dairy milk shed; salmonella and E. coli were collected from dairy farms (animals and their environments), bulk milk, human and bovine clinical cases, water treatment plants, wild birds, and surface water. Over a four year period approximately 7500 salmonella and 12,000 E. coli isolates were collected and characterized.

Results

Approximately 7500 salmonella and 12,000 E. coli isolates were collected and characterized. The dominant salmonella serotype exhibiting a reduced susceptibility to ceftiofur is S. Newport. In the collection, XNL-AR represents 15% of the salmonella isolates. S. Newport was found in every source type and became a dominant serotype in 2000-2001. XNL-ANR is not confined to S. Newport, but includes 18 different serotypes. In contrast to S. Newport, these isolates tended to have source specificity i.e. cows, water treatment, etc. A small number of these isolates have been evaluated for the bla_{cmx}-2 genetic element using PCR and all were positive for the element.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)
311	Animal Diseases
403	Waste Disposal, Recycling, and Reuse
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

722 Zoonotic Diseases and Parasites Affecting Humans

Outcome #3**1. Outcome Measures**

Develop PCR test for mycoplasma mastitis in milk samples

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Mycoplasma mastitis, a contagious pathogen, is an emerging mastitis disease. A 4 fold increase in the dairy farms affected over the last decade in WA has been found. Numbers will increase given that a NAHMS survey has found that the incidence of this disease is linked to increasing herd size and herd size has been increasing steadily in WA state. Culture of milk samples to detect the disease requires 8 days, so a more rapid diagnostic procedure, like PCR, is needed.

What has been done

Adaptation of a nested PCR technique used to distinguish Mycoplasma sp in tissue culture has been attempted in a milk media. This technique has also been tested on Mycoplasma sp. isolated from milk cultures.

Results

The nested PCR technique can be used to distinguish Mycoplasma sp. from Acholeplasma sp., the latter also a mollicute. Moreover, it will identify and distinguish between the predominant Mycoplasma sp. causing mastitis: M. bovis, M. californicum, M. alkalescens, M. canadense, and M. bovigenitalium. However, it has not been successfully used to identify Mycoplasma sp. directly in milk. The Mycoplasma sp. must be first isolated by standard culture techniques before speciation with PCR.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #4**1. Outcome Measures**

Assess Epidemiology of mycoplasma mastitis

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Mycoplasma mastitis is an emerging cattle disease. A 4 fold increase in the number of dairies affected over the last decade in WA has been reported. That number is likely to increase given a NAHMS survey found that the incidence of this disease is linked to increasing herd size. Herd size has been increasing steadily in WA state in particular over the last decade, and that trend will continue. There is a need to improve clearance rates of this disease from herds.

What has been done

Project personnel have visited 18 dairies to assess the risk factors associated with time to clearance of mycoplasma mastitis. Factors assessed include preferential culling, milking time hygiene techniques (premilking and postmilking teat asepsis, single service udder towel use, milker hygiene, and milking unit backflush), and disease identification, control, and monitoring systems.

Results

Approximately half the herds could be categorized into those that were able to correct the situation and become mycoplasma mastitis free within 30 days of initial identification, and those that took longer than one month. No one factor seemed to uniquely differentiate between herd groups. Rather, it appears that there are multiple factors that influence time to clearance of mycoplasma mastitis from a dairy herd.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #5

1. Outcome Measures

Research support in dollars for the project on E. coli O157:H7

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

The major factors affecting the outcomes of the reported projects are producer cooperation and funding. The Agricultural Animal Health program has focused on studying important diseases in farms and flocks of the major livestock industries in Washington State. Thus the program is reliant on the general cooperation of the livestock industries, and of specific individual producers. Several years ago, the dairy industry, which is the largest livestock industry in the state, suspended the use of research funding from check off dollars to fund production problems. Additionally this program has traditionally relied on the Extension Service for help in identifying prospective cooperating producers. In Washington State, there is now less than 1 FTE in area and regional dairy extension--there were seven agents 20 years ago. Additionally, there were 3 full time state agents but now only 1.1. This reduction in Extension staff has limited the ability to conduct cooperative research. This may be best demonstrated in the survey study of factors associated with time to clearance of mycoplasma mastitis. In this effort, we intended to enroll 36 herds in this year's study. Only 18 herds were willing to cooperate.

Whereas funding for the food safety projects has been strong, the funding for projects in the mastitis areas has been weak. Efforts to obtain additional funding to support mastitis research are ongoing. Two grant proposals involving cooperative research have been submitted. One will be a cooperative project between the Universities of: Wisconsin, Connecticut, and Vermont. A second is a BARD proposal with Israel.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

The program is reviewed both at the level of the individual investigator and the program at annual review time. The program is also evaluated by both Colleges as part of their annual review process.

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 10****1. Name of the Planned Program**

Program in Fruit and Vegetable Development, Production and Management

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			8%	
202	Plant Genetic Resources			10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			13%	
204	Plant Product Quality and Utility (Preharvest)			28%	
205	Plant Management Systems			23%	
206	Basic Plant Biology			7%	
212	Pathogens and Nematodes Affecting Plants			3%	
216	Integrated Pest Management Systems			1%	
404	Instrumentation and Control Systems			4%	
601	Economics of Agricultural Production and Farm Management			1%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			2%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	45.3	0.0
Actual	0.0	0.0	38.1	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	442682	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	3365810	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1848483	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Specific activities vary across a wide range from molecular level inquiry to field based studies concerning the efficacy of horticultural production practices. These activities include: (1) basic research applying molecular biology, genetics and biochemistry to the calcium/calmodulin-mediated signal network that influences plant response to environmental factors; (2) development of data mining tools and resources for genomics research on Rosaceae; (3) studies in fruit production and biology, with an emphasis on sustainability of fruit production systems; (4) breeding and genetic studies in apple, cherry, raspberry, and strawberry, including genomics approaches to identify functional genetic markers for crop improvement; (5) studies of the anatomy and structure of grape berry during growth and development; (6) research that emphasizes the use of plant bioregulators for apple, pear, and sweet cherry; (7) studies related to the interaction of various environmental and production factors influencing yield and quality of potato tubers; (8) research focusing on environmental factors and management practices as they influence grape physiology; (9) studies of effects of deficit irrigation and partial root zone drying in apple, cherry, and grape; (10) research that focuses on the development of an understanding of factors that cause skin disorders of apples; (11) evaluation of potato cultivars for introduction into the Washington potato industry; (12) studies focusing on practical means of achieving balanced cropping; (13) effects of new clonal rootstocks on scion productivity, growth, and fruit quality in cherry; (14) research focusing on novel management strategies for high density cherry production; (15) the potential for mechanical harvest of fresh-market quality, stemless sweet cherries; and (16) the development of automation, sensing, control, and information systems for precision agriculture. The outputs of these activities will include: patents, plant variety releases, scientific journal articles, conference publications and presentations, poster presentations, field day presentations, web sites, and knowledge about production and management practices that is passed along to users in other informal settings.

2. Brief description of the target audience

The audience for this program is other scientists, economists, agribusiness, farmers, horticulturists and the fruit, potato and vegetable industries.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	1250	600	0	0
Actual	7293	0	0	0

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

Year: 2009

Plan: 1

Actual: 3

Patents listed

- 1) Schrader L. Use of Lipid Formulations to Protect Horticultural Crops. submitted Apr. Published 4/27/06 as WO2006/044060 by World Intellectual Property Organization. Geneva, Switzerland: World Intellectual Property Organization. Patent PENDING.
- 2) Schrader L. "Compositions and Methods for Suppressing Cracking and Water Loss from Cherries". submitted Aug 16. Filed 4/19/07 as a CIP & published 8/16/07 as Appln. No. 20070190097. Washington, D.C.: USPTO. Patent PENDING.
- 3) Poovaiah B., L. Du. Compositions and methods for modulating plant disease. submitted. Patent Case A 1028.

3. Publications (Standard General Output Measure)**Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	3	22	
Actual	3	53	56

V(F). State Defined Outputs**Output Target****Output #1****Output Measure**

- Peer reviewed journal articles

Year	Target	Actual
2009	10	53

Output #2**Output Measure**

- Variety Releases

Year	Target	Actual
2009	4	6

Output #3**Output Measure**

- Plant Patents

Year	Target	Actual
2009	1	1

Output #4**Output Measure**

- Number of graduate students supported by Agricultural Research Center and external funds

Year	Target	Actual
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2009

6

19

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	See below under Evaluation.

Outcome #1**1. Outcome Measures**

See below under Evaluation.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)****What has been done****Results**

Breeding and development of potato varieties that are more efficient in nitrogen use (Pacific Northwest Potato Variety Development Program, PNWPVD) has reduced the use of nitrogen, resulting in less nitrate contamination of ground water. The potential economic savings to NW potato growers was estimated to be \$1.3 million or \$72 per acre in 2006. Varieties released by this collaborative program accounted for 26% and 32% of potato acreage in the Pacific Northwest and WA in 2007, respectively. Farm gate value of these new varieties in WA in 2007 is estimated to be \$160,000,000. It is estimated that the potato varieties developed by the PNWPVD program have returned \$39 for every dollar (research & institutional) invested.

Other researchers in this program have identified the process that causes sun burning in apples, and have developed a product that reduces this disorder significantly. This discovery has the potential to save fruit growers literally tens of millions of dollars annually. It is estimated that the patented apple sunburn protectant (RAYNOX[®](r)) alone saved the industry several million dollars during the past three growing seasons. The invention of RainGard to aid in the protection of cherries from cracking/splitting is also expected to have tremendous positive economic impact on the industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology

V(H). Planned Program (External Factors)

External factors which affected outcomes

- 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 and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- Before-After (before and after program)
- During (during program)

Evaluation Results

Breeding and development of potato varieties that are more efficient in nitrogen use (Pacific Northwest Potato Variety Development Program, PNWPVD) has reduced the use of nitrogen, resulting in less nitrate contamination of ground water. The potential economic savings to NW potato growers was estimated to be \$1.3 million or \$72 per acre in 2006. Varieties released by this collaborative program accounted for 26% and 32% of potato acreage in the Pacific Northwest and WA in 2007, respectively. Farm gate value of these new varieties in WA in 2007 is estimated to be \$160,000,000. It is estimated that the potato varieties developed by the PNWPVD program have returned \$39 for every dollar (research & institutional) invested.

Other researchers in this program have identified the process that causes sun burning in apples, and have developed a product that reduces this disorder significantly. This discovery has the potential to save fruit growers literally tens of millions of dollars annually. It is estimated that the patented apple sunburn protectant (RAYNOX[®](r)) alone saved the industry several million dollars during the past three growing seasons. The invention of RainGard to aid in the protection of cherries from cracking/splitting is also expected to have tremendous positive economic impact on the industry.

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 11****1. Name of the Planned Program**

Program in the Post Harvest Quality of Fruits and Vegetables

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			10%	
202	Plant Genetic Resources			10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
204	Plant Product Quality and Utility (Preharvest)			10%	
205	Plant Management Systems			10%	
206	Basic Plant Biology			10%	
501	New and Improved Food Processing Technologies			10%	
502	New and Improved Food Products			10%	
503	Quality Maintenance in Storing and Marketing Food Products			10%	
701	Nutrient Composition of Food			10%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	15.0	0.0
Actual	0.0	0.0	9.6	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	30933	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	706297	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	441537	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Specific activities and outputs vary across a wide range from molecular level inquiry to field and lab based studies related to postharvest handling, storage, and processing of horticultural crops. These activities include: basic research that focuses on the application of molecular biology, genetics and biochemistry related to the biological, chemical, and physiological mechanisms that explain postharvest phenomena in horticultural crops; studies directed at the identification of CA storage regimes for apples and other fruits; investigation of flavor chemistry in apples; studies of the post-harvest/processing quality attributes of potatoes in the Tri-State Variety trials; research to identify factors that affect storability and processing quality of potatoes; research to identify improved strategies for storage of seed potatoes; research focused on the mechanical harvest and subsequent handling and storage requirements in asparagus; studies that address the use of microwave-vacuum drying technology for fruits and vegetables; studies that focus on lenticel breakdown and fruit finish in apples; and research that focuses on crop management factors that affect postharvest fruit and vegetable quality.

2. Brief description of the target audience

The target audience will be scientists in the area of postharvest quality of fruits and vegetables, agribusiness, economists, and the participating vegetable and fruit industries (in particular the stone and pome fruit industries, and the potato industry).

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	500	300	0	0
Actual	991	1600	0	0

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

Year: 2009

Plan: 1

Actual: 1

Patents listed

Knowles, N.R and L.O. Knowles. 2009. Aliphatic aldehydes, ketones, and primary and secondary alcohols to inhibit sprouting of potato tubers. U.S. patent application published March 5 (filed Aug. 6, 2008; serial no. 12/186,861; USPTO.

3. Publications (Standard General Output Measure)**Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	3	13	
Actual	1	10	11

V(F). State Defined Outputs**Output Target**

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	13	10

Output #2

Output Measure

- Graduate students supported on Agricultural Research Center and external funding

Year	Target	Actual
2009	4	5

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Please see written paragraph under evaluation.

Outcome #1

1. Outcome Measures

Please see written paragraph under evaluation.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Reversal of MCP-induced ripening inhibition in apples could potentially allow higher-quality fresh products to be available in the late storage season thus increasing international and domestic value of the Washington fresh apple crop. Studies described increase our knowledge of metabolic responses to the stress induced in the postharvest storage environment. Based on the results from the potato seed age studies, growers are altering the way in which they manage seed at the end of the growing season and throughout storage to maximize productive and economic value to commercial growers. Project findings have broadened the knowledge of stone fruit texture and its genetic control, for the benefit of the present industry as well as breeders and beneficiaries of future cultivars. Existing cultivars were characterized for their endoPG genotype to reveal underlying fruit type, resolve many ambiguous cases, and identify softening phenotypes controlled by genetic mechanisms other than endoPG allelic variation. This information is being exploited by industry, breeders, and researchers. The interaction of Stony hard with Freestone-Melting flesh is also better understood. The endoPG markers have proven valuable for identifying potentially useful functional genetic diversity in germplasm collections. The massive diversity detected for the endoPG gene in Prunus has important implications for fruit evolution and crop domestication in this genus, and represents much potential for genetic improvement of texture attributes in stone fruit.

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 12****1. Name of the Planned Program**

Program in Environmental Horticulture

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
124	Urban Forestry			10%	
134	Outdoor Recreation			10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
212	Pathogens and Nematodes Affecting Plants			25%	
724	Healthy Lifestyle			10%	
802	Human Development and Family Well-Being			5%	
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures			5%	
903	Communication, Education, and Information Delivery			10%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.3	0.0
Actual	0.0	0.0	12.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	85597	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1333526	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	964360	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Specific activities that are part of this program include: investigations of the effects of cultural practices on plant root health and the establishment of landscape plants, research focusing on the development of an understanding of environmental and cultural factors that affect water stress and cold hardiness in landscape plants, research focusing on identifying superior ornamental landscape plants for urban environments, studies of the influence of human experience in the development of perceptions related to urban landscapes, and research aimed at developing further understanding of the relationships between physical environments and human behavior. The outputs of these activities will include: plant variety releases, scientific journal articles, conference publications and presentations, poster presentations, field day presentations, web sites, and knowledge about production and management practices that is passed along to users in other informal settings.

2. Brief description of the target audience

The target audience for this program consists of other scientists in the related disciplines, extension personnel, social scientists, landscape horticulture industry, and the consumer/gardener.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	600	100	0	0
Actual	1200	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	4	10	
Actual	1	20	21

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year

Target

Actual

2009

13

20

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	See below under Evaluation.

Outcome #1

1. Outcome Measures

See below under Evaluation.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- 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 and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 13****1. Name of the Planned Program**

Program in Entomology

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
121	Management of Range Resources			5%	
135	Aquatic and Terrestrial Wildlife			10%	
136	Conservation of Biological Diversity			15%	
211	Insects, Mites, and Other Arthropods Affecting Plants			20%	
215	Biological Control of Pests Affecting Plants			20%	
216	Integrated Pest Management Systems			10%	
304	Animal Genome			5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			15%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	56.6	0.0
Actual	0.0	0.0	37.6	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	489519	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	2800320	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	2516607	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Both basic and applied research have been conducted. Results of research efforts were disseminated through refereed publications, general interest publications, Extension outlets, and presentations at scientific, stakeholder, and general public venues. All programs involve the training of graduate students. Specific activities were designed to develop a better understanding of biological diversity of native and disturbed habitats in Washington and the greater Pacific Northwest. Specimens collected and prepared during studies were deposited in the James Entomological Collection. Native and exotic species of arthropods were studied in order to evaluate their potential for the control of and impact upon non-native, rangeland weed species. Studies were directed at the management of direct and indirect pests through traditional technologies and were guided by basic biological and ecological principles as they related to the management of pest and beneficial arthropods. Other projects included the development and implementation of biological control and integrated pest management strategies for the management of pest arthropods, especially insects; genomic studies of primarily honey bees and parasitic wasps to better enhance their beneficial potentials; the development and implementation of methods that measure and monitor agricultural chemicals in the environment and; the development of methods that test the toxicological effects of agricultural chemicals on non-target organisms.

2. Brief description of the target audience

Target audiences for our work in the Department of Entomology include scientists in various related disciplines, farmers, extension, agribusiness, public policy makers, legislators, government agencies, and the general public.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	5500	1500	1000	100
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	20	32	
Actual	39	40	79

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	32	39

Output #2

Output Measure

- Graduate Students supported on Agricultural Research Center and other external funds

Year	Target	Actual
2009	22	20

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Percent of holdings that are implementing changes to IPM based on research findings
2	Percent decrease in pesticide use

Outcome #1**1. Outcome Measures**

Percent of holdings that are implementing changes to IPM based on research findings

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	65	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

The use of Integrated Pest Management leads to a reduction in chemical control applications through improved monitoring of pest populations and the use of treatment "thresholds" to determine timing of treatment rather than a calendar. Inclusion of Biological Control further reduces chemical control use and often leads to improved diversity of resident predator and parasite populations that aid growers in managing pest populations. Growers who implement IPM generally have reduced chemical and application costs. IPM also can be a factor to reduce pesticide exposure to farm workers and the general public, both in the work place and in consumed agricultural products. In addition to workplace and food safety, reductions in chemical use through IPM can also improve the biological diversity of resident parasite and predator species in agricultural systems.

What has been done

A number of research projects in the unit are directly involved in development, assessment and implementation of Integrated Pest Management programs. In addition basic research is underway on predator-prey interactions and biological control.

Results

Research leading to the registration of numerous "soft" chemicals for the control of pests, release of numerous "beneficial species" for biological control, development of mating disruption and other pheromone-based techniques to effectively reduce pest populations to levels below an "economic threshold", selective breeding of honey bees that exhibit increased resistance to mites and diseases, design and release of IPM management systems for a number of crops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
304	Animal Genome
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Outcome #2

1. Outcome Measures

Percent decrease in pesticide use

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 Programmatic Challenges

Brief Explanation

Several research programs have benefited from external funding targeted to Specialty Crops, IPM and apiculture. These funds have helped the programs through significantly reduced state budgets, especially in Extension.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- Before-After (before and after program)
- During (during program)
- Time series (multiple points before and after program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 14****1. Name of the Planned Program**

Program in Natural Resource Sciences

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
112	Watershed Protection and Management			20%	
121	Management of Range Resources			10%	
123	Management and Sustainability of Forest Resources			15%	
135	Aquatic and Terrestrial Wildlife			40%	
136	Conservation of Biological Diversity			15%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	7.0	0.0
Actual	0.0	0.0	10.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	178048	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	595390	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	846737	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

In our research in the Department of Natural Resource Sciences, we perform laboratory and field experiments. Data is collected and analyzed. Papers, books, book chapters and reports are written. Presentations are given in local, national and international venues. Graduate students and undergraduate students are mentored and trained. Curriculum is revised and developed.

2. Brief description of the target audience

Our target audience includes other researchers within and without the discipline of natural resource sciences including extension educators, persons in industry, economics, policy makers and the general public.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	100	0	0
Actual	0	100	0	0

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

Patent Applications Submitted

Year: 2009
 Plan: 0
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	10	
Actual	0	13	13

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer Reviewed Publications

Year	Target	Actual
2009	10	13

Output #2

Output Measure

- Graduate students supported on experiment station and grant funds

Year	Target	Actual
2009	15	26

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	graduate students and post-docs trained
2	Percent increase in research support
3	New personnel in research positions

Outcome #1

1. Outcome Measures

graduate students and post-docs trained

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	5	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Our graduates have been very successful in finding employment throughout the western United States and are in demand by state and federal agencies in particular.

What has been done

We continue to seek extramural funding to support our graduate program.

Results

Four Masters and 2 PhD students completed their degrees in 2009.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #2

1. Outcome Measures

Percent increase in research support

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	5	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Industry, stakeholders, and natural resource researchers.

What has been done

Results

Due to cuts in funding it has become more difficult to obtain grants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #3

1. Outcome Measures

New personnel in research positions

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Due to lack of funding this goal could not be realized

What has been done

Results

Budget cuts at the state level blocked both university and state agency hiring.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations

Brief Explanation

Due to the economy we were not allowed to hire any faculty and this has made it more difficult to procure extramural funds.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Other (See below)

Evaluation Results

Each faculty member with a Hatch project included in this group is reviewed annually, first by the Department Chair and subsequently by the Dean and Directors of the College of Agricultural, Human and Natural Resource Sciences. Target Measures used include: (1) Number of refereed journal articles produced, (2) Quality of refereed journal articles produced, (3) Amount of extramural funding received from other sources in support of these research efforts and (4) the number of masters and doctoral students completing their degrees. Over the longer term, the chair considers the impact of the research on resource management decisions. Unfortunately, these evaluations typically occur several years after the completion of the research.

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 15****1. Name of the Planned Program**

Composite Materials and Engineering Center (formerly Wood Materials Eng. Lab)

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
511	New and Improved Non-Food Products and Processes			100%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.6	0.0
Actual	0.0	0.0	4.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	64056	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	127443	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	357898	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

For the past year, we have conducted further investigation on processing technology and application development of biopolyesters. Specifically, we have advanced the investigation in the following aspect of the materials technology; (1) reinforcing and toughening of biopolyesters; (2) novel processing techniques for soy protein (SP) blends; (3) microcellular foaming of the polyester blends and composite and; (4) reinforcement via in-situ fibrillation. Three oral presentations of the results were given at: (1) International Symposium on Polymers and the Environment: Emerging Technology and Science & the 2009 BioEnvironmental Polymer Society Annual Meeting; (2) 238th ACS annual meeting and; (3) 2009 Genes to Products: Agricultural Plant, Microbe & Biobased product Research, United States Agriculture Department, respectively.

2. Brief description of the target audience

U.S. corn growers will be the immediate beneficiaries of the investigation by finding new applications of PLA and PHAs in a

market dominated by petroleum-based plastics, because both polymers are corn starch-based. The general public will benefit from the results, because PLA and PHAs are environmentally friendly: both are biodegradable and compostable. In addition, the findings from this project will advance the bioplastics knowledge base and stimulate future developments within the biobased plastic materials industry.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	150	3000	2	0
Actual	150	3000	2	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 2

Patents listed

1. compositions containing poly(lactic acid), sugar beet pulp and polymeric methylene diphenyl diisocyanate
2. Rosin derived epoxies and curing agent

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	2	3	
Actual	0	5	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer Reviewed journal Articles

Year	Target	Actual
2009	3	3

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Methods to improve the compatibility of natural fiber and biopolyesters and melt strength of biocomposites, knowledge of composition-morphology-property relationships of composites
2	Microcellular foaming extrusion process design and processing optimization of biocomposites; characterization of composition-morphology-property relationships of microcellular foam
3	Product application development of microcellular foaming technology of biocomposites

Outcome #1**1. Outcome Measures**

Methods to improve the compatibility of natural fiber and biopolyesters and melt strength of biocomposites, knowledge of composition-morphology-property relationships of composites

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

PHBV polymers are not strong or durable enough for many applications and additional materials may need to be added to the polymers in order to improve these properties.

What has been done

We have found that bamboo pulp fiber displays both reinforcing and toughening effects for PHBV polymers, This is very different from other short natural fibers which usually introduce detrimental effect on toughness of the composites.

Results

This finding is important to the researchers in the composite field, because most short natural fibers only demonstrate reinforcing effect but not toughening effect.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

Outcome #2**1. Outcome Measures**

Microcellular foaming extrusion process design and processing optimization of biocomposites; characterization of composition-morphology-property relationships of microcellular foam

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	1	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

In blends, SPC or other types of soy protein are usually used as filler. When SPC is used as plastic by regulating its moisture content, the morphology of the blends is manipulated greatly and hence the properties.

What has been done**Results****4. Associated Knowledge Areas**

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

Outcome #3**1. Outcome Measures**

Product application development of microcellular foaming technology of biocomposites

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	1

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Water and glycerol show opposite effects on the fineness of SPC phase structure in the blends when both are used together.

What has been done**Results**

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Public Policy changes
- Government Regulations

Brief Explanation

The name of the unit was changed from Wood Materials Engineering laboratory to Composite Materials and Engineering Center to reflect the greater diversity of materials we are now working with. Since our emphasis is still on biologically derived material, this probably will not affect the position of CMEC relative to the Colleges of Agriculture and Engineering.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 16

1. Name of the Planned Program

Program in Biological Systems Engineering

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			5%	
111	Conservation and Efficient Use of Water			5%	
112	Watershed Protection and Management			5%	
133	Pollution Prevention and Mitigation			5%	
135	Aquatic and Terrestrial Wildlife			5%	
141	Air Resource Protection and Management			5%	
205	Plant Management Systems			5%	
402	Engineering Systems and Equipment			10%	
403	Waste Disposal, Recycling, and Reuse			10%	
404	Instrumentation and Control Systems			5%	
501	New and Improved Food Processing Technologies			15%	
502	New and Improved Food Products			5%	
503	Quality Maintenance in Storing and Marketing Food Products			5%	
511	New and Improved Non-Food Products and Processes			10%	
601	Economics of Agricultural Production and Farm Management			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	37.9	0.0
Actual	0.0	0.0	37.3	0.0

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

Extension		Research	
Smith-Lever 3b & 3c 0	1890 Extension 0	Hatch 333883	Evans-Allen 0
1862 Matching 0	1890 Matching 0	1862 Matching 1838550	1890 Matching 0
1862 All Other 0	1890 All Other 0	1862 All Other 3244722	1890 All Other 0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

We have supported a vigorous graduate research program crucial to the development of high quality research in our focal areas of interest. We are developing and evaluating innovative water/soil management practices to mitigate the effects of uncertain water resources (both precipitation and irrigation) and other factors associated with climate change and atmospheric CO2 elevation. We are developing a roadmap for bioproducts and bioenergy technology that is specific to the region's energy needs and to the crops/biomass grown in the region. We are developing food processing technologies that provide nutritious new products, increase the safety of existing products, and help improve the overall health of the population.

2. Brief description of the target audience

The target audience is the scientific community in biological systems engineering, general agriculture, agribusiness, extension personnel, growers in the region, state and national agencies, and non-governmental agencies.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	90	220	35	70
Actual	1500	300	50	0

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

Year: 2009

Plan: 0

Actual: 1

Patents listed

Chen, S., Chi, Z., Zheng, Y., Lucker, B. Integrated system for production of biofuel feedstock. Filed July 30, 2009.

3. Publications (Standard General Output Measure)**Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	0	45	

Actual	0	54	54
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V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer Reviewed Journal Articles

Year	Target	Actual
2009	45	54

Output #2

Output Measure

- Graduate Students supported on Agricultural Research Center and grant funds

Year	Target	Actual
2009	22	39

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Conduct laboratory bench research on processing technologies for agricultural feedstocks to produce new products, and new energy sources.
2	Conduct pilot scale research on processing agricultural feedstocks to produce new products or energy sources.
3	A processing concept to produce new products or energy sources from agricultural commodities is available for transfer.
4	Food processing Technology concept tested at the laboratory and pilot scale.
5	Development or application of computer models to analyze agricultural systems.
6	Hire one faculty member to expand research in biofuels and bioproducts engineering.
7	Conduct field research for soil and water conservation and to improve the environmental impacts of agriculture.
8	Initiate research activities in agricultural automation.

Outcome #1**1. Outcome Measures**

Conduct laboratory bench research on processing technologies for agricultural feedstocks to produce new products, and new energy sources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	5

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Adding agricultural feedstocks to produce new products and energy sources will be of significant benefit to producers in developing new uses for agricultural byproducts and to consumers in developing new ways to produce energy sources and other useful products.

What has been done

The goal of part of this work is to use biological and thermo-chemical (pyrolysis) technologies to convert biomass waste to a crude bio-oil that can then be further refined into transportation fuel to reduce transportation costs by condensing the biomass at waste sites such as areas of cutting timber. We have further improved analytical laboratories available in the department to study the selectivity of thermochemical reactions and to characterize pyrolysis oils. The research has expanded to understand the impact of pre-treatment conditions on biomass structure and its effect on the yields of sugars obtained by pyrolysis. Algae biofuel research has focused on developing technologies that can be used in colder climates such as the Northern states of the US and on a concept for algae biorefinery. Biological conversion of lignocellulosic biomass has focused on biological pretreatment of the biomass to produce sugars for subsequent fermentation to various fuel and chemical products. A unique research thrust exploring termite system for delignification was initiated. Other research is aimed at improved understanding of anaerobic digestion of waste, especially waste from dairy farms. The department has three new faculty members in this area of research, one in Pullman and two in the Tri-Cities.

Results

The research has shown that it is possible to increase the yields of anhydrosugars if the lignocellulosic materials are pre-treated between 200 and 300 degrees C, depending on the feedstock. High yields of bio-oils are possible under certain circumstances using auger pyrolysis reactors. Research on detoxifying and fermenting pyrolysis sugars has shown that it is possible to use the pyrolytic sugars present in bio-oils to produce ethanol. New knowledge of anaerobic digestion is allowing for improved design and operation of the processes with subsequent reduction of the cost of these systems. The research is improving existing models of anaerobic digestion by integrating different levels of mass transfer and process kinetics. Work on anaerobic digestion has produced improved computer models and a better understanding of nutrient recovery and process kinetics. The work has allowed the research to expand to include the organic fraction of municipal wastes. An integrated system for algae-based bio-oil was developed and a patent application was filed. In addition, two provisional patents on algae harvesting and nutrient recycling were filed. In terms of biological conversion of ligno-cellulosic biomass, evidence was discovered of lignin modification in various gut portions of termite species and the initial results have been accepted for publication.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

Conduct pilot scale research on processing agricultural feedstocks to produce new products or energy sources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Adding agricultural feedstocks to produce new products and energy sources will be of significant benefit to growers in developing new uses for agricultural byproducts and to consumers in developing new ways to produce energy sources.

What has been done

Feedstocks under study are bark from trees commonly harvested in forests in Washington, straw from crops, and manure from a dairy. The work on bark is proceeding with results as noted above. The work on manure is more advanced, especially in regard to computer modeling of anaerobic digestion and understanding the basic chemical and biochemical reactions.

Results

Understanding the process of converting biomass to fuel and to useful products is continuing. Technology to extract phosphorus and ammonia from manure using anaerobic digestion has proceeded to the application of patents, making it available for technology transfer to producers using anaerobic digesters in confined animal feeding operations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #3**1. Outcome Measures**

A processing concept to produce new products or energy sources from agricultural commodities is available for transfer.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	0	2

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Adding agricultural feedstocks to produce new products and energy sources will be of significant benefit to growers in developing new uses for byproducts and to consumers in developing new ways to produce energy sources.

What has been done

Researchers filed a patent on integrated systems for production of biofuel feedstock, algae-based bio-oil production, and nutrient recovery for anaerobic digestion systems.

Results

This work continues to add knowledge important to commercial use of anaerobic digestion to convert waste to fuel and other products, and technologies for biological and thermo-chemical conversion of biomass to fuel. The filing of a patent makes it possible to transfer the results to commercial entities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #4**1. Outcome Measures**

Food processing Technology concept tested at the laboratory and pilot scale.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The development of technologies in food engineering will improve food processing, making processed food safer, healthier, and more flavorful. These developments are especially important in maintaining the competitiveness of the food industry in the United States in the midst of international competition.

What has been done

Part of the work is focused on developing basic understanding of engineering properties of foods to develop better mathematical models for microwave and radio frequency heating processes. This work is proceeding to the development of processes to improve microwave and radio frequency processes and to develop scale-up systems for industrial applications. A second area of research is developing a stability map of selected functional foods in order to design packaging systems that can include these foods and store them on shelves for significant periods of time. Work is also continuing on the use of nonthermal technologies, a third area of research. The use of pulsed electric fields, high hydrostatic pressure, and ultrasound were of particular interest.

Results

The work on the use of microwave energy has resulted in the first U.S. Food and Drug Administration approval for microwave sterilization of homogeneous foods. Several prominent food processing companies have expressed interest in using the technology. Pulsed electric fields were under study to process milk, milk products, and grape juice and to inactivate or activate selected microorganisms, including spores. High hydrostatic pressure was explored with regard to processing fruit products and ultrasound was under study for use in dairy products such as yogurt and milk.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products

Outcome #5

1. Outcome Measures

Development or application of computer models to analyze agricultural systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The development of computer models is of substantial benefit in various ways to people making decisions regarding agriculture. Agencies, consultants, extension personnel and producers can make better decisions about potential for developing crops or for changing practices. Models provide better information to people making decisions about land use and about conserving resources such as soil, water, and nutrients. Such models can also be developed and used to determine the role of agriculture in storing carbon in the soil, in changing the rates of emission of greenhouse gases, and in estimating the impact of climate change on agriculture. Modeling the emission of ammonia and other gases from confined animal feeding operations will improve the management of these facilities to reduce gaseous emissions.

What has been done

Modeling is underway to evaluate soil carbon storage and greenhouse gas emissions based on long-term simulations verified with limited experimental data for selected cropping systems in the State of Washington. Additional emphasis is being placed on models for raising specialized crops that can be used to produce energy and other useful products under conditions outside the state where these crops are now grown.

Results

A final report assessing the potential for carbon sequestration and the impact on nitrous oxide emissions of several irrigated and dryland cropping systems in eastern Washington was completed. A simplified model was developed and evaluated for a quick assessment of potential for carbon sequestration from agricultural fields by consultants and faculty members from WSU Extension. A computer simulation determined the potential impact of climate change on agriculture in eastern Washington.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
205	Plant Management Systems
511	New and Improved Non-Food Products and Processes

Outcome #6

1. Outcome Measures

Hire one faculty member to expand research in biofuels and bioproducts engineering.

Not Reporting on this Outcome Measure

Outcome #7**1. Outcome Measures**

Conduct field research for soil and water conservation and to improve the environmental impacts of agriculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Agriculture makes significant use of natural resources, especially land and water, and can have serious detrimental effects on the environment (soil, water, and air). Recent research has mitigated both of these factors and offers continuing promise toward further reductions in the use and conservation of resources and the production of certain kinds of pollution. Research is also investigating the emerging issue of water pollutants affecting fish, especially newly-described pollutants such as pharmaceuticals and other biologically active compounds common near populated areas or large confined animal feeding operations.

What has been done

One element of this project has gathered detailed data on ammonia emissions from the WSU dairy and confirmed it with data from cooperating commercial dairy farms. These data have been used to refine computer models of such emissions. For water conservation, the research effort includes development of a web-based computerized tool to schedule irrigation for crops common in Washington, Oregon, and Idaho with subsequent availability for producers. A study of farms tilled conventionally and under no till revealed differences in snow distribution and water in the soil. Another research element is the examination of the effectiveness of a novel sediment remediation method along with an investigation into the potential impacts of contaminated sediments (unremediated and remediated) on fish. Laboratory trials have revealed an organic compound that shows potential for use to manage diffuse contaminated sediments.

Results

The work on dairy emissions has been able to make specific recommendations on practices with regard to post-collection handling and storage of dairy waste. The irrigation project included testing an on-line tool for irrigation scheduling that a limited group of growers found useful and easy to use. The study of soil water distribution revealed that residues left by no till farming, as opposed to conventional methods, retarded the generation of runoff, retained more snow at the ridge top and steep-sloped areas, and likely reduced the soil water spatial variation. The organic compound under study for the possibility of remediating certain water pollutants works in the laboratory and a separate experiment determined that it appears to have no detrimental effects on certain fish common in the Pacific Northwest.

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
- 133 Pollution Prevention and Mitigation
- 135 Aquatic and Terrestrial Wildlife
- 141 Air Resource Protection and Management
- 205 Plant Management Systems
- 403 Waste Disposal, Recycling, and Reuse

Outcome #8

1. Outcome Measures

Initiate research activities in agricultural automation.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	{No Data Entered}	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The focus of this project is on automated production and post harvest equipment for specialty crop producers. The need for this type of equipment is based on the economics of raising specialty crops, many of which have labor costs as one of the highest costs for production.

What has been done

The overall goal of the research, which has just begun, is to develop agricultural automation technologies, from intelligent agricultural machinery to smart crop sensors, for mechanized precision farming applications. One aim is to adapt biological concepts associated with specialty crop production, harvest, and postharvest handling into quantifiable parameters that are amenable to use as the basis for sensors and sensing systems that can measure and interpret the parameters. The project is looking for automated solutions for disease/pest monitoring, for managing crops as they develop, and for controlling specialty crop production.

Results

One of the research projects is considering the application of sensing and robotics technology to canopy management for specialty crops. This work eventually will involve workshops with producers to collect information and to develop problem statements that will form the goals of future proposed projects. A second project that has just begun is aimed more broadly at developing mechanization and robotic solutions for production of a wide range of specialty crops. The department hired a new faculty member in 2009 to move forward research on agricultural automation.

4. Associated Knowledge Areas

KA Code Knowledge Area

205	Plant Management Systems
404	Instrumentation and Control Systems
601	Economics of Agricultural Production and Farm Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Changes in Market)

Brief Explanation

The main factors potentially affecting the outcomes of the program are: a) our ability to attract highly qualified faculty members, support personnel, post-doctoral associates, and graduate students, b) our ability to obtain sufficient extramural support to fully fund our planned research, and c) a positive state and university budgetary situation allowing us to compete for resources to enhance our research position (infrastructure, equipment, seed funds, etc.). Lower funding levels for the university and the Agricultural Research Center will prevent us from hiring new faculty members as rapidly as planned, affecting our ability to constitute research teams of reasonable size. Lower funding levels from granting agencies might prevent us from having the extramural money necessary to proceed with research even when all faculty members are aggressively pursuing opportunities to secure money for their research. Public policy changes and changes in markets for new food products or for new biologically based products are two factors that could adversely affect us, but such change seems improbable. Attention to environmental issues hardly seems likely to wane. Likewise, the current attempt to pursue alternatives to petroleum based products—fuel, chemicals, or pharmaceuticals—appears to be a trend that will continue for the life of this plan. Americans seem highly likely to continue preferring convenience foods that are safe and nutritious and that have an attractive taste; this trend might even accelerate based on overseas demand. We believe, in short, that these two factors will be in our favor in the next five years, but one or both could change.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- After Only (post program)
- Retrospective (post program)
- Comparisons between different groups of individuals or program participants experiencing different levels of program intensity.
- Other (See below)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 17****1. Name of the Planned Program**

Institute of Biological Chemistry

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			18%	
202	Plant Genetic Resources			2%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			19%	
204	Plant Product Quality and Utility (Preharvest)			3%	
205	Plant Management Systems			4%	
206	Basic Plant Biology			34%	
211	Insects, Mites, and Other Arthropods Affecting Plants			8%	
511	New and Improved Non-Food Products and Processes			6%	
701	Nutrient Composition of Food			6%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	63.0	0.0
Actual	0.0	0.0	65.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	279587	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	2858684	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	5238189	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Institute of Biological Chemistry has a very vigorous graduate research and training program. This leads to the graduation and placement of its highly trained (Ph.D./M.S.) scientists, to publications in high quality journals, to developing patents and working with industry to implement the technologies developed, as well as carrying out needed outreach activities (e.g. to focus groups, high school students, general public, etc.).

2. Brief description of the target audience

The primary target audience of the Institute of Biological Chemistry is scientists within various disciplines in plant biotechnology, particularly plant biochemistry. Their research activities attract attention within the biochemical, forest products, and agricultural industries.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Year: 2009

Plan: 2

Actual: 3

Patents listed

Browse, John; Lu, Chaofu; Xin, Zhonguo. Protein and nucleotide sequence of plant phosphatidylcholine diacylglycerol cholinephosphotransferase and methods for differential regulation of fatty acid unsaturation in membrane lipids and seed oil. PCT Int. Appl. (2009), 74pp. CODEN: PIXXD2 WO 2009111587 A2 20090911 CAN 151:329957 AN 2009:1108279 CAPLUS

Ryan, Clarence A.; Ryan, Patricia Louise; Pearce, Gregory L.; Huffaker, Alisa; Yamaguchi, Yube. Plant defense signaling peptides and their receptor kinases, role in innate immunity, and orthologous genes. U.S. Pat. Appl. Publ. (2009), 197pp., Cont.-in-part of U.S Ser. No. 795,733. CODEN: USXXCO US 2009300802 A1 20091203 CAN 152:31735 AN 2009:1511184 CAPLUS

Lange B.M., Turner G.W., Rios-Esteba R. (2009); Production of small molecules in glandular trichome-bearing plants. Provisional Patent Application (filing date: March 26, 2009)

3. Publications (Standard General Output Measure)**Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	0	40	
Actual	0	33	33

V(F). State Defined Outputs**Output Target**

Output #1

Output Measure

- Peer reviewed journal articles

Year	Target	Actual
2009	45	33

Output #2

Output Measure

- Supporting graduate students on Agricultural Research Center and External Funding

Year	Target	Actual
2009	36	19

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Increase numbers of students
2	Patents
3	External Funding in millions of dollars
4	Peer reviewed journal articles

Outcome #1**1. Outcome Measures**

Increase numbers of students

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	30	19

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Students at the IBC earn PhDs in Molecular Plant Sciences, in Biochemistry, (School of Molecular Biosciences), Chemical Engineering and in Chemistry of Biological Systems; these are generally multidisciplinary programs. Additional (quality) students will result in more highly trained plant researchers for both Washington State and the United States, addressing topical/priority areas, such as bioenergy/biofuel and bioproducts development, photosynthesis, nutritional improvement of protein, starch and lipid quality in seeds and plants, understanding of metabolic pathways (enabling one to re-engineer plant forms to enhance formation of metabolites with health related significance) and other potentially useful basic research. Such areas are critical to plant productivity, human health and nutrition, bioenergy/bioproducts research, as well as to allied industries.

What has been done

The Department of Chemistry at Washington State University began a new graduate program in 2008 entitled "Chemistry in Biological Systems." This program recruits students with strong chemistry backgrounds and an interest in biological systems to Washington State University. In turn, those interested in plants are drawn into (bio)chemistry-related research programs at the IBC, and this is being used for future active recruiting of chemistry/biology-oriented students. Chemistry holds a recruitment program in March and we also recruit many of our current students through the Molecular Plant Sciences (MPS) Graduate program, and to a lesser extent the School of Molecular Biosciences (SMB) and the Department of Chemical Engineering. MPS holds an Integrated Plant Sciences Retreat and recruitment program each February, as does SMB. Top ranked students in the nation who have applied to these programs are invited to meet with faculty at the retreat. Students with strong biochemistry or molecular biology backgrounds may directly enter IBC laboratories as a result (without undergoing a rotation through various faculty labs during the first year of graduate school) under a program called, Accelerated PhD. To help support and recruit these students, most of the IBC faculty are also involved in a NIH-supported Protein Biotechnology grant. Other methods of recruitment involves mailing recruitment posters to various (often including land-grant) universities in the United States. Prospective students also contact IBC researchers directly, e.g. via email.

Results

Graduate student numbers per faculty member are anticipated to increase. Currently, the IBC has nine faculty researchers, of which three are Assistant Professors (the newest joining in 2009), one is on 50% phased retirement, and another is in a full-time administrative position within the College's Agricultural Research Center. As the newest members begin to obtain additional extramural funding, the IBC expects to be able to support more graduate students thereby leveraging existing resources. Included in the 9 faculty members is one individual who

no longer takes graduate students and will retire in 2011.

Within the last few years, many of the students entering the Molecular Plant Sciences program have had weak biochemistry backgrounds, and accordingly have not fared as well in IBC research programs. The new Biological Systems in Chemistry program may recruit students with better educational backgrounds and preparation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
701	Nutrient Composition of Food

Outcome #2

1. Outcome Measures

Patents

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The award of patents for research protects intellectual property. If licenses are obtained by other entities to use the research, this generally results in royalties and/or contracts coming to the University, the IBC and, to some extent, the researcher. Novel and useful research results are an indication that researchers are making important discoveries.

What has been done

Although 3 patents were filed in 2009, none were awarded

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms

202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
511	New and Improved Non-Food Products and Processes
701	Nutrient Composition of Food

Outcome #3

1. Outcome Measures

External Funding in millions of dollars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	5	7914759

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Actual fiscal year extramural funds July 1 2008-June 30, 2009, \$5,961,504. Fiscal year estimated extramural funds July 1, 2009-June 30, 2010 -as of 1/31/2010 are \$7,914,759.

Generally, extramural funds are necessary for financing research at the Institute of Biological Chemistry, and fund about 57% of all activities.

What has been done

Principal Investigators submit competitive research proposals to federal agencies such as the National Science Foundation, United States Department of Agriculture, Department of Energy and the National Institutes of Health, as well as negotiating contracts with private industries (Monsanto, Dow Chemical, Bayer, Boeing, Philip Morris, etc.).

Results

Since fiscal year 2000, extramural funds have increased from \$4.8 million to \$7.9 million, a positive change of 65%. Tenured/tenure track faculty FTEs receiving a salary through the Institute is 8.5. One additional FTE from Agricultural Research Center also maintains a program in the Institute. Average funding per tenured/tenure track faculty in 2009 was $9.5 / \$7,914,759 = \$833,132$.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms

202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
511	New and Improved Non-Food Products and Processes
701	Nutrient Composition of Food

Outcome #4**1. Outcome Measures**

Peer reviewed journal articles

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	45	33

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Peer reviewed journal articles are important because they generate research results that meet certain standards - experiments are repeatable, results are understandable, and the article has been reviewed by credible individuals in one's own field. When published in quality journals, these articles generally represent evidence of substantial progress in research.

What has been done

Tenured/tenure-track faculty work with undergraduates, graduate students, postdoctoral research associates and collaborators to write thorough and accurate reports of research and research findings. Graduate students or postdoctoral research associates may be first listed authors who have had the opportunity to learn how to translate their research into scientific publication ("products") under the mentoring of the research leader. When complete, an article is submitted to an appropriate journal, such as Phytochemistry or Plant Cell, etc., and is reviewed on its own merit. Articles may be returned to the authors with recommendations for further research before publishing, or for revisions.

Results**4. Associated Knowledge Areas**

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
511	New and Improved Non-Food Products and Processes
701	Nutrient Composition of Food

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Brief explanation of external factors which may affect outcomes:

External Factors: The cost of gasoline and diesel was at an all-time high in 2008, making research in biofuels and bioenergy appear more attractive. While not as high this year, there still seems to be a deliberate intention by Congress to support biofuel/bioenergy research. Some funding opportunities in 2009 were partially affected (increased) by a nationwide interest in biofuel development, resulting in continued funding to IBC researchers. The IBC is in an excellent position to conduct research directed to development of potential feedstocks, such as biofuels from and other species. All indications are that this will continue to be a federal/state high priority for future (energy-related) research. WSU was subjected to significant cuts in its state appropriations. While IBC fared better than most units in the level of required reduction, we also did not get the modest increase in resources we were hoping for and there have been consequences for university-based infrastructure. Budget reductions are also on the horizon for next year.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 18****1. Name of the Planned Program**

Program in Crop Genetics and Breeding

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			24%	
202	Plant Genetic Resources			12%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			26%	
204	Plant Product Quality and Utility (Preharvest)			13%	
206	Basic Plant Biology			4%	
211	Insects, Mites, and Other Arthropods Affecting Plants			5%	
212	Pathogens and Nematodes Affecting Plants			16%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	50.0	0.0
Actual	0.0	0.0	38.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	166777	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1777336	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	3175940	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

We developed, tested, patented (PVP) and released new commercial cultivars of spring and winter wheat, and spring barley for conventional and targeted management systems, such as direct seed, organic, perennial, and integrated animal-based. We

identified and/or elucidated the mechanisms of gene function leading to enhanced disease resistance, quality attributes, abiotic stress tolerance, and emergence, cold tolerance, herbicide resistance, and genetic recombination. We established patents on biologically unique organisms (varieties) and processes. We published journal papers on the development of new breeding techniques that improve efficiency by using genetic markers (marker assisted selection, marker assisted backcross selection) and a variety of other molecular, statistical, and genetic/genomic techniques, on wheat and barley genomes, and genome structure and function. We published papers and advanced technology transfer of novel end use purposes for food, medicine, bioproduct and bioenergy applications for commercial adaptation.

2. Brief description of the target audience

The target audience includes other crop scientists, economists, commodity commissions, policy makers, legislators, agribusiness, food processors, and farmers.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	2400	2600	100	1100
Actual	1800	65000	150	550

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 4

Patents listed

1. Genetic manipulation of the At-hook domain in plant AHL genes to modulate cell growth.
2. Registration of 'Kelse' wheat (PVP # 200900351)
3. Registration of 'Whit' wheat (PVP # 200900350)
4. Registration of 'Farnum' wheat (PVP # 200900327)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	1	17	
Actual	4	23	27

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal publications

Year

Target

Actual

2009	17	23
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Output #2

Output Measure

- Graduate students supported on Agricultural Research Center or other external funds

Year	Target	Actual
2009	21	26

Output #3

Output Measure

- Plant Patents and plant variety protections (PVPs)

Year	Target	Actual
2009	1	4

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Publications on improved knowledge of wheat, barley genetics, genome, new breeding tools impacting the national, international breeding, and genetic scientific community
2	Commercial cultivar releases that are adapted regionally.

Outcome #1**1. Outcome Measures**

Publications on improved knowledge of wheat, barley genetics, genome, new breeding tools impacting the national, international breeding, and genetic scientific community

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	16	21

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Publications on aspects of genetics and breeding affect the international community of cereal geneticists and plant breeders. Expanded knowledge in these areas allows progress in understanding genes, genetic mechanisms, and breeding processes, particularly in barley and wheat.

What has been done

Reports have been made on herbicide resistance in weeds and crops; inheritance of seed dormancy and pre-harvest sprouting in barley; wheat and barley end use quality; new systems and approaches in genetic analysis; genetic analyses of wheat and barley rust and Septoria resistance, wheat chromosome pairing, and wheat coleoptile length; and breeding methodologies for low input and perennial wheat production systems.

Results

New information has been gained to better understand the genes involved and inheritance patterns of wheat and barley rust and Septoria resistance; wheat and barley end use quality, coleoptile length, and chromosome pairing; herbicide resistance genes in crops and weeds; and genes for dormancy and pre-harvest sprouting in barley. In the latter case the genes have been mapped and molecular markers identified, which will aid in breeding of improved balance between dormancy and pre-harvest sprouting in barley and potentially wheat. New knowledge also will aid small grain breeding for low input and perennial production systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
212	Pathogens and Nematodes Affecting Plants

Outcome #2**1. Outcome Measures**

Commercial cultivar releases that are adapted regionally.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2	2

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

New grain cultivars carry improvements over existing cultivars, which benefit farmers, processors, exporters, and/or end users in terms of enhancing yield and end-use quality. Variety development is followed closely, especially by farmers and processors.

What has been done

Two new wheat cultivars were released in 2009 (two spring types).

Results

The new cultivars will give more options for farmers to plant in their rotations. They will also provide new export opportunities. In 2009, in Washington State, about 50% of the 2,400,000 acres sown to wheat were WSU cultivars, while about 15% of the 200,000 acres sown to barley were WSU cultivars. The proportional earnings from WSU wheat and barley cultivars harvested were estimated at \$530 and \$8 million, respectively. The WSU cereal variety testing program provided information to growers, which enabled them to select improved cultivars vs. average cultivars. It was estimated that this information has a value of \$25 million/yr to farmers in terms of increased yield and quality returns.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Competing Public priorities
- Other (Staffing Changes)

Brief Explanation

Major factors in 2009 include localized drought, which impacted field results and the total loss of several cultivar test sites; localized winter injury and emergence problems in the low rainfall zone; and disease associated with extended winter snow cover. We refilled two key positions in winter and spring wheat breeding in 2009, and executed a program reorganization in the winter program, which will allow these programs to move forward again fully staffed in 2010. Uncertainty over public (state) funding for higher education and budget cuts in this area forced staff FTE reductions.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 19****1. Name of the Planned Program**

Program in Sustainable Crop and Soil Management

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			25%	
102	Soil, Plant, Water, Nutrient Relationships			10%	
104	Protect Soil from Harmful Effects of Natural Elements			12%	
111	Conservation and Efficient Use of Water			5%	
112	Watershed Protection and Management			5%	
133	Pollution Prevention and Mitigation			4%	
141	Air Resource Protection and Management			3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			4%	
205	Plant Management Systems			9%	
212	Pathogens and Nematodes Affecting Plants			1%	
213	Weeds Affecting Plants			13%	
402	Engineering Systems and Equipment			1%	
403	Waste Disposal, Recycling, and Reuse			5%	
511	New and Improved Non-Food Products and Processes			1%	
601	Economics of Agricultural Production and Farm Management			2%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	39.9	0.0
Actual	0.0	0.0	54.2	0.0

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

Extension		Research	
Smith-Lever 3b & 3c 0	1890 Extension 0	Hatch 348730	Evans-Allen 0
1862 Matching 0	1890 Matching 0	1862 Matching 4323275	1890 Matching 0
1862 All Other 0	1890 All Other 0	1862 All Other 3398062	1890 All Other 0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

We continue to develop and demonstrate high quality and safe food production from organic, direct seeded and other sustainable cropping systems. We document ecosystem services and other environmental benefits provided by sustainable cropping systems in the form of carbon sequestration, reduced soil erosion by wind and water, reduced greenhouse gas emissions, improved water capture and use, and reduced leaching of contaminants in the vadose zone. This research also improves the efficiency and safety of waste recycling systems in environmental and agricultural production systems. We identify and characterize soil biological organisms and processes important in crop production, residue and by-product decomposition, and soil quality enhancement. We develop soil management programs for new crop species and cultivars of evolving cropping systems in collaboration with crop genetic and breeding teams. We are seeking to develop a variety of bioproducts from crop residues. We have published journal articles and extension bulletins on unique findings related to the above topics, and disseminate information on the above systems to facilitate adoption and commercialization.

2. Brief description of the target audience

The target audience includes soil scientists, state and federal agency personnel, economists, commodity commissions, policy makers, legislators, agribusiness, and farmers.

V(E). Planned Program (Outputs)**1. Standard output measures**

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	2500	2100	100	1000
Actual	17500	53500	200	150

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

Year: 2009

Plan: 0

Actual: 0

Patents listed**3. Publications (Standard General Output Measure)****Number of Peer Reviewed Publications**

2009	Extension	Research	Total
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Plan	10	21	
Actual	7	38	45

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed journal publications

Year	Target	Actual
2009	32	38

Output #2

Output Measure

- Graduate students supported by Agricultural Research Center and other external funds

Year	Target	Actual
2009	21	27

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Publications dealing with improved knowledge of crop rotations, nutrient cycling, soil building and carbon sequestration, fertility management, soil structure and soil water movement, chemical movement in soils, tools for spatial monitoring and management.

Outcome #1**1. Outcome Measures**

Publications dealing with improved knowledge of crop rotations, nutrient cycling, soil building and carbon sequestration, fertility management, soil structure and soil water movement, chemical movement in soils, tools for spatial monitoring and management.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	21	38

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Publications on these aspects of sustainable crop and soil management affect the international community of agronomists and soil scientists. Expanded knowledge in these areas allows progress in understanding basic aspects of sustainable crop production practices. This in turn allows progress in developing best management practices, which directly benefits farmers and their success, and indirectly benefits the greater public, as the environment improves and food production costs are kept low.

What has been done

Numerous reports and presentations have been delivered on weed ecology and control in crops; fertilization of crops to optimize nutrient use efficiency; fertilization effects on grain and residue composition, decomposition, and processing; organic crop production practices; crop rotation and direct seeding / reduced tillage methods and their effects on erosion, production and economics; and improved methods of measuring soil physical, chemical, and microbial parameters.

Results

Better understanding has been gained of the ecology and control of weeds in Washington State and regional crops and environments. It was estimated that the adoption of one new herbicide alone saved farmers approximately \$13 million across the region, and reduce the chemical load in the environment by approximately 120,000 lbs. The cost of soil erosion in the Palouse alone has been >\$70 million/yr due to lowered crop yields, lost nutrients, and cleanup. Adoption of reduced tillage methods has reduced erosion by 25-50% with a cost savings of up to \$35 million/yr. This has improved water and air quality for all as well. Improved fertilizer application methods in cereals, forages, potato, grape, onion, and turfgrass production has reduced production costs and nutrient runoff and leaching with a cost savings of >\$5 million/yr and reduced nitrogen emissions into the atmosphere by 80,000 lbs annually. Organic agriculture production has risen dramatically in Washington partly due to increased demand and partly due to WSU's emphasis on education and production methods research.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources

102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
205	Plant Management Systems
213	Weeds Affecting Plants
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
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
- Competing Public priorities

Brief Explanation

Major factors in 2009 include localized drought, which impacted field research results; the state and national economy, which affected production input costs, which in turn puts downward pressure on farmer adoption of new technologies, especially soil conservation measures; increased costs of inputs affecting farmers also affect researchers.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 20****1. Name of the Planned Program**

Global Food Security and Hunger

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890

Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Because the work reported in the annual review goals anticipated for 2009 includes effort that will be duplicated by also reporting under the newly mandated goals, quantitation of effort is not included under Inputs. However, we estimate that about 56% of Hatch expenditures were in this area.

Since making the decision many years ago to focus research efforts on aspects of agricultural production, the WSU Agricultural Research Center has invested heavily in areas like basic plant and animal science, agricultural productivity, sustainable agriculture, cropping systems, agricultural economics, pest and pathogen control, food processing and agricultural mechanization. Much of this research is directed toward the major agricultural products of the state, like wheat, barley, dry legumes, tree fruit, wine grapes, onions, produce, berries, hay, dairy and beef cattle, but this effort also extends to minor state crops and, in some cases, crops that are not grown here at all, like rice and cassava. The goals are diverse but have the common theme of trying to produce quantity and quality, while minimizing off-farm inputs like farm chemicals and while maintaining soil productivity and environmental quality. Special funding is available for long-term cropping research and sustainable production practices, including organic farming. Although Extension reports separately, it is important to note that there is considerable integration of effort between Research and the consumers of that research. One index of this is the recent success of WSU programs in competing for Specialty Crop Research Initiative funds—about 20% of the dollars committed in 2009 for integrated projects were awarded to WSU. Much of the research is applicable to other areas of the world with similar

climates; at a recent meeting with wheat farmers, one of our growers commented a bit sourly that Uzbekistan and Kazakhstan were now his competitors on the world wheat market, thanks to WSU outreach efforts.

Notable events this year include: Introduction of a new apple by WSU's Tree Fruit Breeding program, one of the first products of a several year emphasis on accelerating fruit tree cultivar development; receipt of an NSF IGERT award for training graduate students in science and policy questions related to nitrogen, including agricultural issues like fertilizer inputs and waste management; Expansion of long term management programs for wheat, including organic and perennial wheat production and erosion and particulate management; Strengthening of the viticulture and enology program; Acquisition of a major NIH grant to explore biochemical and biosynthetic possibilities of medicinal plants; Expansion of various IPM programs, especially in management of tree fruit pests; FDA approval of a microwave sterilization process for rapid and low energy food preservation; Development of new bio-based composite materials and technologies and; Improved mechanization for tree fruit and vineyard management.

2. Brief description of the target audience

For the researchers, the initial audience is other researchers who can validate and test how robust the results are. The ultimate audience is some mixture of producers and processors, and includes regulators and policy makers. Ultimately, the value of much of the work is determined by market prioritization and by efforts to make the production systems sustainable by including all direct, ecosystems services and human resources costs in determining the cost of production.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

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

Patent Applications Submitted

Year: 2009

Plan:

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan			
Actual	{No Data Entered}	{No Data Entered}	{No Data Entered}

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

{No Data Entered}

V(H). Planned Program (External Factors)

External factors which affected outcomes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 21****1. Name of the Planned Program**

Climate Change

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890

Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Because the work reported in the annual review goals anticipated for 2009 includes effort that will be duplicated by also reporting under the newly mandated goals, quantitation of effort is not included under Inputs. However, we estimate that about 14% of Hatch expenditures were in this area.

Except for the work described under the Program in Sustainable Energy, our research portfolio is not very targeted to altering factors leading to climate change. Instead, our work in this area is primarily an extension of our usual need to deal with agriculture in a region with diverse microclimates and one where year-to-year variation in weather can have important implications for that year's crop production. Our expertise is more about dealing with climate change than in preventing it but we are not ignoring areas where changing farm practices might make a difference in carbon sequestration. The WSU Climate Friendly Farming Team won a 2009 USDA NIFA Partnership Award for Innovative Program Models.

Areas where we have strength in this Program area include: (1) Adopting and adapting new crops to specific areas within the Pacific Northwest region; (2) Using weather inputs as real-time variables in crop protection, especially with regard to insects and pathogens; (3) Modeling the potential consequences for the region of changed weather patterns.

In trying to plan for changes in local climate that may accompany global warming and understanding the implications of these changes for regional agriculture, it is important to realize that we already deal with significant variation in local climate. For

example, in the Palouse wheat-growing region, there is a consistent east-west rainfall gradient and a consistent north-south temperature gradient. The latter is also associated with persistence of winter snow cover that makes the wheat crop in the northern parts of the region more susceptible to snow mold. Thus our wheat breeding programs develop varieties that differ in traits related to water use, with a priority for snow mold resistance in varieties that would be used in the northeastern Washington. To keep up with the speed of climate change, we will need to do what we already do, only faster. The WSU breeding programs for grains and other crops are already trying to incorporate faster methods of genotyping and phenotyping plants. They are also using other breeding strategies to bring specific traits to the field more rapidly. This will be even more important for local perennial crops, including fruit trees and grapes. One of the most likely effects of warmer weather is the expansion of insects and diseases into areas where they had previously been limited by cold winter weather. Our ongoing investment in entomology and plant pathology is potentially a defense against these. Local weather data is an input to AgWeatherNet(weather.wsu.edu), a system developed to provide weather tracking information to the WSU Tree Fruit IPM Decision Aids System, an expert system that helps the tree fruit industry predict the potential severity of pest problems so that growers can make informed decisions about using pesticides. Finally, we have strong programs in modeling the impact of rainfall and temperature on crop growth.

2. Brief description of the target audience

The audience for this work is scientists in adjacent regions, producers who may wish to incorporate the idea that warmer temperatures and longer growing systems may be part of their future, decision makers and the general public.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan:

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan			
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

{No Data Entered}

V(H). Planned Program (External Factors)

External factors which affected outcomes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 22****1. Name of the Planned Program**

Sustainable Energy

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890

Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Because the work reported in the annual review goals anticipated for 2009 includes effort that will be duplicated by also reporting under the newly mandated goals, quantitation of effort is not included under Inputs. However, we estimate that about 11% of Hatch expenditures were in this area.

The primary impacts of our research programs in the area of sustainable energy are: (1) Exploring the potential for altering cropping systems in the Pacific Northwest to include more options for incorporating plants that can be used as energy sources; (2) Altering current agricultural processes to require less energy input; (3) Understanding the basic properties of plant production of potential energy feedstocks with the goal of adding value to biological energy production; (4) Developing methods for using plant derived products as energy sources; and (5) Developing usable models that include energy costs associated with production so that producers can estimate the economic consequences of various production alternatives.

We have projects looking at the regional potential of new "energy crops" like algae, camelina, switchgrass and giant reed, and the possibility of using rapidly growing plants like poplar, prickly lettuce and other weeds for their biomass or specialty chemical production. These efforts sometimes include work to increase production of these plants by altering cropping practices or by genetic improvement through traditional breeding. Work is also underway to understand how photosynthesis is controlled and to alter the flow of photosynthate to useful energy products, like starch and lipids. The more reduced compounds could lead

to potentially higher value fuels than ethanol. Research into reshaping plant allocation strategies is coupled to physiological studies examining the potential consequences for the growth of the whole plant, including properties, such as stress and disease resistance, that would be important in growing crops able to generate products at a competitive price. Because of the diversity of plants grown in the state and the relatively lignified state of the tree biomass identified as a major potential source of energy, pyrolysis is the major conversion option being explored, especially small scale pyrolysis that would allow high temperature conversion to be tailored to individual biomass inputs. The cropping research that accompanies some of these projects includes further analysis of low-input farming techniques, like no-till farming in the eastern part of the state, and designed studies of the long-term impact of various farming practices. In the last year, WSU obtained a large organic dryland farming grant from USDA, a planning grant for the Long Term Agricultural Program, and an NSF IGERT grant to examine reactive nitrogen. The organic farming program is also associated with the WSU Center for Sustaining Agriculture and Natural Resources, which is investigating various alternatives for growing crops, many of which are judged by their ability to be productive while minimizing external inputs, including energy and farm chemicals. These are also supported by analyses by WSU economists of the potential profitability of production alternatives.

2. Brief description of the target audience

Because the implications of sustainable energy development are diverse, there is a similar diversity in the audience for this research. A study carried out by WSU economists that was commissioned by the Washington legislature and released in late 2008, has helped shape state energy policy and defined where our production might fit in the energy market. Some of this is reflected in the research priorities described above. More generally, the research has found several target audiences, from farmers considering long-term strategies with regard to cropping and production practices, to the US Department of Energy, which funds several of our investigators, especially in the basic science areas. The audiences include other scientists working in similar areas, industry scientists, and decision makers at several levels.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

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

Patent Applications Submitted

Year: 2009

Plan:

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan			
Actual	{No Data Entered}	{No Data Entered}	{No Data Entered}

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

{No Data Entered}

V(H). Planned Program (External Factors)

External factors which affected outcomes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 23****1. Name of the Planned Program**

Childhood Obesity

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890

Actual	0.0	0.0	0.0	0.0
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

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

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Because the work reported in the annual review goals anticipated for 2009 includes effort that will be duplicated by also reporting under the newly mandated goals, quantitation of effort is not included under Inputs. However, we estimate that about 1% of Hatch expenditures were in this area. We do include descriptions of the research efforts within the Agricultural Research Center that most directly relate to the new Planned Programs.

While our researchers put considerable effort into quantifying the qualities of the agricultural commodities they support, including those like nutrient content, sensory qualities, processing qualities, etc., we currently carry out little scientific research that directly addresses issues related to human obesity. So, for example, some of our animal scientists are examining the feeding efficiency of cattle and the ability of various diets to support weight gain and meat quality, this research is not directly related to how humans process their food or the context in which it is consumed.

2. Brief description of the target audience**V(E). Planned Program (Outputs)**

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan:

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan			
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

{No Data Entered}

V(H). Planned Program (External Factors)

External factors which affected outcomes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 24****1. Name of the Planned Program**

Food Safety

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890

Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)**1. Brief description of the Activity**

Because the work reported in the annual review goals anticipated for 2009 includes effort that will be duplicated by also reporting under the newly mandated goals, quantitation of effort is not included under Inputs. However, we estimate that about 4% of Hatch expenditures were in this area. We do include descriptions of the research efforts within the Agricultural Research Center that most directly relate to the new Planned Programs.

Research in the area of Food Safety has focused primarily on microbiological contamination but has also included research and technical ability to determine chemical contamination of food. Work carried out in the WSU College of Veterinary Medicine has concentrated on learning the dynamics of highly pathogenic *E. coli* and *S. typhimurium* bacteria in animal production systems, especially related to cattle, and has included epidemiological studies to measure the prevalence and population biology of pathogens in different dairy and beef cattle operations, with a special focus on the transmission and persistence of antibiotic resistance traits. Research on bovine mastitis is also included in this effort, in an attempt to deal more effectively with infective *Staphylococcus* and a newly emerging *Mycobacterium* problem. At the level of the introduction of pathogens into the food supply, we are investigating how these bacteria might be introduced into field crops and more rapid methods for detecting pathogens on vegetables and in processed foods like cheese. This has included experiments to reexamine the ability of pathogens to survive composting conditions used to convert animal waste into manure. In addition, several groups are investigating methods for decontaminating or decreasing numbers of viable pathogens using methods including microwave irradiation, chemical washes,

and cold plasma technology. In association with IR-4 certification support programs, we also test levels of chemical contamination and pesticide and herbicide residues in food.

2. Brief description of the target audience

For the researchers, the initial audience is other researchers who can validate and test how robust the results are. The ultimate audience is some mixture of producers and processors, regulators who attempt to balance the costs of procedures and their efficacy and applicability, and ultimately, the people who consume the food and are trying not to risk their health in doing so.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

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

Patent Applications Submitted

Year: 2009

Plan:

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan			
Actual	{No Data Entered}	{No Data Entered}	{No Data Entered}

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- {No Data Entered}

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

{No Data Entered}

V(H). Planned Program (External Factors)

External factors which affected outcomes

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}