Oregon State University | Agricultural Experiment Station

Plan of Work

Annual Report of Accomplishments

Oregon Agricultural Experiment Station
Oregon State University

Federal Fiscal Year 2006

Thayne R. Dutson
Dean, College of Agricultural Sciences
Director, Oregon Agricultural Experiment Station

Table of Contents

FY2006 Annual Report of Accomplishments
Oregon Agricultural Experiment Station

INTRODUCTION

In this report, the Oregon Agricultural Experiment Station (OAES) will highlight a number of projects in each of the five (5) major CSREES Goals and for 28 key theme areas. We provide summary outcome and impact information under individual key themes. Those units which conducted the research are identified within each summary. The major selection criteria used are quantifiable outcome and impact.

ASSESSMENT:

Units in the OAES conduct performance evaluation of their faculty members. These reviews are based on goals established during the previous year's reviews and development of workplans. Since all faculty members with OAES FTE are required to establish station projects, performance evaluation serves as a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals. We continue to expand the station's output and outcome measures for reporting in preparation for reporting progress and updating the Plan of Work.

DISSEMINATION:

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; branch station field days; extension publications and offices; press releases and media outlets; GIS climate, geophysical and plant maps; and an array of web pages of an array of types. The faculty reported that they had published 455 refereed journal articles, 17 books or book chapters, 60 proceedings papers, and 54 abstracts.

ACCOUNTABILITY:

Additional information regarding research programs conducted through the Oregon Agricultural Experiment Station may be found in *"Oregon Invests"*, a research accountability database accessible on the web at:

http://oregoninvests.css.orst.edu

There are currently 317 reports contained in the database, searchable by selected criteria. 210 of them focus on research, and the others are integrated projects (research and extension). Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate. Examples of keyword search for each goal are:

Goal 1: disease resistance, pest management, genetics, irrigation, plant pathogens, genomes, biotechnology, sperm mobility, seafood processing, wheat cultivars, and pollination management.

Goal 2: fiber, food system, food quality, and food safety

Goal 3: human health, and human nutrition

Goal 4: environment, waste management, biological control, biodiversity, endangered species, forest resources, climate change, integrated pest management, soil quality, sustainable agriculture, wildfire, and water quality

Goal 5: rural, low-income families, community development, and employment

***TOTAL OAES EXPENDITURES*:** $58,591,386

Hatch:	$1,757,080
Multistate:	$908790
State Outlays:	$25,723,355
Other:	$30,202,161

(other includes funds from sources such as grants, foundations, etc.)

***TOTAL OAES FTE FROM ALL SOURCES*:** 501.6

A. PLANNED PROGRAMS

NATIONAL GOAL #1: An agricultural system that is highly competitive in the global economy.
Through research and education, empower the agricultural system with knowledge that will improve the competitiveness in domestic production, processing, and marketing.

OVERVIEW

Major program/research areas included under Goal 1 of the OAES Plan of Work included: a) **adding value to existing stocks, b) crop production strategies, and c) animal health and management systems.** The following section summarizes projects and programs conducted by station personnel in addressing these areas. More specific information related to what was done and what impacts were achieved in each area is include under the Key Theme Information section. The major selection criteria are the quantifiable outcome and impact.

Adding Value by Improving Existing Stocks:

Our faculty apply traditional and state-of-the-art breeding and genetic techniques and strategies for improving valuable characteristics of important, regional marine and terrestrial stocks such as salmon, oysters, potatoes, wheat, berries, and tree fruits and nuts. Breeding and genetic techniques can enhance yield, tolerance to abiotic parameters, disease resistance, and nutritional characteristics.

Broodstock improvements for regional and national stocks of fish and oysters help improve yield and survival traits, and contribute to management of these important stocks. For example, the value of the West coast oyster harvest is reported to be $68 million per year. If the oyster industry used F2 MBP broodstock and obtained 77% improvement in yield, one could expect an increase in oyster production valued at $52 million. Application of genetic markers for stock ID that we have developed allowed re-opening of fisheries in the knowledge that we could monitor impacts and direct fisheries towards stocks for which harvest was intended. In a similar fashion, our run-timing research has application in segregation of spring and fall runs at Chinook hatcheries and rockfish research has applications in rebuilding of threatened stocks.

The development of high yield and high quality potato varieties with resistance to biotic and abiotic stresses allows producing potatoes under more cost-effective, environmental friendly and healthier conditions by using fewer inputs of chemical fertilizers, fungicides and insecticides and at the same time increasing the nutritional value and quality of the crop. For example, potato is a frost-sensitive species incapable of cold acclimation; our finding that a 2 degree C increase in freezing tolerance can significantly increase potato yield in frost prone areas of the world. The Oregon breeding program has been estimated to return $5.6 million annually to local and state economies. Varieties recently released by the Pacific Northwest (tri-state) program are now produced on over 110,000 acres with value to growers placed at approximately $150 million.

Wheat cultivar development is dependent on a continued supply of genetic variability. However, variability for some traits, such as resistance against the cereal yellow dwarf virus (CYDV), *Cephalosporium* (Ceph.) stripe, stripe rust, and grain protein concentration (GPC) is limited in wheat's primary gene pools and must be sought from secondary and tertiary gene pools and transferred to wheat germplasm adapted to the U.S. Pacific Northwest.

Crop Production

Information obtained from experiments and field trials will facilitate the adoption of sustainable cropping practices and form the basis for farm programs and environmental protection policy formulation. It is estimated that about 10-20 tons ha-1 yr-1 is lost by erosion in conventional tillage systems in the US. Soil organic matter (SOM) and nutrients are lost in the process resulting in reduced soil and crop productivity. The cost of soil erosion in terms of losses of net farm income has been estimated to be $100 million per year. In addition, fugitive dust from wind erosion on tilled summer fallow land is the primary source of particulate matter that is potentially harmful to human health. Direct seeding systems restore SOM in top soil which increase soil aggregation and reduce soil erosion.

Alternative crops research contribute to crop diversification, soil enrichment, and reduce demand for scarce water supplies in the region. Experiments have shown that legumes can add as much as 10 to 50 lbs N/a with potential savings of $5 to $25.00 per acre for the next wheat crop. Demand for biofuel feedstocks has increased the value of alternative crops and currently there are over two-dozen growers that are experimenting with winter pea, chickpea, mustard, and safflower. Development of alternative crops such as mint, teff, poplar trees, and oilseed crops will contribute to crop diversification in the Klamath Basin, where very few commodity crops are currently grown. In addition, some of these alternative crops may allow decreased demand for scarce water supplies in the region.

Development of natural weed control methods for organic farming will increase organic production. Currently, organic wheat fetches about $220 ton-1, about twice as much as conventionally grown wheat. The use of natural weed control methods will have great impact on the environment and human health.

Animal Health and Management Systems

Project information has been used to develop nutritional management strategies that reduce costs associated with beef production. For example, costs associated with protein supplementation can be decreased by up to 83% when protein is provided infrequently (i. e., once every 6 days) as compared with daily supplementation, which equates to a saving of approximately $650 per month (or roughly $2 per head) when supplemental protein is provided. Development of safe-feeding strategies for the use of high alkaloid grass seed straw which can help reduce winter feed costs from $5 to $45 per cow compared with traditional forage source. Potential annual savings in winter feed costs because of research from this project is in excess of $26 million (assuming 50% of the 630,000 beef cows in Oregon are early weaned, consume grass seed straw, and are supplemented protein once every 6 days).

Supplementing niacin to a Jersey cow during the last three weeks of gestation is $5 per head. ($0.005 per g of niacin). A one unit increase (lb or kg) in prepartum feed intake has been shown is lead to a one unit increase in postpartum feed intake. This increase in postpartum feed intake will lead to increased milk production and/or improved energy balance during the early postpartum period.

TOTAL EXPENDITURES:	$32,734,295
Hatch:	$1,105,341
Multistate:	$708,065
State Outlays:	$15,312,192
Other:	$15,608,697

(other includes funds from sources such as grants, foundations, etc.)

TOTAL FTE FROM ALL SOURCES:	277.44

KEY THEME INFORMATION

Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected 33 projects from nine (9) key themes to highlight in this year's report.

Key Theme: Agricultural Value-Added Products

Title: Improving Yields of Pacific Oysters Through Selection (Langdon, Coastal Oregon Marine Experiment Station)

Description: This project is designed to apply traditional and modern selection techniques to improve yields Pacific oysters (*Crassostrea gigas*) on the West Coast, U.S. The breeding program is based on both within and among family selection. Cohorts, consisting of 50 to 60 families, are planted at two or more West coast test-sites. Top-performing families (highest yields) are identified and the top third largest individual oysters are selected from each top family for use as broodstock to produce the next generation. Pedigrees of broodstock are verified by microsatellite analysis. Yields of F2 MBP families from broodstock selected over two generations are compared with those of control families derived from unselected broostock. Yields of F2 families from MBP-selected broodstock are 41% greater than those of unselected broodstock while the average yield of the top five families is 77% greater than that of unselected industry broodstock. A rotational breeding program has been implemented to avoid inbreeding effects. In addition, we have begun to develop approaches to select for desirable shell shape as well as both shell and mantle color for the half-shell oyster market. Inbred lines of the parents of top-performing families have been produced to supply commercial hatcheries with large

numbers of broodstock for production of high quality seed. A repository has been set up in Netarts Bay, Oregon, to rear and hold large numbers of these broodstock oysters for industry.

Impact: Commercial oyster hatcheries have used MBP broodstock to produce large numbers of seed for the West Coast industry and foreign markets. The value of the West coast oyster harvest is reported to be $68 million per year. If the oyster industry used F2 MBP broodstock and obtained 77% improvement in yield, one could expect an increase in oyster production valued at $52 million. In addition, FAO statistics indicate that the Pacific oyster is the most important global aquaculture species, both in terms of weight and value; therefore, this project will have a major global affect on seafood production. Similar programs on the East coast, USA, and in Australia and New Zealand have adopted new approaches and techniques developed for oyster breeding in this project.

Title: New Dimensions for Marine Fisheries Management Through Applications of Molecular Genetics (Banks, Coastal Oregon Marine Experiment Station)

Description: ProjectCROOS, a response to the Chinook fisheries crisis owing to low Klamath escapement, uses state-of-the-art DNA ID and GSI techniques to map the distribution of Klamath and other stocks encountered by the fishery. Primary goals are to research the feasibility of graduating from the year delayed coded-wire data (limited to only hatchery fish) currently used in management to real-time genetic ID/GSI results more in key with changing oceanic conditions and also addressing both hatchery and wild stocks. Pilot results were very promising, with good prospects to extend this project to California and Washington next year.

Impact: ProjectCROOS comprises a classic example of the impact of our research. Fishing opportunities worth several hundred thousand dollars were truncated, significantly impacting fisherman, shore-based support including ice-plants, fishing gear providers, and well developed markets such as the Signature Salmon program. Application of genetic markers for stock ID that we have developed allowed re-opening fisheries in knowledge that we could monitor Klamath impacts and direct fisheries towards stocks for which harvest was intended. In a similar fashion, our run-timing research has application in segregation of spring and fall runs at Chinook hatcheries and rockfish research has applications in rebuilding of threatened stocks.

Title: Assessing and Managing Oregon's Fisheries for Groundfish (Sampson, Coastal Oregon Marine Experiment Station)

Description: Fish stock assessments provide the scientific foundation for fishery management decisions (e.g., catch quotas and fishing seasons), but even the best assessments leave considerable uncertainty about the true size or potential productivity of a fish stock. Because most marine fishes are affected by natural variations in the ocean environment and are inaccessible and patchily distributed, the stock size and dynamics of wild fish populations are difficult to measure and even more difficult to predict. There can be significant costs from having inaccurate stock assessments. Overly restrictive regulations and lost fishing opportunities can result from predictions of stock size or productivity that are too small. Over-fishing, over-capitalization of the fishing fleet, and decreased long-term productivity of the fish stock can

result from predictions that are too liberal. In either case, the benefits that could be derived from exploiting the stock are partially wasted. The overall goal of this research program is to improve the accuracy of stock assessments used for managing Oregon's fisheries for groundfish (e.g., flatfish and rockfish) so that these fisheries can achieve greater economic or other benefits. The specific objectives of the program are: (1) to evaluate current data and methods for assessing the status of US West Coast groundfish and develop new data sources and approaches to assessing stock status; (2) to evaluate current and alternative harvest management policies for US West Coast groundfish stocks; (3) to conduct stock assessments of selected US West Coast groundfish stocks; (4) to develop sources of information on stock assessments and fisheries management issues and inform the public debate about fisheries policy; and (5) to publish the results of this research and communicate relevant findings to fisheries management agencies in the Pacific Northwest. Accomplishments included: serving as chair of a formal technical evaluation of three stock assessments developed for the Pacific Fishery Management Council (PFMC); completion of an assessment for the PFMC of the US West Coast stock of Dover sole; development of a field sampling program to investigate certain unusual aspects of the life history of canary rockfish, which is a weak stock that is constraining commercial and marine recreational fishing along much of the US West Coast; and development of software for evaluating monitoring and management strategies for Oregon's nearshore groundfish resources, for which traditional stock assessment data are unavailable.

Impact: If stock assessments underestimate the health or productivity of an exploited fish stock, then fishery management agencies may inadvertently set overly restrictive regulations that result in lost fishing opportunities and spill-over of displaced fishing activities. Conversely, if assessments are overly optimistic, harvests may be unsustainably large and result in stock declines and reduced long-term productivity. In recent years the Pacific Fishery Management Council has restricted marine commercial and recreational fishing along the U.S. West Coast because several rockfish stocks have been assessed as being depleted. Recent assessments for canary rockfish, for example, estimated that female spawning biomass has been less than 10% of its unexploited level, but a key assumption in the assessment is that a deficit of older female versus male canary rockfish, apparent in data from trawl surveys and trawl landings, is due to elevated rates of natural mortality for reproductive females. Working with fishing industry groups we collected canary rockfish from untrawlable areas and found surpluses of females at numerous sites, which supports the idea that the relative lack of females could be an artifact of trawling rather than mortality. Also, we developed a new assessment for Dover sole that indicated the stock is much more productive than previously thought. Projections of sustainable harvests of Dover sole for 2007 and beyond are more than double the harvests allowed by the Council since 2001 when the stock was last assessed.

Scope of Impact – State, regional, national
Source of Funding - Hatch, State, commodity funds, NOAA competitive grants

****

Key Theme: Biobased Products and Biotechnology

Title: Systems for Biological Production of Hydrogen Gas (Ely, Biological & Ecological Engineering)

Description: We have created homozygous mutants and used our H2 production screening assay successfully to monitor H2 production by different strains under various conditions. The NDH-1 impaired mutant (M55) obtained from a lab in France has been making H2 consistently, as has another mutant we have created, which we call PSS1. We are currently evaluating these two mutants in side-by-side chemostat experiments. We are also exploring mechanisms of H2 production in the PSS1 mutant. Our work under the DOE funded project is ongoing, and we submitted to DOE and NSF six other major proposals, which are currently in review.

Impact: Global energy demand will grow to about 640 quadrillion BTU (quads) per year by 2025, up from 404 quads in 2001, with 86% from carbonaceous matter and more than 11 billion tons of CO2 produced. But with nearly two-thirds of proven oil reserves located beneath Saudi Arabia and its neighbors, the U.S. and other nations must rely increasingly on the politically volatile Middle East for oil. Also, as economies of China, India, and other populous countries grow, competition for oil will increase. Therefore, clean, safe, and sustainable energy sources are needed to meet projected demand, to provide energy and economic security for the U.S. and other nations, and to relieve environmental stresses, including global climate change, related to fossil fuel use. H2 can play a major role in meeting energy demand, mainly as an energy carrier for fuel cells, but clean and environmentally sustainable ways of producing H2 are needed. Using microbes or enzymes to produce H2 from water, using sunlight as an energy source, or from renewable carbonaceous materials, can meet societal energy needs while preserving environmental quality.

Scope of Impact – ntional, international
Source of Funding - Hatch, State, USDA competitive grants

****

Key Theme: Plant Genomics and Germplasm

Title: Multilevel Organization of the Closterovirus Machinery for Cell-To-Cell Movement (Dolja, Botany & Plant Pathology)

Description: The cell-to-cell movement of plant viruses involves translocation of virus particles or nucleoproteins to and through the plasmodesmata (PDs). As shown previously, the movement of the Beet yellows virus (BYV) requires concerted action of five viral proteins including a homolog of cellular ~70-kDa heat shock proteins (Hsp70h). Hsp70h is an integral component of the virus particles that is also found in PDs of the infected cells. The researchers investigated subcellular distribution of Hsp70h using transient expression of Hsp70h fused to three spectrally distinct fluorescent proteins. They found that fluorophore-tagged Hsp70h forms motile granules that are associated with actin microfilaments. In addition, Hsp70h accumulates at the cell

periphery, in the PD-rich areas. To address a potential role of the acto-myosin motility system in Hsp70h targeting to PDs, they isolated and sequenced cDNAs encoding six myosins of Nicotiana benthamiana, a BYV host plant. Using transient protein expression and RNA silencing, they found that class VIII, but not class XI, myosins are required for Hsp70h localization to PDs. This is the first demonstration of the specific function of these myosins in plants suggesting their involvement in plasmodesmatal function.

Filamentous virions of BYV contain long body formed by a major capsid protein and a short tail that is assembled by a minor capsid protein (CPm), Hsp70h, a 64-kDa protein (p64), and a 20-kDa protein (p20). Using mutation analysis and newly developed in planta assays, research results imply that CPm, Hsp70h and p64 act cooperatively to encapsidate a defined region of the closterovirus genome.

In addition, research continued into evolutionary processes that shaped the genomes of closteroviruses and other viruses using phylogenetic analyses of the virus-encoded proteins such as Hsp70h, CPm, etc. This work resulted in advancement of the novel concepts of viral origins and evolution in general and closteroviral evolution in particular.

Impact: This work contributes significant novel information on fundamental aspects of virus-host interactions, mechanisms of plant virus assembly and cell-to-cell movement, and virus evolution. A major applied aspect of the research is development of the virus-derived gene expression and silencing vectors that are important tools for the functional genomics of crop plants. In addition, generated data and reagents are distributed among the labs within and outside the United States, while the results of our research are reported at the numerous national and international meetings and used for educational purposes in several undergraduate and graduate courses at OSU and at the APS educational network.

Title: DNA Repair and DNA Damage-Stimulated Homologous Recombination (Hays, Environmental & Molecular Toxicology)

Description: To investigate roles of DNA mismatch-repair (MMR) systems in promotion of plant genomic stability we isolated Arabidopsis (At) genes encoding four mismatch recognition proteins. We propagated seed-t-seed multiple lines of certain protein-deficient Arabidopsis for five generations. The mutants (but not wt plants) dramatically accumulated a variety of mutations, suggesting MMR-deficient propagation to be a useful way to generate agriculturally-useful plant variants. A USDA/NRICGP grant (7/05-6/08), to study roles in mutation prevention and meiotic recombination in Arabidopsis and tomato, was awarded. Preliminary testing in Arabidopsis shows at least one construct to depress MMR in Arabidopsis. The role of MMR in suppressing somaclonal mutation in vegetative propagation (of tomato) is also under investigation. We initiated an NSF-funded project to investigate roles of the specialized DNA translesion polymerases Zeta and Eta in resistance to UV-B radiation, using Arabidopsis roots as our model system. Abrogation of either or especially both translesion polymerases has dramatic effects.

Impact: Our previous focus on prevention of mutation in the model plant Arabidopsis by its mismatch-repair (MMR) system has been expanded to include the dual roles of MMR in meiosis: (i) promotion of meiotic recombination, hence fertility, by MMR proteins that do not recognize

mismatches and (ii) recognition of mismatches in meiotic-recombination intermediates formed by inter-species hybrids, resulting in impaired meiosis and hybrid infertility. This work is a transition to MMR studies with tomato as well as Arabidopsis. The goal is to selectively prevent MMR antagonism of meiotic recombination in tomato-nightshade hybrids without abrogating the MMR role in anti-mutation. Increased fertility of hybrids and more facile introgression of nightshade traits such as pathogen resistance by backcrossing, without loss of genetic stability would aid tomato breeders.

Title: Genetic Regulation of Embryo Development in Maize (Rivin, Botany & Plant Pathology)

Description: Our current research is focused on understanding gene expression patterns that are essential for reproductive success in corn. In this work, we are investigating the interaction of signaling systems to control both embryo specific maturation genes and genes which are expressed more generally under conditions of dehydration. Also, investigations are concerned with genetic differences that influence pollen fertility. Both of these research programs are using microarrays to characterize the transcripts of maize pollen and embryos at different stages of development and in different genetic backgrounds. Important progress was made methodologically, developing methods to extract microarray-quality RNA, which was particularly difficult for the pollen experiments. There now is an initial characterization of the maize pollen transcriptome at both mature and germinating stages, and of the embryo transcriptome at pre-maturation and maturation stages. Preliminary analysis of pollen data suggest that 1) the maize pollen transcriptome has a large number of transcripts that are unique or enriched compared to the sporophytic (seedling) transcriptome; 2) that a number of pollen transcripts differ in level of accumulation in different inbred lines; and 3) that very few, if any, significant changes in transcript levels occur following pollen germination. Second, we have identified a second rop gene, rop9, that is important for pollen function and competitiveness in vivo. This complements published work indicating that a closely related gene, rop2, has a similar function. Preliminary results indicate that these two genes act similarly, and that pollen mutant for both genes is severely, or perhaps even completely, compromised in its ability to fertilize ovules and generate seed. Approximately 250 genes have been identified in the microarray experiments to be gibberellic acid regulated in pre-maturation embryos. We are looking among the different classes of genes to find candidate genes that may modulate abscisic acid signaling.

Impact: Plant reproduction depends upon the success of the gametophytes, pollen and ovule, and then the success of the embryo and endosperm to create a mature, dehydration-tolerant seed. Our studies of pollen research may have implications for agricultural production. For example, understanding maize pollen may lead to methods for limiting pollen fertility for hybrid seed production, or for controlling transgene dispersal through pollen. In addition, work on the pollen transcriptome may produce molecular markers that allow prediction of pollen fertility in various genetic lines. Our embryo work also has agricultural importance. Proper maturation is critical to seed success in nature, and it is also critical for agriculture. The events of maturation are what make grains both nutritious and storable, and failure of seeds to mature properly results in significant loss of yield and quality Dissection of the pathways in maize will be broadly applicable, since maize genes and genetic hierarchies often closely parallel those in other cereals.

Title: Seed Biology Research for Agricultural Crops (Nonagaki, Horticulture)

Description: We have grown transgenic tomato plants in our greenhouse, harvested seeds and are characterizing enzyme activity and gene expression. Collaboration with Prof. Feng, University of Tennessee, allowed evaluation of Arabidopsis, poplar and rice mannanase genome. We have overexpressed Arabidopsis gene in wildtype Columbia and also the deeply dormant ecotype Cvi (Cape Verde Islands) and are currently screening for overexpression lines.

Impact: Seed dormancy is an important trait in agriculture. Uniform seedling establishment is not obtained without uniform seed germination after breaking dormancy. Therefore, overcoming seed dormancy is important in agricultural production. On the other hand, extremely low dormancy could cause precocious germination such as vivipary in cereal grains, which is a serious problem in the fields. Understanding the mechanisms of seed dormancy and germination is critical for agriculture. This project has identified an important gene for dormancy control that could be a good molecular marker in breeding. Seed dormancy is an important trait in agriculture. Uniform seedling establishment is not obtained without uniform seed germination after breaking dormancy. Therefore, overcoming seed dormancy is important in agricultural production. On the other hand, extremely low dormancy could cause precocious germination such as vivipary in cereal grains, which is a serious problem in the fileds. Understanding the mechanisms of seed dormancy and germination is critical for agriculture. This project has identified an important gene for dormancy control that could be a good molecular marker in breeding. The new project focusing on the embryogenesis mutant will have significant impacts on agriculture, since it is directly related to seed development, the foundation of food production.

Title: Basic and Applied Studies on Genetic Diversity, Cereal Chromosome Engineering, and Gene Flow (Riera-Lizarazu, Crop & Soil Science)

Description: Wheat cultivar development is dependent on a continued supply of genetic variability. However, variability for some traits, such as resistance against the cereal yellow dwarf virus (CYDV), *Cephalosporium* (Ceph.) stripe, stripe rust, and grain protein concentration (GPC) is limited in wheat's primary gene pools and must be sought from secondary and tertiary gene pools and transferred to wheat germplasm adapted to the U.S. Pacific Northwest. These transfers are being carried out using marker-assisted backcrossing. Third generation backcross derivatives have been generated and progeny from these materials will be planted and screened to identify lines that are fixed for the pertinent factors. There have been few studies where mating patterns between wheat and jointed goatgrass have been quantified under field conditions. These studies have suffered from relatively small sample sizes and have not used robust DNA-based markers. For this reasons, we carried out a comprehensive study to determine parentage of 413 first-generation backcross (BC1) seeds obtained from 127 wheat-jointed goatgrass F1 hybrids, produced under field conditions, using a combination of chloroplast and nuclear microsatellite markers (see Gandhi et al. 2006). under field conditions, wheat was the prevalent pollen donor for the production of hybrids and first-generation backcross derivatives. However, hybrids and backcrosses with jointed goatgrass as the male parent also were observed.

Thus, the establishment and persistence of a zone of hybridization between these species would result in the development of jointed goatgrass carrying wheat genes.

Impact: Our studies on the wheat genetic diversity at Oregon State University will allow better management of wheat genetic resources and the continuous development of wheat lines with improved characteristics, thus, contributing to increased productivity and profitability of wheat in our region. Our studies on hybridization dynamics between wheat and jointed goatgrass will lead to the development of a better weed management protocols.

Title: Potato Breeding and Cultivar Development (Vales, Crop & Soil Science)

Description: The Oregon Potato Variety development program plays an important role in the Tri-State Potato Program which includes Oregon, Idaho and Washington. The Oregon program with its diverse five testing experimental stations has been conducting a comprehensive breeding program from parental evaluation, crossing, selections and evaluation to final variety releases. Five experimental lines graduated from the Tri-State program in 2006 and will be released in 2007, Oregon will be the lead institutions for two of them (AO96160-3, a long russet of dual use, and AO93487-2R, a bright red clone). In 2006, the project made more than 240 crosses with major emphasis to PVY, late blight, nematodes, Corky ring spot, Potato Tuber Moth and specialty potatoes with high nutritive value. More than 60,000 seedling tubers were produced for single-hill selection to be planted in 2007. More than 30,000 seedlings will be distributed for collaborators in Texas, Colorado and Minnesota. Advanced clones derived from single hill selections were evaluated at the Oregon Statewide Trial with 4 replicates at five locations (Corvallis, Madras, Hermiston, Klamath Falls and Ontario) and more advanced clones were evaluated in Tri-state and Western Regional sites. Cooperators in Texas, Colorado and Minnesota also compared local selections from Corvallis progeny at various levels in 2006.By using molecular markers for potato virus Y several promising clones were identified at early stages of selection. Detailed Performance data for all 2006 variety trials will be available in January, 2007, and will be posted on http://www.ars.usda.gov/main/docs.htm?docid=3019. The Corvallis station has become a major late blight screening site. More than 650 clones were planted from western breeding programs & cooperators in Wisconsin, Michigan, and Maryland. Crop Science workers produced and distributed approximately 1700 lbs of pre-nuclear minitubers and 6,000 transplants of certified disease-free new and established varieties for Oregon seed growers for commercial crop production.

Impact: The development of high yield and high quality potato varieties with resistance to biotic and abiotic stresses allows producing potatoes under more cost-effective, environmental friendly and healthier conditions by using fewer inputs of chemical fertilizers, fungicides and insecticides and at the same time increasing the nutritional value and quality of the crop. OSU has released nine varieties (Century Russet, Umatilla Russet, Russet Legend, Klamath Russet, Mazama, Winema, Wallowa Russet, Modoc and Willamette since 1995 (see http://www.css.orst.edu/potatoes/variety.htm for additional descriptions) and has joined neighboring states and the ARS in releasing another 14. Umatilla Russet (a PVP release) has thus far shown the greatest potential of all Oregon releases. Umatilla Russet ranked 7th most planted variety in the nation in 2006. Umatilla is grown in more than 20 countries in which North

American frozen processing companies operate. Varieties recently released by the Tri-state program are now produced on over 110,000 acres with value to growers placed at approximately $150 million. This value can increase up to 3 times after processing. In Oregon alone, in 2005, potatoes were planted in 37,100 acres, the total production was 22.0 mill cwt and the value was $129,915,000 (http://oregon.gov/ODA/docs/pdf/pubs/ff.pdf). The Oregon breeding program has been estimated to return $5.6 million annually to local and state economies (see also Oregon Invests -- http://oregoninvests.css.orst.edu/htmls/FMPro).

Title: Improvement of Freezing Tolerance in Horticultural Crops by Genetice Engineering (Chen, Horticulture)

Description: The potato variety Umatilla was transformed with Arabidopsis CBF genes (AtCBF1-3) to seek increased freezing tolerance. While imparting the same degree of freezing tolerance, control of AtCBF expression via the stress-inducible promoter ameliorated negative phenotypic effects - including smaller leaves, stunted plants, delayed flowering, and reduction or lack of tuber production - and restored tuber production to levels similar to wildtype plants. These results suggest that use of a stress-inducible promoter to direct CBF transgene expression can yield significant gains in freezing tolerance without negatively impacting agronomically important traits in potato.

Impact: Potato is a frost-sensitive species incapable of cold acclimation. A brief exposure to frost can significantly reduce its yields, while hard frosts can completely destroy entire crops. Thus, gains in freezing tolerance of even a few degrees would be of considerable benefit relative to frost damage. Our finding that increase 2 degree C in freezing tolerance can significantly increase potato yield in frost prone area of the world.

Scope of Impact – State, regional, and national, international
Source of Funding - Hatch, State, commodity, USDA and other federal competitive grants

****

Key Theme: Plant Health (diseases and nematodes)

Title: Transformation of Plants of Agrobacterium (Ream, Microbiology)

Description: *Agrobacterium tumefaciens* and *A. rhizogenes* are closely related plant pathogens that cause different diseases, crown gall and hairy root. Both diseases result from transfer, integration, and expression of plasmid-encoded bacterial genes located on the transferred DNA (T-DNA) in the plant genome. This project was able to express a protein in transgenic plants that binds and inactivates an essential *Agrobacterium* virulence protein that is secreted into infected plant cells. This significantly reduced susceptibility to crown gall.

Impact: Crown gall disease causes millions of dollars of damage in fruit and nut orchards, vineyards, and nurseries worldwide. Losses in Oregon are ~$400,000 in a typical year. Currently there is no effective means to prevent crown gall except for the method described in this project.

This technology has the potential to prevent crown gall disease in any crop plant amenable to introduction of transgenes. Once gall-resistant transgenic rootstocks are produced, no additional input is required. Plants that have been genetically altered to resist crown gall may prove more effective than biological control.

Title: Tempered Dragons in Hidden niches: Enhancing a Biological Control System with and Avirulent Pathogen (Johnson, Botany & Plant Pathology)

Description: Fire blight caused by *Erwinia amylovora* is the most serious bacterial disease of pear and apple in many regions of the world. In North America, antibiotics have been used for fire blight suppression, but resistance in the pathogen to these chemicals has reduced the effectiveness of antibiotic treatment. Selected strains of nonpathogenic, bacterial epiphytes provide suppression of the blossom blight phase of fire blight. The potential for *E. amylovora* to co-occur with mature, symptomless fruit of winter pears grown in the Pacific Northwest has led to phytosanitary concerns that restrict the export of Northwest-grown winter pears into countries where fire blight does not occur. Overall results indicate that E. amylovora has a very low potential to be associated (on or in) mature symptomless winter pear fruit, and that the risk of association is no different than the very low risk associated with mature symptomless apple fruit.

Impact: Our results are demonstrating that biological control of fire blight in pear and apple can be enhanced and can become a reliable and widely used management strategy provided that cost-effective formulations of the selected biocontrol agents can be developed. Our results continue to add to the base of knowledge concerned with epidemiology of bacterial diseases of plants and the efficiency of control. In addition, our risk assessment project concerned with the low likelihood of association of the fire blight pathogen with mature, symptomless pear fruit has the potential to increase exports of this commodity.

Title: Biology and Management of Septoria Diseases of Wheat (Mundt, Botany & Plant Pathology)

Description: Results from the first season of field experiments with wheat stripe rust indicate that overall population size has little influence on epidemic spread. However, size of the initial disease focus does have an important effect and it may be possible to scale epidemic spread to the size of the initial focus. In genetically heterogeneous populations, epidemics were supressed to a great degree when the grain of diversity was smaller. However, the grain of diversity and the proportion of susceptible individuals in a population may interact. Simple models describing epidemic spread in experimental plots within a season seem to also be appropriate for epidemic spread at a continental scale, and over years in some cases. Interestingly, models seem to fit for West Nile Virus and Avian Flu, both of which spread via aerial dispersal.

Impact: Our work helps to predict how epidemics may spread in time and space, and may provide clues as to the most effective ways to intervene so as to suppress disease spread.

Title: Improvement of Plant Defenses Against Botrytis Cinerea (Stoltz, Horticulture)

Description: We have completed mapping of quantitative trait loci (QTL) for resistance to Botrytis cinerea (gray mold) in an introgression line population derived from a cross between tomato (*Lycopersicon esculentum*) and the nightshade *Solanum lycopersicoides*. The QTL with the largest effect can eventually be used for fine-mapping of the most important resistance locus. Analysis of gene expression during gray mold infection indicates that it is more likely that transcriptional activation and not enzymatic activity is related to Botrytis resistance. Transgenic plants with elevated or reduced levels of defensin expression did not differ in susceptibility to *B. cinerea* from untransformed control plants. No antifungal activity could be isolated from plant extracts or bacterially expressed defensin, indicating that these types of defensins may not involved in defense. On the contrary, seed production and fruit size were reduced by overexpressing defensin. It, thus, appears that floral defensins of tomato are involved in reproductive development and not in defense.

Impact: The tomato lines we have identified as partially resistant to *B. cinerea* will be useful to seed companies and growers for development of improved germplasm. This fungus is difficult to control because it causes infections that remain dormant in the field and develop into fruit decay during post-harvest storage. Crop losses of up to 50% are not uncommon. Strategies for controlling *Botrytis* are limited by the emergence of strains that are resistant to one or several groups of fungicides. Most registered fungicides are protective in their action and will not control gray mold once the fungus is established, which limits effective control to pre-harvest applications of fungicides. Our long-term goal will remain isolation of genes that confer resistance to Botrytis. Because this fungus has a broad host range, these types of genes could be used to protect unrelated crop species against this fungus. Given the limited success of chemical fungicides, genetic improvement of tomatoes is the most economical and environmentally appropriate strategy for disease control. In addition, reduction of the amount of fungicide applications after harvest will leave fewer chemical residues on fruits, thus decreasing negative impacts on human health.

Title: Replication of Positive Strand RNA Viruses (Dreher, Microbiology)

Description: This year, we have continued studying the roles of the untranslated regions (UTRs) of the genomic RNAs of the positive strand RNA viruses Turnip yellow mosaic virus (TYMV) and the mosquito-borne flaviviruses dengue virus and West Nile virus. Concerning TYMV RNA and the role of its 5'-UTR in supporting translation, we published an important study describing the way in which the viral RNA is able to simultaneously express two proteins. This is unusual for eukaryotic mRNAs, and our studies outlined the way in which such dicistronic expression is supported. Close spacing of AUG start sites is critical, and the precise pattern of dicistronic expression is further controlled by the immediate sequence context surrounding each AUG codon. Importantly, we observed no evidence that flanking viral sequences in the mRNA were needed for dicistronic expression. Experiments further showed that dicistronic expression is regulated at the initiation level; we have coined this new expression "mechanism initiation coupling." The understanding provided by these studies suggests that this type of dicistronic expression could exist for other eukaryotic mRNAs, but that its existence has remained unrecognized because of the general belief that eukaryotic mRNAs are restricted to monocistronic expression. Accordingly, we have begun a study to look for evidence that

dicistronic expression through initiation coupling exists among mRNAs from organisms such as humans, animals or plants.

Impact: Studies on the translational expression of Turnip yellow mosaic virus (TYMV) have shown the ability of closely spaced AUG initiation codons to be recognized in a simultaneous or coupled way by ribosomes. We expect that "modality initiation coupling" to be significant in the expression of non-viral eukaryotic mRNAs. Our studies are providing novel insights into gene expression by eukaryotic ribosomes, as well as explaining expression mechanisms used by positive strand RNA viruses.

Title: Genetic Resistance to Cereal Root Diseases: Fusarium, Pratylenchus and Heterodera (Smiley, Columbia Basin Agricultural Research Center)

Description: Soil sampling was performed to determine distributions of root-lesion nematode (*Pratylenchus* spp.) populations deep into the soil profile. Results indicated that peak populations of root-lesion nematodes occurred at depths up to 2- to 3-feet in some soil profiles. It was noted that previous soil surveys for these nematodes have used sampling methods that were too shallow to have detected root-lesion nematodes in some fields, and greatly under-estimated populations in many other fields. We imported wheat genotypes having even higher levels of tolerance and resistance to these pests and are now transferring these characteristics into elite varieties adapted to the Pacific Northwest environment. An International Test Assortment of wheat, barley and oat lines was used to determine the pathotype (race) of the population of *Heterodera avenae* in eastern Oregon. This population was assigned to Pathotype Ha12 and greenhouse tests confirmed that plant types carrying the Cre1 resistance gene eliminated reproduction of this nematode. This gene is now being crossed into elite wheat varieties agronomically adapted to the Pacific Northwest. Similar lines of research were performed to document economic damage by cereal cyst nematode and a crown and root rot complex.

Impact: Wheat producers in the Pacific Northwest are converting winter wheat/summer fallow rotations into cropping systems that are more environmentally acceptable, such as direct-drill annual cropping systems. This research demonstrated that populations of root-lesion nematodes increased as cropping frequency increased, and that as much as 60 percent of the wheat acreage is now infested with root-lesion nematode populations exceeding the economic threshold level for damage. Calculations of acreage planted to each variety and the percentage yield loss from nematodes in our experiments, adjusted downward for percentages of fields having high populations, indicated that it may be possible to improve production efficiency region-wide by 10 to 20 percent for spring wheat and 5 percent for winter wheat, if all acreage could be planted to varieties with a high level of tolerance. Imported wheat genotypes having even higher levels of tolerance and resistance to these pests are now being transferred into elite varieties adapted to the Pacific Northwest environment. Results of this research in Oregon have stimulated an initiation of comparable investigations in at least six other states.

Scope of Impact – State, regional, national, and international

Source of Funding - Hatch, State, Oregon Department of Agriculture, oher federal dollars, commodity funds

****

Key Theme: Plant Production

Title: Developing Sustainable Field Cropping Systems in Semi-Arid Eastern Oregon (Machado, Columbia Basin Agricultural Research Center)

Description: Direct seeding cropping systems, to replace wheat-fallow, are under evaluation. For example, wheat following chemical fallow in a 3-yr rotation with spring barley produced the highest yields although these yields were not significantly different from yields of wheat after conventional or chemical (2-yr rotations) fallow. In rotations involving annual cropping, continuous spring barley produced the highest yields followed by winter wheat after winter pea. Continuous winter or summer wheat produced the lowest yields. The project is ongoing and will be analyzed to determine the most suitable cropping systems for eastern Oregon in 2009 after all rotations have completed full crop cycles.

Alternative Crops Research: The rotational benefits of safflower, chickpea, winter peas, and mustard (crops with most potential) to winter wheat, spring wheat, and spring barley are now being evaluated. It will take another three years for all rotations to complete full cycles before analyzing the results. Preliminary results indicate that yield of spring wheat following safflower and chickpea were lower than yield following other crops primarily because of reduced soil moisture under these cropping systems. More funding now needed to continue these experiments. Work has also been initiated on cereal legume mixtures. Rotating a legume with wheat can reduce the amount and cost of artificial N fertilizers. However, because of lack of steady markets for legumes, growers are usually reluctant to forgo a crop of wheat to grow a legume crop. To this end, experiments were conducted to determine the benefit of a legume to wheat in a mixture in 2004, 2005, and 2006 and still on-going. More agronomic work on safflower,r a potential feedstock for biodiesel, has been planned for 2007.

Organic Farming: Research is underway to develop weed control methods in organic farming systems. Many plant species have allelopathic effects on other plant species that can be used for weed control. Allelopathic potential of 48 plant species was evaluated on downy brome, a major pest of wheat. Meadowfoam seed meal, yard-long bean, blue spruce, and pine extracts completely inhibited the germination of downy brome seed and have the potential for use as natural herbicides for the control of downy brome in wheat-based cropping systems. Wheat seed germination, although inhibited by extracts from MSM and radishes, was less sensitive than downy brome to plant extracts. When mixed with the soil at rates of 0.4, 1.3, 1.7, and 2.2% of soil weight in Petrie dishes, MSM reduced downy brome counts by 60, 78, 90, and 100%, respectively. When incorporated into soil in the field at the rate of 600 g m-2, MSM reduced weed counts by 64%. Collaborative arrangements with Drs. Fred Stevens (OSU Bioorganic Chemist) and Dan Ball, (OSU Weed Scientist) have been established to move this work forward.

Impact: Information obtained from these experiments will facilitate the adoption of sustainable cropping practices and form the basis for farm programs and environmental protection policy

formulation. It is estimated that about 10-20 tons ha-1 yr-1 is lost by erosion in conventional tillage systems in the US. Soil organic matter (SOM) and nutrients are lost in the process resulting in reduced soil and crop productivity. The cost of soil erosion in terms of losses of net farm income has been estimated to be $100 million per year. In addition, fugitive dust from wind erosion on tilled summer fallow land is the primary source of particulate matter that is potentially harmful to human health. Direct seeding systems restore SOM in top soil which increase soil aggregation and reduce soil erosion. Alternative crops research has shown that legumes can add as much as 10 to 50 lbs N/a with potential savings of $5 to $25.00 per acre for the next wheat crop. Demand for biofuel feedstocks has increased the value of alternative crops. Currently there are over two-dozen growers in the Morrow, Sherman, and Wasco counties that are experimenting with winter pea, chickpea, mustard, and safflower. Development of natural weed control methods for organic farming will increase organic production. Currently, organic wheat fetches about $220 ton-1, about twice as much as conventionally grown wheat. The use of natural weed control methods will have great impact on the environment and human health.

Title: Alternative Crops for the Semi-Arid Climate and Soils of Southern Oregon (Roseberg, Klamath Basin Research and Extension Center)

Description: This project examines the agronomic requirements of promising, but poorly understood, alternative crops that may be suitable for high elevation, semi-arid climates such as the Klamath Basin. We began preliminary studies on effects of harvest timing on peppermint oil yield. We evaluated 6 cultivars of the new warm season annual forage grass, teff, in a replicated variety trial. We also screened 367 accessions of teff in an attempt to select for accessions that showed superior growth, yield, and quality characteristics. We continued long-term studies on poplar growth in Medford and Klamath Falls. We planted replicated variety trials of canola and other brassica species to evaluate the potential of spring and fall-planted oilseed crops in the Klamath Basin. Such crops had never been tested in this area before.

Impact: It is expected that development of alternative crops such as mint, teff, poplar trees, and oilseed crops will contribute to crop diversification in the Klamath Basin, which should help stabilize the economic cycle of the very few commodity crops currently grown. In addition, some of these alternative crops may allow decreased demand for scarce water supplies in the region. The preliminary canola data is allowing us to apply for grant funding from several sources to expand and improve these studies. A local farmer decided to build a biodiesel processing facility based on these encouraging local results. Teff continues to draw national interest. They sent out many reprints of the 2005 results and draft copies of the 2006 report. This nationwide interest helped a local seed company to increase their teff seed sales from about 5 tons in 2005 to over 8 tons in 2006, enough to plant over 3000 acres.

Title: Enhance Management Strategies for Bluegrass Seed Production Systems (Butler, Central Oregon Agricultural Research Center)

Description: Insect pests on Kentucky bluegrass seed fields in central Oregon are increasing. An initial survey of insect pests in Kentucky bluegrass fields was conducted in central Oregon and the Grande Ronde Valley during 2003-2005. A follow-up project was initiated in the spring

of 2005 to focus on sod webworm, the pest of most growing concern to the grass seed industry. Larval feeding is what causes damage and is of economic concern. The object was to develop a predictor for which fields will need treatment in late September and October prior to the end of the irrigation season. Pheromone traps and collection of sod samples were used to determine the correlation between adult flights and the number of larvae present in the fall. A second year of data was collected during the 2006-2007 season.

Impact: All the fieldmen responding to a written survey conducted at a Crop Consultant Luncheon during the fall of 2005 indicated that they were aware of this project and that the research results reflect or have influenced their insect control recommendations. All respondents indicated that research results and the information provided on pest biology and control measures have been helpful. This information has been shared through Crop Consultant Luncheons, the Central Oregon Agricultural Research Reports and Seed Production Research Reports, all of which were considered effective by respondents.

Title: Forage Management And Improvement In Central Oregon (Bohle, Central Oregon Agricultural Research Center)

Description: Forage crops (hay and pasture) represents the largest number of acres of all agricultural crops produced in central Oregon. Up to date information on the adaptation of varieties of different species of grasses, alfalfa, and other production and management practices aid economic decision-making. Over 180 variety trials at four locations were planted in the Fall of 2003 and will conclude in 2007. The entries will be tested for adaptation to central Oregon and stand longevity, yield, and other agronomic characteristics will be recorded. Numerous seed companies partially support through testing fees. Grazing intensively of pastures and hay fields in the fall may decrease yield the following spring. The third of four years of a fall management effect on 3-cut and 4-cut tall fescue hay field aftermath, continues, to determine if there are differences in biological yield and economics of the management, if any. More fields in central Oregon are testing deficient in potassium, and sulfur is always deficient. The seventh and final field year of the Potassium and Sulfur Rate Effect on yield, quality, nutrient uptake, and soil nutrients trial was finished (with a 3rd cutting only in 2006). Again no fertlizer was applied to determine how long the previous sulfur fertilizer applications would feed the crop. A $10,000 grant was secured to begin analyzing plant nutrient tissue/uptake and ending soil nurtient testing, analyze the data statistically, and look at economics of potassium and sulfur fertlization. The alfalfa seeding rate trial data will be published in the coming year (2007). Results from trials are extended through crop consultant and producer contacts, and publications, as well as posted to the web.

Impact: Selection of the right variety or species, and harvest management can make the difference of greater than $100 per acre annually. Producers will plant better adapted species and varieties based on the results of this trial. A new winter forage barley variety (of 'Hoody' partentage)will hopefully be released in the future, which will have at least the same yield, quality, and palatability potential, along with much improved disease resistance (resistance to scald and barley stripe rust). Producers will be able to decrease alfalfa seeding rate costs in the future if they so choose, because of the alfalfa seeding rate trial results.

Title: Developing and Managing New Potato Varieties (James, Central Oregon Agricultural Research Center)

Description: A cooperative program to develop new potato varieties for the Pacific Northwest potato industry was conducted at Central Oregon Agricultural Research Center (COARC) during 2006. Potato germplasm screening, potato variety trials and seed increases for future trials were major endeavors of the research program. Blazer Russet (A8893-1) was released during the past year which brings the total number of new releases to 22 since the programs inception. This variety is an early to mid-season, dual-purpose variety notable for its high yield of oblong-long, medium-russeted tubers. It has moderate specific gravity and resistances to sugar ends, tuber malformations and most internal and external defects. Blazer Russet shows good potential for both processing and fresh markets, with the processing industry viewing Blazer Russet as a potential replacement for Shepody. Resistance to *M. chitwoodi*, race 1, derived from *Solanum bulbocastanum* and *S. hougasii* has been successfully incorporated into the cultivated potato gene pool by C. Brown, ARS, Prosser, Washington. Seedling tubers produced during 2006 from this material will be field-planted in 2007 for agronomic screening. Progeny from crosses with potential late blight and Potato Virus Y resistance are currently being evaluated. A program to develop potato varieties with exotic skin and flesh colors was begun in 2001. Currently, 7,000 single hills, 120 second generation and 300 third generation and later selections are being evaluated for desirable agronomic and culinary qualities.

Impact: Seed of 28 TriState developed potato varieties was produced on nearly 14,000 acres in the U.S. (12.2% of the total U.S. seed acreage) during the 2006 growing season. Value to growers producing these varieties has been placed at approximately $150 million. Ranger Russet, Umatilla Russet, Alturas and Western Russet are the 3rd, 7th, 13th and 14th most widely grown potato varieties in the United States. Seed growers in the United States produced Umatilla Russet on 1,700, 1,800 and 2,802 acres in 2004, 2005 and 2006, respectively. This improved potato variety yields 21% more U.S. No. Ones than Russet Burbank under approximately the same fertilizer regime, has 10% less hollow heart/brown center than Russet Burbank and is immune to net necrosis, a tuber flesh blemish caused by leafroll virus infection. Seed of Umatilla Russet sells at a $1.00/cwt premium to Russet Burbank. These improvements have resulted in an estimated additional $8.4 million and $13.0 million in farm gate value for the 2005 and 2006 crops, respectively. Production of specialty potatoes will result in new products with positive benefits to human health and increased market share. New cultivars with resistance to nematodes, late blight and PVY resistance will result in less pesticide usage and lower production inputs. Cultivars, now in their final stages of testing, with resistance to Columbia root knot nematode could save growers fumigation costs of $200 to $600 per acre.

Title: Testing and Evaluation of Berry Crops for Commercial Production in the Pacific Northwest (Strik, Horticulture)

Description: The objectives of this USDA-ARS/OSU cooperative project (with Chad Finn, ARS geneticist) are to develop new blackberry, raspberry and strawberry cultivars for the Pacific

Northwest with traits such as improved yield, thornlessness, better winter tolerance, suitability for machine harvest, and high fruit quality. We also evaluate blueberry genotypes/cultivars and potential minor crops. Advanced selections and new cultivars are evaluated to determine optimal production systems that improve yield and maintain quality. Cooperation from university and research personnel at Washington State University and Agriculture Canada, Agassiz, British Columbia continued. Research was also done to optimize production practices for new releases, when necessary. Pinnacle and Tillamook short-day (June-bearing) strawberries were released in 2002. Five new blackberry cultivars were released in 2004-2005; Black Diamond, Black Pearl, Nightfall, Obsidian and Metolius. A selection, ORUS 1843-3, is slated for release as soon as plants are commercially ready and a name is chosen. ORUS 1142-1 red raspberry and ORUS 5-1 blueberry have been propagated for grower trials. The following blackberries are being evaluated in alternative production systems: Siskiyou, Black Diamond, and Obsidian, trailing blackberry and the new primocane-fruiting cultivars Prime-Jan and Prime-Jim (from Dr. John Clark at the Univ. of Arkansas).

Impact: More than 3,500,000 plants of Pinnacle and Tillamook strawberry have been sold since 2004. Siskiyou and Obsidian blackberry are being widely grown by large and small-scale commercial growers and being shipped nationally by large wholesale shippers based in California and Oregon. Obsidian appears to have wide adaptation and is being tested in commercial trials in Australia, the UK, and Chile. The impact of these blackberry releases to the industry is demonstrated by plant sales of over 100,000. Black Pearl, Nightfall, and Black Diamond blackberry are for the processed market with the latter cultivar already accounting for over 20% of blackberry plant sales in 2005 and 7% in 2006. Primocane-fruiting blackberries are expected to have a major impact on production and availability of fresh blackberries worldwide. The new blueberry cultivars from Michigan State University, tested here in Oregon in this program, are in very high demand by growers and will have a large impact on the late-season fresh market and command a premium price. We continue to measure impacts from our earlier released cultivars; for example, Coho red raspberry continues to be planted (170 acres in 2005-06) and can enjoy a $0.40 to $0.70/lb premium for the fresh market, an estimated impact of [200 acres planted x 6,000 lb/acre x premium] = $480,000 to $840,000 per year. Siskiyou and Obsidian had an average $.80 premium/lb and an impact of about $1.9 million.

Title: Production System Research and Physiology of Berry Crops (Strik and Yang, North Willamette Research & Extension Center)

Description: The effects of sawdust age and N application rates on carbon to N ratio of two sawdust types were evaluated. A mature blueberry field, overhead irrigated, was used to determine water usage patterns amongst cultivars; on average, 26 in. of water was used per season. Field experiments were conducted to determine the effects of nitrogen rate, cultivar, early cropping, and planting density on ericoid mycorrhizal colonization levels in blueberry. Mycorrhizal colonization levels were decreased by higher nitrogen per acres, and colonization was higher in fall than in spring and followed seasonal changes in root carbohydrate concentrations. Crop load and planting density had a lesser effect on root carbohydrate levels than did cultivar.

Impact: Aged sawdust mulch with a C/N ratio of 200 immobilizes up to 3 times more fertilizer N than fresh sawdust. Thus, a 1 acre blueberry field with aged sawdust (C/N ratio 200) mulch (3 in. deep and 2 ft wide) would immobilize about 80 lb fertilizer N per season, compared to 25 lb with fresh sawdust mulch. Estimated crop coefficients at bloom, fruit development, harvest, and post harvest in blueberry were 0.84, 1.11, 0.99, and 1.13 for Bluecrop, for example. The peak water use coincided well with the advancement of fruit maturity, suggesting irrigation scheduling should differ among early, mid, and later season highbush blueberry cultivars. The availability of root carbohydrates may be affected by fertilizer N, cultivar, and crop load, which in turn may regulate mycorrhizal colonization levels in highbush blueberries.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, Smith-Lever, Oregon Department of Agriculture, USDA competitive grants, other federal dollars, commodity funds

****

Key Theme: Weed Control

Title: Weed Control in Cropland and Non-Cropped Areas of Eastern-Oregon (Ransom, Malheur Experiment Station)

Description: Weed control trials were reported for field corn, peppermint, native forbs (wildflowers), onion, potato, sugar beet, and range grasses. Also several aspects of yellow nutsedge biology were examined. Native forb seed is needed to restore the rangelands of the Intermountain West and commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to commercial production of native forb seed is the ability to control weeds within the seed crop. Weeds compete with crop plants reducing establishment, vigor, and seed production. Two initial screening trials were initiated in 2005 at the Malheur Experiment Station, one in the greenhouse and one in the field evaluating 7 herbicides on 7 native forb species. Reliable plant stands were established for three species, *Lomatium dissectum, L. grayi, and Eriogonum umbellatum*, from the greenhouse screening trial. These plant stands showed significant differences between herbicide treatments. Prefar, Balan, and Lorox look promising for *L. grayi*. Prowl has potential for Eriogonum umbellatum. Lorox, Prefar, and Kerb look promising for *L. dissectum*. However, these preliminary results should not yet be used as a basis for field treatments due to a lack of definitive field results and lack of product registrations.

Impact: Minor crop producers lack herbicides to effectively control weeds. Research conducted at the Malheur Experiment Station has identified herbicides that can be safely and efficaciously used in different crops. This research project provided data to support the full registration of dimethenamid-p for use in onion, potato, and sugar beet. The use of dimethenamid in sugar beet alone is estimated to save producers $23 million per year. Data generated by this program has also supported the registration of sulfentrazone and flumioxazin for use in potato. The information gained about the biology of yellow nutsedge under local conditions helps growers understand the level of management that is required to deal with this pest. This information is also being used to educate producers risks associated with this pest in areas where

yellow nutsedge is just now becoming established. Based on this years research, EPTC was granted a special local need registration in Oregon that allows growers to use it to control yellow nutsedge following wheat harvest. This may allow producers to reduce the number of yellow nutsedge tubers they must manage in following crops by 50%. Understanding the factors affecting metham sodium activity may allow producers to apply metham sodium when environmental conditions are more favorable for activity against yellow nutsedge.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, Smith-Lever, Oregon Department of Agriculture, USDA competitive grants, other federal dollars, commodity funds

****

Key Theme: Animal Health

Title: Metabolic Diseases in Poultry: Is It An Inflammatory Disorder? (Cherian, Animal Science)

Description: Metabolic diseases such as pulmonary hypertension syndrome, cardiopulmonary disorders and sudden death syndrome (SDS) are the major cause of mortality in broiler chickens, and cost the U.S. poultry industry over $100 million annually. The etiology and pathogenesis of metabolic diseases are not clearly understood, but have been attributed, at least in part, to intense genetic selection for fast growth rate, resulting in cardiac damage, failure of the cardiovascular system and death. Normal broiler diets are high in saturated and omega-6 fatty acids and are low in omega-3 fatty acids. Our studies are showing a significant depletion of omega-3 (n-3) fatty acids in the tissues of birds dying due to SDS along with a reallocation of omega-6 (n-6) arachidonic acid in the heart and liver. Further, project data demonstrate that "healthy" eggs with increased omega-3 fatty acids and CLA can be generated by minor diet modifications such as adding tocopherols to the hen diet.

Impact: The alteration in saturated, mono and polyunsaturated fatty acid suggests an impairment in fatty acid metabolism affecting the synthesis and tissue deposition of long chain n-3 and n-6 fatty acids in SDS birds. Project results indicate that modulating maternal dietary n-6 and n-3 fatty acids may alter leukotriene production in chicks, which could lead to less inflammatory-related disorders and increased production performance in poultry. Our findings will generate new knowledge about the fundamental relationship between maternal diet, fatty acid and eicosanoid metabolism and metabolic diseases. This will have important practical implications for improving bird health productivity and will bring increased economic returns to US poultry industry.

Title: Degradation of Tall Fescue-Endophyte by Anaerobic Microbes (Craig, Environmental and Molecular Toxicology and College of Veterinary Medicine)

Description: Understanding the metabolism of ergot alkaloids in tall fescue will shed light on the possible causative agent in fescue toxicosis and will aid in the management of feeding

endophyte-infected straw. This year, our research on endophyte toxicosis focused on three projects: 1)development of an HPLC assay to detect lysergic acid, the ring structure moiety common to all ergot alkaloids; 2)assessment of the vasoconstrictive potential of lysergic acid; and 3)effects of feeding a endophyte-infected tall fescue seed diet to mature geldings. All matrices sampled resulted in levels above the LOD and LOQ for the assay, proving that the HPLC assay is sensitive enough for use in real world fescue toxicosis situations. Results in the second project indicate that only highly elevated concentrations of lysergic acid result in vasoconstriction; thus, in relation to the symptoms associated with vasoconstriction, lysergic acid may only play a minor role in the manifestation of fescue toxicosis. Our findings in the third project indicate that exposure time to the ergot alkaloids had a limited effect on the route of elimination or the amounts of ergovaline or lysergic acid excreted by horses. The primary alkaloid excreted was lysergic acid, and urine was the major route of elimination.

Impact: In developing methodologies to more specifically detect each alkaloid at levels applicable to real world fescue toxicosis situation, further developments in understanding the etiology of this disease will be made. These results will be used to develop more effective therapies for fescue toxicosis or could result in eliminating the disease altogether. These studies will benefit livestock producers, who currently suffer approximately $1 billion USD in livestock losses per year to this disease, as well as aid in the marketing of grass-seed straw produced in the Willamette Valley.

Title: Infectious Diseases of Importance to Wild and Cultured Fish (Kent, Microbiology)

Description: We addressed a number of fish diseases in this project. Molecular methods indicated that the Kudoa thyrsites, a myxozoan that causes soft-flesh in pen-reared salmonids and commercially important wild species, is a cosmopolitan, and that strains of the parasite are segregated by geographic location, not hosts. We also provided important evidence that *Mycobacterium marinum*, a common fish pathogen, is capable of growing at 37 C (human body temperatures) under certain circumstances. We developed an assay for evaluating stress in zebrafish, a very important laboratory animal model, that will allow us to optimize husbandry conditions for this species. Using molecular methods, we described a common mycobacteria infection in feral fishes from Hawaii. We have used a new method that we developed to assess pigmented macrophage aggregates (MAs) in spleen, kidney and liver from trout from high mountain lakes. MAs are recognized indicators of chronic exposure to toxicants. Correlations with chemistry data show that mercury is an important cause of these tissue structures

Impact: Studies on Kudoa allow for understanding of sources of the infection. Our work with *M. marinum* demonstrates that this bacterium may be a more important risk to human health than previously thought. The whole body cortisol assay that we developed for zebrafish will provide a useful tool for optimizing husbandry conditions for this important laboratory animal model. Our work with MAs in trout provides an excellent method to screen salmonids for potential exposure to toxicants.

Scope of Impact – Regional, national, international
Source of Funding - Hatch, State, USDA competitive grants

****

Key Theme: Animal Production

Title: Identification of Proteins Determining Sperm Mobility Phenotype (Froman, Animal Science)

Description: An experimental model was proposed that explains phenotypic variation in sperm mobility phenotype. This model was based upon previous work in which sperm mobility phenotype was related to the integrity, and thus, the function of sperm cell mitochondria. In addition, mitochondrial calcium cycling was proven to be the primary driver of fowl sperm motility at body temperature. This was a highly significant observation in that mitochondrial well-being and calcium content are inextricably linked. The current work entailed two inter-related observations. First, as evidenced by the effect of D-homocysteinesulfinic acid, fowl sperm have NMDA glutamate receptors. This is significant because fowl sperm are bathed in deferent duct fluid containing 50 to 100 mM glutamate prior to ejaculation. Second, formation of the mitochondrial permeability transition pore terminated sperm motility. The formation of this pore was inferred from an ability of cyclosporin A to minimize loss of motility induced by thapsigargin, an agent which promotes pore formation. Cyclosporin A, by definition, inhibits pore formation. Sperm egress from the hen's sperm storage tubules approximates an exponential decay. Sperm enter these tubules by ascending the hen's vagina. The difference between a low and high sperm mobility rooster is the proportion of mobile sperm in the ejaculate. In other words, semen from a low mobility males does contain mobile -- and fertile -- sperm. Consequently, the hen's sperm storage tubules can be filled when large numbers of such sperm are inseminated. Such sperm, however, were found to emerge from the sperm storage tubules more rapidly than counterparts from high mobility males.It was concluded that even the mobile sperm from low sperm mobility males have a latent mitochondrial defect; for sperm residence within the storage tubules appears to depend upon a sperm cell's ability to move against a current.

Impact: In summary, it was proposed that glutamate promotes calcium uptake in sperm cells prior to ejaculation. Excessive calcium uptake triggers formation of the mitochondrial permeability pore in a subpopulation of sperm. Sperm motility, and therefore sperm mobility are decreased in proportion. This happens in all males. However, the extent to which it happens varies considerably among males within a random-bred population. Therefore, variation in sperm mobility phenotype appears to be determined by mitochondrial integrity or dysfunction prior to ejaculation. The proposed model is important because it affords a theoretical approach for studying sperm mobility among males with a specific organelle in mind. As such, the work reported herein provides a context for on-going SNP analysis and proteome analysis that should identify key genes that affect phenotype.

Title: Affecting Feed Intake of Pregnant Nonlactating Holstein and Jersey Cows (Gamroth, Animal Sciences)

Description: A feeding trial was completed with 54 Holstein and Jersey cows at the Oregon State University dairy to determine a dose response to nicotinic acid supplementation. There was difference in intake or plasma metabolites by breed or by level of supplementation in this trial. Dry matter intake data from all trials conducted was summarized and reported. There was a correlation of eating time per meal with overall dry matter intake depression. This should be investigated further in other transition feeding trials.

Impact: The additional cost associated with supplementing niacin to a Jersey cow during the last three weeks of gestation is $5 per head. ($0.005 per g of niacin). A one unit increase (lb or kg) in prepartum feed intake has been shown is lead to a one unit increase in postpartum feed intake. This increase in postpartum feed intake will lead to increased milk production and/or improved energy balance during the early postpartum period.

Title: Nutritional Management Strategies to Improve Sustainability of Beef Production in the Intermountian West (Bohnert, Eastern Oregon Agricultural Research Center)

Description: This project was designed to develop nutritional management strategies that help improve the sustainability of ruminant livestock operations in the intermountain west. It has provided data that is being used to develop alternative management strategies for intermountain beef producers. Key points of this project are: 1) energy supplementation of cattle grazing native flood meadows in the spring and summer does not improve performance and is not economically viable; 2) early-weaning spring born calves will improve cow weight and condition entering the winter feeding period, thereby reducing winter feed costs while increasing calf marketing options; 3) high-alkaloid grass seed straw can be safely used as a forage source with proper management; and 4) cow/calf producers can provide supplemental crude protein once or twice a week during the winter, which decreases labor and fuel costs, with results comparable to daily supplementation. Consequently, this research project has increased the nutritional management alternatives available to beef producers in the intermountain west and throughout the United States. On a more basic note, it has provided insight into the physiological mechanisms by which ruminants use supplemental crude protein to effectively use low-quality forage. This data will initiate new research concerning crude protein utilization and digestive physiology in ruminants.

Impact: Project information has been used to develop nutritional management strategies that reduce costs associated with beef production. Examples include: 1) decreasing the costs associated with protein supplementation by up to 83% when protein is provided infrequently (i. e. once every 6 days) compared with daily supplementation, which equates to a saving of approximately $650 per month (or roughly $2 per head) when supplemental protein is provided; 2) development of safe-feeding strategies for the use of high alkaloid grass seed straw which can help reduce winter feed costs from $5 to $45 per cow compared with traditional forage sources; 3) we have developed a nutritional calendar for forage kochia, an introduced species that provides greater nutrition for livestock and wildlife than native plant species during the late fall and winter, which assists in designing winter grazing strategies; and 4) early weaning of spring-born calves on sagebrush-bunchgrass range can improve cow weight and body condition score compared with traditional weaning. Winter feed costs with early weaning are approximately $30 per cow less for early weaned cows compared with traditional weaned cows. Overall, the

potential annual savings in winter feed costs because of research from this project is in excess of $26 million (assuming 50% of the 630,000 beef cows in Oregon are early weaned, consume grass seed straw, and are supplemented protein once every 6 days).

Scope of Impact – State and regional
Source of Funding - Hatch, State, commodity, USDA competitive grants

****

Key Theme: Global Agricultural Profitability

Title: Market Structure & Productivity Growth: Implications for Trade & Foreign Investment in Agriculture (Gopinath, Agricultural & Resource Economics)

Description: International trade is a key factor to improve the profitability of farm and food enterprises. The liberalization of trade in manufactures has immensely benefited developing-country producers (e.g., China) and developed-country consumers. Nevertheless, the adjustments to trade reform in developed countries (falling wages and employment in some segments) has made trade reform difficult in agricultural and food industries, where producers are fairly well organized to lobby respective governments. Developing countries face a similar issue since over 50% of many of these economies' work force is employed in agriculture. It is important that we identify factors that make trade reform compatible with the incentives of individual producers and processors. Thus, factors encouraging global market participation of farms, and food firms need to be identified.

Our work on productivity convergence across countries showed that the leaders such as the United States have gained from other countries catching up to its productivity level. While there is some concern that U.S. market shares may fall with rising productivity in foreign countries, the faster rate of productivity growth in the United States has offset such negative effects. Research on factors behind food processing firms' global market participation suggest a significant role for productivity and entry costs. The former has been identified in aggregate studies, but the latter suggests the need for public policies that provide foreign market information to exporters of food and agricultural products. Focusing on trade barriers, the research has found that differences in noxious weed regulations inhibit interstate trade in commodity, seed and nursery products. Greater uniformity in such regulations would greatly help regional seed and nursery producers in accessing other markets within the United States.

Impact: Initial research show that firms' productivity and ability to understand foreign markets are key to such participation. This research will continue to explore policy options by assessing the impact of investments in productivity and foreign markets' information on not only competitiveness but also factors encouraging political feasibility of trade reform.

Title: University-Industry Relationships in Agricultural Biotechnology Research (Buccola and Fare, Agricultural & Resource Economics)

Description: We have specified and estimated a dynamic model of public investment in life-science research, distinguishing among the three principal life-science fields: agriculture, pharmaceuticals, and basic biology. The dynamic model was employed to account for research adjustment costs potentially incurred when public and private investment levels are changed, and to permit separate examination of the wage effect and spillover effect of public life-science research. We find that, in both agriculture and pharmaceuticals, public expenditures' positive spillover effect (that is, the private-sector knowledge gleaned from public research) dominates these expenditures' negative wage effect (that is, the higher salaries which private research firms must pay because of scientist hiring in the public sector), so that government- sponsored and -conducted research is strongly complementary with that in the private sector. Positive spillovers are especially high in agriculture. However, the supply of scientific labor in agricultural research is found to be much more inelastic than in pharmaceutical research, implying a stronger wage effect in the former than in the latter. This strong wage effect partly counterbalances the strong spillover effect, so that private R&D investment in agriculture has been less responsive to exogenous factors than it has been in pharmaceuticals. We will now turn our attention to the second-tier problem: assessing research investments' spillover and productivity effects in individual agricultural sub-fields, particularly in plants, animals, and natural resources.

Impact: Evidence of public investment's predominant role in creating incentives for industrial investment in life-science research has important implications for government science and technology policy. During the past two decades, the federal government has greatly expanded life-science research investment in response to rising public demands surrounding health and food issues. We have shown this investment strategy to be successful in creating technological opportunities for life-science firms. Simulation results indicate public investment in the life sciences will continue to be highly valuable for the private sector. R&D tax credits may have exerted similar knowledge spillover effects, and represent alternative policy instruments for stimulating industry R&D.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA competitive grants, Agricultural Research Foundation, commodity funds

NATIONAL GOAL #2: A safe and secure food and fiber system.
To ensure an adequate food and fiber supply and food safety through improved science-based detection, surveillance, prevention, and education.

OVERVIEW

Major program/research areas included under Goal 2 of the Oregon Agricultural Experiment Station Plan of Work included: **food quality and food safety**. The following describes the projects and programs conducted by station personnel in addressing these areas. More specific information related to what was done and what impacts were achieved in each area is include under the Key Theme Information sections. Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; GIS climate, geophysical and plant maps; and an array of web pages of an array of types. Our faculty report 52 refereed journal articles, 2 books or book chapters, and 13 proceedings papers.

Food Quality

Efforts to assist food growers and processors to increase their profitability through developing value-added products, enhancing quality and extending shelf-life are vital to the continued health of agriculture. For example, the use of edible coating technology for extending fresh market shelf-life and enhancing nutritional value of the products continuously attracts the interest of berry growers and processors for potential commercial applications. Several pear related business partners are working together for launching the new value-added peels-on pear products. The pomace research may provide a significant reduction in fruit pomace disposal and the development of new, high value biodegradable products for industrial applications.

The fresh-cut industry is growing and continually changing to meet new challenges. Fresh-cut fruits usually have a much larger cut surface, more surface water activity, and a shorter shelf life than fresh-cut vegetables, which have enjoyed billions of dollars in annual sales in the United States. Various approaches have been tried to reduce microbial growth, discoloration, and other deteriorative events of fresh-cut pears, cherries, apples and mangoes. A consumer survey indicates that through fresh-cut, the return to the cherry grower can reach up to 2-10 times.

This study on the practice of aging Pinot noir on the yeast lees is focused on learning the biochemical basis for how the release of yeast mannoproteins during this process leads to an increase in "texture" and "mouthfeel", key indicators of wine quality. Understanding the mechanisms underlying this increase in texture is the first step in developing a rational basis for making recommendations to help winemakers better manage this practice.

Food Safety

The impact of the research effort toward food safety will be significant as food and water borne bacterial illnesses impact every aspect of our society, costing our economy billions of dollars per year and encouraging the legal system to file law suits against every segment of food related

agricultural industries, from slaughter houses to processors to restaurants. The proactive use of probiotics or the development of better detection methods will possibly result in fewer food and water borne bacterial illnesses.

Promoting an awareness of the potential microbial hazards associated with the cultivation and processing of berry fruits will result in growers/processors implementing specific Good Agricultual Practices, Standard sanitation Operating Practices and HACCP. The development of specific interventation processing technologies will provide mechanisms to ensure not only safe products but also products of the highest nutritional value and of desirable sensory characteristics.

Total Expenditures:	$4,453,404
Hatch:	$183,726
Multistate:	$13,458
State:	$2,551,049
Other:	$1,705,171

(other includes funds from sources such as grants, foundations, etc.)

TOTAL FTE FROM ALL SOURCES:	35.77

KEY THEME INFORMATION

Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected six (6) projects from two (2) key themes to highlight in this year's report.

Key Theme: Food Quality

Title: Enhancement of Quality and Nutritional Values of Oregon Small Fruits (Zhao, Food Science & Technology)

Description: The 2006 research efforts were focused on continuous technology development for peels-on canned pear products, for extending postharvest shelf-life of hardy kiwifruits, and for developing new value-added products from berry biowastes. After the success development of a patent technology for retaining green pigments on green pears, a major technical breakthrough for retaining red pigments on the red pears during thermal process was achieved in 2006. A formula containing metallic ions, tannic acid, phenolics and a crosslinging agent was invented as a pretreatment for stabilizing red pigments, typically anthocyanins on the surface of pears. Significant information on zinc-chlorophyll-derivative complex in green pears during thermal process was developed. The study of hard kiwifruits (*Actinidia* species) emphasized understanding of postharvest physiology and extending quality and shelf-life of fresh fruit using

edible coatings (Calcium caseinate, chitosan, PrimaFresh™, and Semperfresh™). Fruit were packaged in low- or high-vent plastic containers and stored under room or refrigerated conditions. A consumer sensory consumer panel found that low-vent packaging significantly reduced weight loss. Refrigerated storage delayed ripening and extended shelf-life by 4 weeks. Coatings provided an attractive sheen to the fruit surface and did not impair ethylene-induced ripening. Consumer test indicated that both coated and uncoated fruit were well liked by consumers. The results provide important information regarding the ripening physiology of hardy kiwifruit and indicate that edible coatings may be an alternative to costly low-vent packaging for reducing moisture loss and extending storage life of fresh fruit.

A study to develop new value-added products from berry pomace was conducted. In addition of developing edible films from pomace extracts, biodegradable biocomposites using whole pomace was investigated. Blueberry, cranberry and grape pomace were converted to biodegradable plastics by thermosetting mechanisms, where pomace was mixed with modified soy flour to form plastic boards with glycerol. It was found that cranberry pomace sheet was the stiffest plastic, while grape pomace sheet was the most flexible. The break strength and modulus of elasticity of blueberry pomace based sheet increased with increased modified soy flour contents. Plasticizing increased flexibility while decreasing the mechanical properties. The water absorption decreased with increased glycerol concentration. Addition of glycerol appeared to result in a smooth fracture surface compared to non-plasticized samples in SEM images.

Impact: Efforts to assist fruit and vegetable growers and processors to increase their profitability through developing value-added products, enhancing quality and extending shelf-life are vital to the continued health of agriculture. The use of edible coating technology for extending fresh market shelf-life and enhancing nutritional value of the products continuously attracts the interest of berry growers and processors for potential commercial applications. Several pear related business partners are working together for launching the new value-added peels-on pear products. The pomace research may provide a significant reduction in fruit pomace disposal and the development of new, high value biodegradable products for industrial applications.

Title: Characterization and Improvement of Wine Yeasts (Bakalinsky, Food Science & Technology)

Description: We evaluated and modified the procedure of Vincenzi et al. (2005) for isolating and measuring wine proteins in both red and white wines and confirmed that the observed recovery of protein was at least 90% of the expected value and free of phenolics as determined by the Harbertson assay. We identified a number of wine proteins and found all of the yeast proteins to be mannoproteins. In addition, we found an enzyme known as Endo H to have the ability to remove the mannan moiety from yeast invertase. We also evaluated the native yeast invertase in the Harbertson assay to learn how the Harbertson protein precipitation assay for tannin can be modified to detect tannin-mannoprotein interactions.

Impact: The key to the continued economic health of the Oregon wine industry is the high quality of its wines, as the relatively small scale of production in the state will never make the wines competitive on a volume basis. Developing and refining grape growing and winemaking

practices that enhance wine quality have the greatest possibility of being economically beneficial. This study on the practice of aging Pinot noir on the yeast lees is focused on learning the biochemical basis for how the release of yeast mannoproteins during this process leads to an increase in "texture" and "mouthfeel", key indicators of wine quality. Understanding the mechanisms underlying this increase in texture is the first step in developing a rational basis for making recommendations to help winemakers better manage this practice. Such recommendations are meant to help answer the following questions: How long should the wine be aged on the lees? What ratio of lees to wine is optimal? Can lees be stored from one year to the next? Are commercial wine additives that mimic lees reasonable replacements?

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA grants, Oregon Economic Development Department, Oregon Department of Agriculture, Agricultural Research Foundation, commodity funds

****

Key Theme: Food Safety

Title: Characterization of the Cadmium Health Risk, Concentrations and Ways to minimize Cadmium Residues in Shellfish (Morrissey, Coastal Oregon Marine Experiment Station)

Description: This study examined the effects of age and tissue weight on Cd concentration in US West Coast Pacific oysters cultured in Willapa Bay, WA. Pacific oysters from 4 age groups (1-4 yrs) and corresponding sediments were collected from an oyster farm in Willapa Bay, Washington. Although all oysters were bottom-cultured at the same farm, each age group was maintained in a distinct growing area. Sample collection was carried out at low tide according to a pre-established sampling protocol. Samples were maintained in ice-filled coolers and were delivered the same day to AM Test Laboratories (Redmond, WA) for Cd analysis. All oyster Cd concentrations were below both the 3.7 ppm level of concern set by the Food and Drug Administration (FDA) and the 2 ppm Hong Kong limit. There was a moderate correlation between age and Cd concentration, indicating some influence of age on Cd concentration in West Coast Pacific oysters, especially during the first few years of life. Both the 3- and 4-yr olds were significantly heavier than the 1- and 2-year olds, which may be due to differences in sexual maturation and gonad development among the age groups.

Impact: Project results indicate that oysters accumulate Cd as they grow during the first two years of their lives, after which point the Cd levels may reach a saturation point during the 3rd and 4th years of life. This may have commercial impacts on certain growing areas depending on what the regulations are for Cd concentration in oysters.

Title: Lactic Acid Bacterial Biopolymers and Potential Probiotic Characteristics (Trempy, Microbiology)

Description: This project seeks to characterize and evaluate the probiotic potential of exopolysaccharide (i.e. biopolymer) producing Lactic Acid Bacterial (LAB) strains. Data generated indicates that a novel genetic mechanism controls the synthesis and characteristics of lactococcal exopolysaccharides, thus impacting the probiotic potential of LAB strains. A novel cell-based biosensor can be used to functionally explore the probiotic potential of LAB, as well as its use in food safety applications. Certain exopolysaccharide producing LAB strains can protect the cell-based biosensor from specific food and water borne bacterial pathogens; this protection arises from an antibacterial-like product produced by certain exopolysaccharide-producing LAB, thus supporting the probiotic potential of this technology. Furthermore, new data demonstrates that this novel cell based biosensor has applications for the detection of bacterial pathogens and chemical toxicants found in areas of Oregon that support fish rearing

Impact: The impact of this research effort will be significant as food and water borne bacterial illnesses impact every aspect of our society, costing our economy billions of dollars per year and encouraging the legal system to file law suits against every segment of food related agricultural industries, from slaughter houses to processors to restaurants. The proactive use of probiotics or the development of better detection methods, such as the described novel cell based biosensor, will possibly result in fewer food and water borne bacterial illnesses. New data demonstrated that the described novel cell based biosensor has applications for assessing levels of pathogenic bacterial contamination and chemical toxicity in fish rearing environments.
In addition, several patent applications related to the properties and genetics of the novel lactococcal exopolysaccharide and the functionality of the novel cell based biosensor were submitted.

Title: Ensuring the Safety of Fresh and Processed Berry Fruits (Daeschel, Food Science

Description: Whole strawberries were washed in acidic electrolyzed oxidizing water (EO water) prepared from different salt concentrations for up to 15 min. More than 2 log reduction was obtained with 10-min and 15-min treatments with EO water prepared from 0.10% (wt/vol) NaCl solution. Efficacy of EO water and sodium hypochlorite (NaOCl) solution was evaluated in eliminating *Listeria monocytogenes* and *Escherichia coli* O157:H7 on strawberries. After dip-inoculation, strawberries were treated with sanitizing agents with a fruit to tested solution ratio of 1:3 for 1,5, or 10 min, and then followed by neutralization or not. Bactericidal activity of disinfecting agents against L. monocytogenes and E. coli O157:H7 was not affected by neutralization after treatment, and their effectiveness against both pathogens in whole fruit tissues did not significantly increase with increasing exposure time. Washing with distilled water provided a limited effect in removing tested microorganisms, while EO water had an equivalent disinfection effect to that of NaOCl solution. Strawberries had been inoculated with L. monocytogenes or E. coli O157:H7 before immersed in distilled water, NaOCl solution or EO water for 5 min. Treated fruits were stored at 4C for up to 15 days after treatment. Unlike yeast and mold count, populations of L. monocytogenes and E. coli O157:H7 decreased over long-term storage regardless of prior treatment. However, EO water and aqueous NaOCl did not have

a significantly greater antimicrobial potential than the water treatment (control) after extended storage at 4C.

Impact: Promoting an awareness of the potential microbial hazards associated with the cultivation and processing of berry fruits will result in growers/processors implementing specific Good Agricultual Practices, Standard sanitation Operating Practices and HACCP. The development of specific interventation processing technologies will provide mechanisms to ensure not only safe products but also products of the highest nutritional value and of desirable sensory characteristics.

Title: Food Safety and Environmental Stewardship Program (Anderson, Environmental & Molecular Toxicology)

Description: Globalization has shifted the world market for fresh fruit making availability year round commonplace. Concerns surrounding disparate agricultural practices, such as a lack of food safety standards and protection of the market share, have led commerce officials to prioritize the dissemination of methods to determine the geographic origin of commodities. Food traceability studies are important for three primary reasons: to improve supply management, to facilitate traceability for food safety and quality, and to differentiate and market foods with subtle quality attributes. Knowledge of geographic growing region is also important to consumers. An example of one of our projects is the development of chemical profiling techniques to determine geographic origin of food commodities. False food labeling has major economic impacts globally, and may pose a threat to human health. This research examines geographic origin using trace metal profile analysis. Elemental analysis of strawberry, blueberry, and pear samples was performed using an inductively coupled plasma atomic emission spectrometer (ICPAES). Samples were analyzed from growing regions in Oregon, Mexico, Chile, and Argentina. The data were classified as Oregon and non-Oregon with statistical recognition pattern analysis currently in progress. The method of elemental analysis may be widely applied to the determination of the geographical origin of unprocessed, fresh commodities using the trace metal profile, fingerprinting technique.

Impact: In February 2001, the Consumer Right-to-Know Act (S. 280) was passed, requiring country of origin labels on perishable agricultural commodities. This act came about largely from public concern about potentially harmful substances in consumables, and polls show that a majority of consumers prefer country of origin labels. On January 27, 2004, President Bush signed Public Law 108-199 which delays until September 30, 2006, the implementation of mandatory country of origin labeling for all covered commodities except wild and farm-raised fish and shellfish. The development of chemical profiling techniques to determine geographic origin of food commodities will provide data for implementation of this policy.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA and other federal funds

****

NATIONAL GOAL #3: A healthy, well-nourished population.
To ensure an adequate food and fiber supply and food safety through improved science-based detection, surveillance, prevention, and education.

OVERVIEW

Major program/research areas included under Goal 3 of the Oregon Agricultural Experiment Station Plan of Work included: **nutrition and safety**. The following describes the projects and programs conducted by station personnel in addressing these areas. More specific information related to what was done and what impacts were achieved in each area is include under the Key Theme Information section. Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; GIS climate, geophysical and plant maps; and an array of web pages of an array of types. Our faculty reported publishing 26 refereed journal articles and 1 proceedings paper.

Human Nutrition

Our data suggest an important function of zinc could be to protect the cell from DNA damage and oxidative stress. Inadequate zinc consumption may lead to enhanced oxidative stress through several mechanisms including altered antioxidant defenses and risk for developing several diseases such as cancer.

Gala apple consumer price models results provide validation for non-destructive instrumental measures establish price points for apples of different firmness and sweetness qualities. This is important for the apple industry since it provides for a practical measure on each apple going to market.

Human Safety

Our researchers broadly study the involvement of microorganisms in the health of the world and its plant, animal and human inhabitants. Bacteria, viruses and microscopic parasites are abundant and in many cases interact with humans or with our activities to result in negative impacts. Many of these impacts are felt in the agricultural sector, through diseases of farm animals or harvested wild animals (including fish) and of people. Not all microbes are pathogens, however, and bacteria, especially, contribute enormously to the health and balance of the soils and oceans that support farm and fisheries productivity, as well as the overall health of the Earth.

As an example, the smallpox virus and/or genetically-engineered orthopoxviruses are considered one of the most significant Category A pathogenic threats for malevolent use as potential agents

of bioterrorism. We have shown that the G1L protease, an unusual viral metalloproteinase, is essential for viral replication, conserved in poxviruses, and lack mammalian homologs. Therefore, this enzyme provides an appropriate and attractive target for antiviral drug development. Our ongoing efforts in this research will help to develop anti-poxvirus drugs which will benefit society in the case of a poxvirus outbreak (either intentionally or from nature), and agriculturally in the case of African Swine Fever Virus which is shown to have high homology to the vaccinia virus proteases.

Cancer is the second leading cause of death in the U.S., with about 550,000 deaths annually and over 107 billion dollars in health care costs. Up to 35% of all cancers are diet-related and approximately 33% of lung cancers, 75% of colorectal cancers, 50% of breast cancers and 20% of prostate cancers. Zinc deficiency does provide an environment for increased DNA damage, inability to respond stress and risk for cancer. Our data suggest an important function of zinc could be to protect the cell from DNA damage and oxidative stress. Our data also suggest that zinc plays an essential role in the prostate and that zinc deficiency results in loss of DNA integrity which may lead to increased risk for prostate cancer.

TOTAL EXPENDITURES: $3,282,9078

Hatch:	$76,036
Multistate:	$38,546
State:	$1,101,679
Other:	$2,066,647

(other includes funds from sources such as grants, foundations, etc.)

TOTAL FTE FROM ALL SOURCES: 30.48

KEY THEME INFORMATION

Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected 7 projects from 3 key themes to highlight in this year's report.

Key Theme: Health Choices

Title: Relating Consumer Lifestyles to Food Choice (Marin, Food Innovation Center)

Description: Analysis of data collected in 2004 relating instrumental quality measures to consumer preference and price data for Gala apples continued. Significant models were obtained showing variables such as apple firmness and soluble solid content have positive, statistically significant effects on willingness to pay and can be measured reasonably well using non-destructive instrumental measures. While the fruit texture analyzer, a destructive firmness

instrument, was the best indicator, it is impractical to use on a packinghouse floor because of its destructive nature. The non-destructive firmness measures were acceptable substitutes for destructive measures in models relating apple quality to price consumers' were willing to pay. The results obtained suggest that there may be additional opportunities for increased premiums if apple quality standards were made more stringent. Analysis and statistical modeling was continued on consumer liking, quality, purchase intent and price expectation ratings for two wines, a Chardonnay and a Merlot, commercially bottled with three different closures, a natural cork, a synthetic cork and a screw cap closure. Results of analysis showed that consumers purchase intent for the wines was determined by how much they liked the wine from tasting it, not its perceived quality. Type of closure had little impact on purchase intent. Alternatively, price expectation was not determined by how much consumers like the wine, but by their perception of the quality. Closure type had a significant impact on quality perception with screw cap closures for both wines considered as significantly lower in quality. Consequently, consumers expected to pay less for wine bottled with a screw cap closure. Four consumer sensory tests were conducted to continue measuring consumer acceptance for new cherry varieties and for stemless cherries that are mechanically harvested. These consumer tests were also designed to compare acceptance for cherries just post-harvest versus cherries stored in commercial refrigeration for 2 to 3 weeks. Preliminary results indicate consumers like the appearance and taste of a new cherry variety, PC 8007-2, as well or better than the conventional sweet cherry, Bing, when they are evaluated just after harvest. However, when evaluated 3 weeks after storage, Bing was preferred to the new variety for appearance, but the new variety was still preferred for taste. Also, more consumers said they would buy the new variety than Bing. In a separate test, consumers indicated they preferred stemless Bing cherries to those with stems.

Impact: Gala apple consumer price models results provide validation for non-destructive instrumental measures establish price points for apples of different firmness and sweetness qualities. This is important for the apple industry since it provides for a practical measure on each apple going to market. Models also provide means for establishing quality standards to more accurately define an elite apple. Implications for the apple industry are opportunities to market an elite apple if production costs can be kept under control. As a direct result of the research showing consumers could not distinguish wines bottled with different closures, Hogue vineyards of Prosser, Washington, has moved ahead to bottle several of their main wine product lines with screw cap closures. The winery reports they have not seen diminished sales to date resulting from this change, but have significantly reduced consumer complaints and wine returns from wine cork spoilage. Consumer acceptance for new cherry varieties has impact on the varieties growers choose to produce. Some new varieties offer the grower advantages such as resistance to splitting, different or extended season, and possible extended storage so greater export potential. Also, consumer acceptance for stemless cherries is a major factor for converting from hand harvested to mechanical harvesting cherries without stems. Mechanical harvesting has potential impact for changing crop volume that can be harvested without the constraint of available labor. This can also impact final fresh cherry price.

Scope of Impact – State, regional, national, and international

Source of Funding - Hatch, State

****

Key Theme: Human Nutrition

Title: Role of Zinc in Oxidative Stress and DNA Integrity (Ho, College of Health and Human Sciences)

Description: About 10% of the U.S. population consumes less than half the recommended dietary allowance for zinc and are at risk for zinc deficiency. Zinc is a component of over 300 enzymes and has proposed antioxidant function. Consequently, inadequate zinc consumption may lead to enhanced oxidative stress through several mechanisms including altered antioxidant defenses and risk for developing several diseases such as cancer. The normal prostate accumulates high levels of zinc which is markedly decreased with cancer development. This unique relationship between zinc and prostate has sparked interest into the role of zinc in the prostate. Since zinc is an essential component of many proteins involved in the DNA damage response, we hypothesize that zinc deficiency will result in loss of zinc from these proteins resulting in the impairment of mechanisms involved in maintaining DNA integrity.
Normal prostate epithelial cells, PrEC, were grown in either zinc deficient (ZnDF) or zinc adequate (ZnAD) media for 7 days. Zinc deficiency caused an increase in single-strand DNA breaks. Using the Affymetrix HG-U133A gene chip, differential expression of genes involved in cell cycle, apoptosis, transcription and DNA damage response and repair were identified. Among genes involved in DNA damage response and repair, TP73, MRE11A, XRCC4 and BRCA2 were down-regulated and p53 was up-regulated with zinc deficiency. Western blotting showed increased nuclear p53 expression in ZnDF compared to ZnAD cells. Zinc deficiency also increased binding activity of transcription factors involved regulating cell proliferation and apoptosis. However, despite increased p53 gene and nuclear protein expression, no significant change in p53 binding activity was observed. Additional in vivo studies in zinc deficient mice also resulted in altered expression of genes involved in transcription, cell cycle regulation and apoptosis; many of which were zinc ion binding. Thus, zinc deficiency may compromise DNA integrity in the prostate by impairing the function of zinc-containing proteins such as p53. Together, these data suggest that zinc plays an essential role in the prostate and that zinc deficiency results in loss of DNA integrity which may lead to increased risk for prostate cancer.

Impact: Our data suggest an important function of zinc could be to protect the cell from DNA damage and oxidative stress. Zinc deficiency does provide an environment for increased DNA damage, inability to respond stress and risk for cancer. Over 70% of Americans are not getting the recommended level of zinc. This research addresses the importance of getting adequate zinc from zinc-rich foods to improve health. Secondly, a reliable test for zinc deficiency in humans does not currently exist. The molecular approaches used in this project may reveal uniqiue gene expression changes with zinc deficiency and provide a more reliable marker for zinc deficiency in humans. This research addresses the importance of getting adequate zinc from zinc-rich foods to improve health. Thus, this research will aid in improving the health of Oregonians and the U.S. population as a whole.

Title: Research in the Development of Value-added Seafood Products (Morrissey, Coastal Oregon Marine Experiment Station)

Description: Growing public awareness of the clinical benefits of n-3 polyunsaturated fatty acids (n-3 PUFAs) have researchers studying various techniques for concentrating these compounds, especially eicosapentaenoic acid (EPA: 20:5n3) and docosahexaenoic acid. One of the more promising is the use of lipase-catalyzed enzymatic hydrolysis reaction which is generally faster compared to other concentration methods such as esterification and interesterification.. Also, these reactions can be carried out under mild conditions of pH and temperature, and no organic solvent is required. The majority of studies on production of LC-PUFA concentrate from fish oil by lipase-catalyzed hydrolysis utilize commercially available free lipases derived from microorganisms such as species of Candida, Aspergillus, and Mucor, and others. However, use of enzymes in chemical and biochemical reactions, as well as their disposal following each application can be costly. Also, the recovery and reuse of enzymes from the reaction medium can be difficult. For these reasons, enzyme immobilization has attracted a wide range of interest from fundamental academic research to industrial applications. Immobilized enzymes have several known advantages over free enzymes: 1) the enzyme can be reused, 2) the process can be readily controlled, 3) enzyme properties (activity and thermostability) can be favorably altered, 4) the process is more cost effective, and 5) immobilized enzyme has more adaptability to a variety of engineering designs. Over the past year we have carried out tests to entrap lipase in chitosan-alginate-CaCl2 beads for the purpose of concentrating n-3 PUFAs from sardine oil. Lipase from *Candida rugosa* (CR) was used because a prior study showed high efficiency in concentrating n-3 PUFAs using the free form of the lipase. Use of immobilized lipase system to increase n-3 PUFA concentration from sardine oil provides new processing opportunities for the fats and oils industry and a hopeful, more efficient alternative to existing enzymatic methods.

Impact: The sardine fishery off the Oregon coast presents a solid opportunity to develop an oil extraction operation that is sustainable and economically viable. These project results show a science-based process to extract and concentrate omega-s fatty acids from sardines harvested in Pacific Northwest waters.

Title: Chemoprotection From Transplacental Carcinogens By Phytochemicals In The Diet (Williams, Environmental & Molecular Toxicology)

Description: Cancer is the second leading cause of death in the U.S., with about 550,000 deaths annually and over 107 billion dollars in health care costs. Up to 35% of all cancers are diet-related and approximately 33% of lung cancers, 75% of colorectal cancers, 50% of breast cancers and 20% of prostate cancers (the four major killers in the U.S.) are preventable by diet. Diets high in phytochemicals from fruits and vegetables have the potential to reduce the occurrence of these cancers. Many people, however, do not consume enough fruits and vegetables to provide a protective effect against cancer, and an increasing number of supplements containing phytochemicals are currently being marketed as alternative sources of phytochemicals, including for pregnant women. There is little information on the risks and

benefits of these supplements to the fetus when taken by pregnant women, however. Our project uses a mouse transplacental model to investigate mechanisms of action of three promising chemoprotective agents: indole-3-carbinol (I3C) from cruciferous vegetables, polyphenols found in teas, and chlorophylls from green and leafy vegetables. We are also studying whether these phytochemicals, when administered to pregnant mice, will provide transplacental chemoprotection against cancer induced by environmental carcinogens known as polycyclic aromatic hydrocarbons (tobacco smoke, diesel exhaust, etc.).

We have demonstrated that green tea, given to the pregnant mouse during gestation and nursing, provided significant protection for her offspring with respect to lymphomas and lung cancers due to exposure of the mother to the polycyclic aromatic hydrocarbon (PAH), dibenzo[a,l]pyrene (DBP), formed from the combustion of many fuels including coal, diesel and gasoline and also from cigarettes. The protective effect appears to be due in large part to the caffeine found in green tea. Decaffeinated green tea and epigallocatechingallage (EGCG, a major active component of green tea) were without effect, whereas, caffeine alone provided the greatest protection. In our most recent experiment, pregnant mice were fed chlorophyllin (CHL, used for many years in geriatric patients to control body odor), the water soluble derivative of chlorophyll. In addition, we tested purified chlorophyll in the diet or freeze-dried spinach. For comparison, one group of pregnant mice was given chlorophyllin, not in the diet, but in an oral dose along with DBP. This was done to test the hypothesis that a major mechanism of action of CHL was binding to the carcinogen, reducing its uptake from the GI tract. We found this method to be extremely effective in protecting the fetus from DBP-dependent lymphoma.

Impact: Results from these studies are designed to prevent adverse health effects to children from in utero exposure to toxic chemicals. This past year, we have documented that caffeine and chlorophyllin when given in the drinking water, and with the carcinogen orally, respectively, provided marked protection of the fetus against cancers caused by maternal exposure to environmental chemical carcinogens (in mouse models).

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, National Institutes of Health, Linus Pauling Institute, USDA

****

Key Theme: Human Safety

Title: Orthopoxvirus Metalloproteinase Inhibitors (Hruby, Microbiology)

Description: Smallpox virus and/or genetically-engineered orthopoxviruses are considered one of the most significant Category A pathogenic threats for malevolent use as potential agents of bioterrorism. The 40 years subsequent to when prophylactic immunization was discontinued have produced a population that is immunologically naive and highly susceptible to orthopoxvirus infection. Due to the small but significant risk of serious complications from vaccination, mass immunization of the populace is presently contra-indicated. Therefore, the focus of our current research efforts is to develop effective anti-poxvirus drug(s) for use in treating or preventing human disease caused by pathogenic poxviruses, a goal that has been

designated as a high priority biodefense project. It has recently been established that poxviruses express two proteinases that are both required for the maturation of infectious progeny virions: I7L, a cysteine proteinase which is the vCPP (viral core protein proteinase) that cleaves the major structural proteins of the virus at an AGX motif; and G1L. The essentiality of both gene products has been demonstrated using conditional-lethal mutants, in which a phenotypic analysis would seem to indicate that the enzymes function in sequence. We have been able to express the G1L protein, an unusual viral metalloproteinase whose substrates are not yet known, from both E. coli and baculovirus expression systems. A conditional lethal mutant produced by our laboratory shows that G1L is required for viral replication. Pulse-labeling studies of the G1L conditional-lethal mutant show that all the major viral proteins are expressed by the mutant in the presence of tetracycline. Also, the major core proteins P25K and P4b are processed in the mutant just as they are in the wild-type virus. Importantly, this indicates that G1L interacts at a different and distinct point in the VV replication cycle than does I7L. G1L also appears to have autocatalytic properties. When G1L is expressed transiently in vaccinia virus infected cells with a FLAG tag at the C-terminal end, we see the full length 66 kDa protein and a truncated 21 kDa protein. It remains to be determined if this cleavage event is essential to G1L activity and whether both the full-length and N-terminal fragment are catalytically active.

Impact: We have shown that the G1L protease is essential for viral replication, conserved in poxviruses, and lack mammalian homologs. Therefore, this enzyme provides an appropriate and attractive target for antiviral drug development. Our ongoing efforts in this research will help to develop anti-poxvirus drugs which will benefit society in the case of a poxvirus outbreak (either intentionally or from nature), and agriculturally in the case of African Swine Fever Virus which is shown to have high homology to the vaccinia virus proteases.

Title: Modifers of Carcinogenesis: Environmental PAH Mixtures (Baird, Environmental & Molecular Toxicology)

Description: This project is designed to attempt to develop a short-term marker for assessing the environmental risk that exposure to polycyclic aromatic hydrocarbon (PAH)-containing environmental mixtures. We are studying three important complex mixtures such as coal tar, diesel exhaust or urban dust and the danger they pose to humans by measuring their ability to induce DNA damage and tumor formation in mouse skin and human cells in tissue culture. We have investigated how environmentally important PAH-containing mixtures including urban dust alter the ability of carcinogenic PAH to cause cancer in animals and found that it actually reduces the ability of such cancer-causing chemicals as PAH to induce cancer. We focused on how this occurs. In humans, PAH are chemically inert and harmless molecules until our body uses enzymes to attempt to detoxify them into a form that can be excreted from the body. Unfortunately one of the intermediates in this process is a reactive molecule that can bind to DNA and cause a change in the DNA sequence that leads to cancer. Our studies demonstrated that the reason urban dust reduces the cancer causing activity of PAH is that it inhibits the enzymes in the body that form this reactive-DNA damaging intermediate. We were able to predict this result based upon our short-term marker: the amount of PAH that binds to DNA. Therefore, this appears to be a valuable predictor for human risk from exposure to these

environmental mixtures. We also showed that diesel exhaust particles increase the frequency of the loss of parts of the DNA after transplacental exposure to mice.

Impact: Cancer in humans causes a huge social and economical toll. Therefore, finding the causes for cancer and establishing methods to evaluate the risk environmental mixtures pose to humans could provide tremendous benefit to the citizens of Oregon and the rest of the United States. During the past year we have found that a DNA damage assay in the blood cells of mice and an assay of oxidative damage to DNA induced by PAH in human cells in culture appears to be an excellent predictor of the cancer induction risk of the mixture, such as urban dust, and helps to link the mouse studies to human response to these chemicals.

Title: National Pesticide Medical Monitoring Program (Sudakin, Environmental & Molecular Toxicology)

Description: The NPMMP provides objective, science-based information on pesticides. It receives approximately 200-300 inquiries from throughout the United States per year. Inquiries are received from the general public, health care providers, federal and state public health and regulatory agencies (including state departments of agriculture). Approximately 15-20% of inquiries received by the NPMMP are in relation to the agricultural use of pesticides. These include informational and exposure-related inquiries, for which the PI provides technical consultation and support in relation to the clinical toxicology of pesticides. As an example of relevant agriculturally-related inquiries, the NPMMP provided assistance in the investigation of an accidental fatality that occurred in association with aluminum phosphide from grain fumigation activities. The NPMMP also serves on the advisory committee of two other federally funded cooperative agreements that aim to improve the education of health care providers in environmental health, particularly in relation to agricultural workers and risks from pesticide exposure. In the past year, the Principal Investigator of the NPMMP provided several peer-selected presentations at national and international meetings, which described the Program's activities. The audience at these meetings included public health and regulatory officials, as well as physicians and toxicologists. These presentations included reviews of epidemiological and toxicological research on human exposure to pesticides, and the use of reliable internet resources that focus on the clinical toxicology of pesticides. The PI published two articles in the peer-reviewed literature. The first article describes changing trends in epidemiological statistics on pesticide exposure incidents involving organophosphates, in association with their phase-out from residential uses. The second article summarizes advances and limitations in the assessment of human exposure to pyrethroid insecticides, a classification of pesticides that are of agricultural importance in the United States and throughout the world. The NPMMP continues to expand the hardcopy and electronic library of technical and scientific information on the toxicology of pesticides. At the current time, over 2,700 articles have been scanned and are readily accessible to the investigators and inquirers to the NPMMP. The NPMMP delivers information through a website, and in the past year the website received over 9,000 visitors. Over 1,114 copies of the 2005 Annual Report of the NPMMP have been accessed from the website.

Impact: Public health and regulatory officials benefit from the work conducted by the NPMMP, through an improved understanding of the epidemiology of human exposure to pesticides

throughout the United States. The NPMMP provides relevant case reports of human exposure to pesticides of agricultural importance. This information provides risk assessors and health care providers with useful information to help reduce the risk of adverse impacts of pesticides on human health. The general public benefits from having access to a physician with knowledge and training in the clinical toxicology of pesticides.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA, other federal funds, contracts and grants, private funds

****

NATIONAL GOAL #4: Greater harmony between agriculture and the environment.

Enhance the quality of the environment through better understanding of and building on agriculture's and forestry's complex links with soil, water, air, and biotic resources.

Overview

Major program/research areas included under Goal 4 of the Oregon Agricultural Experiment Station Plan of Work included: **natural resource management, integrated pest management, soil and water quality, and nutrient management**. The following describes the projects and programs conducted by station personnel in addressing these areas. More specific information related to what was done and what impacts were achieved in each area is include under the Key Theme Information section. Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; GIS climate, geophysical and plant maps; and an array of web pages of an array of types. Our faculty reported that they published 120 refereed journal articles, 8 books or book chapters, 18 proceedings papers, and 10 abstracts.

Natural Resource Management

OAES faculty work to develop and promote policies, programs, technologies, and practices that ensure ecosystem integrity and biodiversity which support sustainable agriculture. Efforts include better monitoring of natural habitats and wildlife adjacent to agricultural operations, developing strategies for dealing with invasive species, soil erosion, and managing soil, plant, water, nutrient relationships.

Deterioration in the quality of streams and riparian areas in areas of agricultural operations is an important factor, among many, contributing to the decline of salmonid populations in the Northwest. In response, riparian restoration projects are often implemented to improve water quality and fish habitat. Between 1995 and 2000, $100 million dollars were spent on restoration projects in Oregon alone. Our research focuses on investigating important gaps in our knowledge about the impact of these projects, such as how riparian condition affects invertebrates that are an important food source for juvenile salmonids or how effective these projects are at restoring stream health.

Working with scientists from several states, we have designed ranch-level multi-period linear Putting land into the CSP is of obvious environmental benefit to Oregon. Being eligible for USDA's Conservation Security Program can be of considerable economic benefit to agricultural producers. In Fiscal Year 2006, CRP paid out $1.6 million to Oregon landowners, $562,453 of which was for soil conservation.

Eevaluating the physical and economic impacts of various grazing management practices can improve the profitability of a typical ranch, dependent upon the rancher instituting both cattle management and herd size changes.

Juniper encroachment has resulted in the loss of important wildlife habitat, livestock forage, soils, and soil water storage. As a result of Western juniper encroachment, land management agencies and private landowners are treating 10s of thousands of acres of juniper annually. Both land management agencies and private landowners have readily incorporated our methods into their management plans. Using this work has also resulted in a substantial decrease in litigation between environmental groups and agencies.

A conservative estimate of the economic impact of the twelve worst noxious weeds in the state is $67 million annually. Research is helping to reduce harm from invasive plant species through the use of biological control. Ragwort Senecio jacobaea, a weed of roadsides, pastures, and grasslands has been successfully controlled by biological methods. Assuming that at least half of the benefits calculated for controlling ragwort at its peak can be attributed to this research, then annual benefits to Oregon growers and livestock producers amount to $3 million/year.

Integrated Pest Management

Our faculty help growers to adopt safer, environmentally friendly and more selective pest control tactics by replacing traditional broad-spectrum chemical controls with selective options including selective insecticides, mating disruption techniques and biological controls. These changes reduce pesticide drift to non-target sites, improve water quality and reduce farm worker exposure to neurotoxic pesticides, especially organophosphate insecticides. The economic benefits to northern Oregon tree fruit growers are estimated to represent one-tenth of the total $70 million annual average sales value of apples, pears and cherries.

In 2006 we have shown that 1) tolerant cultivars, 2) a rotation of 4 or more years, and 3) high biomass oat cover crops are effective management strategies for corn root rot. Changing rotational practices and/or adopting specific cover crops and realizing the impact of that change could take a farmer 5 or more years, so the impact of our rotation findings will not be known immediately. Sweet corn (33,200 A; $28.2 million per annum) is the keystone crop of the processed vegetable industry. This project has contributed significantly to the understanding and management of root rot, a problem which nearly destroyed this industry.

Growers now have a second option for management of the exotic crane fly pests, and one that is not toxic to the environment.

Soil And Water Quality

Water, food, clothing, and shelter are the necessities of life for all people. All four are dependent on soils–soils as water filters and carriers, soils for food and fiber production, and soils as the foundations for structures of all types. In this program, researchers are developing basic and applied knowledge to better understand the roles soils play in meeting these life necessities and how soils function in their natural environment. Work spans a wide range of spatial scales from studies on water movement in soil pores and the assimilation of carbon and nitrogen by individual microbial cells to soil development processes on a continental landscape scale. OSU

scientists are part of state, national, and international multidisciplinary teams that address these issues.

Through Distributed Temperature Sensing, using fiber optics to ecological and hydrologic applications, hidden groundwater inflows to streams, step-wise turbulent mixing in mineshafts, and boundary-layer dynamics of lakes were all revealed at heretofore unprecedented resolution. The “SensorScope” platform is now deployed with over 100 stations, measuring nine environmental parameters, making the system the most advanced network of its kind, and it will be used in no fewer than 3 countries in the next year.

Although we have known for many years that fungi and bacteria are the major microbial components of soils, and that their ratio differs in response to soil properties, no manipulative studies have been performed to determine if the ratios can be changed, and what conditions control the ratios. In this study we showed that both climate and vegetation were major players, and that the fungi were more sensitive to manipulation than were the bacteria. We obtained evidence that soil mineralizable C responded to transfer of soil and to change in the fungal biomass implying that perhaps fungi and bacteria access different pools of C, and that changes in community composition promote changes in the pools of soil C that are being accessed.

Nutrient Management

Worldwide, about 8 X 1013 g of industrially-produced N are applied to croplands annually. Fertilizer N production, primarily as NH3, requires large inputs of natural gas and H2. In croplands fertilized with ammonia-based fertilizers, ammonia oxidizers are beneficial in the treatment of wastewaters and they show potential for bioremediation of soils contaminated with chlorinated aliphatic hydrocarbons. The full genome sequence has opened up new avenues for investigation of these bacteria which may lead to new strategies for controlling their activity in agricultural settings while exploiting their activity in wastewater treatment and bioremediation of chlorinated aliphatic compounds.

TOTAL EXPENDITURES:	$16,657,368
Hatch:	$317,875
Multistate:	$72,003
State:	$5,646,475
Other:	$1,062,015

(other includes funds from sources such as grants, foundations, etc.)

TOTAL FTE:	143.77

Key Theme Information

Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected 28 projects from 12 key themes to highlight in this year's report.

Key Theme: Natural Resource Management

Title: Soil-Landscape Relations in Oregon (Noller, Crop & Soil Science)

Description: This research program involved mapping and inventorying soils of private and public lands in Oregon, particularly those lands which were not yet mapped. Newly mapped private working lands will be eligible for financial and technical assistance from the USDA's Conservation Security Program (CSP), thereby helping to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes. Nearly 2 million acres were studied during the reporting period. This research aimed to enhance soil survey methods by developing Digital Soil Mapping for: (1) Mining existing geospatial databases. (2) Deriving new information and spatial data sets relevant to mapping soils. (3) Predicting the real extent of known and potential new soil map units. (4) Assessing the accuracy of soil survey spatial data. (5) Managing soil survey teams, especially in scheduling the deployment areas for field crews. The scientific approach of this year's study was to investigate soil-forming processes across the entire study area using intelligently targeted state-of-the-art software and techniques. Results of these analyses were combined with contemporary knowledge of the survey areas as revealed by the field scientists. This, in turn, was used to develop a numerical model applied by team members to predict expected soil map units under various scenarios of soil-forming (i.e., environmental) factors.

Impact: Putting land into the CSP is of obvious environmental benefit to Oregon. Being eligible for USDA's Conservation Security Program can be of considerable economic benefit to agricultural producers. In Fiscal Year 2006, CRP paid out $1.6 million to Oregon landowners, $562,453 of which was for soil conservation. Among other things, this research program with its digital soil mapping will assist soil survey teams, especially in scheduling deployment areas for their field crews. Also the research demonstrates intergovernmental agency cooperation in developing a key land resource database, especially in the intricate mosaic of diverse environmental factors inherent to lands of the western states.. While this research is focused on Oregon, the work will provide federal authorities with an improved tool for developing and sustaining soil surveys across the nation. This will prove particularly valuable for the lands of the western states. The project also produced a number of scientific and academic benefits: (1) A clearer understanding of soil-forming processes and their relative importance of soil-forming factors across Oregon and the northern Great Basin. (2) Development of better tools to optimize soil survey production and management. (3) Demonstration of intergovernmental agency cooperation in developing a key land resource database along with the methods used to develop

this database. (4) Providing Oregon State University with an enhanced basis for basic research in pedology and the allied fields of soil and earth sciences.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA and other federal dollars, private funds

****

Key Theme: Natural Resource & Environmental Economics

Title: Economic and Policy Analysis of Rangeland Management Options (Tanaka, Eastern Oregon Agricultural Research Center)

Description: The analysis of the economic and social impacts of controlling cheatgrass in the sagebrush ecosystem was conducted. The evaluation of herbicides, prescribed burning, grazing, and the integration of all 3 practices were evaluated for typical ranches in Oregon, Idaho, Nevada, and Utah. Interviews were conducted with federal agency employees, ranchers, environmental groups, and the interested public to evaluate the social acceptability of the different practices for restoration. Work has begun on the economic evaluation of restoration practices of sagebrush and juniper ecosystems in the Great Basin. The ecosystems will be treated in different ecological states and the results evaluated for their economic effects of private ranches using public lands for grazing during the summer.

Impact: Rangeland users throughout the western U.S. need to know how decisions they make affect the profitability of their businesses or add value to what they care about. Working with scientists from several states, we have designed ranch-level multi-period linear programming models to evaluate the physical and economic impacts of various grazing management practices. Many of these practices can improve the profitability of a typical ranch, dependent upon the rancher instituting both cattle management and herd size changes. Economic feasibility of rangeland restoration practices will affect the acceptability of the various alternatives. There are potentially hundreds of thousands of acres in the Great Basin that can be potentially restored to desired states, while other areas have been allowed to progress to a state where restoration is not economically feasible. This research project is partially aimed at defining where the boundaries are between economically feasible and unfeasible restoration.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA and other federal dollars, private funds

****

Key Theme: Biodiversity and Endangered Species

Title: Microorganism Discovery by High Throughput Cultivation (Giovannoni, Microbiology)

Description: In 2006 simple improvements to the technology of High Throughput Culturing (HTC) rather than major investments in experimental automation was the focus. Routine screening of cultivation experiments, and cultures in physiological studies, is now done using the EasyCyte flow cytometer and the DNA staining dye SybrGreen. The adoption of custom manufactured Teflon plates for the isolation of cells, the innovative work of postdoc Ulrich Stingl, has extended the range of cells that will replicate in culture to include several major targets significant to ocean surface ecology, and several cell lineages that are relatively rare in the ocean surface but are very divergent from known taxa and thus are evolutionarily significant. Two noteworthy examples are isolates of the dominant ocean surface clade SAR116, and isolates of the SAR11 clade from waters close to Bermuda. Dr. Stingl's findings indicate that the polystyrene microtiter dishes commonly used by cell biologists for tissue culture are inimical to the growth of certain important groups of marine bacteria, for unknown reasons. One of our principle activities is maintaining a culture collection of oligotrophic microorganisms, which we routinely distribute to other research laboratories on request. We (Scott Givan) have also developed web accessible bioinformatics tools, which are being used by several other laboratories for genome annotation.

Our major effort in bioinformatics this year has been the analysis of twenty genome sequences determined by the Venter Institute with support from the Gordon and Betty Moore Foundation. Our approach to the analysis of these genomes has been screening for key genes, and focusing on the most interesting genomes, rather than attempting annotation of all the genomes. This work is presented on the laboratory web site: http://bioinfo.cgrb.oregonstate.edu/microbes/org_detail.html?org=PB2503. Perhaps the most interesting detailed genome study in progress is that of the betaproteobacterium HTCC2181. HTCC2181 is the first genome from the abundant coastal marine clade OM43. The genome of HTCC2181, at 1,304,428 base pairs, replaces the SAR11 genome as the smallest genome known for a free-living organism. Aside from its small size, the HTCC2181 genome is remarkable for the metabolism it reveals: this organism is a methylotroph, and possesses a rhodopsin that is not in the proteorhodopsin clade. HTCC2181 is perhaps the most difficult strain to cultivate that we have worked with. Like SAR11, which also has a small genome, HTCC2181 apparently requires unidentified factors that are found in seawater. Technician Joshua Kitner is working to identify the HTCC2181 growth factors.

Impact: In addition to reporting original research results, training researchers and teaching, this project maintains a culture collection that supplies other laboratories with novel microbial strains for a wide variety of research projects. We assisted several other laboratories by providing strains, DNA, or bioinformatic services.

Title: Determining the Critical Habitats of Large Endangered Whales with Satellite Monitored Radio Tags (Mate, Marine Mammal Institute, Coastal Oregon Marine Experiment Station)

Description: The 2006 field project involved the tagging and monitoring of11 blue whales and one fin whale off the southern coast of California. We were still receiving data from some of the whales tagged off California in 2005, and there was no sign of adverse tag effects. Humpback whales tagged off central California in August 2005 showed wide-ranging movements along the

entire California coast, differing from humpbacks tagged in 2004, the majority of whose movements were concentrated along the central California coast. Some sperm whales tagged in June 2005 in the Gulf of Mexico were still providing data in 2006. All animals remained over Continental Slope waters during their tracking periods. Home range and core area analyses over the past five years show that females have high site affinity for specific locations within the Gulf of Mexico.

Impact: In today's world of heavy human competition for marine space and resources, ensuring survival of large whales requires understanding which areas of the oceans and continental shelves are most important to these animals. We are now learning that individual whale populations may have critical habitats specific to themselves (such as the eastern gray whales, which is the only whale population to utilize the Baja California lagoons for breeding), as well as habitats that are shared by several populations (such as the Channel Islands, home to a food resource that attracts multiple species of baleen whales). Defining these habitats and the species that use them is a long-term goal of this and several other research programs. Our ability to learn where whales go translates into a better ability to assist their survival, by sharing data with governments and regulatory agencies with the power to protect the habitats and thence, the whales.

Title: Fishes of Oregon: Distribution, Development and Evolution (Markle, Fisheries & Wildlife)

Description: The Willamette fish deformity work has been completed and published. The Klamath fish larvae and juvenile work continues and publications have described important aspects of recruitment biology. Parts of the Klamath sucker taxonomy and genetics studies have been published and the final part in revision. A PhD and MS student are currently working on coastal and southeastern Oregon fish taxonomy.

Impact: The Willamette fish deformities were generating great public concern over an 'unknown' pollutant and whether a multimillion dollar water treatment plant should be opened. The demonstration that a parasite was the cause and that the areas with deformed fish had no higher levels of measurable pollutants than areas without deformed fish, allowed the public to better evaluate risks associated with the water treatment plant. The long-term analyses of Klamath fish larvae and juveniles is showing that year class failure, and success, can turn on different events in different years. Many of the events are uncontrollable, like weather and exotic species, and so we are working with a colleague to model the key life cycles so that the effects, if any, of normal water allocation decisions can be understood.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA, Sea Grant

****

Key Theme: Invasive Species

Title: Biological Control of Weeds (McEvoy, Botany & Plant Pathology)

Description: Harmful, non-indigenous plant species invade Oregon, threatening agriculture, waterways, native ecosystems, and even human health. Invasive plants can simplify plant community structure, alter ecosystem processes, and undermine the ecosystem services that we derive from biotic diversity. Two invasive plants, purple loosestrife (Lythrum salicaria) and reed canary grass (*Phalaris arundinacea*), are becoming the dominant species in many wetlands across temperate North America. We used a horizontal, observational study to estimate per capita effects (PCEs) of purple loosestrife and reed canary grass on plant diversity in 24 wetland communities in the Pacific Northwest, USA. Four measures of diversity were used. Results indicate that both species are capable of reducing plant community diversity and management strategies need to consider the simultaneous control of multiple species if the goal is to maintain diverse plant communities.

Assessing cause-and-effect relationships of weed biological control programs requires linking herbivore density with plant abundance. Spatial and temporal fluctuations in herbivore density, feeding niche and behavior, and anti-predator behavioral responses often make it difficult to count individuals directly. An alternative to direct counts is to estimate herbivore density indirectly from feeding damage. Project results indicate that plant damage is an increasing function of insect density and that visual estimates of leaf area damaged on the target host plant, purple loosestrife (*Lythrum salicaria*), can be used to estimate *G. pusilla* beetle density for field populations below carrying capacity.

Impact: A conservative estimate of the economic impact of the twelve worst noxious weeds in the state is $67 million annually. Research is helping to reduce harm from invasive plant species through the use of biological control. Three of the 12 worst weeds (ragwort, purple loosestrife, and rush skeleton weed) currently have detailed research programs in the OAES laboratory. Oregon has the largest portfolio of biological weed control systems in the nation, numbering 71 control organism species for 31 weed species. Ragwort *Senecio jacobaea*, a weed of roadsides, pastures, and grasslands has been successfully controlled by biological methods. Assuming that at least half of the benefits calculated for controlling ragwort at its peak can be attributed to this research, then annual benefits to Oregon growers and livestock producers amount to $3 million/year. Purple loosestrife *Lythrum salicaria*, an invader of wetlands, is being controlled by four introduced insect species distributed across invested sites in Oregon and the rest of the USA.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA and other federal dollars, private funds

****

Key Theme: Riparian Management

Title: The Role of Invertebrates in Upland-Riparian-Stream Linkages (DeBano, Hermiston Agricultural Research & Extension Center)

Description: Analysis of gut contents of juvenile salmonids in the mainstem Umatilla River indicate that diets of juvenile salmonids are composed primarily of aquatic invertebrates rather

than invertebrates derived from terrestrial riparian areas and the condition of the riparian area in study did not significantly affect the total abundance or species composition of invertebrates consumed. Along with tribal collaborators, we are continuing to monitor several stream restoration projects, although so far, we have not detected strong differences in indices associated with stream health between restored and unrestored sites. This effort has been expanded to include sites on streams in the Zumwalt Prairie that are to be restored by The Nature Conservancy. In a separate study, we found that riparian patch length was as important, if not more important, than patch width in influencing stream ecosystems. Finally, we have completed our study related to how riparian areas affect surrounding agricultural uplands through their effects on agricultural invertebrate pests and their natural enemies. We found no significant difference in the density of aphids between wheat fields adjacent to large woody riparian buffers and wheat fields that either lacked buffers or had narrow herbaceous buffers. There were also no significant differences in the abundance of any of the most common natural predators in wheat fields adjacent to large woody riparian buffers and wheat fields that either lacked buffers or had narrow herbaceous buffers and no significant correlation between the density of natural predators in riparian buffers and the density of aphids in adjacent fields. This study shows that while woody riparian buffers may not lead to decreases in wheat pests in adjacent wheat fields through their effect on wheat pest predators, they do not appear to act as reservoirs for wheat pests.

Impact: Deterioration in the quality of streams and riparian areas is an important factor, among many, contributing to the decline of salmonid populations in the Northwest. In response, riparian restoration projects are often implemented to improve water quality and fish habitat. Between 1995 and 2000, $100 million dollars were spent on restoration projects in Oregon alone. Our research focuses on investigating important gaps in our knowledge about the impact of these projects, such as how riparian condition affects invertebrates that are an important food source for juvenile salmonids or how effective these projects are at restoring stream health. Less than 20% of restoration projects funded in Oregon incorporate any type of monitoring. Our work on monitoring the effectiveness of on-the-ground projects is imperative in assessing the impact these projects are having on water quality and in gaining an understanding of which types of projects are most effective. Finally, little is known about how riparian restoration projects affect pests that attack crops grown in adjacent fields or the beneficial insects that control those pests. Riparian buffers have been hypothesized to be reservoirs for both pests and beneficial insects, but few studies have tested this hypothesis. Understanding the relative contribution of riparian buffers to pest or beneficial insect abundances in adjacent croplands is important for an accurate assessment of the overall costs and benefits of restoration projects to agricultural growers.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA & other federal dollars, private funds

****

Key Theme: Rangeland Management

Title: Physiology, Ecology and Management of Western Juniper Woodlands and Associated Shrublands (Miller, Rangeland Ecology & Management)

Description: Western juniper, which now occupies over 9 million acres, has increased over ten fold since the late 1800s, encroaching into some of eastern Oregons most productive semi-arid plant communities. Encroachment has resulted in the loss of important wildlife habitat, livestock forage, soils, and soil water storage. In this project we have described the degree and patterns of juniper encroachment, developed guidelines for separating old-growth woodlands from young expanding woodlands, and evaluated the impacts of juniper invasion on soils, plant communities, forage production, and wildlife. We have also developed guidelines for removing western juniper using efficient and ecologically sound methods. These include various techniques of cutting and burning, and guidelines for site selection and follow-up management strategies. A comprehensive summary of our work and others on western juniper titled The Biology, Ecology, and Management of Western Juniper was published in June of 2005

Impact: As a result of Western juniper encroachment, land management agencies and private landowners are treating 10s of thousands of acres of juniper annually. Both land management agencies and private landowners have readily incorporated our methods into their management plans. Using this work has also resulted in a substantial decrease in litigation between environmental groups and agencies. A comprehensive summary of our work and others on western juniper titled The Biology, Ecology, and Management of Western Juniper was published in June of 2005, in which the 2,000 copies printed were exhausted within two months following release.

Title: Development of Electronic Technologies for Inventorying and monitoring Rangelands and Pastures (Johnson, Rangeland Ecology & Management)

Description: Scientists and managers have used the quadrat as a means of measuring and monitoring rangeland vegetation since the foundation of modern plant ecology. Traditional quadrat sampling, unfortunately, is quite tedious and slow. Proper documentation requires not only careful examination of individual quadrats (samples) but large numbers of samples, if the information is to be used in a statistical context. By the 1930's, overhead photography or photographic charting were being employed to achieve enormous saving of time, increased accuracy owing to elimination of the person equation, and a visual record in three dimensions' (Weaver and Clements 1938). Recent advances in digital photography, Global Positioning Systems (GPS), computer processing, and digital information storage have opened new opportunities for photographic charting, of vegetation. This year, we constructed and tested an easily-carried, digital photo-monitoring system consisting of both hardware and software that could be used for measuring vegetation in quadrats, yielding high resolution digital images, collecting accurate GPS coordinates of the camera position when the photo was take, scaling the image, assigning geographic projection system to the registered photographs, mapping the location of images for reference purposes, storing the resultant computer files (geo-corrected aerial photographs) on digital media.

Impact: Work on agricultural crops, pasturelands and rangelands in Oregon has indicated that vegetation data can be collected and analyzed more rapidly using our monitoring system than by traditional means. The saved geo-referenced images provide a valuable source of information

for: 1) analysis of crop damage from wildlife, insects, or other factors, 2) long-term studies on species composition change on rangelands, 3) evaluation of year-to-year variation of forb populations on rangelands, and 4) year-to-year variation in plant cover and production on fields and rangelands. The system is being beta tested by both land management agencies and federal research scientists.

Scope of Impact – State, regional, and national
Source of Funding - Hatch, State, Agricultural Research Foundation, USDA

****

Key Theme: Watershed Management

Title: Watershed Research on Oregon's Rangelands (Buckhouse, Rangeland Ecology & Management)

Description: The relationships between juniper encroached watersheds and a paired watershed with ecologically sensitively tree harvest and water yield, water quality, and timing of delivery of water; as well as vegetation response, erosion prevention, and habitat rehabilitation has been studied on a central Oregon watershed over the past dozen years. This study was initiated to determine the relative responses between a pair of very similar, side-by-side watersheds. Water response was measured in both and models were constructed such that predictions of one based upon response from the other were possible. In 2005 we then harvested the encroached trees from one watershed (about 300 acres). In the year since harvest, water response has been measured.

Impact: This study has huge impacts on the management of the West, and elsewhere, where invasive species have encroached on watersheds. If, as predicted, tree harvest which mimics natural fire or other disturbance, results in positive watershed values, this study will become the prototype for sustainable, aridland watershed management, west-wide, and beyond, where water shortages, degraded water quality, and flash flooding are problems.

Scope of Impact – State, regional
Source of Funding - Hatch, State, Agricultural Research Foundation, USDA,

****

Key Theme: Wildlife Management

Title: Wildlife Population Response to Landscape Structure (Schmitz, Fisheries & Wildlife)

Description: Two unrelated projects were completed during the past year. The first project dealt with modeling habitat characteristics for the endangered pygmy rabbit, using data collected in Washington and Oregon. This work allows us to identify and prioritize sagebrush habitat for

conservation or restoration and to identify sites for reintroduction of Pygmy Rabbits in the wild from captive bred populations. Our models also assist federal land management agencies by identifying sites that are most appropriate for other land uses. We also modeled changes in beaver distributions in the Copper River Delta of Alaska; the work to be used by Forest Service scientist to develop successional models for the Delta and to predict potential climate change impacts.

Impact: Our pygmy rabbit study will allow federal and state agencies to prioritize conservation efforts on this endangered species while releasing unsuitable sites for other potentially conflicting land uses. Limited resources will be better invested and land use conflicts will be reduced. The environmental impacts of the beaver study are uncertain at this time, but it is likely that modeling efforts using our data will identify significant issues associated with climate change impacts in the delta.

Title: Ecology and Conservation of Migratory Waterbirds in Oregon (Dugger, Fisheries & Wildlife)

Description: Winter conservation planning for wetlands birds assumes food limits survival and therefore winter population size. If true, increasing habitat availability should improve foraging conditions and therefore improve bird survival. However, this basic premise has rarely been tested or models have relied on untested assumptions. My research is focused on testing critical assumptions or estimating key parameters needed to develop biologically sound conservation plans.

Impact: I have recently completed or initiated work in Puget Sound (Washington), Klamath Basin (Oregon and California), Great Salt Lake (Utah), and the Lower Columbia River/Willamette Valley (Washington and Oregon) looking at food availability, nutritional value of foods, how wetland management influences food availability and bird use, comparative winter ecology waterbirds. This work is gathering data needed to develop the bioenergetic models used to estimate regional habitat needs to conserve waterbirds. My research on the wintering ecology of waterbirds provides the biological understanding needed to species specific detail in conservation plans. For example, my work with Canada and Cackling geese in Oregon and Lesser and Greater Sandhill Cranes in California combines research on bird energy needs, foraging strategies, habitat use, and movement patterns with data on habitat-specific food availability, to develop spatially-explicit conservation strategies that will protect goose and crane needs in the face of changing land use pressures and reduce concerns on private lands about crop depredation.

Title: Application of Theoretical Ecology and Life History Analysis to Aquatic Wildlife and Fisheries Management (Heppell, Fisheries & Wildlife)

Description: In 2006, the research focused on population dynamics of long-lived species in marine and freshwater environments. For sea turtles, technical information was provided to the National Marine Fisheries Service for development of maximum allowable take rules and for incorporating uncertainty into estimates of population size. A second meeting to compare

potential causes of population decline in Pacific and Atlantic sea turtle populations was hosted and that research is continuing. For long-lived fish management, a sensitivity analysis was developed for evaluation of slot limits (maximum and minimum size regulations) for green sturgeon. Faculty participated in a workshop on evaluation of sustainability of deepsea fisheries, and reviewed stock assessments for the Pacific Fishery Management Council. Research is underway to evaluate the role of age-structure and maternal effects on population dynamics of rockfish, specifically Pacific Ocean perch in Alaska. In freshwater systems, a paper was published with a student on survival and emigration rates of red-legged frogs, a species that is negatively affected by exotic bullfrogs. Extensive work occurred with management agency scientists on a population model and evaluation for endangered suckers in the Klamath Basin.

Impact: The 2006 work on maximum allowable take limits for sea turtles is under evaluation by the Office of Protected Resources and will contribute to policies applied to Endangered Species consultations. The population model developed for suckers in the Klamath Basin will serve as a tool for management plan evaluation by the Recovery Teams that will be updating the Lost River Sucker and Shortnose Sucker Recovery Plans in summer 2008.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, Sea Grant, other federal dollars, private funds

****

Key Theme: Integrated Pest Management

Title: Designing Nematode Management Strategies for the Future of Oregon Agriculture (Ingham, Botany & Plant Pathology)

Description: Corky ringspot disease (CRS), also referred to as spraing, produces dark-brown "corky" necrotic areas in the form of arcs or diffuse brown spots within potato tubers. Damage to tubers from CRS is considered a quality defect by the potato industry, and tubers with more than 10% waste are culled. Crops in which more than 6% of the tubers are graded as culls due to CRS damage are often rejected or substantially downgraded in value. The causal agent of the disease is tobacco rattle virus (TRV) that is vectored by stubby-root nematodes (Paratrichodorus allius) in the western US. Disease can be severe at even low nematode densities making management difficult and expensive. CRS can be controlled by fumigation with Telone but the cost is high ($200/acre). Since stubby-root nematode damage to onions is controlled with the less expensive non-fumigant nematicide, Vydate, trials to test the ability of Vydate to control stubby-root nematodes and CRS were conducted in fields on the Klamath Experiment Station that had a history of CRS. Different application times were tested. None of the Vydate treatment schedules appeared to cause significant mortality in populations of P. allius even when CRS was controlled. However, treatments receiving an early-season application either in-furrow at planting, early post-emergence (33 DAP) or both, significantly reduced CRS expression. These results support prior research in Florida which suggested that newly formed tubers are quite vulnerable to TRV infection. Therefore, oxamyl applications must be made early in the growing season to be effective in controlling CRS. From two years of trials the best Vydate program for

control of CRS was determined to be, in-furrow at planting plus 30, 45 and 60 DAP. This treatment schedule eliminated symptoms in all but a few tubers compared to 18% and 47% of symptomatic tubers in untreated plots. These four applications would cost the grower $80, considerably less than the cost of fumigation. However, other benefits of fumigation would not be obtained.

Impact: Corky ringspot disease causes quality defects in tubers and can be responsible for severe economic loss to potato growers. Management of this disease has been possible with the use of expensive soil fumigants. This research determined that a less expensive nematicide, Vydate, could be very effective for control and reduce control costs by 60% (four applications would cost the grower $80). However, the results of these studies also documented that early timing of applications was critical and if applications were begun too late the treatment was ineffective.

Title: Biology, Ecology and Management of Grass Seed and Rotational Crop Pests in Oregon (Rao, Crop & Soil Science)

Description: Two exotic crane fly species accidentally introduced into Oregon damage grasses in home lawns, golf courses and in seed production fields. The two species are similar in appearance and require time consuming rearing to the adult stage for accurate identification. An earlier identification tool for the larval stage using a molecular marker was fined tuned for reducing the time required for sample processing. Application of the insecticide chlorpyrifos is the only tactic currently available for control of the exotic crane fly species. Two isolates of the insect pathogen, Bacillus thuringiensis israelensis was evaluated for its efficacy in killing the larvae.

The cereal leaf beetle is a new pest of grains in Oregon. Besides loss due to feeding damage, there are additional impacts due to quarantine restrictions on transport of hay, straw and grass seed from infested counties in Oregon. In earlier years, an insectary was established for rapid production of natural enemies that attack the larval stage. Dissections of larvae from the insectary indicated 100 % parasitism of larvae not just at the insectary at Hyslop but in growers' fields several miles away. * Clover is a rotational crop in Oregon and growers are concerned about pollination in their fields. Blue traps were set up in clover and the species richness and abundance of native bees were determined. The impact of drawing native bees to the field using the blue magnet vanes was also determined. This project also provided rural science teachers to provide inquiry-based science education to K-12 students, who are often not excited about science and do not consider science as a career after graduation. Over 120 students from 4 rural schools in Falls City, Halsey, Lebanon and Inavale participated in a new Discovering Partners in Nature program. Through the program, a new pollination unit was implemented and students learned about flowers and bees and were subsequently involved in university research on native bees and were provided access to university resources. They set up traps and collected native bees on the school grounds. Teachers were provided professional development and training to continue inquiry-based science instruction on their own.

Impact: The impact of *Bacillus thuringiensis israelensis* on mortality of the exotic crane fly pests, *Tipula paludos*a and *T. oleracea* was evaluated. Growers now have a second option for

management of the exotic crane fly pests, and one that is not toxic to the environment. The fine tuning of the molecular marker for separation of the two pests at the larval stage reduced the cost and the time for identification of the pests. With the molecular marker, growers can get their samples identified rapidly and apply control measures only when the pest species is present in their fields, thereby avoiding unwarranted sprays.

The parasitoid of the cereal leaf beetle is established in the insectary and has dispersed on its own. This enables growers to reduce the cost of applying insecticides for cereal leaf beetle control. Clover growers were made aware of the great diversity and abundance of native bees in their fields, which enables them reduce their dependence on honey bees for pollination. The Discovering Partners in Nature program provided 120 students with a scientist's experience while engaging them in OSU's native bee research. It got the students excited about science while providing them with a life long learning experience.

Title: Integrated Crop Management in Oregon Vegetable Production Systems (Stone, Horticulture)

Description: Topsin/Rovral and Topsin/Endura two-spray tank mixes on-farm trials demonstrated that these tank mixes controlled white and gray mold as well or better than single applications of Ronilan; farmers shifted over to the two spray tank mixes in 2006. Root rot of sweet corn severity was reduced by approximately 20% in corn grown after a winter oat "Saia" cover crop than when grown after winter fallow. The severity of leaf firing, an above ground symptom of corn root rot, was lowered by 23% in corn grown after the oat cover crop than after the winter fallow. The oat cover crop immobilized nitrogen and reduced corn N uptake in the short term in comparison to the fallow, but nonetheless yield was 12% (one ton) higher in the oat treatment.

Impact: In 2006, the processed snap bean growers successfully transitioned to Topsin/Endura or Topsin/Rovral applications for mold control. To our knowledge, no farmers who applied these tank mixes at recommended rates and with proper timings experienced load rejections due to mold. The successful transition away from Ronilan prevented crop losses which in a wet season could amount to 5-10% of the bean crop (valued at $21 million annually). In 2006 as well, this project has shown that 1) tolerant cultivars, 2) a rotation of 4 or more years, and 3) high biomass oat cover crops are effective management strategies for corn root rot. Changing rotational practices and/or adopting specific cover crops and realizing the impact of that change could take a farmer 5 or more years, so the impact of our rotation findings will not be known immediately. Sweet corn (33,200 A; $28.2 million per annum) is the keystone crop of the processed vegetable industry. This project has contributed significantly to the understanding and management of root rot, a problem which nearly destroyed this industry.

Title: Biology and Control of Insects and Mites on Tree Fruits in Northern Oregon (Riedl, Mid-Columbia Agricultural Research & Extension Center)

Description: New pesticide chemistries and alternative control methods were evaluated in field trials to assess effectiveness against major tree fruit pests, selectivity to natural enemies, potential to cause pest resurgence and phytotoxicity. Research focus in 2007 was on codling

moth, pear psylla, San Jose scale, and mite pests. Laboratory and field studies to assess the impact of new insecticide chemistries on natural enemies continued in 2006 to determine acute as well as sublethal (reproductive) effects. Additionally, several modifications to conventional air blast sprayers, i.e. air induction nozzles and restricting air flow to increase droplet size, and a transverse air flow (tower) sprayer were evaluated using a fluorescent dye method for reducing spray drift. A buffer of dense vegetation near surface water effectively intercepted spray drift. Spray drift from aerial malathion ULV applications in cherry orchards was monitored near salmon-bearing streams. Research on spray drift will be continued in 2007.

Impact:
This research helps growers to adopt safer, environmentally friendly and more selective pest control tactics thus replacing traditional broad-spectrum chemical controls with selective options including selective insecticides, mating disruption techniques and biological controls. These changes reduce pesticide drift to non-target sites, improve water quality and reduce farm worker exposure to neurotoxic pesticides, especially organophosphate insecticides. Without effective pest control programs based on information generated by this project the tree fruits grown in the Mid-Columbia area would suffer unacceptable pest damage or even complete crop loss. The economic benefits to northern Oregon fruit growers from this project are estimated to represent one-tenth of the total $70 million annual average sales value of apples, pears and cherries.

Title: Control of Postharvest Decay of Winter Pears in Southern Oregon (Sugar, Southern Oregon Research & Extension Center)

Description: Sequential treatment programs consisting of summer calcium chloride sprays, Pristine fungicide applied one week before harvest, and postharvest either Scholar or Penbotec fungicide, offer a powerful approach to pear postharvest decay management in conventional systems. In orchards where bull's-eye rot or side rot has been a problem, including ziram fungicide one month before harvest enhances the program. Calcium chloride sprays in summer followed by Pristine one week before harvest increased the resistance of Bosc pears to blue mold, as determined by wounding the pears and inoculating with the fungus after harvest, then measuring the extent of decay lesion development after 6-8 weeks in cold storage. A late summer calcium program (3 lb. actual calcium applied 3 times in August and early September) was equivalent to a mid-summer program (3 lb. actual calcium applied 3 times in July and early August). A single high dose (5 lb. actual calcium) of calcium chloride applied one week before harvest injured the fruit and increased the amount of decay. In laboratory tests, Scholar and Pristine had the broadest range of effectiveness among postharvest pathogens, followed by Penbotec. Scholar and Pristine were generally effective at lower concentrations than other fungicides. These results show the excellent potential of newer fungicides to give broad-spectrum decay control. They also stress the value of knowing the target fungi in a pear orchard-packinghouse system for designing the most effective treatment strategy. A wide array of pre-harvest - postharvest fungicide combinations is available for decay control. All of the pre-harvest fungicides tested provided some decay control, even without use of a postharvest fungicide, and all postharvest fungicides provided some decay control without use of a pre-harvest fungicide. However, combinations of pre- and postharvest fungicides can improve efficacy, and broaden the range of pathogens controlled. Penbotec and Scholar fungicides were highly effective in

controlling blue mold in pear wounds when applied up to three weeks after spores were introduced into wounds, based on prompt fruit storage at 31 F following inoculation. At three weeks post-inoculation, decay control was still significantly better than the control, but the ability to inhibit decay was diminishing. Large-scale (10 acre) plots in two commercial orchards compared Pristine pre-harvest treatments to standard programs. In a low-decay orchard, no difference was detected, but in a late-harvested high-decay orchard, Pristine applications reduced decay. Laser coding may find acceptance as an alternative to stickers in labeling individual pear fruit. Since the coding is accomplished by a certain amount of injury to fruit cells, tests were carried out to determine if laser codes can become entry points for postharvest pathogens. Dip and vacuum infiltration methods with blue mold and gray mold pathogens have thus far shown that laser codes may provide a slightly higher risk of fruit infection. In some cases (without fungicide), fungi preferentially grew on laser-coded characters.

Impact: A new generation of highly effective "reduced risk" fungicides can now be used by the pear industry for management of pear decay during storage. Research in this project has identified comprehensive strategies for deployment of new fungicides in combination with nutritional treatments for maximum decay control. These strategies should give conventional producers greater confidence in the storability of their pear crop, allowing increased flexibility in marketing through the winter and reducing losses due to decay. This should result in greater profitability in pear production. Because these programs involve "reduced risk" fungicides, used at relatively low concentrations, and include fruit nutrition as a key component, the environmental impact and impact on neighbors of commercial orchards should be reduced.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State, USDA & other federal dollars, private funds

****

Key Theme: Nutrient Management

Title: Molecular Investigations of the Ammonia Metabolism of *Nitrosomas Europaea* (Arp, Botany & Plant Pathology)

Description: In the last year, we have made progress in several areas dealing with molecular investigations of ammonia metabolism of *Nitrosomonas europaea*. First, we have continued to make progress on understanding the basis of obligate lithotrophy. We demonstrated that all the genes necessary for a complete citric acid cycle are present. Disruption of the genes for alpha ketoglutarate dehydrogenase led to no discernable phenotype during growth, but led to decreased fitness in the stationary phase. Although alpha ketoglutarate dehydrogenase activity could not be demonstrated in *Nitrosomonas europaea*, the genes could be expressed in Escherichia coli and produced measureable activity. Second, we have determined the response at the transcriptional level of *Nitrosomonas europaea* to exposure to chloromethane and chloroform. a*N. europaae* can initiate the degradation of these pollutants, but is also sensitive to their presence in wastewater treatment plants. We used whole-genome microarrays to show that 37 genes are up-regulated in common. Among these genes are many stress-related genes. Most up regulated was a gene

encoding beta lactamase. We are examining this gene as a reporter for stress in this bacterium. Transcript levels for many more genes are changed in response to chloroform than to chloromethane. This is consistent with the more drastic effects of chloroform on ammonia metabolism. Third, we have compared the genome of *N. europaea* to that of three additional ammonia oxidizing bacteria. These bacteria are close relatives but their genomes are quite different. Comparison of the genomes has provided an indication of the core genome required for ammonia oxidation. To date, all ammonia oxidizing genomes contain several genes in common. These include genes for ammonia monooxygenase, hydroxylamine oxidoreductase, and associated cytochromes. Nitrosocyanin genes are also present in all four. Somewhat surprisingly, all four genomes also contain genes for sucrose synthesis and degradation. Sucrose is unusual as a metabolite in bacteria. We have now examined *N. europaea* for the presence of sucrose and find that indeed sucrose is present. Cells exposed to higher salt concentrations have higher levels of sucrose, supporting a role in osmotic protection. Fourth, we have continued our investigations of the mechanisms of iron acquisition by *N. europaea.* The genome revealed a surprisingly large number of genes involved in iron acquisition. We have now made gene knock-outs in two genes involved in uptake of the siderophore, desferral. Cells with both genes disrupted cannot use this siderophore for iron acquisition. Cells lacking one of the two transporters can not use desferral under any conditions while the absence of the other transporter can still use desferral albeit at higher iron concentrations. Another gene disruption in the cytoplasmic membrane transporter for iron siderophores led to inability to use all hydroxyamate type siderophores. However, catecholate siderophores were still taken up. This has led to identification to a second set of genes for transport across the cytoplasmic membrane.

Impact: Worldwide, about 8 X 1013 g of industrially-produced N are applied to croplands annually. Fertilizer N production, primarily as NH3, requires large inputs of natural gas and H2. In croplands fertilized with ammonia-based fertilizers, ammonia oxidizers contribute to the mobilization of this N by the production of NO2-, which is rapidly converted to NO3- by nitrite-oxidizing bacteria. NO3- is readily leached from these soils into ground waters (often to levels rendering the water unfit for human consumption) and surface waters (contributing to their eutrophication). Furthermore, NO3- is a substrate for denitrification, resulting in the conversion of this plant-available N to N2 and a waste of the energy initially used to produce the NH3. In contrast, ammonia oxidizers are beneficial in the treatment of wastewaters and they show potential for bioremediation of soils contaminated with chlorinated aliphatic hydrocarbons. Mitigation of the negative effects and exploitation of the beneficial effects of ammonia oxidizers will be facilitated by a thorough understanding of their metabolism. The full genome sequence has opened up new avenues for investigation of these bacteria which may lead to new strategies for controlling their activity in agricultural settings while exploiting their activity in wastewater treatment and bioremediation of chlorinated aliphatic compounds.

Title: Utilization of Municipal and Industrial Byproducts in Agriculture (Sullivan, Crop & Soil Science)

Description: This project contributed to the development of guidance for beneficial use of byproducts from municipal, industrial and agricultural sources. The project validated a low-tech

computer simulation model (DECOMPOSITION) that predicts first-year mineralization of nitrogen from a variety of organic soil amendments: composts, manures, biosolids and specialty products. Inputs for this simulation model are relatively simple and can be readily adapted to any organic material. The project also investigated longer-term N mineralization and found that the quantity of N-mineralized per unit of total amendment N applied in Years 2 and 3 after land application was similar for amendments ranging with initial C:N ratios of 5 to 30. Second and third year N mineralization was similar for materials composted prior to application, or for uncomposted materials. The project also investigated compost stability as an indicator of compost quality. Compost stability measurements corresponding to stable compost suitable for most horticultural uses was approximately 2 mg CO2-C per g compost C per day at 22 degreesC for a variety of feedstocks and composting methods. We also demonstrated that compost stability is a key indicator of the ability of the compost to suppress some soil borne pathogens (*Pythium* spp.) but not *Rhizoctonia* spp. Several studies investigated amendment testing procedures for phosphorus in an effort to better predict risks of P loss to surface waters. In one study, the agronomic Bray P1 soil test was found to be a reasonable indicator of water soluble or labile P for western Oregon soils. Another study, done in collaboration with ten other laboratories in North America, developed a common protocol for testing amendments to determine water-soluble P. Research findings from our studies have been incorporated into regional Cooperative Extension guidance and have been featured in clientele workshops.

Impact: Study findings are used to formulate guidance for agronomic rates for land application of biosolids and other municipal, industrial and agricultural byproducts. Scientifically-based guidance provides economic benefits for byproduct generators and farmers, and assists in the protection of the environment from excessive nutrient applications.

Title: Managing Plant Nutrients for Crop Production and Environmental Protection (Christensen, Crop & Soil Science)

Description: Carrot seed generates $6.8 million for central Oregon growers. Accurate crop nutrient information can save growers fertilizer costs, as well as protecting the environment from the results of over application of fertilizers. Field research looked at yields at various nitrogen application rates. Surveys of growers and field representatives were conducted to evaluate awareness of the research and adoption of practices.

Impact: Carrots grown for seed are a high value specialty crop that requires less nitrogen fertilizer for top yields than previously thought. Implementing the recently completed research lowers fertilizer costs, increases seed yield and decreases water pollution. Application of 50 and 75 lb of nitrogen produced a yield of 330 lb/acre while 90 lb produced 242 lb/acre, a 27 percent decrease similar to no nitrogen applied in the spring. Using average hybrid carrot seed yield and price for 2004 and 2005, the yield depression from as little as 15 pounds additional N costs approximately $1,000/a from seed yield loss. Extrapolating the economic impact to all 2300 acres of carrot seed produced, this project potentially saved hybrid carrot seed growers in central Oregon $2.3 million annually. One hundred percent of field representatives responding to a fall 2004 survey on the impact of the carrot research indicated that they were aware of the research. Eighty-eight percent said that the research results have either influenced or reflect their fertilizer

recommendations, and 72 percent of the acreage for which they make recommendations is fertilized in a manner reflecting the research results. A survey of central Oregon carrot seed contractors conducted in 2006 indicates that over 90 percent of growers have adopted the fertilizer management recommendations developed by this project. Leaders in the industry report that our research results have given growers the confidence to reduce fertilizer rates to the level recommended, despite their concern that lower nitrogen rates would reduce yields.

Scope of Impact – State, regional, and national
Source of Funding - Hatch, State, Agricultural Research Foundation, USDA

****

Key Theme: Soil Quality

Title: Investigation of the Movement of Water and Contaminants Through Unsaturated Soils (Selker, Biological & Ecological Engineering)

Description: In part due to the support of this project, Dr. Selker tackled many issues related to movement of water and contaminants through soils. He pioneered the application of Distributed Temperature Sensing (DTS) using fiber optics to ecological and hydrologic applications, such as stream monitoring, abandoned mine shafts, lakes, and glacial snow. Dr. Selker also led the hardware development of the SensorScope platform, an autonomous distributed environmental sensor (DES). Working with Dr. Shmuel Assouline, he also developed a far more precise method for estimating when rainfall will result in erosion. Dr. Selker published an article expanding the theoretical and experimental horizons related to air sparging, one of the most effective tools to clean aquifers. Dr Selker published field evidence of extraordinarily high levels of Diuron in streams adjoining recently planted grass seed fields. Dr. Selker and his students derived new solutions to the equations of flow that describe how water in hillsides drain into streams. Dr. Selker and his students developed a non-invasive method to observe two-dimensional gas flow and colloidal movement in partially water saturated porous media. This will be useful in the study of microbial growth, bioremediation, and the hydrology of natural soils.

Impact: Through DTS, hidden groundwater inflows to streams, step-wise turbulent mixing in mineshafts, and boundary-layer dynamics of lakes were all revealed at heretofore unprecedented resolution. SensorScope is now deployed with over 100 stations, measuring nine environmental parameters, making the system the most advanced network of its kind, and it will be used in no fewer than 3 countries in the next year. The research team found several commonly employed results related to hillside flow had significant errors, and they provided a framework for plotting and interpreting stream flows to better understand the flow generation processes. This is important to the prediction of streamflow under climate change.

Title: Soil Carbon Storage and Release From Oregon Soils (Sulzman, Crop & Soil Science)

Description: Management activities and changes in climate can affect overall ecosystem health and productivity as well as the amount of carbon these systems store. At a network of research plots in the H.J. Andrews Experimental Forest at Blue River, OR, we are continuously monitoring soil moisture, soil temperature, and sap flux as a function of landscape position and soil depth. During our field season, we collect biweekly samples of soil gases at multiple depths and atmospheric samples from multiple heights within and above the canopy to assess ecosystem health. We also carried out a literature review to assess whether carbon could be sequestered in soils of western Oregon's grass seed fields; the results of which will be filed with the Oregon Department of Agriculture. In a third effort, we measured soil chemical, physical, and biological characteristics following wildfire of two intensities, and assessed the impact of salvage logging operations on indicators of soil health. This work is being carried out within a mixed conifer ecosystem dominated by ponderosa pine and Douglas-fir on the east side of the central Oregon Cascade Mountain Range near Camp Sherman, Oregon, within the perimeter of the B&B fire (Summer 2003).

Impact: Data from our first project indicate south-facing slope of the watershed is wetter than the north-facing slope, but the vegetation appear more drought-stressed on the wetter, south-facing slope. The approach of measuring ecosystem health with atmospheric gas samples is feasible on a large scale. Preliminary results of our wildfire work show that although soil respiration, a measure of biological activity, varied predictably with season, there was difference in soil respiration between severely and less severely burned soils in any of the three seasons analyzed thus far (Summer 2005, Fall 2005, Spring 2006). In contrast, less severely burned soils were found to have more organic matter, carbon, nitrogen, and phosphorus in the top 5 cm than severely burned soils. The higher nutrient status of the less severely burned soils is expected to influence seedling growth.

Title: Carbon and Nitrogen Cycling in Oregon Soils (Myrold, Crop & Soil Science)

Description: We completed our study of N-cycling activities and associated microbial communities in soils of high and low N availability. A novel approach using 15N isotopes with bacterial or fungal inhibitors allowed us to demonstrate the importance of bacteria in nitrification and also in the utilization of inorganic N. A novel finding was the presence of ammonia-oxidizing archaea at the high N availability site. A study on the influence of woody plant encroachment on soil microbial communities was done in collaboration with Texas A&M University. We also continued research in collaboration with colleagues in Sweden on the influence of N availability on communities of bacteria associated with N-cycling processes. Finally, we continued our studies on the influence of ectomycorrhizal fungal mats on soil microbial communities by establishing a manipulative experiment to determine how the microbial communities change in response to the death and decomposition or the establishment of ectomycorrhizal fungal mats. The Stable Isotope Research Unit continues to function well as a service laboratory for scientists doing 13C and 15N isotope research. Thousands of samples were processed for projects in my laboratory, others on campus, and around the nations.

Impact: Our research confirms our earlier findings that soil bacteria and fungi communities are responsive to changes in their environment, including changes in vegetation and in soil N

availability. For example, we found the encroachment of N2-fixing trees and shrubs altered soil bacterial and fungal communities. Other research found that communities of ammonia-oxidizing and denitrifying bacteria differ in soils of high and low N availability. This basic information may ultimately be important in soil management or in understanding the response of soil microbial communities to external changes in environmental conditions.

Title: Interaction Between Soil Physical Properties and Microbial Activities (Bottomley, Crop & Soil Science)

Description: Researchers have conducted a series of studies in different Oregon soils to examine how soil heterogeneities interact with environmental conditions to influence N cycling processes. Soil cores were reciprocally transferred between immediately adjacent forests and meadows. After 2 years, cores were removed and changes in fungal and bacterial populations determined by microscopy, and changes in community composition determined by PLFA analysis, and by length heterogeneity PCR of the internal transcribed spacer region of fungal ribosomal DNA. At one site both fungal and bacterial community responded to transfer of forest soil to the meadow environment with the shift in fungal community accompanied by a significant decrease in fungal biomass. At the other site, both fungal and bacterial community structures shifted in response to open versus closed cores, with the shift in fungal community accompanied by a decrease in biomass of closed cores, while bacterial biomass increased in closed cores. Fungal biomass of open cores increased in meadow soil transferred to forest and community structure changed, whereas there was no effect on bacterial community structure of transfer. We noted a correlation between fungal biomass decrease, with change in fungal community structure, and decline in mineralizable C upon transfer from forest to meadow. Similarly, there was an increase in fungal biomass and mineralizable C of meadow soil open cores transferred to forest, and of bacterial biomass and mineralizable C in the equivalent closed cores.

Impact: Although we have known for many years that fungi and bacteria are the major microbial components of soils, and that their ratio differs in response to soil properties, no manipulative studies have been performed to determine if the ratios can be changed, and what conditions control the ratios. In this study we showed that both climate and vegetation were major players, and that the fungi were more sensitive to manipulation than were the bacteria. We obtained evidence that soil mineralizable C responded to transfer of soil and to change in the fungal biomass implying that perhaps fungi and bacteria access different pools of C, and that changes in community composition promote changes in the pools of soil C that are being accessed.

Scope of Impact – State, regional, and national
Source of Funding - Hatch, State, Agricultural Research Foundation, USDA
****

Key Theme: Water Quality

Title: Environmental Stresses and Fish Deformities in the Willamette River (Curtis, Environmental & Molecular Toxicology)

Description: Fish deformities in the Willamette River was thought to be the result of pollutants. One site of particular public concern (Newberg Pool) contains the intakes for the Willamette River Water Supply System. However, extensive analytical chemistry detected no concentrations of toxic substances expected to produce these deformities. Field and lab studies demonstrated that parasite infestations of young of the year fish explained the high prevalence of skeletal deformities at certain sites on the Willamette River.

Impact: The information generated in this project was important in providing the public and decision makers science-based information on safety of the Willamette River as a drinking water source. In addition to peer-reviewed articles and news articles, the results of the work were reported to the public by the municipal government of Sherwood, Oregon. This informed voters participating in an election to decide acceptability of the Willamette River Supply System. The vote supported acceptability. The project cost of $21.6-24.5 million as opposed to an alternative project cost of $31-51 million was an economic benefit. The City of Tigard, Oregon is now considering the Willamette River Water Supply System. One might expect similar economic impact for this project and other future project in suburbs southwest of Portland, Oregon.

Title: Microbial Transformation of Tryichloroethene (TCE) in Anaerobic Groundwater (Field, Environmental & Molecular Toxicology)

Description: This study is designed to evaluate the in-situ reductive dechlorination rate in trichloroethene (TCE)-contaminated groundwater at a former landfill, at Hickam Air Force Base, Oahu, Hawaii. In-situ rates are needed to more accurately predict the time required to reduce contaminant (e.g., TCE and vinyl chloride (VC)) concentrations below the remedial action cleanup goals. A numerical flow model was used to predict the time required to achieve the necessary remedial contaminant concentrations for TCE. Push-pull rates were compared to those by conventional modeling. The in-situ rates correlated significantly with the number of Dehaloccocoides-like microorganisms but not with sulfate concentrations.

Impact: The measured rates of TCFE reductive dechlorination rates (determined from push-pull tests) were consistent with the rates obtained from models. This finding indicates that the rates obtained from push-pull test reflect the in-situ TCE reductive dechlorination rates at this site. This information is being used by the Environmental Restoration Office at Hickam Air Force Base to design a long-term remedial action plan.

Scope of Impact – State, regional, and national
Source of Funding - Hatch, State, other federal grants, local government agencies, private corporations

NATIONAL GOAL #5: Enhanced economic opportunity and quality of life for Americans.
Empower people and communities, through research-based information and education, to address economic and social challenges facing our youth, families, and communities.

OVERVIEW

Program/research areas included under Goal 5 of the Oregon Agricultural Experiment Station Plan of Work included: **quality of life and economic well-being**. The following summarizes some of the projects and programs conducted by station personnel in these areas. More specific information related to what was done and what impacts were achieved in each area is include under the Key Theme Information section. Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; GIS climate, geophysical and plant maps; and an array of web pages of an array of types. Our faculty reported that they published 4 refereed journal articles and 5 proceedings papers.

Improving Quality Of Life

Cotton textiles are vulnerable to microbiological attack and degradation. The microbiological infestation on cotton products affects both the cotton industry and the consumers. Our findings from this project provide useful information to the cotton industry regarding the use of none destructive disinfestations method by combining UV and infrared radiations. Poplar seed hair fiber, which is environmentally friendly and is a sustainable agricultural product, could be used for textile thermal insulation. The seed hair fibers from poplar trees are not only environmentally friendly, but they also posses some characteristics such as resistance to moisture and some extent to the attack and degradation by microorganisms. These features render the fiber a good candidate for bulk textile thermal insulation applications.

Consumers want information on safety, quality, sustainability, and region harvested (e.g., local). Application of traceability concepts to the West Coast Pacific salmon fishery in 2006 supported over $2 million in coastal benefits resulting from additional salmon landings. We have used the focus group information to design a market survey instrument for high-end seafood retailers. This survey will be completed in 2007.

Enhancing Economic Well-Being

Between 1999 and 2001, Oregon had the highest average hunger rate in the nation and ranked in the top five states in the rate of food insecurity. Oregon state and local policymakers have made a priority of reducing hunger in Oregon, and promoting economic conditions favorable to reducing hunger and poverty. Our research suggests that food insecurity is influenced by much more than demographics and individual choices. County level factors such as residential location

(rural or urban) and housing costs significantly affect the likelihood that a low-income household with be food insecure.

Educational reform has called for increased science achievement by U.S. students. Oregon has increased the science diploma requirements for high school graduates. A recent study compared perceptions of science teachers and agriculture teachers on integrating science into the agriculture curriculum. Additional research is needed to determine the opportunity for Science and Technology Programs to impact science achievement of students.

TOTAL EXPENDITURES:	$1,463,412
Hatch:	$74,101
Multistate:	$76,718
State:	$1,111,961
Other:	$200,631

(other includes funds from sources such as grants, foundations, etc.)

TOTAL FTE FROM ALL SOURCES: 14.14

KEY THEME INFORMATION

Those researchers and units which conducted the research with quantifiable impacts are identified within each key theme. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected 2 projects from 2 key themes to highlight in this year's report. Two other projects from key themes dealing with economic well-being and consumer economics are described in the multistate section of the report.

Key Theme: Research Design

Title: Improving Methods for Conducting Rural and Agricultural Surveys (Lesser, Statistics)

Description: Response rates to surveys, including agricultural surveys, are declining. Research conducted at Oregon State University Survey Research Center (OSU-SRC) show that use of the same questionnaires and procedures for mail surveys are producing lower response rates than in the past, thus threatening the validity of survey results. Experimental research conducted by committee members in multiple states contributing to this project (Pennsylvania, New Hampshire, Oregon, Washington, and Iowa) has identified ways of improving response rates that can be applied generally across survey populations. They include the careful use of token financial incentives, personalization, and selected other procedures. Other research conducted at the OSU-SRC has been investigating nonresponse error, i.e. tendency for some types of sampled individuals to be more likely to respond than others, to develop better imputations for modeling

and understanding the consequences of non response. The committee's most recent work is focused on web surveys so that they are an effective and accurate method of conducting surveys.

Impact: Discoveries about the causes of measurement and nonresponse error produced by members of this committee have been applied to the redesign of mail surveys and improving response rates. This research program has and will provide scientists in the agricultural sciences professional assistance for designing, administering, and analyzing all aspects of research surveys.

Scope of Impact – State, regional, and national
Source of Funding - Hatch, State, commodity groups

****

Key Theme: Environmental Textiles

Title: Environmentally Friendly Antimicrobial and Disinfesting Techniques for Cotton Textiles by Infrared, Ultraviolet, and Microwave Radiations (Chen, College of Health and Human Sciences)

Description: Cotton textiles are vulnerable to microbiological attack and degradation. The microbiological infestation on cotton products affects both the cotton industry and the consumers. I studied the possibilities of using effective environmentally friendly and safe techniques to disinfest cotton products that are contaminated with mildew. The combination of high intensity UV and continuous infrared radiation for 30 minutes have been found effective in killing the mildew and the spores. During the year, I also laid out a plan to study poplar seed hair fiber, which is environmentally friendly and is a sustainable agricultural product, to be used for textile thermal insulation. The seed hair fibers from poplar trees are not only environmentally friendly, but they also posses some characteristics such as resistance to moisture and some extent to the attack and degradation by microorganisms. These features render the fiber a good candidate for bulk textile thermal insulation applications.

Impact: Although this disinfestation method may not be ideal for immediate commercial use, the findings from this project provide useful information to the cotton industry regarding the use of none destructive disinfestations method by combining UV and infrared radiations - UV radiation is germicidal while the infrared can selectively cause damage to the DNA in the mildew but will not affect the cotton cellulose.

Scope of Impact – State, regional, national, and international
Source of Funding - Hatch, State

****

Key Theme: Consumer Economics

Title: Marketing Issues Affecting the Oregon Seafood Industry: An Empirical Investigation (Sylvia, Coastal Oregon Marine Experiment Station)

Description: Albacore tuna: Testing was completed on a traceability system using bar codes and computers for albacore tuna information on environmental conditions, bycatch, product quality and handling, and location and date of harvests. A web page links traceability information to individual fish which were processed as canned product. The bar coding and traceability system developed for albacore is also being field tested in the Chinook salmon troll fishery in order to develop digital traceability for market use and to track information for science and management purposes.Focus group sessions with consumers on traceability found that consumers want information on safety, quality, sustainability, and region harvested (e.g., local). We have used the focus group information to design a market survey instrument for high-end seafood retailers. This survey will be completed in 2007.

Pink Ocean Shrimp: The modeling research is now completed except for publication. A bioeconomic model was developed to evaluate management options and their effects on policy objectives including fishery yield, revenue, and net present value (NPV) in the Oregon ocean shrimp (*Pandalus jordani)* fishery. The base model accounted for a multiple cohort seasonal fishery, a count per pound catch composition, and an ex-vessel size-price relationship. The model identified optimal harvest strategies for ocean shrimp fishing by selecting the timing and intensity through 12 seasons of fishing effort. Research also focused on the effects of variability of ocen recruitment and changing oceanographic conditions. Modeling results showed that it is difficult to reduce economic variability in the fishery due to significant changes in ocean environmental conditions. Modeling variation resulting from interdecadal oscillations in temperature and upwelling indicate that in some years it may not be economical to fish pink shrimp due to low abundance and the need to protect female shrimp for reproductive potential.

Impact: The albacore tuna and salmon project developed and tested integrated marketing management systems from the vessel to the consumer and back to the vessel that incorporates traceability, product quality information, and value added products. Application of traceability concepts to the West Coast Pacific salmon fishery in 2006 supported over $2 million in coastal benefits resulting from additional salmon landings.

The Pacific shrimp project was to optimizieresource management including optimal timing and amount of industry fishing effort, which can have significant benefits for a fishery suffering from market pressures including low prices, high costs, and inadequate market development. Research to date indicates between 1-6 million dollars in additional economic impacts (net present value) due to improved management of the fishery by opening the season in June and eliminating approximately one third of fishery effort. Ex-vessel and wholesale prices would be expected to increase by 10-20% and costs decreased by 30% or more. Eliminating fishing in years of low recruitment may generate up to $2 million dollars in economic benefits.

Scope of Impact – State, regional, national
Source of Funding - Hatch, State

B. STAKEHOLDER INPUT PROCESS

Actions Taken to Seek Stakeholder Input and Encourage Their Participation

At Oregon State University College of Agricultural Sciences (CAS), there are several formal avenues for soliciting stakeholder contributions. These groups meet fairly regularly to aid in the direction and guidance of our programs. These include:

1. Dean's Advisory Council – this small advisory council is composed of industry, consumer, and environmental representatives
2. Advisory Councils of each department and branch station – these include membership drawn from the discipline or relevant region
3. Advisory Councils of each county extension office – these are more broadly based and relate to extension program areas in a county or region. Agriculture is one of the Extension program areas in Oregon.

In 2006, CAS leaders also met with a number of Oregonians who work in agricultural, natural resource, and bioenergy industries and organizations for two days of discussions in March, 2006. Over 60 external stakeholders were invited to the meeting with CAS administrators and faculty and select University administrators. CAS and OSU administrators posed questions and listened to what attendees had to say, then compiled these stakeholders' comments, observations, and suggestions. The summary was posted on the CAS website and points were used to modify the CAS Implementation Plan.

The meeting's objectives were to:

a. conduct a forum with the College of Agricultural Sciences and its stakeholders to share and discuss the College's Strategic Plan, budget information, proposed Policy Option Packages, and other University issues related to the College
b. seek stakeholders' views, opinions, insights, and recommendations relating to the College's overall direction and priorities for the future
c. seek stakeholders' views of the issues facing them in their livelihood or professional pursuits
d. seek stakeholders' views of what they expect from the University

Stakeholders felt that the environment in which the industries operate were changing rapidly and the College needed to help them prepare for the crossroads of change. Among the strategies of interest were the:

- creation technological needs as labor becomes more scarce and expensive
- development of a new generation of leadership to help develop new markets for Oregon's diverse agricultural production
- provision of unbiased, credible information and forums for discussion of new ideas
- preparation of students for future work, including development of communication skills, common sense approaches, and uncommon business and professional savvy.

OSU/CAS has and continues to solicit and receive thoughtful critiques and sometimes views that differ from its own. Responses are prepared in a timely fashion.

Research, extension and education faculty within the College of Agricultural Sciences (CAS) represent a wide array of disciplines at Oregon State University (OSU). Their scope of impact reaches stakeholders at the local, state and national levels. In an effort to solicit input from these stakeholders, there are several levels of participation which directly result in opportunities for discussion necessary for continual advancement toward recommended program goals. A sampling of actions taken are provided as follows:

1. OSU/CAS also took part in the planning processes of other units at Oregon State University, including the OSU Extension Service.
2. The College's Agricultural and Resource Economics Department is assessing the effects of university-industry relationships on the type and quantity of agricultural biotechnology research in U.S. universities. Of particular interest is how these relationships affect the excludability of biotechnology research, that is, the degree to which the research is immediately profitable, as opposed to being useful only in the public domain.
3. The Horticulture department organized a stakeholder meeting of the nursery industry and related organizations including Oregon Department of Agriculture, USDA, Oregon Association of Nurserymen, Chemeketa, Horticultural Research Institute and the Oregon Garden.
4. Crop & Soil Science faculty annually discuss departmental priorities with commodity commissions through informal commission meetings and formal special sessions held during grower association meetings. Several faculty work with metro-based businesses (biosolids, cereal breeding, grain dealers, and milling/baking companies).
5. The Coastal Oregon Marine Experiment Station rotates their Board meetings to different locations along the coast and advertises the meetings in local newspapers. A partnership with ShoreBank Enterprise Pacific has formed the Community Seafood Initiative. The mission of this partnership is to foster entrepreneurship, and to help small and mid-size enterprises in the seafood industry to develop products and enter new markets. Engaging stakeholders of various sectors will ensure successful delivery of the program goals. A web site called "Heads-Up" disseminates information about the program as well as giving timely research information.
6. Experiment Stations throughout the state hold "Field Days" for industry and community members to observe research in progress and to discuss new issues. Grower meetings are held to seek input on research needs. Advisory board meetings are held to discuss current research programs and future research direction and needs.
7. We also have active initiatives with the Confederated Tribes of the Warm Springs and the Confederated Tribes of the Umatilla. These include a broad array of programs in education and research. These and other tribes participate in undergraduate teaching in the college particularly in developing a multicultural understanding of natural resource management. OSU degree programs in Natural Resources and General Agriculture are available at Warm Springs. The university has a long standing memorandum of understanding and cooperation with the Confederated Tribes of the War Springs that as been mutually beneficial and includes extension, academic teaching and research.
8. The college operates education programs that focus on Hispanic populations of the region. Hispanics play a major role in the agriculture of the Pacific Northwest. Areas of emphasis have been in the nursery crop and tree fruit crop growing regions of the state.

Process Used for Identifying Stakeholders and Approach Used to Collect Input from These Groups: Oregon has approximately 30 statutorily appointed commodity commissions and grower organizations. Most of these have research committees, and the membership of these groups provide a rich source of engaged individuals from the natural resources community. Oregon has a wealth of active environmental, consumer, and community organizations including the Isaac Walton League, Oregon Environmental Council, the Nature Conservancy, Defenders of Wildlife, and Sierra Club, the Food Alliance, Oregon Tilth, and other organizations. The university has a minority Board of Visitors to advise the university and its component colleges on minority affairs. The college also has student governance through the Agricultural Executive Council. This is a very active student council with representatives from over 30 student organizations representing a broad base of students. These groups add breadth to more traditional student groups expected in a college of agriculture. These organizations provide a broad perspective for input to the management of the College.

How Input Was Considered: Pertinent feedback is received from various stakeholders on a wide range of research and program initiatives which are currently in progress. As a result of the input received, OSU administrators and faculty modify work plans to improve the design of administrative and research projects and provide specific opportunities for continued feedback. Information is disseminated to communities through newsletters, local newspaper coverage, and radio programs. Administrators and faculty use input to prioritize resource allocations, inform other researchers and policy makers of trends and concerns. Recommendations from various advisory boards represent key constituent views, and are useful in the developing extension programs which reach the agroproduction sector.

C. PROGRAM REVIEW PROCESS

There have been no significant changes in our program review processes since our 5-Year and 2-year updated Plans of Work were submitted.

D. EVALUATION OF THE SUCCESS OF MULTI AND JOINT ACTIVITIES

The OAES actively encourages our scientists to participate in multistate activities. The OAES currently has 118 scientists who contribute to 94 multistate projects under the five National Goals (see the following list of projects).

- NATIONAL GOAL #1 (NC-1029, NC-1031, NC-1036, NC-1131, NC-1142, NC-506, NCCC-022, NCCC-173, NCERA-180, NCERA-190, NE-1011, NE-1012, NE-1018, NE-1020, NE-1024, NECC-1008, NECC-1009, NRSP-6, S-294, S-1004, S-1007, S-1020, SCC-80, SDC320, SERA-008, W_TEMP-2081, W-006, W-106, W-1004, W-1112, W-1128, W-1133, W-1147, W-1150, W-1168, W-1171, W-1177, W-1185, WDC-010, WERA_TEMP-2001, WERA_TEMP-2061, WERA_TEMP-2181, WERA-27, WERA-39, WERA-43, WERA-58, WERA-60, WERA-69, WERA-72, WERA-77, WERA-89, WERA-97,WERA-99, WERA-110)

- NATIONAL GOAL #2 (SDC-313)
- NATIONAL GOAL #3 (NC-1023, W_TEMP1981, W-1002, W-1003, W-1005)
- NATIONAL GOAL #4 (NC_TEMP508, NC_TEMP2461, NCERA-3, NCERA-59, NCR-193, NCERA-125, NRSP-3, S-1014, W_TEMP1881, W_TEMP2201, W-1045, W-1170, W-1186, W-1188, W-1190, W-1192, WCC-1003, WERA_TEMP2221, WERA-21,WERA-40, WERA-1008, WERA-102, WERA-103)
- NATIONAL GOAL #5 (NCAC-012, NCAC-024, NC-1011, NCCC-065, NCCC-134, NE-1029, W-1001, W-1006, W-1177, W-2133, WERA_TEMP-2121,WERA-1001)

Each multistate project submits an annual report on the group's activities, accomplishments, publications, and plans for the future to the National Information Management Support System , i.e., NIMSS. The Western Research Coordination and Implementation Committee is responsible for evaluating each new or revised proposal for projects originating from the Western Region, as well as progress in each of the ongoing projects of the Western Region. The OAES reviews progress reported by its scientists into the Current Research Information System towards the objectives of the multistate projects in which they are enrolled, no matter the originating region of the multistate project. Comments are provided to the faculty member and their unit heads for use in performance reviews.

MULTISTATE KEY THEME INFORMATION

This section describes some of the multistate activities and programs conducted by station personnel. Those researchers and units which conducted the research with quantifiable impacts are identified. When appropriate, details of the calculations used to derive the economic impact are presented to substantiate the claim. We selected six (6) projects from five (5) key themes in three (3) goals to highlight in this year's report. As mentioned elsewhere, research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops; GIS climate, geophysical and plant maps; and an array of web pages of an array of types.

Goal 1: Global Agricultural Profitability

Title: Enhancing the Competitiveness of US Meats (Gow, Agricultural & Resource Economics)

Description: In the cattle industry, marketing strategies have traditionally focused on the weight, price, and timing of the marketing to increase producer's profits. Typical marketing strategies included things such as backgrounding animals before feedlot placement; stocking animals on pasture or rangeland; fall calving; and retaining ownership of animals until finished. These strategies were based on the thought that beef was a commodity and value was added by the middleman. However, low profitability and changes in consumer demand has increased attention on niche markets and value-added activities as means for long-term viability in the beef industry. Today, many producers no longer think of their product as a generic commodity without intrinsic qualities and that in order to be valued it must be process or changed by a middleman. Rather producers are now thinking of their product as a consumer product in of

itself. Producers now realize that they control the quality of the final product and are capable of adding attributes to the products that consumers want. Production and management practices can directly impact the taste, freshness, or nutritive value of the product as well as the products image in the minds of consumers. These attributes cannot change or be added with processing or commercial inputs. While many of these concepts of adding-value and niche marketing are not new, they are certainly new to many in Oregon's beef industry that have relied primarily on commodity marketing. Producers in this region remain relatively unfamiliar with the concepts of niche marketing and value added activities. Producers are open to exploring these alternatives, but are still uncertain on how to go about moving from a commodity based production systems to producing for a niche market. Producer education on these marketing alternatives is key to the long-term success of smaller beef cattle operations that cannot necessarily get larger to stay competitive. This effort has focused on providing education to producers on how to implement these concepts on their operations. The goal of the efforts from 2006 was to provide information and practical examples on strategies such as niche marketing, product branding, traceability, and process verification for adding value.

Impact: In 2006, producers from around the region participated in a workshop that focused on marketing options for beef producers. Two publications also focused on producer education and awareness of alternative marketing strategies. These publications discuss the marketing alternatives for beef cattle producers who are interested in adding value to the beef they produce. The first article discusses the basic concepts of adding value, how this has traditionally been thought of in the beef industry, and the need for niche marketing of agriculture products. The second part discusses alternative niche marketing strategies to adding-value for the beef producer, including natural, organic, branded, and cooperatives/alliance niches. An extension publication series was also developed in 2006 that addresses current livestock marketing issues and will be forthcoming in 2007.

****

Goal 1: Plant Health

Title: Genetic Variability in the Cyst and Root-Knot Nematodes (Ingham, Botany & Plant Pathology)

Description: Columbia root-knot nematode (CRKN), *Meloidogyne chitwoodi*, infects potato tubers and cause quality defects that can lead to crop rejection. Most traditional rotation crops in the area (wheat, corn, alfalfa) are good to excellent host crops for CRKN and increase populations between potato crops. This requires intensive chemical inputs to reduce populations to acceptable levels before potato can be planted. Current management generally uses soil fumigants that are effective but are also expensive ($200 or more/acre) and add hundreds (160-350) of pounds of pesticide active ingredient (a.i.)/acre to the soil. Using alternative rotation crops that support little or no reproduction by CRKN can reduce the need for nematicides. However, acreage demand for these crops is low and acreage demand for traditional crops is high.

A four-year rotation experiment was conducted at the Hermiston Agriculture Research and Extension Center in Hermiston Oregon. The experimental site began with high CRKN populations, in spring of 2001. Various cash crops and cover crops suitable to the region were grown to evaluate cropping sequences that may reduce populations of CRKN. Results from this study demonstrated that CRKN could be managed with crops currently grown in the Columbia Basin of Oregon and Washington if excellent host crops were grown early rather than late in the rotation. Alternative rotations may have been more successful if starting populations were lower. Therefore, in long season potato cultivars grown in warm regions, rotation may need to be augmented with nematicides, perhaps at reduced rates. Management would be improved by screening for crop cultivars that are poorer hosts and for more suppressive green manure crops. Management of CRKN with rotation may be more successful with shorter season cultivars or in cooler climates.

Impact: This project demonstrated that traditional host crops could be grown in rotation with alternative non-host crops and green manure cover crops and still reduce CRKN populations. This strategy provided opportunity to grow crops high in demand, required less use of crops in low demand and still reduced CRKN populations and tuber damage.

****

Goal 1: Plant Production

Title: Assessing Nitrogen Mineralization and Other Diagnostic Criteria to Refine Nitrogen Rates for Crops and Minimize Losses (Yin, Mid-Columbia Agricultural Research & Extension Center)

Description: Nitrogen and water use are both inefficient on orchards in the Mid-Columbia region; which has resulted in excessive N and water use, increased production costs, reduced fruit quality, and contaminated water. Although growers and state agencies have found these problems, there were no means available that growers could use to solve them. The objective of this project was to develop best N and water management systems for orchards. Two different N and water management systems (split fertigation of N fertilizer under drip irrigation, single broadcast application of dry N fertilizer to soil surface under micro sprinkler irrigation) were compared under different pear cultivars and rootstocks. Different N application rates and timings were evaluated on Anjou pears. Four ground cover systems and two irrigation systems were evaluated on sweet cherry.

Impact: The split N fertigation and drip irrigation system seems to be an effective replacement to our current N and water management system. Nitrogen fertilizer and water use was reduced by 20% and 70%, respectively, using the split N fertigation and drip irrigation system compared with our current system. Fruit yield and quality were comparable under these two production systems. The profitability of each system has not been calculated; however, the researchers believe that the split N fertigation and drip irrigation system will be more profitable. Additionally, the current N application rates used by growers could be reduced significantly.

Single-line irrigation saved over 70% of irrigation water; which could reduce orchard nitrate leaching.

Title: Reducing Barriers to Adoption of Microirrigation (Shock, Malheur Experiment Station)

Description: We tested drip irrigation systems on potato, onion, poplar trees for saw logs, and native forb seed production. Native forb seed production was achieved with the drip tape buried at 0.3 m depth between two adjacent rows of forbs. Water was managed to apply only 0, 100, and 200 mm of water per year. Good forb seed productivity was obtained with very low levels of irrigation. Soil micro-environmental effects of microirrigation on potato compared drip, sprinkler and furrow irrigation and examined the role of bed configurations on tuber microclimate. Based upon results from bed configurations and irrigation treatments tested, potatoes performed best planted in flat beds and irrigated with drip or sprinkler irrigation. Flat beds appear to provide cooler soil temperatures near developing tubers.

Impact: Observations for onion growers' records showed that growers continue using 115 kg/ha less fertilizer N when irrigated with SDI than in furrow-irrigated onion. Micro irrigation has the potential to reduce water use, leaving more water in streams and reservoirs. Surface water contamination of streams can be less with micro irrigation and groundwater contamination by nitrate and pesticides can be sharply lower. The environmental benefits of micro irrigation can only be achieved if micro irrigation proves to be economically feasible through reductions in other costs not related to the added costs of the micro irrigation system and improvements in crop yield or quality. Drip-irrigated onion has expanded to about 5,000 acres in the Treasure Valley and above 10,000 acres in the Pacific Northwest. There were 2,300 acres in Malheur County, with vastly reduced N inputs and no irrigation-induced erosion and associated pollutant runoff. Thirty to 40 percent less water was required using SDI.

****

Goal 4: Soil Quality

Title: Chemistry and Bioavailability of Waste Constituents in Soils (Sullivan, Crop & Soil Science)

Description: Recent adoption of national rules for organic crop production have stimulated greater interest in meeting crop N needs using manures, composts and other organic materials. This study was designed to provide data to support Extension recommendations for organic amendments. Specifically, our objectives were to (i) measure decomposition and N released from fresh and composted amendments and (ii) evaluate the performance of the model DECOMPOSITION, a relatively simple N mineralization/immobilization model, as a predictor of N availability. Amendment samples were aerobically incubated in moist soil in the laboratory at 22degreesC for 70 days to determine decomposition and plant available nitrogen (PAN) (n = 44), and they were applied preplant to a sweet corn crop to determine PAN via fertilizer N equivalency (n = 37). Modeled PAN values were typically higher than observed PAN,

particularly for amendments exhibiting high initial NH4-N concentrations or rapid decomposition. Based on our field and laboratory findings, we recommend that guidance publications for manure and compost utilization include short-term (28-d) decomposition and PAN estimates that can be useful to both modelers and growers.

Impact: This research will assist small-scale farmers to develop management systems that utilize local organic inputs to produce high-quality, high-value crops efficiently, profitably, and sustainably. This research provides estimates for local growers of nitrogen availability from local organic materials. Research findings will be used to revise current OSU Extension publications for small-scale growers. The findings of this research have already been incorporated into an online calculator ("Organic Fertilizer Calculator", available at http://smallfarms.oregonstate.edu/fertcalc.php).

****

Goal 5: Economic Well-being

Title: Rural Communities, Rural Labor Markets and Public Policy (Weber, Agricultural and Resource Economics)

Description: Between 1999 and 2001, Oregon had the highest average hunger rate in the nation and ranked in the top five states in the rate of food insecurity. Given that the state did not have a high poverty rate (Oregon was near the national average), there was much debate about whether the estimate was reliable. Given the consistency of the estimate over independent samples in several years, the debate turned to causes. Are people hungry in Oregon because of restricted opportunities, unfortunate personal choices or ineffective policies? A multidisciplinary team of researchers in Oregon conducted several analyses in a project initiated under a cooperative agreement with Economic Research Service of USDA. In a shift-share examination of state-level hunger rates, the team found that hunger rates were higher than would be expected in certain demographic groups in Oregon: 2-parent households, and households with full-time full-year workers. This team also fit a multivariate logit model that examined the extent to which household demographics, local economic and social conditions and federal food security program explained the likelihood of food insecurity in Oregon, using data from the 2000 Oregon Population Survey. They found that food insecurity is influenced by much more than demographics and individual choices. County level factors such as residential location (rural or urban) and housing costs significantly affect the likelihood that a low-income household with be food insecure.

Impact: Oregon state and local policymakers have made a priority of reducing hunger in Oregon, and promoting economic conditions favorable to reducing hunger and poverty, without a clear knowledge about which economic conditions are most important. This research suggests that housing costs may be a particularly important factor in Oregon in explaining food insecurity. The findings of this research have been cited in local, state and national media and widely used in policy discussions about hunger. There is particular interest in whether community-based

policy can play an important role in reducing hunger, and the findings about housing costs have given another policy tool to local officials in addressing food insecurity.

E. INTEGRATED RESEARCH AND EXTENSION ACTIVITIES

Oregon State University has a unique organizational approach that integrates research and extension programs. All faculty in the statewide branch stations have an academic home in a campus department. They are full members of the department faculty and are fully enfranchised in the departments, colleges and university. As an example, extension faculty members stationed in a county unit hold an academic appointment in a department and fully participate in promotion and tenure activities of the department. They hold tenure track and professorial positions. They are fully represented in the Faculty Senate of the university. They plan and implement education (both academic and extension) and research programs in a fully integrated fashion.

The following seven (7) projects are good examples of our efforts related to integrated research and extension activities.

Title: Sustaining Local Food Systems In A Globalizing Environment: Forces, Responses, Impacts (Larry Lev, Agricultural & Resource Economics, ORE00685A)

Issue: The globalization of food supply presents significant economic, social, and environmental challenges to Oregon agriculture. As the agriculture and food system becomes more concentrated, it also becomes more vulnerable to disruptions and prone to accidents. This project works to increased knowledge and understanding about the forces that motivate and shape the formation of local food systems and affect food system sustainability.

What has been done: Interest and participation in direct and local marketing remains high and has been expanded to cover much of the state. Earlier events have spun off and now operate successfully on their own (e.g., in La Grande and Portland). The Oregon Board of Agriculture (ODA) requested an in-depth briefing on farm direct marketing and one result of that briefing was the decision by the ODA to become a financial sponsor of the annual direct marketing conference.

Three extraordinary participatory research events were conducted in 2005. In March, a rapid market assessment was conducted of the Hillsdale Winter farmers market. The participants were Oregon farmers and market managers who wished to learn market research techniques and observe a functioning winter market. In June a one-half day market research workshop was conducted as a pre-conference activity for the Agriculture and Human Values Conference. The 20 participants were academics from the US, Canada, Australia, and Italy who wanted to learn market research techniques and observe two Oregon markets. In September, 18 market managers and public sector officials from the U.S. and Canada attended a 2.5 day workshop to learn about market research techniques and visit seven Oregon markets. The net result of these activities was a quantum leap in the spread of these OSU developed research approaches. They are now being used throughout the U.S., Canada, and the U. K. On-going work through efforts funded by the

Western Risk Management Center include the development of a new enterprise screening tool and a value-added toolkit.

August 2005 marked the end of a major USDA/IFAFS grant that focused on direct and local marketing. New proposals were submitted during the year that seek funding for a professional development educational effort to better understand alternative marketing opportunities and a research project to document the emergence of an Agriculture of the Middle for producers who are not competitive in commodity markets and too big for direct markets. In terms of publications, the most significant accomplishments are a (1) detailed extension style manual that explains the costs and benefits of third party certification for agricultural producers, (2) contributed chapters on marketing and certification to the 2006 Farming Sourcebook (3) three rapid market assessment reports. A draft paper on changes in numbers of farmers markets in the state provides the first detailed assessment of numbers of individual markets that have opened and closed. All previous studies have examined net changes and therefore missed this part of the story.

Impact: By all available measures, direct and local food markets continue to boom in Oregon. The number of farmers markets grew from 38 in 1998 to 68 in 2005 while the number of both farmers and restaurants/retailers in the Ecotrust/ Chefs Collaborative guide doubled between 2002 and 2005. OSU has played a key role through outreach, research and training activities. The OSU Small Farms Program workshops and conferences have provided many producers with an entry-level training in direct marketing. Over the period 2000-2005 more than 130 individuals participated in at least one of the 18 rapid market assessment studies and received research methods training. As a direct results of these studies, individual markets have taken decisions to change (or not change) market frequency, length of season, hours, product mix, advertising outlets and a host of other difficult decisions. To cite one example, based on a 2004 OSU-led study, the Winchester U.K. market decide to double the number of markets in 2005 and achieved a doubling of market sales. Communities and statewide organizations have made policy decisions more favorable to direct marketing based on a better understanding of the benefits gained. OSU research results have been put to use in other ways. Just in the past two years, OSU research results have played a key role in successful grants proposal written by the Hillsdale Winter Farmers market and the Ecumenical Ministries of Oregon and in submitted proposals by the Corvallis/Albany Farmers Market Association and the statewide Oregon Farmers Market Association.

Title: Sustainable Soil, Water And Crop Management Strategies For Semiarid Oregon (Don Wysocki, Columbia Basin Agricultural Research Center, ORE00183A)

Issue: Soil and water conservation are very important in sustaining dryland farming in semiarid Oregon. Adopting direct seed farming and producing high end use quality wheats are important aspects that will keep farms in Oregon profitable. This project examines direct seed farming practices and nutrient management strategies. The purpose of this project is to test and develop conservation farming practices that protect soil health and water quality and improve wheat end use quality and maintain or enhance current wheat markets.

What has been done: Cropping systems research was conducted on nitrogen fertility of wheat, variety development of winter and spring canola, and yellow and brown mustard. Nitrogen rate and timing trials were conducted on hard red winter wheat, hard red spring wheat, hard white spring wheat, and soft white spring wheat at Pendleton, Oregon. Trials were sown in the fall of 2004 and 2005 resulting in 80 experimental units each season. Results of these trials collectively show that among fertilizer treatments and varieties optimum nitrogen fertilizer varied significantly with landscape position, soil depth and available water. Canola trials consisted of 24 lines of winter canola sown and Pendleton and Hermiston, Oregon. Trials at Hermiston are irrigated, while trials at Pendleton are rainfed only. Up to 4000 lb/seed per acre were obtained at Hermiston and 2700 lb/seed per acre at Pendleton. Spring yellow and brown mustard and canola were direct seeded into various residue management treatments. Yields were 500-700 lb/acre. Residue was left standing, burned, harrowed, or flail mowed. Canola was more sensitive to residue than either brown or yellow mustard. Brown mustard performed the best of the three crops

Impact: Direct seeding of winter and spring cereals varies between 10 and 80 percent of cropland acres in counties in eastern Oregon and Washington. Information from direct seeded wheat and nitrogen management is helping growers refine fertility rates and apply the appropriate amount of nitrogen, phosphorus and sulfur. Canola research has enable growers to direct seed into chemical fallow and produce acceptable stands and consistent yields. Growers have pooled funds and sought grant money to form an LLC to market value added products from canola. The LLC has received $12,000 in grants monies. A local farmer owned cooperative has purchased crushing equipment and will have crush facilities on-line by January 2006

Title: Integrated Pest Management (IPM) Of Arthropods of Pear in Southern Oregon (Phil VanBuskirk, Southern Oregon Research and Extension Center, ORE00274)

Issue: Managing pests in a cost-effective and environmentally friendly manner is an important component of a profitable and sustainable tree fruit industry in Oregon. The goal of this research is to develop and implement an integrated pest management program in tree fruit, which minimizes the use of disruptive, broad-spectrum pesticides and maximizes the benefits of naturally occurring biological control agents through the use of selective pest management techniques. The project will also look at the impact that ground covers may have on pests and beneficial species. In chemically constrained systems, emphasis will be given to pesticide resistance management, and evaluation of new pesticides for efficacy and impacts on beneficials.

What has been done: Adoption of IPM technologies in southern Oregon orchards has continued through this past year. The project continues to show when implemented correctly and using the most up to date information, results in reduced pesticide use while maintaining high standards of fruit quality. Approximately 50% of the local tree fruit acreage (3,000 acres) is currently utilizing mating disruption based IPM programs with minimal use of problem insecticides (e.g. organophosphates, carbamates, pyrethroids), with one-third of the acreage using no more than one organophosphate or carbamate application in 2006. We continue to show in our surveys that an additional 75% of the tree fruit acreage (4500 acres) employs monitoring of pest populations and use of weather data and phenology models to predict pest development,

together these data are used to reduce the number of unnecessary pesticide applications. Access to these weather data and phenology models has been facilitated by the Pest Alert web page, which continues to have approximately 20,000 hits annually. Thanks to a new grant from the American Farm Trust obtained in 2006 we now have over 60 acres of orchards that are transitioning to or are now certified for organic with and additional 80 acres to be added in 2007. These orchards are utilizing organically approved pest management tactics such as mating disruption, codling moth granulosis virus and kaolin particle films, which were first tested locally at the Research Center. Growers representing two-thirds of the tree fruit acreage attended the biweekly pest management forums and discussed monitoring methods and results, and used this information to modify and improve their pest management programs.

Impact: Southern Oregon IPM program has been implemented on 75% of pear acreage in southern Oregon. There has been a 90% reduction of OP's in orchards where IPM program was implemented. There has been a 75% reduction of all synthetic pesticides in pear orchards where program has been implementing. We have been successful in implementing organic pest control practices in 3% of our pear acreage in southern Oregon where pest damage at the end of the first year (2006) was equal to conventional orchards in the area

Title: Value-Added Processing For Fish And Fishery By-Products (Jae Park, Coastal Oregon Marine Experiment Station, ORE00498A)

Issue: Conventional protein recovery system yields 20-25%, resulting in a significant amount of unused proteinous materials. Surimi processing also leaves 33,000 mt of refiner discharge in the U.S. each year. Dark muscle fish such as sardine has not been utilized as human food yet. This project investigates a new protein recovery system, using pH shift, for the recovery of functional proteins from Pacific whiting and sardine. In addition, consumer-friendly gelatin from surimi by-products will be developed. The overall objective is to investigate various ways for maximum utilization of fish and fishery by-products through protein recovery using pH shift and upgrading feed/waste to food.

What has been done: Biochemical characteristics of Pacific whiting muscle proteins extracted at acidic, neutral, and alkaline conditions were investigated as affected by various ionic strength levels. Protein solubility at pH 4 declined, as NaCl was added up to 200 mM, due to protein aggregation through hydrophobic interactions. In contrast, at pH 7 and 10, solubility increased as NaCl was added up to 400 mM after which it remained constant. Changes in total SH content and So were highly related to the different molecular weight distributions of the soluble proteins. Physicochemical characteristics of sarcoplasmic proteins (SP) from rockfish and their interaction with Alaska pollock surimi (myofibrillar proteins) were investigated. Solubility of SP was significantly suppressed at acidic pH (2-4) and in the presence of high salt concentration (0.5 M NaCl). Addition of SP appeared to delay thermal denaturation of myosin and actin. The least amount of proteins was lost when SP were treated at pH 2 or 3 followed by precipitation at pH 5.5. Gelation properties of SP were inferior to myofibrillar proteins, but positively contributed to gelation with myofibrillar proteins as judged by breaking force.

Impact: Studies of protein solubility at various pH confirmed that the maximum level of proteins can be extracted and recovered if the proper pH condition is provided, which contributes to improved yield and increased profits. Gelation properties of SP were inferior to myofibrillar proteins, but positively contributed to gelation with myofibrillar proteins as judged by breaking force. SP proteins could therefore be beneficial in gelled products by improving yield of Pacific whiting harvests for human use and reducing protein lost in waste water streams.

Title: Bridging The Divide - Collaborative Integration Of Research And Community Development (Michael Morrissey and Gil Sylvia, Coastal Oregon Marine Experiment Station, ORE00945)

Issue: There is a need to maximize the economic impact of existing and future research on rural and distressed coastal communities in Oregon and Washington and elsewhere. It is important as well to involve communities in rebuilding their economy and protecting their natural. This project will use a coordinated network of institutions and industry groups that combines research, education, and community and economic development in a community-based delivery model to support rural communities. The collaborators include the OSU Seafood Laboratory and Coastal Oregon Marine Experiment Station, the Duncan Law Seafood Consumer Center (a non-profit regional facility providing links between the seafood industry and the consumer, and promoting the consumption of seafood through education, training, research and dissemination of information) and Shorebank Enterprise Pacific (a non-profit conservation-based loan fund that services the Oregon and Washington coast, specializing in providing capital and business services to promising ventures which add value, provide quality employment opportunities, and offering long term economic and environmental integrity to rural coastal communities).

What has been done: One of the most significant results in this project was the formation of the partnership between Oregon State University and ShoreBank Enterprise Pacific, a community development financial institution. This partnership which began with the OSU Seafood Laboratory, the Coastal Oregon Marine Experiment Station and ShoreBank has expanded to include other institutions such as the Seafood Consumer Center and Oregon Sea Grant and is now called the Community Seafood Initiative (CSI). CSI has been able to continue after the initial USDA funds were expended by obtaining additional support from federal grants, foundations and private capital.

The mission of the partnership is to strengthen food systems in rural communities by supporting key catalysts for change. CSI does this by encouraging small businesses to cooperate in new ways around common goals; and creating pathways for harvesters and processors to easily access traditionally disparate resources--research knowledge, product and market assistance, and business and capital assistance. Partnerships like CSI are vital for economic development, especially when most rural communities have minimal to no institutional resources available for small food producing businesses to assist them through the process of change. The outcomes for the CSI are categorized by 1) RESEARCH AND TECHNOLOGY and 2) EXTENSION AND EDUCATION.

RESEARCH AND TECHNOLOGY: CSI has implemented a systematic product development process (Stage-Gate) to assist small and mid-size businesses in developing new value-added products. Some of these products include a salmon-jerky, frozen shellfish products

and fish products focused toward the Hispanic marketplace. Small-boat albacore fishermen have also benefited by using time/temperature effects on quality to improve their onboard handling techniques and expand into new markets and receive a higher ex-vessel price. The Dungeness crab fishery is pursuing Marine Stewardship Council certification with CSI assistance which signifies sustainability of their fishery and opens additional markets. The nutritional value found through research on West Coast fish, primarily albacore, on omega-3 fatty acids and low mercury levels, is being quoted in marketing and sales materials of many fishermen and small coastal processors and has helped to expand their markets. There has also been an increase in the number of local businesses using new technologies such as high pressure processing, flexible packaging and ultra-fast freezing which is generating new opportunities for value-added products.

EXTENSION AND OUTREACH: CSI continues to hold beneficial industry training workshops on value-added products and new market opportunities. These workshops include presentations on the realities of accessing new markets, how to develop new products, research opportunities that can improve business practices, and where to go to get the resources. Several attendees have followed up for direct one-on-one assistance or assistance for an entire association, like the Pacific Shellfish Growers. We also have educated over 500 end-consumers a year on the benefits of consuming and purchasing value-added seafood that is harvested and processed locally.

Impact: CSI has exceeded its investment goals for coastal seafood businesses by investing more than $1 million and providing product development assistance to over 15 businesses which resulted in six new products launched into the marketplace. CSI has also provided planning and development assistance to over 40 businesses. In addition to our proposed outcomes, CSI has raised the profile and value of scientists, institutions and organizations that support food system change. The activities include 1) presenting our work at key seafood conferences and to key state officials; 2) creating a product development system and resource pool to help entrepreneurs successfully develop value-added products; 3) applied research projects requested by small and mid-size businesses that helps sustain the resource and strengthen their position in the marketplace. CSI has helped increased and/or preserve the number of economically successful locally owned food related enterprises. The financial investments and technical assistance of CSI has retained 205 jobs and created 35 new jobs for seafood harvesting and fishing companies. CSI has leveraged financial resources and strategically grew the number of active partners. Every year CSI has raised an additional $150,000 or more from other funding sources to support our activities. CSI has also attracted new food market experts and public partners to assist in our activities.

Title: Ecological Analysis Of Rural Land Use Practices (Pat Kennedy, Eastern Oregon Agricultural Research Center, ORE00147)

Issue: There is data to suggest the decline in agroecosystem biodiversity is related to changing agricultural practices, and these changes have caused declines in a wide variety of plants and animals. For example, there is evidence that nesting populations of ferruginous hawks and Swainson's hawks are declining nationally and being replaced by red-tailed hawks (the white-tailed deer of the raptor world) as human disturbance increases in native rangelands. It is

important to determine the landscape and land use factors that contributed to supporting earlier abundant raptor populations as well as to evaluate past and present trends in landscape change. Such information will allow the development of sustainable rural land use practices that include mitigation of direct lethal effects, e.g., reducing electrocution of raptors by rural powerlines, and enhanced habitat management, e.g., development of ecologically sustainable grazing practices. .

What has been done: This OAES project consists of four research and extension components:
(1) We were awarded a four-year USDA National Research Initiative grant for $450,000 to conduct and 'Experimental Analysis of Cattle Stocking Rates on Rangeland Biodiversity.' The research team has held Planning sessions, hired doctoral students, and established a project web page.
(2) The team completed the third field season in an examination of whether the Zumwalt Prairie still excellent hawk habitat and have applied for additional funding from USDA NRCS, Wildlife Habitat Management Institute to conduct a 4th and final field season in 2006. Also in 2005, the team was awarded a $96,000 grant from The Nature Conservancy to hire post-doctoral research associate in landscape ecology to analyze the temporal changes in the land use patterns of this landscape relative to hawk habitat. Dr. Anne Bartuszevige started with EOARC January 1, 2005 and is scheduled to continue working until the end of 2006. As a result of her efforts and the efforts of our computer/GIS Specialist, Colette Coiner, we have georeferenced a digitized all of the historic aerial photos for this landscape (photos are available every decade since 1938). These are ready for landscape analyses to evaluate the landscape changes that have occurred in the hawk nesting territories.
(3) 'The Influence of Rural Powerlines on Rangeland Raptor Populations' is being conducted by a PhD student (Robert Lehman) who has submitted his first dissertation chapter for publication review. He has produced a draft of the second chapter and is expected to finish his dissertation (3-4 chapters) by the end of 2006.
(4) Initial efforts investigating the 'Effects of Livestock Management Alternatives on Riparian Biodiversity' were devoted to working with a private company to develop a fenceless method of livestock control in riparian areas. However, that collaborative relationship ended at the end of 2005 when the company did not making sufficient progress at developing a workable prototype. Instead, a collaborative relationship was established with Dr. Ken Diebel with the Oregon Department of Agriculture to evaluate the effectiveness of private land riparian restoration efforts at restoring wildlife habitat. A proposal to EPA Region 10 is pending.

Impact: The team expects to produce ecological information that can be used by scientists, managers, policy makers and local landowners to identify and develop natural resource management practices that both maintain biodiversity and are economically viable.

Title: Utilization Of Municipal And Industrial Byproducts In Agriculture (Dan Sullivan, Crop and Soil Science, ORE00162)

Issue: Byproducts from farms, industry, and cities have nutrient value for crop production, but careful management practices are needed to protect environmental quality. Projects with municipal biosolids, wood ash, paper processing sludge, food processing residuals, and composts are underway or anticipated. Understanding and managing nitrogen and phosphorus in

byproduct-amended soils is identified as a key area of project focus across a variety of industrial and municipal byproducts. This project develops guidelines for appropriate utilization of byproducts to protect environmental quality and to provide economical alternatives to landfill disposal or incineration.

What has been done: As interest in food waste composting grows, so does the need for proven low-technology composting methods. Stability testing has been proposed as a compost quality assurance tool to verify that finished compost will not serve as a substrate for human pathogen regrowth. We conducted this study to: (i) to evaluate the efficacy of low-technology, outdoor composting methods in producing a compost with a low, stable decomposition rate, and (ii) to determine the reliability of simple, 4-h compost stability evaluation methods.

Composting was conducted outdoors in winter and spring in Eugene, Oregon without moisture addition. Mixed food waste was combined with screened dairy solids and ground yard trimmings. Sawdust was used to cover windrows for the first 27 d of composting. Compost windrow temperatures remained above 55 oC for 30+ d. Carbon dioxide evolved with several 4-h test methods was strongly correlated ($r2 > 0.7$) with CO2 evolved using a 48-h test. A limited-turn windrow (LTW) composting system produced compost with slightly greater stability than a passively aerated windrow (PAW) composting system. Food waste compost samples had a low CO2 evolution rate after 71 to 99 d using either system. Compost CO2 evolution rate at 25 oC decreased with composting time, reaching approximately 1 to 4 mg CO2-C g compost C-1 d-1 for the PAW method and 0.5 to 2 mg CO2-C g compost C-1 d-1 for the LTW method. Putrescible organic matter in food waste was effectively decomposed by low technology composting methods. Several 4-h stability tests showed promise for implementation as quality assurance tools.

Impact: Improved compost testing procedures provide better management of the composting process, thereby improving product quality and reducing composting costs. Effective, reliable, composting methods for putrescible materials like food waste assist solid waste managers in reaching recycling goals, provide valuable soil amendments for soil improvement, and provide business opportunities for local entrepreneurs.