

**ANNUAL REPORT**  
**OF**  
**ACCOMPLISHMENTS AND RESULTS**

**Agricultural Research Center**  
**College of Agricultural, Human and Natural Resource Sciences**  
**Washington State University**  
**Pullman, Washington**

**Submitted to USDA/CSREES**

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**Period Covered**

**Federal FY2004**  
**October 1, 2003 to September 30, 2004**

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## SECTION I

### INTRODUCTION

The Agricultural Research Center (ARC) (state agricultural experiment station) College of Agricultural Human and Natural Resource Sciences (CAHNRS), Washington State University (WSU) chose to submit an individual Plan of Work (POW) rather than a joint plan with Cooperative Extension (CE) at WSU. Therefore, the contents of this Annual Report (October 1, 2003 – September 30, 2004) are for ARC only.

The ARC chose to develop the POW within the framework of the institutional strategic plan [1997-2002]. The Annual Reports of the individual units, which constitute Section II of this report, are built around their corresponding components of the WSU Strategic Plan and the POW revision submitted on July 2, 2001.

Each of the following units of CAHNRS were designated as a "program unit", each of which has one or more planned research programs addressing issues important to one or more components of the agricultural industry of the State of Washington.

#### **Program Planning Units**

School of Economic Sciences (formerly Agricultural and Resource Economics)  
Animal Sciences  
Biological Systems Engineering  
Crop and Soil Sciences  
Entomology  
Food Science and Human Nutrition  
Horticulture and Landscape Architecture  
Natural Resource Sciences  
Plant Pathology  
Rural Sociology

#### **Special Program Units and Institutes**

IMPACT Center  
Institute of Biological Chemistry  
Veterinary Medicine - Field Disease Investigation Unit

### CONTACT INFORMATION

All correspondence/contacts regarding this annual report should be directed to:

Ralph P. Cavalieri, Associate Dean and Director  
Agricultural Research Center  
Washington State University  
Pullman, WA 99163-6240  
Voice: 509-335-4563  
FAX: 509-335-6751  
e-mail: cavalieri@wsu.edu

OR

Sandra S. Ristow, Associate Director  
Agricultural Research Center  
Washington State University  
Pullman, WA 99163-6240  
Voice: 509-335-4563  
FAX: 509-335-6751  
e-mail: ristow@wsu.edu

## **CERTIFICATION**

I, signed By Ralph P. Cavalieri\_\_\_\_, Ralph P. Cavalieri, Associate Dean, College of Agriculture and Home Economics, and Director, Agricultural Research Center, do hereby certify that this Annual Report of Accomplishments and Results constitutes official submission of all required reports.

## **ANNUAL REPORT PREPARATION**

In the preparation of this report department chairpersons and research directors have provided the bulk of the information based on their respective portions of the revised POW. Their reports include research results and impacts benefiting stakeholders and members of the scientific community on research programs (projects), which were active at the time of preparation of the Washington State University Agricultural Research Center Plan of Work.

Individual unit expenditure data was taken from the CRIS AD419 report.

## **PLAN OF WORK UPDATE**

After the first Plan Of Work Report was submitted in April 2001, it became apparent from the instructions and key theme categories received from CSREES that an update/revision of the ARC POW was desirable. Accordingly, an update to the original five-year plan of work was prepared and submitted to the USDA-CSREES on July 2, 2001. Preparation of the update included new research projects and shifted selected projects to their related federal goals. The revision more accurately reflects the research being performed under the auspices of the ARC.

## **RESEARCH FUNDING**

In federal FY2004, the ARC received and expended \$1,998,311 in Hatch funds and \$1,399,364 in Hatch Multistate Research funds. The ARC also received and expended \$294,507 in McIntire-Stennis funds.

Hatch and Hatch Multistate Research funds constitute 4.43 % and 3.10 %, respectively, of the total funds expended on Agricultural Research Center (ARC) projects. McIntire-Stennis funding accounts for only 0.65% of the funds expended. State appropriations are 30.24 % of the total with all other grants totaling 48.06 %.

Hatch Multistate Research funds are expended exclusively in support of approved Multistate Research Fund projects, Multistate Research Coordinating Committee projects, and partial support of faculty and staff salaries, goods and services, and travel on those projects.

Data extracted from the CRIS AD419 report documents the following total expenditures from various fund sources.

**EXPENDITURES FOR WSU AGRICULTURAL RESEARCH CENTER  
PROJECTS FEDERAL FY 2004**

Funding Source	CSREES Goals					Total	% of Totals
	1	2	3	4	5		
Hatch Funds	\$1,377,981	\$113,120	\$5,005	\$397,817	\$104,388	\$1,998,311	4.43%
Multistate Research Funds	\$895,672	\$316,504	\$28,660	\$158,528	\$0	\$1,399,364	3.10%
McIntire-Stennis	\$235,800	\$0	\$0	\$58,707	\$0	\$294,507	0.65%
Federal Research Grants	\$3,345,383	\$345,260	\$47,173	\$2,077,726	\$288,622	\$6,104,164	13.52%
State Appropriations	\$8,452,873	\$1,600,185	\$341,028	\$2,829,066	\$426,401	\$13,649,553	30.24%
All Other Grants	\$13,996,618	\$1,967,174	\$321,397	\$4,764,696	\$639,425	\$21,689,310	48.06%
Totals	\$28,304,327	\$4,342,243	\$743,263	\$10,286,540	\$1,458,836	\$45,135,209	--
Percentage of Total \$	62.71%	9.62%	1.65%	22.79%	3.23%	100.00	--
FTEs	310.47	50.09	7.69	110.65	12.07	490.97	--
Percentage of Total FTEs	63.24%	10.20%	1.57%	22.54%	2.45%	100.00	--

## SECTION II

### GOAL 1

#### AN AGRICULTURAL SYSTEM THAT IS HIGHLY COMPETITIVE IN THE GLOBAL ECONOMY

#### EXECUTIVE SUMMARY

The majority of research performed in FY 2004 by faculty having appointments in the WSU Agricultural Research Center supports national **Goal 1**, “an agricultural system competitive in the global economy.” Early on, it was decided that in the face of diminishing state support, the focus of research in the WSU Agricultural Research Center would be on the food system of Washington and its stakeholders. Because the State is agriculturally diverse (over 250 different crops) the Plan of Work 1999-2004, its revision in 2001 and the new 2005-2006 extension of the Plan of Work have also focused on the food system. The new WSU and College Strategic Plans have also reinforced the “food systems” direction of our work. Within those plans there is a large focus on biotechnology and on natural resources and the environment, which necessarily places the ARC focus on goals I and IV of the USDA-CSREES National Plan. Although Eastern and Washington is an area primarily devoted to large wheat farms and irrigated agriculture, an additional emphasis has been forming in the area of organic and sustainable agriculture and its profitability, primarily in Western Washington. Western Washington is home to an extraordinarily diverse agriculture in an expanding urban environment in which local food systems have become quite important. Thus, the outcomes and impacts cited below emerge from the original POW and its revision as influenced by the strategic plans and the myriad of audiences the ARC serves. In this report, we cite impacts and outcomes by department. It is indeed evident that the departments and units are also focused on their goals as stated in the 1999 and in the 2001 revised plans of work.

Certain impacts and outcomes achieved in 2004 under goal 1 were particularly noteworthy and included new thrusts in nutrient management by a number of departments and centers-- the Animal Sciences Department, Biological Systems Engineering and the IMPACT Center. In particular, there was an effort in Biological Systems Engineering (under both goals 1 and 4) to derive bio-based products out of the biomass (whey, manure, cull potatoes, which would ordinarily be cast aside. Out of the bio-waste is coming methane, fiber, antibiotics, ethanol, lactic acid, etc. In joint efforts by the Departments of Biological Systems Engineering and Food Sciences and Human Nutrition, there were projects to make our foods safer and tastier by using new preservation methods such as microwave and radiofrequency. The Department of Crops and Soil Sciences continues to develop, evaluate and release new germplasm tailored for the Pacific Northwest. For example, 66% of the 153,000 acres of soft white winter wheat in Washington is now planted with WSU varieties. A new formulation (invented by a faculty member in Horticulture) when sprayed on apples prevents apples from becoming sunburned, saving Washington orchardists \$10-15 million in 2004. The Institute of Biological Chemistry continues to make fundamental discoveries in plant biochemistry including measuring the energy budget of a plant, studying the control of heartwood formation in a tree, formulating the in vitro synthesis of the cancer drug taxol, elucidating the nutrient exchange pathways in one of the bacteria performing nitrogen fixation, and discovering the immune defense and polypeptide signaling in plants. The Department of Plant Pathology continues to work on the taxonomy and control of fungi which damage Washington crops and ruin international markets. In 2004 one of our faculty members invented a test which would distinguish dwarf bunt spores from cheatgrass bunt spores and thereby kept the markets in China open to our wheat exports. The School of Economic Sciences has analyzed the competitive position of our new Washington wine industry which competes against the California industry. All in all, the researchers in the Agricultural Research Center are contributing to the knowledge base in agricultural and natural resource sciences.

## DEPARTMENTAL REPORTS

### DEPARTMENT OF ANIMAL SCIENCES

1. **WNP00154. Environmental and Economic Impacts of Nutrient Management in Dairy Forage Systems**
  - A. **Key Theme:** Global Competitiveness of Agricultural Production Systems
  - B. **RPA 302:** Nutrient Utilization of Animals
  - C. A winter manure application study was initiated in January of 2002 and continued in 2003, and 2004 to evaluate the uptake of manure nutrients applied during the early winter period and/or early summer application.
  - D. **Impacts, Outcomes and Scope of Research:**
    - i) Impacts of Research: Winter application was shown to increase forage yield 25-50% in 2002, 50-100% in 2003 and 175-229% in 2004.
    - ii) Geographic Scope: The State of Washington
    - iii) The project has immediate and direct application for dairy producers in Western Washington and results are being communicated by extension personnel.
    - iv) Affiliated with multi-state project NE-132 including: MA, MI, NJ, WV, PA, NY, OR, WA, MD, UT, IN, IL, and LA.
  - E. **Source of Funding:** Hatch, USDA Competitive Grant, DOE, and Community Funding.
2. **WNP00446. A Candidate Gene Approach for Mapping of Quantitative Trait Loci for Marbling in Wagyu X Limousin Crosses**
  - A. **Key Theme:** Animal Genomics
  - B. **RPA 304:** Animal Genome
  - C. Molecular markers allow the marker-assisted selection of breeding stock and feeder cattle for marbling selection and reduce costs for cattle fed for a long time.
  - D. **Impacts, Outcomes and Scope of Research:**
    - i) Impacts of Research: Genes previously identified as affecting marbling display different degrees of linkage disequilibrium with gene or genes controlling the trait in different populations. In addition, results suggest that a common QTL for both marbling and back fat is unlikely.
    - ii) Geographic Scope: This project has an international scope.
    - iii) This project does not have integrated research and extension.
    - iv) Not affiliated with a multi-state project.
  - E. **Source of Funding:** Hatch, State, and Donations.
3. **WNP00568. Nutrient Animal Genomics Research Project**
  - A. **Key Theme:** Animal Genomics
  - B. **RPA 304:** Animal Genome
  - C. A gene-based approach was utilized to in silico to clone orthologous genes sequences in livestock by using the EST's deposited in the Gen Bank database.
  - D. **Impacts, Outcomes and Scope of Research:**
    - i) Impacts of Research: At least 19,928 orthologous genes in cattle, 13,962 in the pig and 11,066 in chickens were identified. The orthologous genes were used to study genome evolution among species.
    - ii) Geographic Scope: International
    - iii) This project does not have an integrated research and extension.
    - iv) Affiliated with NRSP8 and numerous states.
  - E. **Source of Funding:** Hatch, State, and Donations.
4. **WNP00374. Feeding for Reduced Excretion of Nutrients by Ruminants**
  - A. **Key Theme:** Animal Production Efficiency
  - B. **RPA 302:** Nutrient Utilization in Animals
  - C. Digestibility studies were conducted to determine if exogenous phytase feed to dairy calves and lactating cows improved phosphorus digestibility in cattle fed diets containing barley.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: Digestibility of phytate phosphorus was increased by the exogenous phytase and has the potential to reduce phosphorus excretion by dairy cows.
- ii) Geographic Scope: International
- iii) Findings are being incorporated into recommendations made to producers by dairy extension personnel.
- iv) No multi-state affiliation.

**E. Source of Funding:** Hatch, State, and Donated Industry Funds.

**DEPARTMENT OF BIOLOGICAL SYSTEMS ENGINEERING**

**1. WNP00371: Studies of Using Microwave and Radio Frequency Energy in Food Safety, Phytosanitary and Quarantine Applications**

**A. Key theme:** Food Safety

**B. RPA 503:** Quality and Maintenance in Storing and Marketing Food

**C.** The goal of the project is to determine the effectiveness of a 915 MHz microwave single mode sterilization system for food processing and for treatment of fruits and vegetables to kill insects. The investigators filed a patent in September 2004 to protect the intellectual rights for the unique design of a 915 MHz microwave single mode sterilization system that has proven to be effective and stable. At a September meeting with FDA in Washington DC, progress in MW sterilization technology development was shared with the FDA Acidified and Low Acid Food team. The WSU Microwave Sterilization Consortium is developing a semi-industrial microwave sterilization system for FDA approval.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: The project made major progress in developing novel thermal processing technology for packaged foods that holds the promise to change the landscape of the thermal processing industry. Investigators developed a white paper for NASA strategic planning to include microwave sterilization technology for future production of high quality shelf-stable foods for long duration space missions.
- ii) Geographic Scope: The research is especially important in states such as Washington, Oregon, Alaska, and California that have substantial food canning and processing industries.
- iii) This project does not have research/extension integration.
- iv) This is not affiliated with a multistate research committee.

**E. Source of Funding:** Hatch, Department of Defense, Other Federal Funds, State Appropriations, Industry Grants and Agreements, and Other Non-Federal Funds.

**2. WNP00412: Development and Application of Harvesting and Processing Technologies for Production of Value Added Fruit and Vegetable Products.**

**A. Key theme:** Food handling

**B. RPA 402:** Engineering Systems and Equipment

**C.** One of the goals of the project is to establish collaborative research projects with the fruit and vegetable production and processing industry sectors. A second goal is to create and validate harvesting and processing technologies to increase the value of fruits and vegetables. The project is also oriented toward providing support in the proof and implementation of microwave technologies for processing and dehydration of fruits and vegetables. Efforts continue to support the commercialization of these technologies.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: Developing new technologies in harvesting and processing of fruits and vegetables allows producers and processors to address increasingly urgent concerns including global competition, maximizing the healthfulness and nutrition of foods, and maintaining Washington state's position in national and international markets. Changes in international trade policies have presented significant challenges to agriculture in Washington. Research and development in collaboration with Tree Top, Inc. and the Washington Technology Center will



reposition this domestic supplier of fruit ingredients to produce unique value-added products that off-shore competitors are unable to reproduce.

- ii) Geographic scope: The results of the project will be of benefit to producers in states with large fruit and vegetable industries such as Washington, California, Oregon, and Florida.
  - iii) The WSU scientist holds extension appointment and will be informing stakeholders.
  - iv) This project is not part of a multistate project.
- E. Source of Funding:** Hatch, State Appropriations, and Other Non-Federal Funds.

**3. WNP00573: Physical Properties of Food Powders**

**A. Key theme:** Food Safety

**B. RPA 501:** New and improved Food Processing Technologies

**C.** This year was dedicated to complete studies on the flowability of selected food powders of interest to the US food industry. In cooperation with the WSU Civil and Environmental Engineering Department, the investigators developed a comprehensive study on flowability, which is becoming essential for optimal utilization of vending machines dispensing coffee and coffee products (cappuccino, espresso, latte), tea, milk and milk products.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: The outcome of this project is a book entitled “Food Powders” published by Springer-Verlag.
- ii) Geographic Scope: The Principal Investigator presented several short-courses on the subject in countries such as Viet Nam, Spain, Uruguay and Argentina.
- iii) There is no integrated research/extension.
- iv) Not affiliated with a multistate project.

**E. Source of Funding:** Hatch.

**DEPARTMENT OF CROP AND SOIL SCIENCES**

**1. WNPOO175 Adaptation Studies of Cereal Varieties and Selections**

**WNP00196 Molecular Markers for Barley Disease Resistance Genes**

**WNP00232: Breeding and Genetics of Winter Wheat**

**WNP00334: Improving Spring Wheat Varieties for the Pacific Northwest**

**WNP00359: Early Generation and Market Specific Quality Evaluation of New Wheat Varieties**

**WNP01006 Breeding and Genetics of Barley**

**A. Key Theme:** Agricultural Probability, Plant Germplasm, Plant Health, Plant Production Efficiency and Small Farms Viability.

**B. RPA 201:** Plant Genome, Genetics and Genetic Mechanisms, **RPA 202:** Plant Genetic Resources and Biodiversity, **RPA 204:** Plant Production Quality and Utility (Pre-harvest)

**C.** Wheat and barley germplasm improvement, variety development, selection and testing for yield, end-use quality, nutrient use efficiency, pest resistance, and regional adaptability are the goals of our land standing program for wheat and barley breeding, genetics and end use evaluation.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: The researchers in these programs work collectively to develop, evaluate and release new germplasm and commercially competitive wheat and barley cultivars with improved yield potential, end use and pest resistance. Classes of wheat cultivars developed include hard red, hard white, soft white, and club. Barley cultivars include feed and malting types. Approximately 1 million acres of soft white winter wheat were grown in WA in 2004, of which 66.6% were planted with WSU releases, producing a gross value of \$260 million dollars. Soft white winter club varieties were planted on 153,000 acres, with 98.6% of the acreage planted with WSU varieties, grossing \$40 million. Hard red winter wheat was grown on 89,000 acres, with 67% planted to WSU varieties, grossing \$18 million. Soft white spring wheat was grown on 275,000 acres with 92% WSU varieties grossing \$49.5 million. Hard red spring wheat was grown on 66,000 acres with 31% planted to WSU varieties grossing \$14.8 million. Twenty-five percent of the barley acreage is planted to WSU varieties.

- ii) Geographic scope: Variety releases mostly have regional impact due to their specific adaptability to soil and climatic conditions but unique, basic approaches to genetic modification and variety development have national/international impact.
  - iii) Research and extension are well integrated among these programs to facilitate effective germplasm characterization and mapping, variety development, field testing, end use evaluation and transfer to the agricultural community. Researchers and extension specialists in these programs log many hours in field days, tours, grower meetings for outreach to farmers.
  - iv) None of these projects are affiliated with Multistate activities.
- E. Source of Funding:** Hatch, Wheat and Barley Commodity Commissions, Industry Grants and Agreements, State, USDA-NRI and Other Federal Funds.

## **DEPARTMENT OF ENTOMOLOGY**

### **1. WNP00455: Biological Diversity Studies of Arthropods**

- A. Key Themes:** Invasive Species, Biological Diversity
- B. RPA 211:** Insects, Mites and Other Arthropods Affecting Plants
- C.** Biological diversity studies have been initiated to examine the arthropod (insects and related organisms) fauna of several native (non-farmed) Palouse Prairie sites in eastern Washington and northern Idaho. Sites have been selected based on size, proximity to other such sites, and the degree to which they maintain a native (pre-agricultural or disturbed) plant community. Survey studies for select groups of arthropods have been initiated in an effort to examine the degree to which these sites may or may not support an arthropod fauna that has changed significantly in surrounding agricultural and urbanized lands. We are evaluating these sites on the degree of endemic (native) arthropod species present, whether they serve as refugia for potential pest or beneficial species, and size as well as other physical characteristics that determine the fauna. Preliminary efforts primarily have involved light trapping studies for moths.
- D. Impacts, Outcomes and Scope of Research**
  - i) Impacts of Research: A first year of survey has provided just fewer than 200 species of moths on the one largest site being sampled (approximately 30 acres). This compares to just 22 species found in trapping in surrounding agricultural lands. Many of these moths appear to be host specific on vegetation found on the native sites and are not of agricultural concern. In fact, the sites appear to harbor very few species that would be considered pestiferous. Several of these species are "newly" recorded for the state but in actuality, probably represent species that were at one time common throughout the area but today are confined to the few remaining native areas. We are just beginning to examine these native sites as refugia for potential biological control organisms.
  - ii) Geographic Scope – Regional
  - iii) Integrated Research and Extension Activities: The WSU scientist uses his extension appointment to disseminate information.
  - iv) Not affiliated with multistate projects.
- E. Source of Funding:** Hatch, Other Federal Funds, State, and Other Non-Federal Funds.

## DEPARTMENT OF FOOD SCIENCE AND HUMAN NUTRITION

1. **WNP00305: Applications of Spectroscopic Methods to Improve Food Quality and Safety of High Value Aquatic Food Products.**
  - A. **Key Theme:** Food Quality, Foodborne Pathogen Protection and Foodborne Illness.
  - B. **RPA 712:** Protect Food from Contamination by Pathogenic Microorganisms, Parasites and Naturally Occurring Toxins.
  - C. Spectrophotometric methods have been developed to predict microbial growth in fish (production of metabolites, microbial cell injury both in model and real food systems).
  - D. **Impacts, Outcomes and Scope of Research:**
    - i. Impacts of Research: This project was the first to use spectral methods to predict microbial growth in fish products and will have important application to food safety implementation.
    - ii. Geographic Scope: National
    - iii. There are no integrated extension/research activities.
    - iv. No multi-state affiliations.
  - E. **Source of Funding:** Hatch, State, USDA

## DEPARTMENT OF HORTICULTURE AND LANDSCAPE ARCHITECTURE

1. **WNP00326: Enhance Market Quality by Improving Fruit Finish in Apple**
  - A. **Key Theme:** Agricultural Profitability
  - B. **RPA 203:** Plant Biological Efficiency and Abiotic Stresses Affecting Plants
  - C. This project studied several aspects of fruit finish in apples. Improper hand thinning on apples results in a condition that occurs late in the season, when non-acclimated apples are suddenly exposed to sunlight that is similar to Type 3 sunburn. A fruit surface temperature sensor was further developed to be used to control evaporative cooling, which along with the use of RAYNOX provides effective sunburn protection. A patent is pending on the fruit surface temperature sensor. This strategy also reduces Fuji flecking, a condition caused by high relative humidity resulting from excessive evaporative cooling, and also substantially reduces the use of water.
  - D. **Impacts, Outcomes, and Scope of Research:**
    - i) Impacts of Research: Annual losses from sunburn of apple total about \$100 to \$150 million in Washington (10% to 12% of the farm gate value). A new sunburn suppressant (RAYNOX™), which was developed in previous years of this project, reduces sunburn by 50%. The technology for RAYNOX™ was licensed by WSU Research Foundation to FruitGard, LLC during the reporting period, and the sunburn protectant was successfully introduced to apple growers in Washington State during 2003. It was used on 30-35,000 acres in 2004. The total savings to Washington growers from the use of RAYNOX in 2004 is estimated to be \$10 - \$15 million. RAYNOX™ is rainfast and, when combined with evaporative cooling, reduces sunburn by 98%. The development and commercialization of a fruit surface temperature sensor has the potential to reduce the economic impact of sunburn to an even greater extent.
    - ii) Geographic Scope: Although the research that led to the development of RAYNOX™ and the fruit surface temperature sensor was carried out in Washington, the technology is applicable to any location where similar environmental conditions (intense radiation and high temperatures) exist.
    - iii) Integrated Research and Extension: Not Applicable
    - iv) This project has no multistate affiliation.
  - E. **Source of Funding:** Hatch, State Appropriations, Industry Grants and Agreements.

## 2. **WNP00640: Breeding Superior Raspberry Cultivars for the Pacific Northwest**

**A. Key Theme:** Agricultural Profitability

**B. RPA 202:** Plant Genetic Resources and Biodiversity

**C.** The objective of this research is the development of new raspberry cultivars that are adapted to the Pacific Northwest. The focus is on breeding new high yielding, high quality, pest resistant raspberry cultivars that will enhance the competitive ability of commercial growers in the Pacific Northwest. It is expected that these new cultivars will benefit commercial growers, home gardeners, fruit processors and consumers. Fruit studies will provide information that will be used to identify clones with superior fruit characteristics.

**D. Impacts, Outcomes, and Scope of Research:**

- i) **Impacts of Research:** Two raspberry selections were recommended for release. WSU 1068 will be released as 'Cascade Dawn', an early season, local fresh market cultivar with a moderate level of root rot tolerance. WSU 1162 will be released as 'Cascade Bounty' a very productive, machine harvestable cultivar with very high levels of root rot tolerance. 'Cascade Delight,' (2003 release), 'Cascade Dawn,' and 'Cascade Bounty' represent significant advances in root rot tolerance for summer fruiting red raspberries. They are the first summer fruiting PNW cultivars with significant root rot tolerance since 'Summer' (1956 WSU release). 'Cascade Bounty' is the first machine harvestable summer fruiting raspberry for the Pacific Northwest with significant levels of root rot tolerance. Both 'Cascade Dawn' and 'Cascade Bounty' will be protected by US plant patents. Patent data was collected, analyzed, summarized, and transmitted to the patent attorney.
- ii) **Geographic Scope:** Pacific Northwest
- iii) **Integrated Research and Extension:** The principal investigators have Extension appointments.
- iv) This project has no multistate affiliation

**E. Source of Funding:** Hatch, USDA, State Appropriations, Industry Grants and Agreements, and Non-Federal Funds.

## IMPACT CENTER

## 1. **WNP00451: Enhancing Competitiveness of Agricultural Products**

**A. Key Theme:** Agricultural Competitiveness

**B. RPA 511:** New and Improved Non-Food Products and Processes.

**C.** **Project Description:** More than 170,000 acres of potatoes are planted annually in Washington State. With harvesting averages of 60,000 pounds per acre the estimated total production is 10,200 million pounds, 10% of which are culls. At \$10 per ton the cull potato is an underutilized agricultural product providing minimal return to the grower. Cull potatoes, with their rich composition in starch and nutrients, are an ideal raw material for lactic acid production. Lactic acid is a colorless compound commonly used as a food additive for flavor and preservation and is of high value and importance in both international and domestic markets.

**D. Impacts, Outcomes and Scope of Research:**

- i) **Impact of Research:** With 15.44% potato starch content and a yield of 60% of glucose to lactic acid, cull potatoes can be converted to approximately 94.5 million pounds of lactic acid. At the current wholesale price of \$0.50 per pound of lactic acid, the estimated total value would be \$47 million. The fact that during lactic acid production the cost of raw material per pound of lactic acid produced using cull potato is less than \$0.10 will allow the potato growers to offer a very competitive price for the Washington lactic acid. In the future this competitively priced product can replace imported products and the long run it will allow export to international markets.
- ii) **Geographical Scope of Research:** National, International
- iii) **Integrated Research and Extension:**-None.
- iv) No multistate affiliation with this project.

**E. Source of Funding:** Contracts, Grants, and Competitive Agreements, USDA, and Other Federal Funds.

## INSTITUTE OF BIOLOGICAL CHEMISTRY

1. **WNP00197: The flexibility of the Light Reactions of Photosynthesis**
  - A. **Key Themes:** Plant Health, Biotechnology, Plant Production Efficiency, Adding Value to New and Old Agricultural Products, Bio-based Products, Nutrient Management, Agricultural Profitability, Precision Agriculture, Plant Genomics.
  - B. **RPA 206:** Basic Plant Biology
  - C. Research has focused on understanding the energy budget and regulation of photosynthesis, the process that powers essentially all life on the planet, scrubs the atmosphere of the greenhouse gas, CO<sub>2</sub>, and strongly impacts crop productivity. We have elucidated major new processes by which the light reactions of photosynthesis are regulated and respond to changes in the dark reactions and thus to changes in the environment. We have also developed a new model for understanding the mechanism of the key proton translocation step in photosynthesis and mitochondrial respiration, and have provided new evidence in support of this model. We have made several important contributions to the understanding of the cytochrome bc<sub>1</sub> and b<sub>6</sub>f complexes, which are essential parts of the plant energy transduction pathways in the mitochondrion and chloroplast. In particular, we now have a better understanding of, and a good working model for how the enzyme carried out its unique redox cycle without killing the plant with toxic byproducts.
  - D. **Impacts, Outcomes, and Scope of Research**
    - i) Impacts of research: Our work has led to new technologies which allow researchers, for the first time, to probe an entire genre of important reactions in living plants. These reactions are essential for energy storage and the regulation of the photosynthetic apparatus. Both of these processes are critical for plant survival and productivity. Thus, practical application of our techniques and instruments should allow for the selection of new crop varieties and growth conditions to improve crop yield, lower stress and target irrigation fertilizers etc. In addition, the tools can be and are being used to further elucidate the energy storage reactions in plants. They are presently the only tools that allow these processes to be characterized in detail under physiological conditions.
    - ii) Geographic scope: International
    - iii) The project does not integrate research and extension
    - iv) Not affiliated with a multistate project
  - E. **Source of Funding:** Hatch, DOE, Other Federal Research Funds, and State Appropriations.
2. **WNP00202. Unraveling the Molecular Interactions at Lignin Initiation Sites and in Heartwood Formation**
  - A. **Key Theme:** Adding Value to New and Old Agricultural Products; Agricultural Profitability; Biotechnology; New Uses for Agricultural Products; Plant Health; Plant Production Efficiency; Biological Control; Forest Crops; Forest Resource Management
  - B. **RPA 123:** Management of Forest Resources
  - C. This study is aimed to investigate how both initiation of lignin assembly and heartwood metabolite formation occur, using western red cedar, loblolly pine, *C. japonica* and poplar, as needed, with the lignan biosynthetic pathway being employed as markers of heartwood deposition.
    - i) We characterized the initiation site(s) of lignification in loblolly pine secondary xylem using confocal microscopy in conjunction with lignin/cellulose specific dyes. We showed that lignin deposition not only occurs in a highly organized and controlled manner, but the cells undergo a polarized deposition of the lignin monomers at different rates in different cell corners. The cells closest to the cambium begin to develop lignin initiation sites at the cell corners/S1 sublayers of the lignifying matrix as previously known. These are extended uniformly, in a continuous thread-like pattern, down the entire length of the developing tracheid. Additionally, cell corners furthest from the cambial zone undergo both lignin initiation and lignification at a greater rate than those adjacent to the cambium, with the enlarging lignified domains in the former again being uniformly evident down the length of the tracheary element. These observations give, for the first time, direct evidence for polar or differential deposition of monolignols into the various cell wall corners in developing tracheary elements. These data thus establish that monolignols within the same cell are differentially transported in the cytoplasm to the plasma membrane, and then to precise positions in the outermost regions of the developing wall, i.e. cell corner.
    - ii) Using a Palm-Zeiss laser microscope, we are now excising specific cells at different stages of

lignification/cell wall development in *Pinus taeda*, and have collected these using a “catapult” retrieval mechanism. We have applied this technique also to *Arabidopsis thaliana* stems, where the xylem and interfascicular fiber regions were individually excised, with readily soluble and “cell-wall and plasma-membrane” associated proteins isolated. The latter were subjected to short path SDS gel electrophoresis, trypsin digestion and microcapillary HPLC followed by Nano-ESI Ion Trap MS/MS. Following data retrieval and manual review (for fidelity), the various spectra obtained resulted in unambiguous identification of 261 proteins from the xylem regions and 356 from the interfascicular fiber region. The *P. taeda* cells will next be treated in the same manner.

**D. Impacts, Outcomes, and Scope of Research**

- i) Impacts of research: The data generated in this proposed study will be of enormous importance whether for transgenic organisms and/or in trait selection. For example, it is the heartwood tissue which typically contains >95% of the merchantable bole, and it is these (non-structural) components which engender particular characteristics to any given species, *e.g.* leading to enhanced durability, longevity, color, quality, odor and texture. Indeed, even the trend away from conventional wood treatment (*e.g.* chromate-copper-arsenate) argues for an enhanced understanding of how nature’s mechanisms can be better deployed. The significance of the heartwood tissue becomes even more apparent in terms of its value (>\$135 billion annually, 1990 figures), which dwarfs all other plant (agriculture, horticulture) income. Consequently, it is timely and important to the national research effort that this area of plant metabolism is even more incisively investigated. The results stemming from this research will enable us to develop and apply rational biotechnological strategies to either modify sapwood/heartwood properties, or to introduce specific pathways into other woody plants, *e.g.* to improve lumber quality, durability, ease of paper making *etc.*
  - ii) Geographic Scope: International.
  - iii) This project does not integrate research and extension.
  - iv) This project does not have multistate affiliation.
- E. Source of Funding:** McIntire-Stennis, NSF, DOE, Public Health Service, National Aeronautics and Space Admin., and State Appropriations.

**3. WNP00268: Biochemistry of Plant Terpenoids**

- A. Key Themes:** Plant Health, Biotechnology, Plant Production Efficiency, Adding Value to New and Old Agricultural Products, Biobased Products, Nutrient Management, Agricultural Profitability, Precision Agriculture, Plant Genomics
- B. RPA 206:** Basic Plant Biology
- C.** Peppermint is being genetically engineered for improved essential oil composition and yield; transformed plants are in field trials by the industry.
- D. Impacts, Outcomes, and Scope of Research**
  - i) Impacts of research: The impact will be to lower the cost of mint oil production so that U.S. growers will remain competitive on the international market.
  - ii) Geographic scope: National.
  - iii) The project does not integrate research and extension.
  - iv) This project is not affiliated with multistate activity.
- E. Source of Funding:** Hatch, NSF, DOE, Public Health Service, State Appropriations, Industry Grants and Agreements, and Other Non-Federal Funds.

**4. WNP00773: Nutrient Exchange and Metabolism in the Rhizobium-Legume Symbiosis**

- A. Key Themes:** Plant Health, Biotechnology, Plant Production Efficiency, Adding Value to New and Old Agricultural Products, Biobased Products, Nutrient Management, Human nutrition, Plant Genomics, Agricultural Profitability
- B. RPA 201:** Plant Genome, Genetics and Genetic Mechanisms
- C.** Exchange and metabolism of nutrients by symbiotic bacteria is at the center of the symbiotic relationship. Several lines of research in the laboratory are exploring bacterial nutrient use including investigations of transport, electron flow and carbon catabolism through the TCA cycle. In addition, the laboratory has been leading a large scale genetic dissection of the *Sinorhizobium meliloti* genome in order to develop materials for genetic, physiological and life history analyses.
- D. Impacts, Outcomes, and Scope of Research**

- i) Impacts of research: Exploration of the physiology and genetics of *Sinorhizobium meliloti* is yielding new information about how this organism operates in supporting its nitrogen-fixing symbiosis with alfalfa. Manipulation of the bacteria has shown that genes thought to be important in bacterial symbiotic metabolism can have multiple roles in the symbiosis.
    - ii) Geographic scope: International
    - iii) The project does not integrate research and extension.
    - iv) This project does not have multistate activity.
  - E. Source of Funding:** Hatch, NSF, DOE, and State Appropriations
- 5. WNP00967: Diterpene Biosynthesis in Taxol Production and Conifer Defense**
- A. Key Themes:** Adding Value to New and Old Agricultural Products, Agricultural Profitability, Biotechnology, New Uses for Agricultural Products, Plant Health, Plant Production Efficiency, Biological Control, Forest Crops, Forest Resource Management
  - B. RPA 123:** Management of Forest Resources
  - C.** Yew cell cultures are being engineered with Taxol biosynthetic genes to increase drug yields; two commercial partners are conducting feasibility studies.
  - D. Impacts, Outcomes, and Scope of Research**
    - i) Impacts of research: The impact will be to lower the cost of production and increase availability of an important anticancer drug.
    - ii) Geographic scope: International
    - iii) The project does not integrate research and extension.
    - iv) This project is not affiliated with multistate activity.
  - E. Source of Funding:** McIntire-Stennis and State Appropriations.
- 6. WNP01791: Polypeptide Signaling for Plant Defense, Growth, and Development**
- A. Key Themes:** Plant Health, Biotechnology, Plant Production Efficiency, Adding Value to New and Old Agricultural Products, Biobased Products, Nutrient Management, Agricultural Profitability, Precision Agriculture, Plant Genomics
  - B. RPA 206:** Basic Plant Biology
  - C.** Research under this project has identified, isolated and purified novel peptide signals (hormones) from plants that regulate defense and development. Twelve of the peptides regulate defense genes in plants in response to herbivore and pathogen attacks. These signals are comprised of from 15 to 20 amino acids and are included in two subfamilies of systemins. All systemins are active at nM concentrations in their respective plants, they all activate genes through the octadecanoid pathway, are derived from precursor proteins, and all have multiple proline or hydroxyproline residues. One subclass of systemins includes homologs of tomato systemin. Their lack post-translational modifications are synthesized on cytoplasmic ribosomes and sequestered intracellularly. The second sub-family members contain post-translationally hydroxylated proline residues and have carbohydrate attachments, and all are found sequestered in the cell walls. The goals of this research are to fully characterize the systemin precursor genes and gene products for their roles in defense in agriculturally important crops. While so far, systemins have only been found in Solanaceae species, we are investigating their possible presence in species of grasses (wheat, barley and rice), and legumes (soybeans, cowpea and alfalfa).
  - D. Impacts, Outcomes, and Scope of Research**
    - i) Impacts of research: The isolation of the new defense signals and genes in Solanaceae and other important agricultural crop species provides new opportunities to understand how plants cope with herbivore and pathogen attacks. This knowledge can be used to design strategies to enhance both breeding and biotechnological approaches to improve crop yields.
    - ii) Geographic scope: International.
    - iii) This research is primarily fundamental, but is presently being integrated into applied activities.
    - iv) This project is not affiliated with multistate activities.
  - E. Source of Funding:** Hatch, NSF, State Appropriations, and Other Non-Federal Funds.

## DEPARTMENT OF PLANT PATHOLOGY

1. **WNP00300: Population Biology of Plant Pathogenic Fungi**
  - A. **Key Theme:** Plant Health
  - B. **RPA 212:** Disease and Nematodes Affecting Plants.
  - C. The objectives of this project are to use the techniques of molecular biology to address questions about the biology, genetics, systematics, evolution and ecology of plant pathogenic fungi with emphasis on those causing diseases important in the Pacific Northwest USA. An extensive sample of isolates of *Ascochyta rabiei*, the pathogen causing blight of chickpeas (garbanzo beans) was collected from the Central Valley of California from 1996 to 2003. Isolates were screened for genetic variation; all isolates sampled prior to 2000 belonged to 2 genotypes and all were a single mating type. The alternate mating type was detected at low frequency at one location in 2000 and increased in frequency between 2000 and 2003. The introduction of the other mating type was accompanied by an increase in genetic diversity, which was likely the result of new introductions of the pathogen on seed imported for agronomic evaluation.
  - D. **Impacts, Outcomes, and Scope of Research:**
    - i) Impacts of Research: Determination of the population structure of *A. rabiei* in the US Pacific Northwest, California, and worldwide has allowed us to pinpoint likely routes of introductions of plant-pathogenic fungi into the US. This information will be used to strengthen quarantine regulations and improve early detection of this and other pathogens. In addition, the information is being used to help breeders develop varieties with more effective disease resistance.
    - ii) The results of this project are multi-state with greatest impact in the Pacific Northwest region of the U.S.
    - iii) This project does not have an integrated extension-research component.
    - iv) Affiliated Multi-state Research Committee – none
  - E. **Source of Funding:** Hatch, Federal, State
  
2. **WNP00678: Disease Warning Systems for Potato and Mint**
  - A. **Key Theme:** Plant Health
  - B. **RPA 212:** Disease and Nematodes Affecting Plants
  - C. The activities of this project involve using a series of disease forecasting models for Potato late blight to help growers in the Columbia Basin of Washington manage potato late blight and to ensure effective fungicides are available for its control. Output from one of these computer models is distributed via a “hotline” that growers call to receive updates on potential risk for disease so they can make decisions on whether to apply fungicides.
  - D. **Impacts, Outcomes, and Scope of Research:**
    - i) Impacts of Research: The Columbia Basin Late Blight Forecasting Information Line logged 1006 calls and delivered about 50 hours of information, which is comparable to last year. The management recommendations for potato late blight control resulting from this project are now used on over 70% of the potato acreage in the Columbia Basin of Washington and have resulted in fewer, more effective applications of fungicides for disease control.
    - ii) This project has state, regional, and national scope.
    - iii) This project has integrated research-extension activities. The scientist involved is active in disseminating information to industry groups and clientele on the results of this research and its application.
    - iv) Affiliated Multi-state Research Committee – none
  - E. **Source of Funding:** Hatch, Federal, State.
  
3. **WNP00837: Systematics and Biology of Phytopathogenic Fungi with emphasis on Tilletiales**
  - A. **Key Theme:** Plant Health
  - B. **RPA 212:** Disease and Nematodes Affecting Plants.
  - C. The activities of this project are directed at enhancing and preserving collections of fungi in the genus *Tilletia*, which cause direct yield losses to cereal crops and indirect impacts due to quarantine restriction, by characterizing genetic variability and determining relationships among species. The presence of smut spores in grass seed and grain shipments imported to China has the potential to disrupt trade. A lack of understanding of genetic variability and relatedness of species makes



identification difficult, which complicates enforcement of quarantine laws. A collaborative project was established with scientists at the Tianjin Entry-Exit Inspection and Quarantine Bureau to identify spores in US grass seed and grain shipments imported into China. Scientists from the Tianjin bureau visited WSU in July, 2004, to discuss this project and later hosted the WSU scientist during a visit to China during December, 2004.

**D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: The principal investigator helped resolve a problem with misidentification of smut spores in wheat shipments for export to China. Working with USDA scientists and wheat industry officials, she helped develop a new test to distinguish spores of the cheatgrass bunt from those of dwarf bunt, which helped to avert possible rejection of wheat shipped to China and resolve problems with identification of these fungi at the point of origin in the US. Accurate identification of *Tilletia* species depends on the use of DNA sequence data from multiple loci and her laboratory is one of only two labs in the world doing this type of research on this group of fungi.
  - ii) This project has regional, national and international scope.
  - iii) Integrated research/extension activities - none
  - iv) Affiliated Multi-state Research Committee – none
- E. Source of Funding:** Hatch, Federal, State.

## SCHOOL OF ECONOMIC SCIENCES

**1. WNP00275: Agricultural Production, Processing, Trade, and Environmental Quality**

- A. Key Theme:** Agricultural Competitiveness.
- B. RPA603:** Market Economics
- C.** Research focused on a case study of the induced innovation hypothesis to bluegrass seed production in the State of Washington following the imposition in 1997 of a permanent ban on stubble burning.
- D. Impacts, Outcomes, and Scope of Research**
  - i) Research impacts: The finding suggests that the nearly simultaneous implementation of new irrigation technology and rotation options kept the bluegrass seed industry viable and growing despite a policy regulation that increased marginal cost. Neither the new technology nor the rotation options would have been available had it not been for prior research and demonstration efforts. Both Washington and national agricultural research and extension policy can play important roles in assuring that technological change responds efficiently to signals of relative factor scarcities and changing marginal costs.
  - ii) Geographic scope: National
  - iii) Integrated research and extension: none
  - iv) Not affiliated with multistate projects.
- E. Source of Funding:** State Appropriations

**2. WNP00549: Analyzing the Competitive Position of the Washington Wine Grape Industry.**

- A. Key Theme:** Agricultural Competitiveness
- B. RPA603:** Market Economics
- C.** This research developed an accurate depiction of current investment costs of constructing, owning and operating a winery in the state of Washington.
- D. Impacts, Outcomes, and Scope of Research**
  - i) Research Impacts: This work provides for a better decision-making basis for producers and wineries, helping the continued expansion of the industry in an orderly fashion for an industry with over 30,000 acres of wine grapes and 270 wineries in Washington with a \$2.4 billion impact on the state's economy.
  - ii) Geographic scope: statewide
  - iii) Integrated research and extension: none
  - iv) Not affiliated with multistate projects.
- E. Source of Funding:** Hatch

## DEPARTMENT OF STATISTICS

1. **WPN00254: Evaluation of Methods Used to Analyze Resource Selection Data**
  - A. **Key Theme:** Other; Statistical Design
  - B. **RPA 901**, Research Design and Statistics; **RPA 0254**: Analysis of Resource Selection Using Generalized Linear Models
  - C. Research focused on the evaluation of old methods for the analysis of resource selection data and their effectiveness, and the development of new and more efficient methods for the same type of data.
  - D. **Impacts, Outcomes, and Scope of Research**
    - i) Impacts of Research: The research resulted in publication of a chapter in the book entitled “Techniques in Wildlife Investigations and Management.” The impact of this publication is to increase understanding of issues involved in resource selection studies by wildlife scientists and statistical scientists. The publication also provides up to date background for the authors as well as other research scientists to develop new methods and modifications of existing methods for resource selection analysis.
    - ii) Geographic scope of research: nationwide.
    - iii) There are integrated extension/research activities.
    - iv) No multi-state regional project.
  - E. **Source of funding:** Hatch and State

## WOOD MATERIALS AND ENGINEERING LAB

1. **WNP00307: Forested Riparian Buffers: Species, Function, and Management for Agriculture.**
  - A. **Key Theme:** (1) Adding Value to New and Old Agricultural Products; (2) Agricultural Profitability
  - B. **RPA 511** New and Improved Non-Food Products and Processes.
  - C. A cooperativity analysis technique was developed for molecular-scale evaluation of wood/phenol-formaldehyde interphases in composite materials.
  - D. **Impacts, Outcomes and Scope of Research**
    - i) Impacts of Research: The cooperativity analysis is a novel tool for understanding wood-resin interactions in wood-based composites. As a molecular probe of adhesion, the cooperativity analysis can be used to develop superior adhesives for wood-based composites, such as formaldehyde-free and bio-based adhesives.
    - ii) Geographic Scope: This project has an international scope.
    - iii) Integrated research and extension: Not Applicable.
    - iv) Multistate research: Not Applicable.
  - E. **Source of Funding:** McIntire-Stennis, USDA-NRI, and State Appropriations.

## GOAL 2

### A SAFE AND SECURE FOOD AND FIBER SYSTEM

#### EXECUTIVE SUMMARY

Two Departments participate in work related to National Goal 2: the Departments of Food Sciences and Human Nutrition (FSHN) and the Field Disease Investigative Unit. Both departments are making excellent progress in achieving their goals as stated in the Plan of Work. The Field Disease Investigative Unit has had as its focus animal health and the prevention of zoonotic disease. This year it made important discoveries concerning the epidemiology of mastitis in dairy cattle. Food Sciences and Human Nutrition has had as a major goal the adoption of thermometer use in home cooking as a means of preventing food-borne illness.

#### DEPARTMENTAL REPORTS

##### FIELD DISEASE INVESTIGATIVE UNIT

###### 1.WNP00858 .Investigation of Food Animal Disease Problems in the State of Washington.

- A. **Key Theme:** Animal Health, Food Security and Foodborne Pathogen Protection.
- B. **RPA 311.** Animal Diseases.
- C. Preparturient heifers (n = 545) from 9 herds in 7 states (US) and one province (Canada) were enrolled in a study to test the hypothesis that prepartum intramammary therapy would cure existing intramammary infection and lead to increased milk production, reduced somatic cell count, and improved reproductive performance. Overall, 34.1% of mammary quarters were found to be infected with a mastitis pathogen prior to parturition. Quarters that were infected prepartum and treated with antibiotic therapy had a 79.9% cure rate. Control quarters had a spontaneous cure rate of 31.7%. Treatment had a significant effect ( $P < 0.001$ ) on the cure rate of infected quarters. While this trial demonstrated that prepartum intramammary antibiotic therapy did reduce the number of intramammary infections, this improvement in udder health did not translate into a significant improvement in milk production, nor improved reproductive performance during the first 200 days of the first lactation.
- D. **Impacts, Outcomes, and Scope of Research:**
  - i. **Impacts of Research:** The results of this study demonstrate that although these infections are present, they do not have any long lasting implications since they do not result in a significant increase in milk somatic cell count nor loss of milk production. Thus intramammary treatment of preterm heifers is not an effective method to improve mammary health and improve milk production and milk quality. The finding of this study has the potential to save dairy producers substantial sums of money. Some producers may have been inclined to attempt to treat out these infections, which would have resulted in the threat of loss of revenues through possible residue contamination, discarded milk, cost of treatment, and labor/management charges associated with this practice.
  - ii. **Geographic Scope:** This was a project that included dairies from several states (7) and 1 Canadian province (Ontario).
  - iii. Although this project did not formally integrate research and extension, it can be used directly by extension personnel since the results have strong application to current dairy management on any farm.
  - iv. This project was initiated and supported by the NE1009, Mastitis Resistance to Enhance Dairy Food Safety, a Multistate Regional Research Project (<http://w3.aces.uiuc.edu/AnSci/USDA/NE-112/MRWC.shtml>).
- E. **Source of Funding:** Hatch

## DEPARTMENT OF FOOD SCIENCE AND HUMAN NUTRITION

1. **WNP00288: Microbial and Chemical Factors Affecting Calcium Lactate Crystal Formation in Cheddar Cheese.**
  - A. **Key theme:** Food Quality, Foodborne Pathogen Protection and Foodborne Illness.
  - B. **RPA 501.** New and improved Food Processing Technologies.
  - C. Cheddar cheeses, made with and without race muse-positive non-starter lactic acid bacteria were cubed, vacuum packaged and flushed with gas to determine the effect of various gasses upon calcium lactate crystal formation.
  - D. **Impacts of Research:**
    - i) Impacts of Research: Calcium lactate crystals are more likely to form in cheeses flushed with gas, regardless of gas, than cheeses that are vacuum packaged, regardless of the presence of non-starter lactic acid bacteria.
    - ii) Geographic Scope: National
    - iii) There are no integrated extension/research activities.
    - iv) No multi-state affiliation.
  - E. **Source of Funding:** Hatch, State, Commodity
  
2. **WNP00395: Reducing Risk with Food Thermometers: Strategies for Behavioral Change**
  - A. **Key Theme:** Human Health and Human Nutrition
  - B. **RPA 703:** Nutrition Education
  - C. Educational materials were developed and distributed emphasizing quality in addition to safety, ease of using a food thermometer, and feature pictures of thermometers in use.
  - D. **Impacts, Outcomes, and Scope of Research:**
    - i) Impact of Research: 34% of the 286 participant respondents were classified as being in action or maintenance stages of change, a highly significant shift in stages of change.
    - ii) Geographic Scope: National
    - iii) Extension personnel distributed education materials across 11 states.
    - iv) No multi-state affiliation.
  - E. **Source of Funding:** Hatch, State, USDA.
  
3. **WNP03505: Engineered Enzyme-Based Time Temperature Indicators for Validating Food Pasteurization Processes.**
  - A. **Key Theme:** Food Quality, Foodborne Pathogen Protection and Foodborne Illness.
  - B. **RPA 712:** Protect Food From Contamination by Pathogenic Microorganisms, Parasites and Naturally Occurring Toxins.
  - C. Technology was developed that produces removable enzyme-based indicators that have physiochemical and dielectric properties similar to the food products into which they are inserted. The degree of inactivation of these indicators is directly proportional to the degree of microbial inactivation and allows thermal distribution within the foods in a few minutes.
  - D. **Impacts, Outcomes and Scope of Research.**
    - i) Impacts of Research: Using these indicators, it is possible to develop thermal distributions throughout the food in only a few minutes.
    - ii) Geographic Scope: National
    - iii) There are no integrated extension/research activities.
    - iv) No multistate affiliation.
  - E. **Source of Funding:** Hatch, State, USDA, U.S. Army-Natick.

## GOAL 3

### A HEALTHY WELL NOURISHED POPULATION

#### EXECUTIVE SUMMARY

The Department of Food Sciences and Human Nutrition is the primary department of the ARC which participates in activities related to Goal 3. An important outcome this year has to do with the relationship of nutrition, in this case, vitamin C intake and the risk of kidney stone formation.

#### DEPARTMENTAL REPORTS

##### DEPARTMENT OF FOOD SCIENCE AND HUMAN NUTRITION

1. **WNP00370: Nutrition and Kidney Stones**
  - A. **Key Theme:** Human Health and Human Nutrition
  - B. **RPA 702:** Requirements and Function of Nutrients and Other Food Components.
  - C. A comparative assessment of oxalate absorption and endogenous oxalate synthesis in sub populations of stone-formers and non-stone formers was done and an assessment of the effect of ascorbate supplementation on oxalate absorption and endogenous oxalate synthesis was performed.
  - D. **Impacts, Outcomes, and Scope of Research**
    - i) Impacts of Research: Vitamin C supplements may increase risk of kidney stones for both stone-formers and non-stone formers and these findings will impact the next version of the dietary allowances, which currently state that 2g/d is the upper limit for safety.
    - ii) Geographic Scope: National
    - iii) There are no integrated extension/research activities.
    - iv) No multi-state affiliation.
  - E. **Source of Funding:** Hatch, State, NIH.

## GOAL 4

### AN AGRICULTURE SYSTEM WHICH PROTECTS NATURAL RESOURCES AND THE ENVIRONMENT

#### EXECUTIVE SUMMARY

Noteworthy achievements of the Departments of the ARC were the efforts to convert waste biomass into more environmentally friendly substances that would also contribute to the economy and the well-being of the farmer. The agricultural industries in WA provide millions of tons of biomass that could, if properly converted, be transformed into bioenergy and biochemicals. Utilizing reactors which they have designed or modified, Biosystems engineers are utilizing this waste to produce energy and chemicals. The Department of Crop and Soil Sciences is continuing its studies of no-till and systems cropping research for conservation of the land and turning a profit both for the organic and conventional farmer. The Department of Entomology is utilizing a biologically-based management method to decrease herbicide inputs in the control of Dalmation Toadflax, a noxious weed. In the School of Economic Sciences, faculty members are studying the management of inter-sector mobilization of water in irrigation.

#### DEPARTMENTAL REPORTS

##### DEPARTMENT OF BIOLOGICAL SYSTEMS AND ENGINEERING

###### 1. WNP00450: The Science and Engineering for a Biobased Industry and Economy

A. **Key theme:** Agricultural Waste Management

B. **RPA 511: New and Improved Non-Food Products and Processes**

C. The agricultural industry in Washington State provides a tremendous amount of biomass that can be potentially used as feedstock for the production of biochemicals and bioenergy. Technical barriers exist in developing enabling technologies that can produce bioproducts competitively. The purpose of this project is to develop basic knowledge in characterizing biomass as a feedstock and to develop processes and technologies to reduce the cost for converting these feedstocks into bioproducts and bioenergy.

D. **Impacts, Outcomes and Scope of Research:**

- i) **Impacts of Research:** This is a project that involves various efforts at Washington State University in the area of bioproduct research and development. Significant progress has been made in all of the areas. Three key processes are moving towards commercialization through development of pilot scale studies. These include a novel anaerobic digestion process focusing on the treatment of flush dairy manure for reduced capital costs and improved co-product sales; a lactic acid and chitosan co-production process from the fungal fermentation of cull potatoes using a unique pelletization process; and a lactic acid and nisin co-production process for the fermentation of cheese whey using a unique mixed culture method. All three processes are undergoing the patent protection process.
- ii) **Geographic Scope:** The project's results will be important in states (national) that produce large quantities of biological waste.
- iii) There is research/extension integration through the multistate affiliation and the WSU scientist's extension appointment.
- iv) This project is associated with multistate project S1007.

E. **Source of Funding:** Hatch, Regional Research Funds, DOE, State Appropriations, Industry Grants and Agreements, and Other Non-Federal Funds.

2. **WNP00554: Enhanced Anaerobic Digestion of Animal Manure with Nutrient Recovery**
  - A. **Key theme:** Agricultural Waste Management
  - B. **RPA 403:** Waste Disposal, Recycling, and Reuse.
  - C. Management of manure from animal feeding operations has become an increasing challenge as the size of farms increases and available land area for manure disposal becomes limited. The purpose of the research is to continue development of anaerobic digestion in order to reduce odors, produce by-products, and reduce the overall cost of waste management for producers.
  - D. **Impacts, Outcomes and Scope of Research:**
    - i) Impacts of Research: Three major types of reactors have been examined, including plug-flow baffle reactors, leaching bed reactors, and hybrid reactors; each under conditions of solids/liquid separation and no solids/liquids separation. As bench top research progressed a novel systems approach to anaerobic treatment of dairy and municipal waste has developed. This new approach, focusing on liquid/solid separation and high value co-product development has begun pilot scale studies and is now undergoing the patent process. New avenues in anaerobic digestion research have just begun involving mathematical modeling of the process in relation to dairy manure and simultaneous production of hydrogen and methane.
    - ii) Geographic Scope: The results of the project will be important instates with substantial livestock industries. National
    - iii) The WSU scientist has extension appointment.
    - iv) It is not affiliated with a multistate project.
  - E. **Source of Funding:** Hatch

#### DEPARTMENT OF CROP AND SOIL SCIENCES

1. **0182: Impact of no till on soil quality physical, chemical, and microbiological properties**  
**0250: Cropping systems research for low-precipitation dryland in Eastern WA**  
**0363: Nutrient management for improved crop yield and quality for dryland cropping systems**  
**0373: Carbon and nitrogen cycling and management in alternative cropping systems**  
**0722: Organic amendments and cover crops in sustainable agricultural systems**
  - A. **Key Theme:** An Agriculture System Which Protects Natural Resources and the Environment.
  - B. **RPA 102** Soil, Plant, Water Nutrient Relationships
  - C. These programs in the Department of Crop and Soil Sciences seek identification of improved crop and soil management practices and crop rotations for reducing soil erosion, and reducing negative impacts on soil, air and water quality. Their purpose is to characterize critical soil and plant processes involved in soil stability, improving soil quality, nutrient cycling, carbon sequestration, and water and nutrient use efficiency. Variations on reduced tillage and no-tillage systems as well as organic production systems have been evaluated for economic, agronomic and environmental performance. Fundamental understanding of driving factors in wind erosion/particulate emissions are more clearly delineated, allowing for more effective particulate transport modeling.
  - D. **Impacts, Outcomes, and Scope of Research:**
    - i) Impacts of Research: According to NRCS (2001) data, more than 40% of Palouse cropland is now under no-till or conservation-till, and water erosion rates have been reduced from an average of 45 Mg/hectare in 1978 to an average of 38 Mg/hectare in 2001. Soil erosion from dry farmed cropland in all regions of the Inland PNW still exceeds tolerable rates. CTIC reports that direct seeded wheat in 2004 occupied 10-18% of the acreage, but as high as 60-70% in Columbia County. Improved soil carbon sequestration and soil quality with continuous direct seeded spring cropping in place of summer fallow has been demonstrated. Incidents of air quality violations reported by local municipalities due to soil particulate emissions have decreased. Constraints on direct seed adoption, such as increased pest pressures have been identified.
    - ii) Geographic scope: Environmental and economic impact is mainly regional, basic scientific principles have national/international impact.
    - iii) Research and extension are well integrated. Information on alternative systems and their impacts is regularly disseminated to the agricultural, environmental and legislative segments of society.
    - iv) None of these projects are affiliated with multistate projects.

- E. **Source of Funding:** Hatch, USDA Special Grants programs CP3 and STEEP, Wheat Commodity Commission, USDA-NRI.

## DEPARTMENT OF ENTOMOLOGY

1. **WNP00430: Enhancement of Dalmatian Toadflax Biological Control in Washington**
  - A. **Key theme:** Invasive Species
  - B. **RPA211:** Insects, Mites, and Other Arthropods Affecting Plants
  - C. Dalmatian toadflax is a pernicious Eurasian plant that has presented itself as a serious impediment to the successful utilization of agricultural and nonagricultural environments by Washington's citizenry. Releases of an introduced, host-specific, foliage-feeding and stem-boring bioagent, *Mecinus janthinus*, have already resulted in the diminishment of negative impacts by the weed on over 100,000 acres of land in central and eastern Washington. Established "nursery" populations of the beetle in northeastern Washington yielded over 31,050 adults for redistribution in 2004. The bioagent was released in Chelan (800), Douglas (200), Grant (8,500), Lincoln (5,850), Okanogan (10,200), Spokane (2,800), and Yakima (2,600) counties; another 100 were provided to an Oregon cooperator. Since 2002, in excess of 133,000 adults have been redistributed; all counties infested by the weed have been targeted for releases. Beetle attack is producing quantifiable plant mortality, and markedly curtailing seed production and plant invasiveness.
  - D. **Impacts, Outcomes, and Scope of Research**
    - i) Landowner implementation of this long-term, ecologically sound, and biologically-based management method has decreased herbicide inputs by as much as 100% and generated an economic savings of nearly \$100K, and the economic savings associated with the preservation of plant/animal biodiversity and unnecessary contamination of surface and groundwater by herbicides are inestimable. Public interest in toadflax biological control has increased by 150% in the last three years and the technique is being implemented in every county where the weed occurs.
    - ii) Geographic Scope: Multistate
    - iii) Integrated Research and Extension: The WSU scientist uses his extension appointment and has coauthored a book to distribute for this information.
    - iv) Not affiliated with a multistate project.
  - E. **Source of Funding:** Hatch, Cooperative Agreements, Other Non-Federal Funds

## SCHOOL OF ECONOMIC SCIENCES

1. **WNP00160: Interfacing Technological, Economic, and Institutional Principles for Managing Inter-sector Mobilization of Water**
  - A. **Key Theme:** Natural Resource Management and Other: Policies Concerning Water Use, Land Use and Environmental Quality.
  - B. **RPA 111:** Agricultural Water Management Technologies, Institutions and Policies Affecting Economic Viability and Environmental Quality.
  - C. Research focused on the linkages between on-farm irrigation effectiveness and water conservation, and water allocation institutions in the Western United States, showing that current water allocation institutions do not protect other irrigators or ecological instream-flow users from the negative impacts of increased consumptive use.
  - D. **Impacts, Outcomes, and Scope of Research**
    - i) Research impacts: Educated stakeholders on the drawbacks of relying on policies encouraging farmers to increase on-farm irrigation effectiveness to conserve agricultural water.
    - ii) Geographic scope: Western Region
    - iii) Affiliated with integration of research/extension with the multistate project.
    - iv) Multistate W-1190.
  - E. **Source of Funding:** Regional Research Funds, USDA, and State Appropriations.
2. **WNP00299: Fisheries Management and Marketing of Marine and Aquaculture Seafood**



- A. Key Theme:** Marketing of Seafood
- B. RPA605:** Natural Resource and Environmental Economics
- C.** The research focused on developing a quota trading model to predict quota prices and fleet behavioral responses to fishery rationalization, including an evaluation of conservation potential.
- D. Impacts, Outcomes and Scope of Research**
  - i) **Research Impacts:** The crab policy developed under this project was enacted into law January 2004, with implementation planned for August 2005, to the benefit of harvesters, processors and fishery dependent Alaska coastal communities.
  - ii) **Geographic Scope:** International
  - iii) **Integrated research and extension:** 10% of the PI's time is spent on Extension activities.
  - iv) **Not affiliated with multistate activity.**
- E. Source of Funding:** State Appropriations and Other Non-Federal Funds.

## GOAL 5

### ENHANCED ECONOMIC OPPORTUNITY AND QUALITY OF LIFE FOR AMERICANS

#### EXECUTIVE SUMMARY

Currently, there are only three Departments which contribute to the work under goal V. These are the Department of Horticulture and Landscape Architecture, which did not choose not to report, the Department of Community and Rural Sociology, which reported on two projects, and the Department of Natural Resource Sciences, which reports on a single project. Community and Rural Sociology has taken on as one of its themes “local food systems” and reports its progress in organizing groups to achieve local food systems. Another project out of the Social Sciences Research Center reports that the manner in which a survey is laid out often influences the outcome of the survey. Finally, Natural Resource Sciences reports on its efforts to define an agricultural buffer zone to preserve salmon, a major issue in the Pacific Northwest.

#### DEPARTMENTAL REPORTS

##### COMMUNITY AND RURAL SOCIOLOGY

###### 1. WNP00230 Sustaining Local Food Systems in a Globalizing Environment: Forces, Responses

###### Impacts

**A. Key Theme:** Agricultural Competitiveness, Small Farm Viability, Organic Agriculture

**B. RPA: 803:** Sociological and Technological Change Affecting Individuals, Families and Communities

**C.** Data collected from Washington farmers and consumers are being used to investigate the status and potential of direct marketing as a tool to revitalize local agriculture in Washington State. It has been shown that direct market farms do retain a higher share of gross sales than their conventional counterparts. Also, economic modeling based on Implan data suggests that in King County, for example, agriculture could capture an additional 6 million dollars if ten percent of the agricultural products produced in the county were direct-marketed to consumers in the county. On the demand side, consumers are most interested in obtaining specific components of their diet, particularly fruits and vegetables, from local sources. The project is also exploring how relationships between consumers and producers are mediated by social, demographic, historical and ecological factors that are associated with locality.

###### **D. Impacts, Outcomes and Scope of Research:**

- i) Impacts of Research: Information collected as part of this project has drawn a great deal of interest. Data from the producer and consumer surveys was posted on a web site, and in the second half of 2004 these reports were downloaded a total of 173 times. The data were also used in three Community Food System Workshops that were organized in different parts of Washington State in 2004. These workshops were conducted in King, Skagit and Chelan counties. These workshops informed community members about the research and empowered them to address local farming issues. The King County (Seattle) workshop resulted in the creation of an ongoing working group and a food policy committee in that county. Forty participants, including farmers and school food service representatives from six school districts, attended the Skagit County workshop. Around 40 people attended the workshop in Chelan county. These included representatives from farms, schools, food banks, and restaurants. Chelan County participants decided to form an ongoing steering committee to develop new ways to promote local agriculture. In addition, managers at farmers’ markets from throughout the state are replicating a research design developed through this project to continue their own customer research, make physical and operational changes, shift budget priorities, and otherwise improve market management.

- ii) Geographical Scope: Statewide

- iii) This project is closely tied to the Small Farms Extension Team.

- iv) Multistate Research Committee: NE-1012
  - E. Source of Funding:** Hatch
- 2. WNP00942: How Visual Design and Layout Influences Answers to Self-Administered Paper and Internet Surveys**
- A. Key Themes (Other):** Public Policy, Improving the Quality of Public and Private Data Gathering
  - B. RPA: 805:** Community Institutions and Social Services.
  - C.** This research project, which has roots that date back to 1969, utilizes various methods, including cognitive interviews and field experiments with surveys, to provide the opportunity to develop procedures for reducing measurement and nonresponse error in sample surveys undertaken by mail, telephone, and now the Internet. Past research led to improvements in the 2000 Decennial Census, and evaluations of forms and implementation procedures proposed for use in the 2010 Decennial Census has revealed significant problems with current designs that are being addressed.
  - D. Impacts, Outcomes and Scope of Research:**
    - i) **Impacts of Research:** This work has been critical to the obtaining of more accurate survey results at less cost in state and national surveys that public and private sector organizations rely upon to make policy decisions. For example, the methods developed as part of this project led to the 2000 Census obtaining a higher mailback response rate than in 1990, thus lowering the cost of followup household enumeration by about \$40/household. Barbara Bryant, Director of the Census, has written about this accomplishment. The procedures that have been developed for improving response rates and visual design and layout are now in use in many U.S. national statistical agencies, including the USDA, GAO, Census, and NSF. Also, in 2004 alone, this project led to the printing of a dozen scholarly publications, which are widely read and cited.
    - ii) **Geographical Scope:** Nationwide.
    - iii) This project has integrated research and extension activities.
    - iv) Multistate Research Committee: WERA-1001.
  - E. Source of Funding:** State.

#### DEPARTMENT OF NATURAL RESOURCE SCIENCES

- 1. WNP000307: Forested Riparian Buffers: Species, Function, and Management for Agriculture.**
- A. Goal 5: Key Theme:** Water Quality
  - B. RPA 112:** Watershed Protection and Management
  - C.** The project goal is to identify what constitutes a functional riparian buffer to protect water quality and improve salmon habitat on agricultural land in western Washington, and to determine the economic impact of such buffers on farm enterprises.  
**Project Activities:** During the reporting period, the project has progressed significantly. In January, the PIs used the USDA SARE project to leverage \$50,000 Safe Food Initiative Grant from Washington State University and a mature native forest buffer site was added to the project. Work completed this year included the determination of the direction of ground water flow at our three buffer sites, installation of a total of 120 piezometers for ground water sampling, 255 soil water samplers and 93 tensiometers, experimental buffer plots were established, ground was sampled for two months, economic modeling for potato, blueberry and raspberry farms was conducted and the project website was completed.
  - D. Impacts, Outcomes, and Scope of Research**
    - i) **Impacts of research:** This research is relevant to 19 western Washington counties that practice agriculture in riverine flood plan areas. This area includes 213,000 acres of cropland and 406,000 head of livestock. The research will also be relevant for commercial plant nurseries and western Oregon agriculture. The measurable economic impact to farm and ranch and communities is unknown at this time, but one of the objectives of this project is estimate the cost of installing riparian buffers on agricultural land. All of Washington State is subject to new agricultural regulations designed to recover endangered salmonid populations. Clearly, the potential economic impact is very large. Washington's 1999 agricultural production totaled \$5.3 billion.

The high degree of landowner cooperation that has been achieved to-date in undertaking a project designed to address a significant regulatory issue (which was not well received by the agricultural sector initially) is also highly noteworthy.

- ii) Geographic Scope: Relevant to the 19 Western States.
  - iii) There is integrated Research and Extension Effort in the project.
  - iv) Not affiliated with a multistate project.
- E. Source of funding:** McIntire-Stennis, USDA Contracts, Grants, Cooperative Agreements, Other Federal Funds, State, and Other Non-Federal Funds

## **SECTION III**

### **PROGRAM REVIEW PROCESS**

There have been no significant changes in the ARC research program review process since the 5-year POW was submitted, nor are any important changes under consideration.

### **STAKEHOLDER INPUT PROCESS**

The active engagement of College of Agriculture and Home Economics with its stakeholders is fostered by the statewide presence of our College in every county of Washington and through the College's network of Research and Extension Centers. The Centers address mainstream issues of organizations, communities, and enterprises within the state. The resulting partnerships garner and direct financial resources towards priority needs of stakeholders.

The College focuses on critical stakeholder issues through a variety of mechanisms. Ongoing dialogues stimulate effective communication about current and emerging issues. A formal advisory council includes representatives from major agricultural commodities, food processors, special interest groups and organizations, and partnering state agencies and institutions. Representatives of our College regularly attend meetings of commodity commissions and agricultural organizations such as Washington Ag Presidents, Washington Friends of Farms and Forests, the West AgriBusiness Association, and the Washington Sustainable Food and Farming Network.

The Agricultural Research Center (ARC) coordinates research reviews at which College faculty present annual reports on their past research efforts and request new funds in support of new research. Major commodity research review panels involve wheat, barley, peas and lentils, potatoes, and tree fruits. The ARC also coordinates with the Washington State Commission for Pesticide Registration (WSCPR) to fund research proposals involving new pesticides or IPM strategies to protect both major and minor crops. In addition to funding projects seeking registration for special uses of pesticides, WSCPR funds integrated pest-control strategies that minimize the use of pesticides through the use of biocontrol.

Four years ago, all units of the College participated in stakeholder meetings to develop comprehensive strategic plans directed at priority research and educational goals for the ensuing 5 year period. Department chairs participated in three statewide stakeholder meetings to review their plans and develop the framework for funding requests for both state and federal levels. A comprehensive white-paper was developed from the stakeholder input and discussions that occurred during these meetings.

In each case, stakeholder input is carefully considered so that the Agricultural Research Center remains responsive to all groups within our constituency. Stakeholder input has been woven into our Strategic Plan as well as the research plans and programs carried out within the College.

### **EVALUATION OF THE SUCCESS OF JOINT REGIONAL AND MULTISTATE ACTIVITIES**

The ARC POW described the ongoing regional cooperation and joint activities that have existed among the Pacific Northwest land-grant institutions and others for several decades. The POW identified joint regional projects in which research efforts continue to produce desired results. Those listed below are special USDA grant-funded projects.

- Tri-state potato variety breeding programs conducted cooperatively by scientists at University of Idaho (UI), Oregon State University (OSU), USDA-Agricultural Research Services (ARS), and WSU.
- Cool Season Food Legume Research Program with scientists at UI.
- Jointed Goatgrass: A Threat to U.S. Wheat Production involves coordinated research in Colorado, Idaho, Kansas, Montana, Nebraska, Oklahoma, Oregon, Utah, Washington, and Wyoming.

- STEEP III - Solutions to Environmental and Economic Problems. Includes research and extension programs to protect soil and water resources in the Pacific Northwest - UI, OSU, WSU, and USDA-ARS.
- Grass Seed Cropping Systems for a sustainable Agriculture is conducted in cooperation with UI and OSU.
- PM-10 involves particulate emission prediction and control from agricultural land with scientists from WSU, USDA-ARS, and UI.
- The Barley Genome Study involves personnel at WSU and OSU.
- WSU, OSU, USDA-ARS, and UI have entered into joint agreements on release of all new varieties on all crops, the majority of which are cereal grains.
- The Northwest Center for Small Fruit Research and Northwest Center for Nursery Crop Research continue to be effective vehicles for obtaining stakeholder input on research needs and coordination of research for the Pacific Northwest land-grant universities.
- Aquaculture Idaho-Washington is a collaborative program between the University of Idaho and Washington State University, which seeks to solve disease, production, and marketing problems in the trout aquaculture industry.

Each of the multistate research projects is subjected annually to review, and progress reports are submitted via CRIS. Because these programs are “stand-alone” joint multistate projects and have detailed objectives for each of the cooperating institutions, the ARC POW did not further identify objectives, outputs, and outcomes. Information about each is available through CRIS and will not be duplicated in this report. The joint efforts on the projects have resulted in continued program effectiveness benefiting agricultural producers in many locations, especially the Pacific Northwest.

WSU research scientists participate in a large number of multistate research projects and coordinating committees. Administrative advisors file annual reports in addition to the CRIS progress reports filed by scientists at each cooperating institution. These reports will not be duplicated in this report. See Appendix A for a list of WSU ARC faculty serving as administrative advisors to various multistate projects.

Appendix B is a list of current Multistate Research projects and Coordinating Committees in which WSU faculty and ARS cooperators participate. It also includes Hatch Multistate Research Funds travel expenditures for WSU participants to the annual MRF meetings as well as the coordinating committee meetings. Appendix C lists faculty members with split appointments among research, teaching, and/or extension or faculty members with a 100% extension appointment who attended multistate research or coordinating committee meetings in FY 2004.

#### **AGRICULTURAL RESEARCH CENTER – UNIVERSITY EXTENSION COORDINATION**

Faculty of the ARC and WSU Extension cooperate in program planning and delivery primarily on an individual basis. Sixty faculty members, plus five college administrators for a total of sixty-five, have split appointments between ARC and Extension. Such assignments assure a significantly high level of cooperation and coordination, although most is informal. Scientists stationed at the off-campus Research and Extension Centers/Units routinely conduct research and extension education responsibilities jointly. Appendix C illustrates the split appointments for faculty participating in multistate research and coordinating committee projects.

U.S. Department of Agriculture  
 Cooperative State Research, Education, and Extension Service  
 Supplemental to the Annual Report of Accomplishments and Results  
 Multistate Extension Activities and Integrated Activities  
 (Attach Brief Summaries)

Institution: Washington State University  
 State: Washington

Check One:  Multistate Extension Activities  
 Integrated Activities (Hatch Acts Funds)  
 Integrated Activities (Smith-Lever Act Funds)

Actual Expenditures

Title of Planned Program/Activity	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Local Dimensions of the Globalization of Food and Agricultural Marketing Systems			_____	_____	\$39,962.94
Cropping Systems Research for Low-precipitation Dryland in Eastern Washington			_____	_____	\$64,842.45
Agricultural Production, Processing, Trade and Environmental Quality			_____	_____	\$62,840.00
Integrated Disease Control Programs for Economically Important Vegetable Crops in Western Washington			_____	_____	\$36,630.45
Development of Integrated Management Systems for High Value Specialty Crops in Central Washington			_____	_____	\$45,346.65
Integrating Whole-tree Physiological, Horticultural and Genetic Research in Prunus Tree Fruits			_____	_____	\$43,227.12
Biologically-Intensive Management of Arthropod pests of Pear		_____	_____	_____	\$37,501.73
<b>Total:</b>	_____	_____	_____	_____	\$330,351.34

\_\_\_\_\_  
 Ralph Cavaliere  
 Director

\_\_\_\_\_  
 Date

Form CSREES-REPT (2/00)

## **WSU COMPLIANCE WITH AREERA**

In July 2000, ARC requested a post-waiver from target percentage for Integrated Activities with Extension. The appropriate forms on file at CSREES document that the target percentage for FY2000 was zero. For the FY 2004, the target percentage is 5%; however, we are choosing to report on a higher percentage (approximately 9.5 %) of integrated projects below.

Since Washington is an agriculturally diverse state, we are reporting on seven projects encompassing benefits for a cross-section of Washington's citizens. For FY 04, we have chosen to feature: (1) local dimensions of the food systems that are becoming more important in Western Washington, (2) dryland cropping systems tailored for the low rainfall areas of Eastern Washington, (3) a study of bluegrass production touting the benefits of proper research and extension policies to support an industry operating on the margins, (4) integrated disease management programs for vegetable crops, (5) development of integrated management systems for high value specialty crops in Central Washington, (6) integrating whole-tree physiological, horticultural and genetic research in prunus tree fruits, and (7) biologically intensive management of arthropod pests of pear. The total funding allocated to these integrated projects is \$330,351.34, which is approximately 9.5% of our allocated Hatch formula funds.

### **Local Dimensions of the Globalization of Food and Agricultural Marketing Systems Project 0127**

An ongoing analysis is focusing on the ways in which consumers and farmers are working to re-structure food systems in ways that are more responsive to values and needs. Data from consumer and producer surveys was analyzed. One focus was the examination of sustainability practices. Preliminary findings show that farmers who engage in direct marketing with consumers are more likely to engage in a variety of practices that are considered to be helpful in promoting agricultural sustainability. Tabulated data from the consumer survey were also placed in the public domain (<http://www.crs.wsu.edu/outreach/rj/ag-consumer/index.html>). Thus, data from these surveys can now be accessed by the public via the WSU Department of Community and Rural Sociology website. In the second half of 2004, 132 individuals and organizations downloaded the results of the consumer survey from the department web site, and 51 individuals and organizations downloaded the results of the producer survey.

#### **Impact Statement**

There is an increasing interest in various regions of the state in promoting local agriculture and food systems. Various community groups utilize this data to better understand the agri-food system in their community and to organize events aimed at strengthening that system. For example, citizen groups like Skagitonians to Preserve Farmland have indicated that they find the data set that is available on the web to be of great value in their own efforts. Such responses indicate that there is a burgeoning interest in promoting local food systems, and that such types of marketing systems should continue to be supported state-wide.

**\$39, 962.94 in Hatch Funds**

### **Cropping Systems Research for Low-precipitation Dryland in Eastern Washington Project 0250**

This project, based out the Washington State University Dryland Research Station at Lind, is primarily focused on the 8 to 12 inch annual precipitation dryland cropping zone. The project includes two long term dryland cropping systems research studies at Lind and Ritzville as well as a long term irrigated cropping systems study at Lind. Other ongoing work includes experiments on Russian thistle ecology, dormant seeding of cereals, enhancement of winter wheat seedling emergence, and reducing runoff from frozen agricultural soils. Two new studies were initiated in 2004, which are: i) winter wheat seedling emergence as affected by soil crusting, and ii) seed priming winter wheat to enhance emergence from deep sowing depths. Research has shown that, in the low-precipitation zone, spring cereals have good yield potential when five or more inches of plant available water are stored in the soil over the winter. With less than five inches of stored available water, spring cereal production is risky and farmers are



advised to instead fallow the land using the undercutter method for summer fallow farming. Results of these studies are disseminated by extension bulletins, conference proceedings, technical reports, and field days.

### **Impact Statements**

Longterm dryland cropping systems research at Ritzville has conclusively shown that the severity of the soil fungal disease Rhizoctonia root rot can be significantly reduced with a two-year spring crop rotation of wheat – barley compared to continuous cropping of annual spring wheat. We believe this is the first study ever to document Rhizoctonia suppression with crop rotation.

This project has shown that by using the undercutter method to make summer fallow, 30 percent ground cover can be easily achieved even when grain yield from the preceding wheat crop is as low as 25 bushels per acre. If the undercutter method for summer fallow farming were widely practiced, airborne particulates would be reduced by at least 50 percent.

**\$64, 842.45**

### **Agricultural Production, Processing, Trade and Environmental Quality Project 0275**

In a seeming paradox, bluegrass seed production in the State of Washington increased following imposition in 1997 of a permanent ban on stubble burning. Burning bluegrass stubble was an important and efficient production practice that removed thatch, controlled weeds, and increased production and stand life of this perennial crop by shocking the crown of the plant. Despite forecasts that alternative production practices would increase the cost of producing bluegrass seed so much that the industry would be driven from the state, production in the years 1997-2003 was a full third higher than in any seven-year period in recorded history. A plausible explanation for this paradoxical behavior was examined by testing several hypotheses emanating from the production economics literature. The hypotheses of higher output price, lower competitive output prices, and data errors were each rigorously tested and rejected as sufficient explanations. The final hypothesis, induced innovation, could not be formally tested because of data limitations, but it was examined and supported by an assessment of innovations that occurred contemporaneously with the burning ban and by corroborative statistical evidence. This is an important case study in the broad applicability of the induced innovation hypothesis that has recently faced increasing skepticism.

### **Impact Statement**

Understanding the role of resource endowments and market forces in directing past technological change can help institutions design policies that will lead to more efficient paths of technological change in the future. Our findings suggest that it was the nearly simultaneous implementation of new irrigation technology and rotation options that kept the bluegrass seed industry viable and growing despite a policy regulation that increased marginal costs of traditional producers. Neither the new technology nor the rotation options would have been available had it not been for prior research and demonstration efforts. Our findings suggest that both Washington and national agricultural research and extension policy can play important roles in assuring that technological change responds efficiently to signals of relative factor scarcities and changing marginal costs.

**\$62,840**

### **Integrated Disease Control Programs for Economically Important Vegetable Crops in Western Washington Project 0336**

The WSU Pacific Northwest Research and Extension Center (WSU-PNWREC located at Mt. Vernon WA – north of Seattle) is the primary regional Center in Washington concerned with the health of fruit and vegetable crops. It is

located in the midst of the Skagit Valley cropping region and thus is immediately useful to the farmers and other stakeholders there. The State recently chose to build a new building at the site to house the programs of the Center.

Studies there continued to document the survival and transmission of *Phytophthora infestans* in volunteer potatoes. Several experimental field and greenhouse trials were conducted including: i) a comparison of in-furrow fungicides and biological products used at planting and/or emergence for controlling pink rot and *Pythium* leak (*Phytophthora erythroseptica* and *Pythium ultimum*) on potato tubers at harvest and after storage, ii) A study established that mid-season applications of phosphorous acid to volunteer potato plants controls development of late blight on daughter tubers, iii) Another study compared seed treatment fungicides and biological products used at planting and/or emergence for controlling seedling and root rot diseases (caused by *Fusarium*, *Pythium*, *Phoma*, *Thielaviopsis* and *Aphanomyces*) on green peas, iv) Yet another study evaluated an RIL population of green peas for resistance to pea root rot pathogens under field conditions, and to *Fusarium solani* f.sp. pisi in inoculated soils under greenhouse conditions, v) impacts of cover crops on development of potato tuber diseases, particularly common scab (*Steptomyces scabies*), were studied in organic transition crop rotations typical of Western Washington. vi) Another study evaluated host range of isolates of *Verticillium* species obtained from spinach, potato and pumpkin on major vegetable crops grown in Western Washington. Collections of isolates obtained from diseased plants in 2004 were maintained for further study. As a part of the outreach of the Center, WSU's Vegetable Pathology Team assisted vegetable workers in Washington with diagnosis of various vegetable disease problems and participated in research and extension presentations to the stakeholders. Partially, as a result of the activities of the Center, the new potato variety, Defender, a cultivar with durable resistance to late blight was released from the Tri-State Potato Variety Development Program. The considerable field evaluations associated with the new potato were performed by the members of the Vegetable Pathology program at WSU-NWREC. It is anticipated that the new variety will be planted throughout the U.S. and Canada, and possibly Europe. The activities performed at the Center helped NuFarms America obtain registration of Phostrol (phosphorus acid) to control root diseases caused by oomycete pathogens affecting potatoes and green peas. Phostrol is a new disease management tool, not previously used in the U.S.

### **Impact Statement**

These projects have impacted potato and pea growers and other vegetable growers throughout Washington state and the Pacific Northwest Region, increasing disease control options and the understanding of the stakeholders concerning vegetable diseases.

**\$36,630.45**

### **Development of Integrated Management Systems for High Value Specialty Crops in Central Washington Project 0381**

Cost-effective production of hops in south central Washington is threatened annually by insect and mite pests. Control of these pests remains dependent on the use of insecticides and miticides. However, progress has been made in research, development and adoption of conservation biological control, as an additional management strategy enabling a reduction in dependence on chemical inputs. Continued development and adoption of integrated management strategies based on biological control, is needed to enhance the cost-effectiveness and sustainability of the Washington hop industry. This project will continue the research needed for development and adoption of practical integrated management strategies for arthropod pests of hops. This research is justified by the need to move away from pesticide-based control of insects and mites on hops. Continued dependence on pesticides will result in increasing costs and diminished efficacy; because mites and aphids develop resistance and chemical companies struggle to find replacement chemicals. Government and community pressures to reduce environmental contamination by pesticides and stricter market requirements on acceptable residue levels, will also reduce the viability of pesticide-based arthropod management on hops in the future.

The overall objective of this program is to develop cost-effective, sustainable and environmentally-friendly integrated management strategies for insect and mite pests of hops that are useful and safe. The biology and the ecology of mites and aphids were studied along with the habits of their enemies in the laboratory and in the hop agroecosystem. The project investigated the potential of using synthetic plant volatiles to recruit/sustain predators

and enhanced biological control in an effort to promote IPM/biological control strategies to hop growers. Three miticides and one aphicide were examined for efficacy in two hop yard trials conducted during June-August. Full, half and quarter field rates of 13 miticides, 15 insecticides and 13 fungicides have now been tested for safety to 5-8 species of beneficial arthropods. The investigators screened and evaluated new specific miticides and aphicides in the laboratory and field for efficacy against the two-spotted mite and hop aphid and evaluated the safety of the chemicals to beneficial insects and mites. They also examined mite and aphid strains from hop yards and other sources for side-effects and susceptibility to currently used pesticides and established baseline toxicity levels as a reference for resistance detection. The susceptibility of two-spotted mite to pymetrozine, sulfur, lime sulfur, myclobutanil and trifloxystrobin was also examined.

### **Impact Statement**

Implementation of biological control strategies in commercial hop yards reduced levels of pesticide use. The use of synthetic herbivore-induced plant volatiles as a way of enhancing early season predator populations was explored and shows great potential for hop pest management. This research program has produced tangible economic benefits for hop growers. Adoption of our IPM-based management recommendations has led in some instances to substantial cost savings through reductions in miticide/aphicide use of 50-75%.

**\$45,346.65**

### **Integrating Whole-tree Physiological, Horticultural and Genetic Research in Prunus Tree Fruits Project 0420**

The program evaluated over 60 sweet cherry selections and 30 rootstock selections for their potential in the PNW. Rootstocks that offer greater precocity and productivity as well as dwarfing have been identified and planted in larger tests. Two new sweet cherry varieties were patented and commercially released from the WSU Irrigated Agriculture Research and Extension Center germplasm collection. In collaboration with an MSU breeder, a sweet cherry scion breeding program was initiated in 2004. The chemical blossom thinners ATS and FOLS have proven effective at reducing fruit set and improving sweet cherry fruit quality through their impact on whole tree source-sink relations. Novel irrigation strategies (e.g., deficit irrigation and partial rootzone drying) show promise for saving water resources and reducing canopy vigor while not impacting fruit quality or yield. We further tested the mechanical harvest system and found little negative effect on fruit quality.

### **Impact Statement**

Sweet cherry growers have more tools (horticultural and genetic) to improve orchard efficiencies while harvesting top quality fruit. For example, as a result of this program's research efforts, mechanical harvest of fresh market quality sweet cherries is possible effectively reducing the cost to harvest from about 20 cents per pound to three cents per pound. Sweet cherry growers now have access to new varieties that offer improved fruit quality and potential for sustainable cropping.

**\$43,227.12**

### **Biologically-Intensive Management of Arthropod pests of Pear Project 0431**

In 2002 this project established an area-wide insect pest management project in the Peshastin Creek Valley of Washington, using primarily organic pest control for insect pests of pear. Results for 2004 were excellent: pear psylla were controlled well, equal to conventional programs; codling moth damage was very low, equal to conventional; spider mites and rust mites required no sprays; grape mealybug was an occasional pest. Overall costs of organic and soft programs were equal to conventional programs.

Field trials for control of organophosphate-resistant codling moth demonstrated that newly developed codling moth control programs can successfully manage this pest. Organophosphate resistance was reduced in this program. Neonicotinyl resistance in pear psylla was documented from several areas of the Wenatchee Valley. Programs for

biological control of pear psylla using inundative releases of green lacewing were initiated. Direct measurement of biological control in organic pear did not demonstrate any significant increase in efficacy in organic and soft management programs. Results of this program were communicated to informal grower groups, at commission meetings, and at national meetings. The information was also delivered to stakeholders by means of county extension faculty members.

### **Impact Statement**

Conventional insecticides, including organophosphates and other neurotoxins, were eliminated from 310 acres of pear in the Peshastin Creek Watershed. This allowed growers to market the fruit under a unique label, 'Gently Grown,' for which they received a premium for their fruit. Total increase in income as a result of this program was approximately \$100,000 over the entire project. Additionally, agricultural impacts on the watershed, a habitat for endangered salmonids, was greatly reduced.

**\$37,501.73**

## SECTION IV

### APPENDIX A

#### **Agricultural Research Center Administrative Advisors FY 2004**

##### **Ralph P. Cavalieri, CAHNRS Associate Dean and Director, Agricultural Research Center**

- W-006 "Plant Genetic Resource Conservation and Utilization"
- NRSP-5 "National Program for Controlling Virus Diseases of Temperate Fruit Tree Crops"
- WERA-20 "Virus and Virus Like Diseases of Fruit Trees, Small Fruits and Grapevines"
- WERA-043(co-AA) "Establishing Bio-Intensive Pest Management Programs for Western Orchard Systems"
- WERA-092 (co-AA) "Beef Cattle Energetics"
- WERA -097 (co-AA) "Research on Diseases of Cereals"

##### **Sandra Ristow, Associate Director, Agricultural Research Center**

- WERA-099 "Broodstock Management, Genetics and Breeding Programs for Molluscan Shellfish"
- WERA-023 (co-AA) "Textiles and Apparel Coordinating Committee"

##### **Vicki A. McCracken, Director, Academic Programs**

- WERA-1001 "Reduction of Error in Rural and Agricultural Surveys"
- WERA-101 "Assessing the Chinese Market for U.S. Agricultural Products"

##### **Linda Arthur, Chair, Apparel, Merchandising, Design, and Textiles; Interior Design**

- WERA-023 (co-AA) "Textiles and Apparel Coordinating Committee"

##### **John Brown, Chair, Entomology Department**

- WERA-043 (co-AA) "Establishing Bio-Intensive Pest Management Programs for Western Orchard Systems"

##### **Ray W. Wight, Chair, Animal Sciences Department**

- WERA-092 (co-AA) "Beef Cattle Energetics"

##### **Tim Murray, Chair, Plant Pathology Department**

- WERA-097 (co-AA) "Research on Diseases of Cereals"

##### **Linda K. Fox, Associate Dean and Associate Director, Extension**

W-1001 "Population Change in Rural Communities"

W-167 "Family and Work Identities During Times of Transition"

## FY 2004 Multistate Research Fund Projects with WSU Faculty and ARS Cooperator Participation

Project	Title	MRF #	Term		Researcher
			Date		
0913	Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation	NC-131	09/2005	1	Dodson, M.V.
0913	Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation	NC-131	09/2005	2	Rodgers, B. D.
0467	Improvement of Thermal and Alternative Processes for Food	NC-136	09/2005	1	Powers, J.R.
0467	Improvement of Thermal and Alternative Processes for Food	NC-136	09/2005	2	Barbosa-Canovas, G.V.
0467	Improvement of Thermal and Alternative Processes for Food	NC-136	09/2005	3	Cavalieri, R.P.
0467	Improvement of Thermal and Alternative Processes for Food	NC-136	09/2005	4	Swanson, B.G.
0467	Improvement of Thermal and Alternative Processes for Food	NC-136	09/2005	5	Tang, J.
0452	Rootstock and Interstem Effects on Pome and Stone Fruit Trees	NC-140	09/2007	1	Barritt, B.H.
0452	Rootstock and Interstem Effects on Pome and Stone Fruit Trees	NC-140	09/2007	2	Whiting, M
0406	Characterizing Weed Population Variability for Improve Weed Management Decision Support Systems to Reduced Herbicide Use	NC-202	09/2005	1	Parker, R.
0128	Marketing and Delivery of Quality Cereals and Oilseeds	NC-213	09/2008	1	Baik, B.K.
0403	Systems Analyses of the Relationships of Agriculture and Food Systems to Community Health	NC-1001	09/2006	1	Jussaume, R.A.
0261	Enteric Diseases of Swine and Cattle: Prevention, Control and Food Safety	NC-1007	09/2007	1	Besser, T.E.
0261	Enteric Diseases of Swine and Cattle: Prevention, Control and Food Safety	NC-1007	09/2007	2	Gay, J.M.
0261	Enteric Diseases of Swine and Cattle: Prevention, Control and Food Safety	NC-1007	09/2007	3	Hancock, D.D.
0261	Enteric Diseases of Swine and Cattle: Prevention, Control and Food Safety	NC-1007	09/2007	4	Call, D. R.
0261	Enteric Diseases of Swine and Cattle: Prevention, Control and Food Safety	NC-1007	09/2007	5	Cobbold, R
0862	Metabolic Relationships in Supply of Nutrients for Lactating Cows	NC-1009	09/2007	1	McNamara, J.P.
0119	Regulation of Photosynthetic Processes	NC-1142	09/2007	1	Okita, T.W.
0119	Regulation of Photosynthetic Processes	NC-1142	09/2007	2	Edwards, G.E.
0797	Postharvest Physiology of Fruits	NE-103	09/2003	1	Fellman, J.K.
0797	Postharvest Physiology of Fruits	NE-103	09/2003	2	Kupferman, E.M.
0154	Environmental and Economic Impacts of Nutrient Management on Dairy Forage Systems	NE-132	09/2004	1	Harrison, J.H.
0156	Multidisciplinary Evaluation of New Apple Cultivars	NE-183	09/2004	1	Barritt, B.H.
0409	Eradication, Containment and/or Management of Plum Pox Disease (Sharka)	NE-1006	09/2006	1	Eastwell, K.C.
0990	Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain	NE-1008	09/2007	1	Tang, J.
0990	Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain	NE-1008	09/2007	2	Fellman, J.K.

0709	Mastitis Resistance to Enhance Dairy Food Safety	NE-1009	09/2007	1	Fox, L.K.
0709	Mastitis Resistance to Enhance Dairy Food Safety	NE-1009	09/2007	2	Davis, W.C.
0998	Rural Communities, Rural Labor: Markets and Public Policy	NE-1011	09/2007	1	Holland, D.W.
0230	Sustaining Local Food Systems in a Globalizing Environment: Forces, Responses, Impact	NE-1012	09/2007	1	Jussaume, R.A.
0230	Sustaining Local Food Systems in a Globalizing Environment: Forces, Responses, Impact	NE-1012	09/2007	2	Ostrom, M.
0122	High Value Specialty Crop Pest Management	NRSP-4	09/2004	1	Walsh, D.B.
1262	National Program for Controlling Virus Diseases of Temperate Fruit Tree Crops	NRSP-5	09/2008	1	Eastwell, K.C.
1262	National Program for Controlling Virus Diseases of Temperate Fruit Tree Crops	NRSP-5	09/2008	2	Howell, W.E.
1262	National Program for Controlling Virus Diseases of Temperate Fruit Tree Crops	NRSP-5	09/2008	3	Cavalieri, R.P.
1262	National Program for Controlling Virus Diseases of Temperate Fruit Tree Crops	NRSP-5	09/2008	4	Murray, T.D.
0568	National Animal Genome Research Program	NRSP-8	09/2008	1	Jiang, Z
0806	Fruit and Vegetable Supply-Chain Management, Innovations, and Competitiveness	S-222	09/2003	1	Schotzko, R.T.
0450	The Science and Engineering for a Biobased Industry and Economy	S-1007	09/2007	1	Chen, S.
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	1	Jones, S.S.
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	2	Coyne, C.J.*
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	3	Clement, S.L.*
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	4	Hannan, R.M.*
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	5	Johnson, R.C.*
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	6	Dugan, F.M.*
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	7	Cavalieri, R.P
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	8	Welsh, M.
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	9	Bradley, V.
1134	Plant Genetic Resource Conservation & Utilization	W-006	09/2008	10	Hellier, B.
0372	Mechanisms and Mitigation of Agrochemical Impacts on Human and Environmental Health	W-45	09/2005	1	Hebert, V.
7996	Multistate Research Coordination, Western Region	W-106	09/2029	1	Cavalieri, R.P.
7996	Multistate Research Coordination, Western Region	W-106	09/2029	2	Ristow, S.S.
0957	Reproductive Performance in Domestic Ruminants	W-112	09/2006	1	Reeves, J.J.
0957	Reproductive Performance in Domestic Ruminants	W-112	09/2006	1	McLean, D.
0215	Freeze Damage and Protection of Horticultural Species	W-130	09/2003	1	Keller, M
0560	Genetic Improvement of Beans ( <i>Phaseolus vulgaris</i> L.) for Yield, Disease Resistance, and Food Value	W-150	09/2005	1	Swanson, B.G.
0560	Genetic Improvement of Beans ( <i>Phaseolus vulgaris</i> L.) for Yield, Disease Resistance, and Food Value	W-150	09/2005	2	Hang, A.N.
0647	Family and Work Identities During Times of Transition	W-167	09/2005	1	Fox, L.
0399	Community Economic Development by Merchandising, Producing, and Distributing Textiles and Sewn Products	W-194	09/2004	1	Salusso, C.J.



0445	Population Change in Rural Communities	W-1001	09/2007	1	Kirschner, A.
0905	Nutrient Bioavailability - A Key to Human Nutrition	W-1002	09/2007	1	Shultz, T.D.
0276	Factors Influencing the Intake of Calcium Rich Food Among Adolescents	W-1003	09/2007	1	Edlefsen, M.S.
0570	Marketing, Trade, and Management of Fisheries and Aquacultural Resources	W-1004	9/2008	1	Matulich, S.
0448	Benefits and Costs of Natural Resource Policies Affecting Public and Private Lands	W-1133	09/2007	1	McCluskey, J.J.
0448	Benefits and Costs of Natural Resource Policies Affecting Public and Private Lands	W-1133	09/2007	2	Wandschneider, P.R.
0564	Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture	W-1147	09/2008	1	Riga, E
0564	Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture	W-1147	09/2008	2	Weller, D.M.
0564	Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture	W-1147	09/2008	3	Grunwald, N.J.
0564	Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture	W-1147	09/2008	4	Paulitz, T.
0564	Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture	W-1147	09/2008	5	Okubara, P.
0690	Chemistry, Bioavailability, and Toxicity of Constituents in Residuals and Residual-Treated Soils	W-1170	09/2009	1	Kuo, S.
0706	Germ Cell and Embryo Development and Manipulation for the Improvement of Livestock	W-1171	09/2009	1	Wright, R.W.
0764	Enhancing the Global Competitiveness of U.S. Red Meat	W-1177	09/2007	1	Busboom, J.R.
0121	Biological Control in Pest Management Systems of Plants	W-1185	09/2007	1	Piper, G.L.
0185	Genetic Variability in the Cyst and Root-Knot Nematodes	W-1186	09/2008	1	Riga, E.
0152	Characterization of Flow and Transport Processes in Soils at Different Scales	W-1188	09/2009	1	Flury, M.
0152	Characterization of Flow and Transport Processes in Soils at Different Scales	W-1188	09/2009	2	Wu, J. Q.
0160	Interfacing Technological, Economic, and Institutional Principles for Managing Inter-Sector Mobilization of Water	W-1190	09/2009	1	Huffaker, R.G.
0160	Interfacing Technological, Economic, and Institutional Principles for Managing Inter-Sector Mobilization of Water	W-1190	09/2009	2	Yoder, J.
0160	Interfacing Technological, Economic, and Institutional Principles for Managing Inter-Sector Mobilization of Water	W-1190	09/2009	3	Chouinard, H.

**Multistate Research Funds Travel (October 1, 2003-September 30, 2004  
Expenditures for WSU Participants (Not Including Coordinating Committees)**

**MRF**

<b>Comm</b>	<b>Title</b>	<b>Total</b>
NC-131	Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation	1307.71
NC-136	Improvement of Thermal and Alternative Processes for Foods	1722.48
NC-1001	Systems Analyses of the Relationships of Agriculture and Food Systems to Community Health	678.00
NC-1009	Metabolic Relationships in Supply of Nutrients for Lactating Cows	836.73
NC-1142	Regulation of Photosynthetic Processes	539.96
NE-132	Environmental and Economic Impacts of Nutrient Management on Dairy Forage Systems	481.07
NE-1006	Eradication, Containment and/or Management of Plum Pox (sharka) Disease	574.89
NE-1008	Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Market Chain	1093.42
NE-1009	Mastitis Resistance to Enhance Dairy Food Safety	986.83
NE-1012	Sustaining Local Food Systems in a Globalizing Environment: Forces, Responses, Impact	614.24
NE-1018	Postharvest Biology of Fruit	1355.19
NRSP 5	Develop and Distribute Deciduous Fruit Tree Clones that are Free of Viruses and Virus-Like Agents	1190.51
S-1007	The Science and Engineering for a Biobased Industry and Economy	1525.66
W-6	Plant Genetic Resource Conservation and Utilization	859.74
W-45	Mechanisms and Mitigation of Agrochemical Impacts on Human and Environmental Health	726.41
W-112	Reproductive Performance of Domestic Ruminants	700.27
W-167	Family and Work Identities During Times of Transition	825.80
W-1001	Population Change in Rural Communities	1579.09
W-1002	Nutrient Bioavailability - A Key to Human Nutrition	776.76
W-1003	Parent and Household Influences on Calcium Intake Among Preadolescents	807.07
W-1133	Benefits and Costs of Resource Policies Affecting Public and Private Land	1784.34
W-1188	Characterizing Mass and Energy Transport at Different Scales	976.10
W-1190	Interfacing Technological, Economic, and Institutional Principles for Managing Inter-Sector Mobilization of Water	1481.08
<b>Total:</b>		<b>24,231.17</b>

## APPENDIX B

### Current Multistate Coordinating Committees with WSU Faculty and ARS Cooperator Participants FY 2004

MRF #	PI	Title	Term Date
WERA-001	Charles Gaskins	Beef Cattle Breeding in the Western Region	9/07
WERA-011	William Johnston Gwen Stahnke E. Miltner	Western Regional Turfgrass Research	9/09
WERA-020	K.C. Eastwell W. Howell Ralph Cavalieri (AA)	Virus and Virus-Like Diseases of Fruit Trees, Small Fruits, and Grapevines	9/06
WERA-021	J. Dobrowolski B. Zamora	Revegetation and Stabilization of Deteriorated and Altered Lands	9/09
WERA-023	Linda Arthur Sandra Ristow (AA)	Textiles and Apparel Coordinating Committee	9/04
WERA-027	Robert Thornton N. Richard Knowles	Potato Variety Development	9/05
WERA-040	Linda Hardesty	Rangeland Ecological Research and Assessment	9/06
WERA-043	Jay Brunner John Brown, AA Peter Landolt* Tom Umruh* Dave Horton* Alan Knight* Larry Lacey* Vince Jones John Dunley Elizabeth Beers Ralph Cavalieri (AA)	Establishing Bio-Intensive Pest Management Programs for Western Orchard Systems	9/08
WERA-055	Dave Scarnecchia	Rangeland Resource Economics and Policy	9/06
WERA-058	Rita Hummel	Production, Transition Handling, and Reestablishment of Perennial Nursery Stock	9/09
WERA-060	John Dunley	Science and Management of Pesticide Resistance	9/07

WERA-066	Keith Pike William Turner	Integrated Management of Russian Wheat Aphid and Other Cereal Aphids	9/06
WERA-067	David Granatstein Christopher Feise	Western Coordinating Committee for Sustainable Agriculture	9/05
WERA-069	D. Walsh L. Tanigoshi	Coordination of Integrated Pest Management Research & Extension/Education Programs for the Western United States and the Pacific Basin Territories	9/05
WERA-072	F. Chaddad	Agribusiness Research Emphasizing Competitiveness	9/04
WERA -077	J. Yennish	Managing Invasive Weeds in Wheat Grass Weeds in Winter Wheat	9/09
WERA-081	Brady Carter	Systems to Improve End-Use Quality of Wheat	9/06
WERA-089	Hanu Pappu Jim Crosslin	Potato Virus Disease Control	9/06
WERA-091	Steven Fransen	Improving Stress Resistance of Forages in the Western United States	9/04
WERA-092	Kristen Johnson Ray Wright, (AA) Ralph Cavalieri, (AA)	Beef Cattle Energetics	9/04
WERA-093	Alan Busacca Bruce Frazier	Western Region Soil Survey and Inventory	9/04
WERA-097	Timothy Murray, (AA) Ralph Cavalieri, (AA)	Research on Diseases of Cereals	9/05
WERA-099	K.K. Chew (UW) Sandra Ristow, (AA)	Broodstock Management, Genetics and Breeding Programs for Molluscan Shellfish	9/06
WERA-101	R. Tichy T. Lumpkin T. Wahl P. Thiers V. McCracken (AA)	Assessing the Chinese Market for U.S. Agricultural Products	9/05
WERA-102	F. Pierce	Climatic Data and Analyses for Applications in Agriculture and Natural Resources	9/05
WERA-103	Robert Stevens Greg Schwab	Nutrient Management and Water Quality	9/06
WERA-110	Mark Nelson	Improving Ruminant Use of Forages in	9/04

		Sustainable Production Systems for the Western U.S.	
WERA-201	S. Ullrich J. Froseth	Enhanced Use of Barley for Feed and Food	9/04
WERA-203	Ron Kincaid Mark Nelson	Animal Utilization of Products from Processing Agricultural Commodities	9/05
WERA-204	Ruth Newberry	Animal Bioethics	9/05
WERA-205	R. Simmons	Integrated Water Quality Research and Extension Programs for the Western United States	9/05
WERA-207	M. Swan	Agricultural Literacy	9/06
WERA-208	H. Dennis Brown	Western Region Impact Statement Development	9/06
WERA1001	D. Dillman V.A. McCracken, (AA)	Reduction of Error in Rural and Agricultural Surveys	9/07
IEG-31	Holly Wang	Economics and Management of Risk in Agriculture and Natural Resources	9/04
NCERA -059	D. Bezdicsek J. Halvorson	Soil Organic Matter and Soil Quality	9/06
NCR-022	P. Moore	Small Fruit and Viticulture Research Committee	9/06
NCR-131	R. Newberry	Animal Care and Behavior	9/07
NCR-134	H. Wang	Applied Commodity Price Analysis, Forecasting and Market Risk Management	9/03
NCR-170	R. Alldredge	Research Advances in Agricultural Statistics	9/06
NCR-174	J. Harsh	Synchrotron X-Ray Sources in Soil Science Research	9/07
NCR-180	Fran Pierce B. Frazier Joan Davenport	Site Specific Management	9/06
NCR-189	L. Fox J. Froseth W.C. Davis	Air Quality Issues Associated with Animal Facilities	9/06

CR-193	G. Chastagner	Maintaining Plant Health: Managing Insect Pests and Diseases of Landscape Plants	9/06
NCR-194	K. Duft F. Chaddad	Improving the management and effectiveness of cooperatively owned business organizations	9/03
NCR-199	Charles Gaskins	Implementation & Strategies for National Beef Cattle Evaluation	9/06

\* UDSA Participant

<b>Multistate Research Funds Travel (Oct. 1, 2003-Sept. 30, 2004)</b>		
<b>Expenditures for WSU Participants, Coordinating Committees Only</b>		
<b>MRF</b>	<b>Traveler</b>	<b>Totals:</b>
NCR-22	Moore, Pat	765.82
NCR-131	Newberry, Ruth	715.94
NCR-170	Zhang, Hao	1206.71
NCR-193	Chastagner, G	873.44
NCR-194	Chaddad, Fabio	835.41
NCR-199	Gaskins, Charlie	911.90
WERA-20	Howell, Bill	574.89
WERA-001	Gaskins, Charlie	1047.31
WERA-11	Stahnke, Gwen	944.64
WERA-20	Cavalieri, Ralph	2026.36
WERA-20	Eastwell, Ken	388.89
WERA-21	Dobrowolski, James	882.55
WERA-23	Anderson, Joan	1368.65
WERA-23	Arthur, Linda (AA)	1478.59
WERA-27	Knowles, Rick	870.82
WERA-66	Pike, Keith	994.79
WERA-69	Walsh, Douglas	1725.95
WERA-72	Chaddad, Fabio	858.72
WERA-77	Yenish, Joe	606.93
WERA-81	Carter, Brady	697.27
WERA-89	Pappu, Hanu	786.75
WERA-93	Frazier, Bruce	1260.90
WERA-99	Ristow, Sandra (AA)	1646.83
WERA-101	Wahl, Tom	1004.23
WERA-102	Pierce, Fran	285.82
WERA-103	Davenport, Joan	1330.63
WERA-207	Swan, Mike	1029.93
WERA-1001	Dillman, Don	908.32
	<b>Grand Total:</b>	28,028.99

## Appendix C

### Faculty with Split Appointments or 100% Extension Appointments Attending Multistate Research or Coordinating Committee Meetings FY 2004

MRF#	R/T FTE	EXT FTE	Participant
NC-1001	0.75	0.25	Jussaume, Ray
NCR-193	0.6838	0.3162	Chastagner, Gary
NE-132	0.5	0.5	Harrison, Joe
NE-1012	0.2	0.8	Ostrom, Marcie
S-1015	0.8	0.2	Riga, Ekaterini
W-45	0.5	0.5	Hebert, Vince
W-167		1	Fox, Linda
W-1001	0.6	0.4	Kirschner, Annabel
W-1133	0.9	0.1	Wandschneider, Phil
W-1147	0.8	0.2	Riga, Ekaterini
W-1186	0.8	0.2	Riga, Ekaterini
WERA-11	0.187	0.813	Stahnke, Gwen
WERA-21	0.14135	0.85865	Dobrowolski, James
WERA-69	0.25	0.75	Walsh, Douglas
WERA-77	0.25	0.75	Yenish, Joe
WERA-92	0.76	0.24	Ray Wright