Plan of Work Report

University of Idaho

College of Agricultural and Life Sciences

Idaho Agricultural Experiment Station

Federal Fiscal Year
2003

Index to IAES Plan of Work

Plan of Work for the College of Agriculture and Life Sciences, Idaho Agricultural Experiment Station (IAES), University of Idaho

Introduction

This **Plan of Work (POW) Report** describes the research programs and impacts of the College of Agricultural and Life Sciences (CALS) and the Idaho Agricultural Experiment Station (IAES) for fiscal year 2003, as required by the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA). The IAES research project portfolio is segmented into nine different "programs" or thematic research areas which are linked to the five National REE Goals. IAES Programs 1-4 are linked to **REE Goal 1**, IAES Program 5 is linked to **REE Goal 2**, IAES Program 6 is linked to **REE Goal 3**, IAES Programs 7 and 8 are linked to **REE Goal 4**, and IAES Program 9 is linked to **REE Goal 5**. While this organization of the IAES research program portfolio is somewhat arbitrary and imperfect, it does represent a logical framework for accountability reporting for the first POW multi-year cycle. Given changes that occur over a 5-6 year period within a university and college and, more specifically, the dramatic personnel and budget reductions that the University of Idaho, the CALS, and the IAES have experienced in the previous two budget years and are experiencing for the current budget year (Idaho FY 2005); our next POW will likely have a more simplified organizational structure. Conceptual development of our next POW is in the early stages of development.

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Background Information

University of Idaho

The University of Idaho was created in 1889 by the territorial legislature with a major objective to offer all people higher education in the arts, letters and sciences. Total enrollment during the 2002-2003 academic year was 12,894 including 2,499 graduate students, and 309 law students. The University serves as the main center for research, professional education and research-based graduate programs and has the primary responsibility for granting the Doctor of Philosophy degree in the state of Idaho. In order to carry out its statewide mission, the University maintains instructional centers in Coeur d'Alene, Boise, Twin Falls, and Idaho Falls. Off-campus instruction is also presented at extension offices in 42 of 44 counties, 12 research and extension centers and field stations.

The University of Idaho is a Doctoral/Research University-Extensive, the most comprehensive Carnegie Foundation rankings among Ph.D. granting research universities. The National Science Foundation (NSF) reports that UI historically receives 80-85% of all federal

agency science and engineering research funds awarded to Idaho universities and colleges. In its latest available ranking, NSF reports UI ion the top 25% (119 of 547) of U.S. universities and colleges in total research and development expenditures from all sources. There has been a 68% increase in total research funding from all sources since 1991.

College of Agricultural and Life Sciences

In addition to traditional campus instruction, the College of Agricultural and Life Sciences at the University of Idaho serves communities across the state with agricultural and family and consumer science research, and extension or "outreach." The fall 2003 enrollment totaled 1,120, which is an all-time high for the College. The FY03 budget, including all revenue sources, was $63.4 million. The college maintains twelve agriculture research centers across the state to meet unique regional research needs. Almost half of the 214 college faculty members and 300 staff (210 permanent staff positions) are located off of the Moscow campus at research and extension centers and cooperative extension offices. Since the last reporting period, the College of Agricultural and Life Sciences has experienced severe budget reductions that have resulted in an approximate 15% reduction in both faculty and support staff positions

Idaho Agricultural Experiment Station (IAES)

The Idaho Agricultural Experiment Station (IAES) was created in 1892 with a federal allocation due to the Morrill Act (1862), which established the U.S. land-grant educational system and the Hatch Act (1897). The College of Agricultural and Life Sciences has always been a major contributor to research efforts at the University of Idaho due the basic philosophy that founded the land-grant educational system and the fact that agriculture has always been a major segment of the Idaho economy. The IAES and College of Agricultural and Life Sciences have a long tradition of supporting Idaho and Pacific Northwest agriculture, rural communities and families, and food processing industries with information derived from its agricultural research programs. Since it's beginning, the IAES has been closely linked with- and responsive to- the needs of our stakeholder citizens. Accordingly, the majority of the projects in the IAES research portfolio has been and currently is mission-oriented and has been conceived and conducted as a result of stakeholder input. Obviously, these projects (approximately 80% of the IAES project portfolio) entirely or fractionally address specific research priorities articulated by stakeholders. About 20% of the IAES research projects fall into the realm of fundamental research and are focused on the discovery of new knowledge and answering more fundamental questions in the life sciences rather than addressing a specific agricultural or societal problem. This latter category of projects allows the IAES to be responsive to research priorities of the broader university and their importance to the IAES portfolio is both appreciated and supported by many, if not most, of our stakeholders.

The IAES's current Plan of Work and for this POW Report, the research project portfolio has been divided into 9 different "**Programs**" or broad thematic research areas that fall under the five National RE&E Goals. This has been explained above in the introduction and is further delineated in the text that follows.

IAES Program Progress & Impacts for FY2003

REE Goal 1: An Agricultural Production System that is Highly Competitive in the Global Economy

Impacts for REE Goal 1

IAES Program 1: Plant Germplasm, Genetic Resources and Conservation, Plant Health and Well Being

The Idaho National Plant Germplasm Program provides material to public and private programs to study specific traits and develop improved cultivars. Combined, our researchers participated in the release of 15 plant varieties (4 potatoes, 9 wheat, 2 rape/mustard) with improved agronomic or end use functionality/quality during this reporting period. Idaho contributed to the Northwest Potato Variety Development Program. Added value of potato variety releases is estimated at $135 million. Some newer potato varieties use water and nitrogen more efficiently than Russet Burbank, allowing for significant savings to the grower and decreased potential for nitrate leaching. In 2003, 18% of the soft white winter wheat grown in Idaho was from two cultivars (Lambert and Brundage) produced by IAES breeders. In addition to the new release of 'Brundage 96', other examples of promising new wheat cultivars developed include Jerome (hard red spring) for irrigated production in the Pacific Northwest and Idaho 587 (soft white winter) with resistance to imidazoline herbicides. The Idaho rape/mustard programs have developed for Northwest growers, yellow and oriental mustard, Athena winter canola, and the Raptor resistant cultivars which are resistant to Persuit herbicide. This latter trait allows growers to include a legume and Brassica in a six year rotation with cereals. Our bean breeding program is focused on producing high yielding great northern and pinto bean cultivars and breeding lines resistant to major diseases. The Sandpoint R & E center has conducted groundwork for establishing a huckleberry and bilberry industry based on cultivation and managed fruit production. A newspaper article on the IAES huckleberry research program by Associated Press in 2003 was carried in newspapers and electronic media across the United States, generating numerous queries for more information on these crops.

Our biocontrol research addresses issues affecting Idaho and the Northwest US. We showed that planting a green manure crop can reduce losses from rhizomania, in addition to planting of resistant varieties. Efforts are in place to commercialize Pseudomonas corrugata for use as a fungicidal seed treatment; it increases yields by at least 27%. Similar findings were observed for Ganoderma lucidium's helminthocidal activity. Experiments suggest that accurately applying insecticides affecting feeding behavior via degree-day make it possible to revise the green peach aphid management plan for PLRV control and reduce the cost and environmental impact. Olfactometer studies are used to provide an understanding of biocontrol for predatory mites and powdery mildew in hop; powdery mildew control costs can be reduced by as much as $50.00/acre. Biofumigant research is aimed at developing Best Management Practices for Brassica green manures in potato cropping systems and improving N and P rate recommendations for onions and small grains in Southern Idaho. Other research aimed at preparing grazing guidelines for control of noxious weeds allows land managers to more carefully implement grazing in weed control efforts to reduce the damaging effects of noxious weeds and create a new type of livestock enterprise.

The economic impact of IAES research on potato, corn, and onion seed treatments is significant. One ongoing study investigates effectiveness of primed onion seed and treatment with Ridomil. These treatments add substantial cost to growers in Idaho ($3 to $15 / acre; 18,000 acres annually in the Treasure Valley) but have not yet been evaluated in the field. New seed piece treatments for managing potato Rhizoctonia canker and black scurf are providing alternatives to established chemistries and are important preventing pathogen fungicide resistance. Other work on potato seed storage demonstrated that cultivars respond differently to various treatments in regard to early growth, yields and yield profiles. It also indicates the lessened impact of seed aging on final yield and tuber size for long-season cultivars. The seasonal affect on seed physiology and age impacts how the seed responds to storage conditions and field performance. IAES researchers have obtained data which assist in choosing sweet corn seed treatments for different genotypes and various geographical regions.

Plant pathology studies have made progress in protection against viral infections. Ongoing studies on virus epidemiology will benefit consumers and producers. New viruses with a potential to reduce yield and quality of potatoes have entered the US. One program utilized sequence information and characterized a new strain of Potato Virus V, making it possible to assay for these viruses in an effort to eradicate them from US seed potato stocks. One IAES researcher discovered virus induced previously unrecognized volatile compounds produced from interactions between plant viruses and their aphid vectors. This finding could allow their exploitation to limit virus spread. Initial studies will focus on potato leaf roller virus and barley yellow dwarf virus, two of the most destructive crop viruses worldwide and pea enation mosaic virus, the most important virus of dry peas in north ID.

IAES continues to be conduct basic and applied studies of microbial life processes and food microbiology. Investigators have been assessing novel methods for detecting microbes in soils. This group is also characterizing rhizosphere isolates for potential use as inoculants that promote legume growth as antifungal biocontrol or therapeutic agents for agriculture and medicine. Other work investigates molecular genetics of fungal sporulation using Aspergillus as a model to obtain insights into the control of aerially dispersed spores of both pathogenic and beneficial fungi. One program developed an Agrobacterium based method to transform rhododendron leaf explants. We also discovered GTPases and coiled-coil proteins in prokaryotic organisms and shown that these proteins interact with one another in ways similar to homologs in higher organisms. The further association of these proteins with motility is an important breakthrough of general significance to evolutionary biologists. Further work on optimize storage to minimize cracks in foods during processing will yield food and biomaterials with improved quality that are not easily damaged by microbes and are preferred by the consumers.

IAES Program 2: Animal Health and Well-Being

Animal infectious disease research in Idaho focuses on the molecular and cellular basis of host-pathogen interactions and when relevant, biology of insect vectors. The beef and dairy industries in Idaho consistently rank among the top 3 revenue generating Idaho agricultural commodities. Infectious diseases compromise productivity of these industries in the Pacific Northwest and throughout the US. IAES researchers focus on key infectious agents. One group investigates microbial superantigens and their role in staphylococcal bovine mastitis. This group also is exploring the use of these bacterial proteins as vaccines to reduce mastitis and somatic cell counts. Gram negative pathogens are also important causes of disease. Research on Yersinia, E. coli O157, and Campylobacter type III secretion systems is leading to an

understanding of their roles in motility and toxin secretion. This work is important because it could lead to novel mechanisms of intervention and targeted drug delivery. Our researchers recently discovered a novel type III system and demonstrated the cross utilization of type III secretion apparatuses for secretion and motility. This latter finding provides the first experimental explanation for the mutually exclusive temperature regulation of motility and secretion. Despite extremely low incidence in ruminants in the U.S., transmissible spongiform encephalitis is of critical concern to the dairy and beef industries in the Pacific Northwest. Researchers in Moscow and at the Caine Veterinary Center are involved developing diagnostics for scrapie. Research this past year showed that there is no single good tissue for scrapie diagnosis. Increasing the number of lymphoid tissues tested increases the sensitivity of the diagnosis for live animal testing or slaughter surveillance. Additional work at the Caine Center is addressing ruminant infections caused by Cryptosporidium andersoni, Mycoplasma sp. and Pasteurella trehalosi so that their incidence can be monitored and to assess whether vaccines could be effective.

We also place considerable efforts toward understanding cell physiology and gene regulation and their roles in health and disease. One research program, studying interactions between insulin and leptin, is exploring mechanisms for manipulating cellular signaling pathways to improve the efficiency of nutrient utilization of nutrients and consequently profitability of beef production. Other complementary research on cellular apoptosis and intraflagellar transport in algae are excellent models for studying diseases in humans and animals. The discovery by IAES researchers that proteins involved in intraflagellar transport are homologues to those involved in polycystic kidney disease and retinal degeneration was a key advancement in understanding the evolutionary relatedness of this protein family.

Dietary studies can provide information to enhance animal production yields and also allow producers to modify practices to minimize their impact on the environment. One study this year demonstrated that energy requirements of cattle may be met economically by a 40% substitution of grain for conventional forage. Ammoniation of low quality forages may also provide an alternative to expensive conventional forages. Also, overfeeding of ruminally available nitrogen to dairy led to increased urinary nitrogen losses and less efficient use of dietary nitrogen for milk protein synthesis, thus potentially contributing to nitrogen pollution by dairy operations.

Infertility has the largest impact on profitability in animal agriculture. IAES reproductive biology programs are aimed at improved efficiency of artificial insemination in dairy and beef cattle. Estradiol is known to play an important role in fertility. To enhance estrous synchronization and breeding in dairy cows, GnRH is routinely used to induce ovulation, even though exogenous GnRH may impair ovarian estradiol secretion prematurely. Our researchers showed that administering a low dose of estradiol when GnRH is used to induce ovulation may overcome the premature GnRH-induced estradiol suppressions and improve fertility in dairy cattle. Similarly, studies of Mx gene expression in peripheral blood cells provides an opportunity to examine timing of early pregnancy signaling and determine non-invasively when pregnancies are lost. Results should help reduce days open in the cattle industry.

IAES Program 3: Crop and Livestock Production Systems

Crop and livestock production are impacted by many IAES researchers. Three projects focus predominantly in this program and are described in this section. Two research projects impact crop production systems. One has been studying new proportional chemical injection

control systems for center pivot systems. These systems are equipped with an end gun and/or corner watering system. Results of our confirm that this technology reduces chemical over-application that can result in groundwater contamination and increase production efficiency by increasing chemical application precision. Others have confirmed the negative effect of high rates of phosphorus on potato yield, tuber quality, and zinc nutrition in vines and leaves. Although this effect has been shown in other soil and environmental conditions, these studies confirmed the phosphorus induced zinc deficiency in conditions typical in the Pacific Northwest. The impact of this zinc deficiency is impacting large portions of potato fields in our region. It is estimated that uniformly fertilized fields (as opposed to variable rate fertilization) have 10 to 40% of the field impacted by this problem. Net yield loss is estimated at 2-10% in these localized areas. The economic impact is estimated at $10-$100 per acre for the average grower. Although management options have not been fully defined at this time, growers are encouraged to: 1) base phosphorus fertilization on soil test results, 2) apply zinc in conjunction with phosphorus, and 3) variable rate apply fertilizer based on intensively soil sampled management zones.

Conjugated linoleic acid from dairy products has numerous beneficial activities when consumed. An Idaho researcher has been studying activities in humans and CLA's physiology in beef and dairy cattle. In this past year, this group showed that studying the effects of CLA in bovines via intravenous infusion can be utilized as an alternative to abomasal infusion. This allows the study the mechanism of action without having to install a rumen cannula and will greatly facilitate the future studies of CLA in ruminant animals.

IAES Program 4: Farm business management, economics and marketing

The IAES maintains an economic database which was updated for acreage, production, and price changes. Personal interviews were conducted with Idaho scientists to account for new projects and renewed old projects during the last five years to complete phase two of the database. This study shows the benefit of continued investment in agricultural research. Results of a waste utilization study will help farmers reduce synthetic fertilizer use and lower production costs to agriculture and reduce phosphorous run off.

IAES research pioneered the biodiesel industry in the US and expanded its use abroad. Biodiesel is now produced commercially in all 50 states. Successful incorporation of biodiesel will require enhancing its commercial feasibility. Yellow mustard is a feedstock which could reduce the cost of biodiesel and add to its commercialization. Work on lubricity will make biodiesel more attractive as a blend with diesel as ultra low sulfur diesel comes to market. This will require integrated processing and utilization of oil seeds. To accomplish this we 1) extract toxic chemicals in the meal for use as natural pesticides 2) isolate erucic acid from high erucic acid oils for use in industrial products such as lubricants, surfactants, engineering plastics, and 3) incorporate advanced techniques for biodiesel production to reduce costs.

Trade reforms strongly influence US food processing and agricultural commodity markets. Examining the characteristics of the food manufacturing sector is critical for analyzing the trade reform effects on processed foods industries and bulk commodity markets. The Pacific Northwest Wheat Shipment spatial model was revised and tested using applications involving technical barriers and user charges. Also, the noncompetitive behavior of the food processing firms needs to be considered. The results of these studies provided an information basis to support legislators and other policy makers.

Two issues facing Idaho in recent years are drought and land development. Continued droughts in Idaho have had major impacts on agriculture. IAES research into Best Management

Practices under drought conditions, benefits growers. We provide information on water supply conditions and advice on growing practices under varying severity of drought. Crop insurance is identified as a valuable risk management tool for Pacific Northwest producers. We continued our analysis of how development pressures affect farmland values. Research results are being used to assist land-use policy makers in several Idaho counties. Related work continues on a USDA IFAFS grant - Understanding, Evaluating, and Improving Direct Marketing Strategies of Small Farms in the northwest US.

RESEARCH PROJECT ANNUAL REPORTS

IAES Program 1: Plant Germplasm, Genetic Resources and Conservation, Plant Health and Well being (RPAs 102, 121, 123, 133, 201, 202, 203, 204, 205, 206, 211, 212, 213, 214, 501, 502). This program area constitutes the largest program of the IAES and includes 40 active research projects enrolled in CRIS and approximately 29.33 Scientist Years (SY) of research effort.

Performance Goals:
Identify and manipulate plant germplasm to improve crop plant performance and the production of seed and other plant products. Develop economical, biological and socially compatible crop management strategies that increase production efficiency.

1. PLANT GENETIC RESOURCE CONSERVATION AND UTILIZATION

Investigators: Zemetra, R. S.
Termination Date: 09/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
During the last six years over 4,000 accessions involving over 200 species were ordered by researchers/individuals from the National Plant Germplasm system. The average number of individuals ordering germplasm each year was 25 with the split between private and public programs/individuals being 14 and 11 respectively. Species used at the University of Idaho include Triticum aestivum, Hordeum vulgaris, Brassica napus, Sinapis alba, Pisum sativum, Phaseolus vulgaris and Solanum tuberosum. The germplasm was used for cultivar development and for physiological studies. Research in the cereals included evaluation of germplasm for insect resistance, disease resistance and agronomic traits of use for wheat improvement in the Pacific Northwest. Germplasm lines were developed and released for public use with improved insect resistance. Accessions were also used to determine the potential for gene flow between weedy species and agronomic crops. As part of the renewal for this regional project a new project has been initiated to utilize Aegilops cylindrica germplasm as a new source of genes for wheat (Triticum aestivum) improvement.

Impact:
The collection, evaluation and distribution of plant germplasm by the National Plant Germplasm Program is essential for improving the productivity and profitability of the nation's farms.

Germplasm from the plant introduction stations have been utilized by both public and private programs/individuals in Idaho to study specific traits and to utilize the germplasm in both public and private plant breeding programs to develop improved cultivars. These improvements will lead to increased productivity while improving profitability for producers and the companies that produced the improved cultivars. Private individuals have also evaluated germplasm in hopes of identifying unique characteristics of various species that they could market.

2. DOMESTICATION OF WESTERN HUCKLEBERRIES

Investigators: Barney, D. L.
Termination Date: 06/30/2008
Reporting Period: 07/01/2003 to 12/31/2003

Progress Report:
Work completed earlier in this program was detailed on the termination report for project IDA01153, which terminated 6/30/2003. This project continues that research. Germplasm collection, establishment, and evaluation continue as part of a cultivar development program. Breeding continued in 2003, with efforts to create monospecific genotypes representing black huckleberry (Vaccinium membranaceum) and oval-leaved blueberry (V. ovalifolium), plus interspecific hybrids between these two species, Cascade huckleberry (V. deliciosum), highbush blueberries, lowbush blueberries, and half-high blueberries. Preliminary data relating to the compatibility and success of such crosses in producing viable seed was collected. In crosses with domestic blueberries, black huckleberry proved more effective as a seed parent than a pollen donor, while oval-leaved blueberry proved more effective as a pollen donor than seed parent. No oval-leaved blueberries evaluated to date have been self-fruitful, while approximately 57% of black huckleberries have set and ripened fruit following self-pollination. The degree of self-fruitfulness varies between genotypes and years. Numbers of viable seed produced by interspecific crosses and self-pollination were significantly lower than for cross-pollinations within single species. Twenty black huckleberry, 12 oval-leaved blueberry, and one bilberry (V. myrtillus) genotypes were identified as early selections. Plans are to distribute eight black huckleberry and four oval-leaved blueberry selections to cooperating growers in 2005 for field evaluation in different growing regions. Shade and soil physiology trials continue, as does development and testing of model production systems for field cultivation and management of forest Vaccinium colonies. Soil samples associated with huckleberry, bilberry, and wild blueberry colonies in five northwestern states have been collected and will be analyzed for physical and chemical profiles beginning in late 2003. Trials to refine in vitro propagation of black huckleberry, Cascade huckleberry, and oval-leaved blueberry are underway. Trials to refine seed propagation protocols for Cascade huckleberry, oval-leaved blueberry, dwarf huckleberry (V. caespitosum), red huckleberry (V. parvifolium), and evergreen huckleberry (V. ovatum) are underway. An herbarium collection representing ten Vaccinium species in Idaho, Oregon, Washington, Montana, and Wyoming was developed and donated to the University of Idaho herbarium. Seeds from the same species were donated to the USDA-ARS National Clonal Germplasm Repository in Corvallis, Oregon.

Impact:
Much of the groundwork needed for establishing a huckleberry and bilberry industry based on cultivation and managed fruit production has been competed. Production guides describing risks

and opportunities, site selection and preparation, selection and propagation of plant materials, crop management, and marketing have been made available to prospective growers in print, on-line, and at workshops and conferences. A newspaper article on the University of Idaho huckleberry research program by Associated Press in 2003 was carried in newspapers and electronic media across the United States, generating numerous queries for more information on these crops.

3. DOMESTICATION OF WESTERN HUCKLEBERRIES

Investigators: Barney, D. L.
Termination Date: 06/30/2003
Reporting Period: 01/01/2003 to 6/30/2003

Termination Report:
We have made significant progress toward managed production of western huckleberries, bilberries, and blueberries (genus Vaccinium section Myrtillus). Germplasm has been collected from throughout the species' range. Seed germination protocols have been developed and are being refined for six species and in vitro propagation techniques for five species. Seedlings have been established and a cultivar development program begun. The program includes efforts to develop intra- and intersectional progeny using section Myrtillus species, as well as hybrids between Myrtillus species and domestic highbush and lowbush blueberries. In 2003, 20 black huckleberry (V. membranaceum), 12 oval-leaved blueberry (V. ovalifolium), and one bilberry (V. myrtillus) genotypes were identified as early selections. Eight black huckleberry and four oval-leaved blueberry selections will be distributed to cooperating growers to evaluate performance in other regions. Flavor chemistry analyses were completed for Cascade huckleberry (V. deliciosum), black huckleberry, and oval-leaved blueberry, with comparisons to highbush blueberry. Profiles of anthocyanins and other bioactive compounds with potential health-related benefits have been determined for Cascade huckleberry, black huckleberry, oval-leaved blueberry, evergreen huckleberry (V. ovatum), red huckleberry (V. parvifolium), alpine bilberry (V. uliginosum), and wild cranberry (V. oxycoccus), with comparisons to highbush and half-high blueberries. Cascade and black huckleberry have excellent flavors, with antioxidant potentials similar to domestic blueberries. Oval-leaved blueberry and evergreen huckleberry are less flavorful, but contain significantly higher anthocyanin concentrations and antioxidant capacities than do domestic blueberries. Section Myrtillus species' antioxidant activities relate primarily to high concentrations of cyanidin and delphinidin. Domestic blueberry antioxidant activities are related primarily to high concentrations of phenolic acids, particularly chlorogenic and caffeic acids. Physiology trials are underway to determine optimum soils and shading levels for production in managed forest stands and cultivated fields. Model production systems have been developed and test plantings started. Many prospective huckleberry growers have been contacted and provided information on risks, opportunities, and production techniques. Production guides have been published in print and on extension websites. A study evaluating present and potential markets and marketing strategies has been completed. Cascade and black huckleberry appear to offer excellent and alpine bilberry reasonable, potential for managed production of fruit for culinary products. Oval-leaved blueberry may have potential as a source of nutritional and botanical products. Despite its small plant and berry size, bilberry is harvested commercially from the wild in Europe and marketed widely for culinary use and as a source of health-related products. It may have potential for cultivation in North America. Evergreen

huckleberry fruit yields appear too low to be of commercial use, but the foliage is used commercially in floral arrangements.

Impact:
Decreased yields of wild crops due to forest and fire management policies, decreased access to public lands where huckleberries are found, and increased fruit prices spurred by overseas export threaten this industry. In a region where rural unemployment and poverty often exceed national averages and natural resource industries, such as logging and mining, are severely restricted, huckleberry and bilberry production and processing offer economic opportunities. The ability to produce reliable, high-quality, reasonably-priced fruit should allow expansion of the industry, while allowing people in the region to maintain their cultures and utilize an important natural resource unique to that region.

4. MANAGEMENT OF RHIZOMANIA DISEASE OF SUGARBEET

Investigators: Gallian, J. J.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
STANDARD RHIZOMANIA VARIETY TEST. Rhizomania varieties adapted to the Idaho and eastern Oregon growing area were tested at Twin Falls in 2003 on a previously rhizomania-free field that had been inoculated with rhizomania in 2002 and planted to sugarbeets to establish the disease. Additional inoculum in the form of rhizomania-infested soil was applied in planting beds in 2003 immediately prior to planting. Thirty-four varieties plus one susceptible commercial check were planted on May 7, 2003, to be tested for root yield and quality, and rated for disease. Disease was mild and uniform throughout the test, and symptoms of rhizomania were observed in mid-July. Average root yield/A of the 9 highest performing varieties was 9.5 tons higher than the susceptible check. The average estimated recoverable sugar for the top 8 varieties was 3589 lb/A higher than the susceptible check variety. Root disease ratings in mild disease conditions ranged from 87.5 to 99.2% resistant in the resistant varieties compared with 74.6% resistant in the susceptible check. GLYPHOSATE/RHIZOMANIA VARIETY TEST. A field test of varieties with resistance to both glyphosate and rhizomania was conducted under the same conditions as the standard test. The test included three glyphosate resistant varieties, one standard rhizomania resistant and one rhizomania susceptible variety as checks. Root yield for two of the three glyphosate resistant varieties was greater than the rhizomania susceptible check. Recoverable sugar/A, however, was not different among any of the rhizomania resistant varieties and averaged 2990 lb/A greater than the susceptible check. GREEN MANURE FOR RHIZOMANIA MANAGEMENT. Oilseed radish (Raphanus sativus) that is used as a trap crop for sugarbeet cyst nematode (Heterodera schachtii) is being tested as a green manure for rhizomania management. Oilseed radish had been planted August 20, 2002, at Twin Falls, Idaho, at a seeding rates of 25 lbs/A on a rhizomania infested field in a randomized complete block design with 8 replications and plots 33 x 100 ft. Radish was incorporated on November 7, 2002 by double disking and plowing. Rhizomania resistant (Beta 4490R) and susceptible (HM Owyhee) sugarbeet varieties were planted on May 8, 2003, following the green manure treatments. These varieties consistently perform equally under disease-free conditions but in this test root yield of the resistant variety was greater than the susceptible in the untreated check

treatments by 10.1 tons/A. With green manure treatments, the susceptible variety was greater in root yield by 1.2 tons/A than the untreated check. There was no difference with the resistant variety in the green manure treatment. Experiments will be continued in 2004. Oilseed radish was planted in three experiments on August 22, 2003, at Twin Falls, Idaho, disked twice and plowed down on November 18 and 19, 2003. Resistant and susceptible sugarbeet varieties will be planted in the spring of 2004. Yield and quality differences will be measured and disease ratings taken. The effect of the green manure crop on several soil physical properties will be measured.

Impact:
Using information developed by this project, growers reduce loss from rhizomania. Rhizomania resistance continues to be developed and improved by sugarbeet seed companies, and growers are recognizing the need to plant resistant varieties. In addition to planting resistant varieties, growers must use additional management practices to achieve acceptable yields under rhizomania conditions. Data from this project shows that planting a green manure crop can be a valuable practice for improved disease control. Each year there is increasing sugarbeet acreage of oilseed radish being planted by growers for rhizomania management, and it is expected that losses from rhizomania will continue to decrease as these practices are further adopted.

5. BIORATIONAL DISEASE CONTROL
Investigators: Chun, W. W.
Termination Date: 09/30/2003
Reporting period: 01/01/2003 to 09/30/2003

Termination Report:
Pseudomonas corrugata is a bacterial pathogen that causes pith necrosis in tomatoes and a few cultivars of peppers. However, its has strong antibacterial and antifungal activities. We utilized the antifungal nature of Pseudomonas corrugata as a biological control agent. Biological control strains were patented (US Patent No. 6,156,560) and deposited with the American Type Culture Collection. These strains were specifically selected for their superior fungicidal ability and processed to be tolerant of desiccation. This was further followed by the development of a process to process these bacteria as talc based formula with a shelf life in excess of eight months at room temperature (US Patent No. 6,383,798). The biological control bacterium was tested and shown to reduce Pythium and Aphanomyces root rot on peas when the talc formula was applied as a seed treatment. Yield increase ranging from 27% to 45% were obtained in annual field evaluations. However, it is a plant pathogen so the genetic region required for pathogenicity was identified by transposon mutagenesis, and characterized by sequencing. These mutants showed increased antifungal activity and is being explored in future studies. Our exploratory work has identified unique antifungal, antibacterial and helminthocidal activities in Ganoderma lucidium, the chicken of the woods fungus. These extracellular activities are detected in liquid culture, less than 3,000 in molecular weight; not lipid soluble, and sensitive to heat. A plant hormone like effect was also detected in heat treated culture fluids. The third line of investigation has shown that extracellular polysaccharide production by Xanthomonas campestris pv. campestris is essential for pathogenicity. Also identified was a Bacillus species and Xanthomonas vesicatoria that are effective competitors and antagonists of X. c. pv. campestris on crucifer leaves.

Impact:
Efforts to develop a commercial product with Pseudomonas corrugata would lead to a new fungicidal seed treatment that can be used in combination (to increase effectiveness of fungal disease control), or alone (in rotation with chemical fungicides to reduce resistance). Use of the bacterium in a background of mild soil pathogen infestation increases yields equal to or greater than 27% which would be a significant income return relative to the low cost of applying the bacterium. Greater impact is expected with Ganoderma lucidium, especially for its helminthocidal activity. Current options available for nematode control in agricultural crops is limited and no new chemistries are being developed due to prohibitive cost. Developing the activity from G. lucidium will be a major tool available for all crops and is expected to significantly enhance agriculture competitiveness.

6. MANAGING PLANT MICROBE INTERACTIONS IN SOIL TO PROMOTE SUSTAINABLE AGRICULTURE
Investigators: Chun, W. W.
Termination Date: 09/30/2008
Reporting period: 10/01/2003 to 12/31/2003

Progress Report:
Current work examined specific biological components produced by microorganisms and their effect on crop performance. LCF is a fermentation culture of Ganoderma lucidium in waste pineapple juice. The material is filtered and boiled to eliminate microorganisms. This material is produced by ABR, LLC in Maui, HI and has plant growth stimulating properties when applied as drench or as a foliar spray to plants. We examined the ability to use this material as a seed treatment on chickpea. In 2003, chickpea seeds were treated with different concentrations of LCF. It was found that a 1:64 dilution applied to chickpea seed, can increase stand establishment by as much as 17% when disease pressure from Pythium spp. is high. This was significantly better than a combination of Apron and Maxim treatment. In combination with Apron and Maxim singly, a synergistic increase over the LCF treatment alone was observed.

Impact:
There is an apparent interest in agriculture for this product. Pineapple producing companies are employing this material as a plant growth enhancer to compensate for slight phytotoxic effects from synthetic chemicals. We expect that we will be able to adapt this material successfully for dryland crops. Unlike other biologicals, this material appears to work by assisting plant root and foliar growth to compensate for damage caused by pathogens. Thus, it is a new opportunity to explore a relatively new method for plant disease management other than antibiosis or induced resistance.

7. BIOLOGY AND MANAGEMENT OF INSECT PESTS OF WHEAT IN IDAHO
Investigators: Bosque-Perez, N. A.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
Research was conducted in two main areas: 1) Biology and management of wheat insects and 2) Host plant - virus - vector interactions. Studies were conducted from 1998 - 1999 to determine the abundance and distribution of Hessian fly and its parasitoids in northern Idaho. Surveys of commercial wheat fields were conducted in eight counties, and samplings done in variety trials in Bonners Ferry, Genesee, Lewiston, and Greencreek, Idaho. Hessian fly was found in all northern counties where wheat is grown. Seven species of hymenopterous parasitoids were identified. Parasitoids were collected from flies in all eight counties. Parasitism levels varied widely depending on location and year, and ranged from 10 to 85%. A Hessian fly colony was established in our laboratory in 1998 and used regularly to conduct resistance screening tests. Over 150 breeding lines and varieties were evaluated for fly resistance in the laboratory over the last five years. Evaluation of wheat breeding lines for resistance to Russian wheat aphid was also conducted. This work, conducted in collaboration with wheat breeders, resulted in the development and release of insect resistant germplasm and varieties. Tests conducted in collaboration with Roger Ratcliffe, confirmed that the biotypic composition of Hessian fly in Idaho is complex. The percentage of each biotype identified in fly samples from Lewiston was: GP=25%, E=8%, F=38%, G=12%, L=4%, M=3% and O=10%. Four biotypes (GP, E, F, and G) made up 83% of the sampled population. Biotype E is virulent to H3. However, field trials and samplings in farmer's fields over the last five years revealed that the H3 resistance gene continued to exhibit effectiveness in controlling Hessian fly in northern Idaho. Field trials were conducted from 2000-2002 near Genesee to evaluate the incidence of Hessian fly under no-till (NT) and conventional till (CT) practices. Data on Hessian fly egg density from all three years show bimodal egg density variations (i.e. two insect peaks: one during the spring and one in the early summer). Significant differences in mean number of Hessian fly puparia per plant were observed during the last two sampling periods in July 2002, when CT plots had higher numbers of puparia per plant than NT plots. NT plots had a lower percentage of infested plants than CT throughout the growing season in 2002. Studies on host plant - virus - vector interactions included experiments to measure life history of insect vectors on non-infected and virus-infected plants. BYDV infection of susceptible wheat enhanced the life history of the bird cherry-oat aphid. Nymphal development was significantly shorter and aphid fecundity significantly greater on BYDV-infected than on non-infected plants.

Impact:
The medium term goal of our work is to provide growers with two new spring wheat varieties with resistance to Hessian fly. Information from this work will help growers manage pest populations to optimize productivity under no-till systems.

8. FACTORS INFLUENCING THE ACQUISITION, TRANSMISSION, AND SPREAD OF PLRV BY APHID VECTORS

Investigators: Mowry, T. M.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
Experiments testing six insecticides for their efficacy in killing green peach aphids and their ability to limit PLRV acquisition and inoculation were completed. Imidacloprid, thiamethoxam

and pymetrozine were excellent aphicides and significantly reduced PLRV transmission. Based on these results, field experiments were conducted to determine if certain combinations of insecticides would control green peach aphids in the potato crop and reduce the spread of PLRV. Green peach aphid degree-days corresponding to peak seasonal population development were used to trigger four insecticide applications consisting of alternating combinations of imidacloprid, pymetrozine, and/or thiamethoxam. For comparison, the current Pacific Northwest Green Peach Aphid Management Plan was included as an additional treatment. The Plan calls for a systemic insecticide at planting and application of foliar insecticides if aphids exceed the threshold. Experiments revealed that the insecticide combinations triggered by accumulated degree-days controlled green peach aphids as well as the Management Plan. Using degree-day triggers, only four insecticide applications were made throughout the season while the Management Plan required nine applications in addition to a systemic insecticide applied at planting. The amount of PLRV spread for each of the treatments was not significantly different with infection ranging from 45-60%. This was due to the incorporation of PLRV-infected spreader plants into all plots in the experiment. These results indicated that growers can use green peach aphid degree-days for making insecticide application decisions rather than thresholds based on intensive, season-long field sampling. It appears that reducing the amount of insecticide applied during the season does not jeopardize aphid control if applications are made when aphid populations are most likely to develop. It will be necessary to carefully manage the amount of viral inoculum within the crop as no level of aphid control can reduce the spread of PLRV if inoculum levels are too high. Experiments were conducted to better understand the relationship between PLRV, the aphid vector, and the plant host relative to virus transmission mechanisms. It has been observed that not all aphids transmit PLRV, even though they are from clonal colonies. Green peach aphids were allowed to acquire PLRV and were then sequentially transferred through a series of five transmission indicator plants. Not all indicator plants became infected with PLRV as indicated by ELISA testing, but at least three plants in every sequence became infected. This showed clearly that 100% of the aphids had acquired PLRV and were competent to transmit the virus. Therefore, vector incompetence was not the reason that all plants did not become infected. It appears that there are aphid behavioral and/or plant refractoriness factors associated with failure to transmit PLRV. Additional experiments are now being conducted to determine if the potato aphid transmits PLRV more effectively than previous experiments have shown. If so, this will have a significant impact on aphid management strategies in the field.

Impact:
Second year experiments support the idea that it will be possible to completely revise the green peach aphid management plan for PLRV control. Use of insecticides having feeding behavior effects with application accurately timed via degree-day triggers will reduce the cost and environmental impact of more intensive insecticide management strategies. In most years, the number of insecticide applications can be reduced by at least half resulting in substantial savings to growers through lower chemical and equipments costs. In addition, growers can be freed of labor-intensive field sampling and the vagaries of trying to keep aphid densities below empirical threshold levels. This revised strategy can certainly be adopted by potato growers in Idaho and probably throughout the Pacific Northwest.

9. APHID TRANSMISSION OF PLANT VIRUSES: VECTOR COMPETENCE AND TRANSMISSION EFFICIENCY
Investigators: Mowry, T. M.
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 06/30/2003

Progress Report:
Experiments were conducted to better understand the relationship between PLRV, the aphid vector, and the plant host relative to virus transmission mechanisms. It has been observed that not all aphids transmit PLRV, even though they are from clonal colonies. Green peach aphids were allowed to acquire PLRV and were then sequentially transferred through a series of five transmission indicator plants. Not all indicator plants became infected with PLRV as indicated by ELISA testing, but at least three plants in every sequence became infected. This showed clearly that 100% of the aphids had acquired PLRV and were competent to transmit the virus. Therefore, vector incompetence was not the reason that all plants did not become infected. It appears that there are aphid behavioral and/or plant refractoriness factors associated with failure to transmit PLRV. Additional experiments are now being conducted to determine if the potato aphid transmits PLRV more effectively than previous experiments have shown. If so, this will have a significant impact on aphid management strategies in the field.

Impact:
Development of potato aphid management strategies in the field.

10. A CHAPERONE CONTROLLING MOTILITY AND DEVELOPMENT OF MYXOCOCCUS xanthus
Investigators: Hartzell, P. L.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
This year we completed work on AglZ and submitted a manuscript describing this novel protein. The aglZ gene of Myxococcus xanthus was identified from a yeast two-hybrid assay in which MglA was used as bait. MglA is a 22kDa cytoplasmic GTPase required for both adventurous and social gliding motility and sporulation. Results suggest that MglA interacts with AglZ to regulate motility because disruption or deletion of aglZ abolishes A motility and greatly diminishes S motility. The aglZ gene encodes a 153 kDa protein. The N-terminus of AglZ shows similarity to the receiver domain of two-component response regulator proteins while the C-terminus contains heptad repeats (a b c d e f g)n characteristic of coiled-coil proteins such as myosin. Consistent with this motif, expression of AglZ in E. coli resulted in production of striated-lattice structures. As with myosin heavy chain, the purified C-terminal coiled-coil domain of AglZ forms filament structures in vitro. This work was submitted to J. Bacteriol. We also began to produce antibody against AglZ which will be used to determine the cellular location and filament-forming capability of AglZ in M. xanthus.

Impact:
Our results show that GTPases and coiled-coil proteins, previously though to be restricted to the

domain eukarya, are present in prokaryotic organisms. Moreover, our data show that these proteins interact with one another in ways similar to homologs in higher organisms. The fact that these proteins are involved in motility is an important breakthrough that will be of general significance in the motility field. We believe that these data also will be critical for evolutionary biologists.

11. RESIDUE AND ROTATION IN A SMALL GRAIN PULSE AND BRASSICA CROPPING SYSTEM

Investigators: Guy, S. O.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Field studies in 2003 included no tillage (NT) variety evaluations and sister variety evaluations conducted under conventional tillage (CT) management. However, due to genotype X environment interactions that occur with variety evaluations, this does not allow investigation of the interaction of variety with tillage systems. A study to investigate the tillage X variety interaction was initiated in 2000 and is a long-term study, carried into 2003 and projected to run for six years. Three crops are in rotation, dry pea, followed by wheat, and spring barley or wheat. In each year of the study, pea yields were lower in NT than CT when averaged across varieties. Winter wheat yielded nearly the same between tillage treatments this year, 80 bu/a in CT versus 77 in NT, but in 2002, wheat yielded significantly lower in NT than CT. Both years, the variety Rod was the highest yielding variety in NT. This year, spring wheat grain yield was nearly the same in CT and NT, but crop biomass and plant height were lower in NT; while grain test weight, kernel size, and harvest index are higher in NT. Spring barley grain yields were nearly equivalent most years, but favored CT as with the other crops. It was projected that the trend to lower yields in NT was to moderate or disappear over time as the NT areas moved through the transition period, but in this comparison the lower yields in NT are persisting through the first four years of comparisons. For barley in 2003, test weights, % of plump seed, seed weights, and harvest index tend to be higher in NT than CT, but % thin seed, plant height, and biomass tend to be lower in NT than in CT. There were differences among the varieties compared for each of the three crops. In some comparisons there are interaction of yield for tillage and variety. Stand establishment was good with no differences between tillage treatments for any crop in any year evaluated. Fertility and pest control were as needed and not factors in the experiment. The higher seed weights and test weights in NT reflect that the plants stayed greener longer in NT for a longer grain filling period. However, plant height and biomass was less in NT probably due to slower growth from the cooler environment. This combination of less biomass and long grain filling lead to lower wheat protein in NT, especially for the hard red spring varieties. This may indicate the need for increased nitrogen management in NT for grain protein management. Winter wheat varieties were planted for the 2004 season on the previous dry pea bulk planted area. The bulk areas are sites for other data collection by other investigators including: beneficial and harmful insect differences between tillage treatments; soil physical properties; soil macro-fauna; and biological and moisture comparisons.

Impact:
Variety performance presented to growers allows them to select the best varieties for profitable

management of the farming system in various commonly used tillage practices. Information about differences in quality and protein of wheat will allow better management of crop regardless of tillage systems for more profitable and marketable products. Other knowledge about NT will help with adoption of the environmentally friendly practice of direct seeding by growers.

12. INTEGRATED MANAGEMENT STRATEGIES FOR ARTHROPOD PESTS OF HOP IN IDAHO

Investigators: Barbour, J. D.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We have completed studies of the response of N. fallacis to spider mite damage hop. We have begun Experiments Y-tube olfactometers and wind tunnels to established that the presence of mating pheromones in the California prionus, a cerambycid root feeding pest of hop in the Pacific Northwest. In initial experiments male beetles showed a definite response to female beetles in wind tunnel experiments. Head space volatiles from male and female beetles have been collected and will be analyzed via gas chromatography/mass spectrometry for differences in chemical profile. We repeated experiments examining spatial and temporal epidemiology of hop powdery mildew in Idaho hop yards in order to test an infection risk forecasting model for utility in timing pesticide applications for this pest. Powdery mildew incidence in these experiments too low for valid data analyses.

Impact:
Data from N. fallacis olfactometer studies provide a better understanding of factors affecting predatory mite population in hop and will help to devise effective biological control strategies for spider mites in hop. Olfacometer experiments with California prionus if successful might be used to devise early warning or mating disruption strategies for this hop pest. Experiments with hop powdery mildew epidemiology have shown that use of the risk forecasting model in combination with effective fungicides can reduce powdery mildew control costs by as much as $50.00 per acre.

13. BROADENING GENETIC BASE AND DEVELOPING HIGH YIELDING EARLY MATURING BEAN WITH RESISTANCE TO DISEASES

Investigators: Singh, S. P.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Seventy-two new advanced breeding lines of great northern and pinto market classes were developed. These along with checks were evaluated for their general adaptation, plant type, maturity, and seed characteristics at Kimberly Research and Extension Center. Of these 19 breeding lines of great northern and 24 of pinto were selected for further evaluation. These will be tested in greenhouse for their reaction to anthracnose, bean common mosaic virus (BCMV), common bacterial blight, halo blight, and rust. Subsequently, seed of the most promising

breeding lines will be increased for yield trials in contrasting environments. Approximately 500 F2, F3, and F4 families from about a dozen multiple-parent interracial populations were grown at Parma and Kimberly Research & Extension Centers. Due to prolonged hot and dry weather no objective selection could be made at Parma. However, selection for adaptation, plant, and seed traits were made at Kimberly, and plants within selected families were bulk-harvested for further evaluation and selection.

Impact:
Genetically broad based high yielding great northern and pinto bean cultivars and breeding lines resistant to major bacterial, fungal, and viral diseases developed through this project should increase dry bean production, reduce production cost, and increase competitiveness of Idaho farmers and industry in national and international markets.

14. VARIABILITY AND EVOLUTION OF POTYVIRUSES

Investigators: Berger, P. H.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 06/30/2004

Termination Report:
Potato virus Y is one of the most common pathogens found in potato. It is found in all potato growing regions of the world and causes disease loss in the form of reduced yield or loss of quality. Recently, PVY infected potato samples were sent to the University of Idaho for analysis because they were unusual in their reaction to the serological assays commonly used to screen for potato virus certification. These assays were designed to detect strain O, but aberrant symptomological and serological results indicated the presence of a new PVY strain in U.S. certified potato seed lots. These virus isolates have been analyzed by host-range bioassay and by molecular techniques. There is considerable confusion in the scientific literature and GenBank accessions as to what isolates belong in what groups and in definitive assays for the delineation of these PVY strains. This report focuses on the correlation between biological observations of these new isolates and development of molecular assays to identify and most effectively differentiate these PVY isolates. Serological and molecular analysis of the coat protein indicates that most of the isolates associated with veinal necrosis in tobacco belong to the necrotic strain of PVY that has not been previously observed in the potato growing regions of the North American continent. Of these, several isolates were also associated with tuber necrosis symptoms in potato (strain NTN). However, several isolates associated with veinal necrosis in tobacco and atypical tuber necrosis symptoms belonged to the O serotype. Because it is an O serotype, it will escape detection by any program that targets these new isolates using antibodies designed to detect N serotypes. This new type is similar to one recently reported to occur in Canada. Molecular analysis of the P1 region shows good correlation between banding patterns and observations of either veinal necrosis in tobacco or tuber necrosis in potato, with apparent simultaneous infections with several distinct isolates observed. Sequence analysis of the P1 region shows that all new isolates associated with these symptoms belong to N, European NTN, or North American NTN PVY groups. So far, only Eu-NTN isolates produced tuber necrosis symptoms on cv. Ranger Russet in greenhouse tests. Molecular and biological characterization of these new isolates indicates the presence of natural recombinants between N serotype and O serotype in at least two instances. It is currently unknown if the recombination occurred before introduction or

if N serotype strains are recombining with endemic O serotype strains. Only complete sequence analysis of the genome of the new isolates will provide definitive information on the origin of many of the new isolates. To accomplish this goal, we have generated full-length PCR products of the PVY genomes of the new isolates. Additional analysis of potato accessions used by U.S. potato breeders revealed a new strain of Potato virus V that does not react to antisera prepared for the type virus. PVV has so far not been reported to occur in the U.S. and all known isolates of PVV have so far been confined to one serological strain.

Impact:
New viruses that have the potential to reduce yield and quality of potatoes are now present in the US. Results from this research have been directly used to assay for these new viruses in a sustained and coordinated effort to reduce and eradicate these pathogens from US seed potato stocks. In addition, this research has provided vital information on the prevalence and diversity of this virus threat to scientific and seed certification personnel within the state as well as nationally. Complete sequencing of several of these viruses has taken place and will provide definitive information on the identity and the source of these viruses. The discovery and characterization of a new strain of Potato virus V simultaneously provides information on a new virus and underscores the potential of these pathogens to circumvent the established detection system in place to prevent their entry into the US. Seed importation into the US requires strict screening for pathogens, often relying on serological screening. Potato virus V is currently not present in the US and prevention of its importation may be hampered by the lack of serological reactivity of this newly described strain. The rapidly changing situation with both PVY and PVV indicate that there are still unknown sources of virus diversity present outside the US and that these sources can contribute to the pathogenicity and spread of these viruses.

15. DEVELOPING MORE EFFECTIVE WEED MANAGEMENT SYSTEMS FOR SUGARBEET

Investigators: Morishita, D. W.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Several weed control experiments were conducted to further develop weed management information for growers and crop advisors. Experiments included evaluating various micro herbicide rate combinations, utility of soil-applied herbicides used with postemergence foliar herbicides, and late season weed control practices. Most broadleaf and grass weeds were controlled successfully with micro herbicide rates. However, kochia (Kochia socparia) is one weed species that was not controlled effectively with micro rates. Ethofumesate at 1.0 to 1.5 lb ai/A applied preemergence with micro rates or standard herbicide rates improved kochia control. Studies also evaluated increasing triflusulfuron or ethofumesate + desmedipham + phenmedipham rates with sequential applications. Satisfactory kochia, common lambsquarters, redroot pigweed, annual sowthistle, green foxtail, and barnyardgrass control was obtained with triflusulfuron rates up to 0.031 lb ai/A or increasing ethofumesate + desmedipham + phenmedipham rates up to 0.675 with the later applications. Late season wiper applications with glyphosate, fluroxypyr and others were investigated. Little or no long-term crop injury was observed with glyphosate concentrations at 25 to 37.5%. Long-term injury was observed with

50% concentrations.

Impact:
Growers will learn how to best manage herbicide inputs for successful and economical weed management. This will lead to more profitability for the producer.

16. SEED POTATO QUALITY IMPROVEMENT

Investigators: Nolte, P.
Termination Date: 06/30/2004
Reporting period: 01/01/2004 to 12/31/2004

Progress Report:
Trials investigating the effectiveness of fungicides against Rhizoctonia canker and black scurf were performed on 9 different fungicides and fungicide combinations. Treatments included both in-furrow applied fungicides and fungicide dust treatments applied directly on cut seed. The tested fungicides all showed a reduction in the number of infected stems. Tubers are currently in storage and will be evaluated for black scurf in early 2004. Trials were also performed on 30 different seed piece treatment fungicides for their effectiveness against Fusarium dry rot and Rhizoctonia stem canker. New chemistries were compared with untreated controls and with established industry seed treatment standards such as mancozeb, fludioxanil and thiophante-methyl. Several of these new chemicals appear to be very effective against Rhizoctonia stem canker.

Impact:
Improved management of Rhizoctonia canker and black scurf should mean improved quality in the harvested potato crop, particularly for fresh market potatoes. New seed piece treatments provide alternatives to established chemistries and are especially important to stay ahead of fungicide resistance in the pathogen populations.

17. PLANT REGENERATION TECHNIQUES AND GENETIC TRANSFORMATION OF LANDSCAPE AND FLORAL PLANTS

Investigators: Tripepi, R. R.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Genetic engineering of rhododendron this past year solely involved using an Agrobacterium-mediated transformation system on leaf explants from Rhododendron catawbiense 'America'. The duration of explant culture time (referred to as preconditioning) before co-cultivation with bacteria, the duration of co-cultivation time, and the effect of regeneration medium pH on adventitious shoot regeneration were examined this past year. The strain of Agrobacterium tumefaciens used in genetic transformation experiments was LBA 4404 with the plasmid pBI121. This plasmid contained the NPTII gene (for kanamycin resistance) and the GUS gene for beta-glucuronidase. Leaf explants were placed on shoot regeneration medium supplemented with 50 mg/L kanamycin 8 days after bacterial inoculations for all experiments. The effect of

preconditioning times on transformation success was determined by making leaf explants 1 day (standard procedure), 3 days, or 7 days before co-cultivation with Agrobacterium. The preconditioning time of leaf explants affected the number of shoots formed on kanamycin. Leaf explants preconditioned for 3 or 7 days formed numerous shoots, but these shoots died within 2 months, indicating they were not transformed. Although three shoots initially formed on explants preconditioned for 1 day before co-cultivation, only one shoot from one explant has survived and been multiplied for 8 months on 50 mg/L kanamycin. Four of 30 shoots tested positive for GUS when assayed. To test the effects of co-cultivation times, leaf explants were made and placed on shoot regeneration medium for 1 day before Agrobacterium inoculation, and leaves were then co-cultivated for 4, 8, 12, or 16 days before placing the explants on 300 mg/L cefotaxime. The 4-day co-cultivation period resulted in the most shoots forming on leaf explants on selection medium compared to explants co-cultivated for 8, 12, or 16 days. All shoots, except four separate shoots formed on one leaf explant co-cultivated for 4 days, died on selection medium after 1 month. The surviving shoots are currently growing on 50 mg/L kanamycin but have not yet been tested for GUS activity. To test the effect of the pH on shoot regeneration from 'America' leaf explants, the pH of the medium was adjusted to 4.5 or 5.6 before autoclaving. At least 78% and 92% of the explants formed adventitious shoots on regeneration media with pH 4.5 and 5.6, respectively, and 17 and 20 shoots, respectively, formed per regenerating leaf explant. A genetic transformation experiment is currently in progress for testing the effect of regeneration medium pH (4.5, 5.2, or 5.6) on 'America' leaf explants co-cultivated for 4 or 8 days with Agrobacterium. One other accomplishment for this past year was finding that the DNeasy Plant kit from Qiagen, Inc. could be used to extract genomic DNA reliably from 'America' rhododendron microshoots. Other kits or procedures often resulted in poor extraction and DNA yield. In summary, making leaf explants one day before co-cultivating them for 4 days with Agrobacterium LBA 4404 seemed to be the most efficient method for obtaining putatively transformed shoots for 'America' rhododendron.

Impact:
We have attempted to improve the efficiency of the genetic transformation procedures used for 'America' rhododendron leaf explants. Although the procedures are still inefficient, we can obtain putatively transformed shoots using our protocol. The techniques developed in our study could enable researchers who use Agrobacterium to transform particular rhododendron cultivars more easily than using other published methods to date.

18. DEVELOPING IMPROVED SOFT WHITE WINTER WHEAT CULTIVARS FOR THE PACIFIC NORTHWEST

Investigators: Zemetra, R. S.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The advanced soft white winter wheat line ID91-34302A was released as the cultivar 'Simon'. It is the first cultivar to be released from the University of Idaho wheat breeding program with moderate resistance to Cercosporella foot rot. Simon is a high yielding line with good end-use quality that is adapted to the intermediate to high rainfall areas in the Pacific Northwest. The advanced line ID91-20503A is currently under evaluation for release in 2004. A herbicide

tolerance gene has been incorporated via backcrossing into three soft white winter wheat backgrounds and lines from all three backgrounds are being evaluated in the field for agronomic performance and herbicide tolerance. Germplasm with resistance/tolerance to Cephalosporium stripe has been collected from the three Pacific Northwest soft white winter wheat breeding programs and will be intercrossed and evaluated in the field for resistance/tolerance to Cephalosporium stripe. A recombinant inbred population was developed from a cross between Brundage and Coda, two adapted cultivars that differ for several agronomically important traits. The population has been planted in the field for seed increase and initial evaluation. A project has been initiated to determine the potential to transfer useful genes from Aegilops cylindrica to wheat by manipulating chromosome pairing and recombination using a Ph1 deletion.

Impact:
Adoption of soft white winter cultivars with improved end-use quality produced by this program should improve the marketability of soft white winter wheat produced in Idaho and the Pacific Northwest. In 2003, 18% of the soft white winter wheat grown in Idaho was cultivars produced by this breeding program (Lambert and Brundage). During the time of adoption of these cultivars the percentage of Idaho wheat sold domestically increased from 25% to 40%. This diversification of market can be related in part to improved end-use quality that meets the needs of the domestic market. The new release 'Brundage 96' should continue this trend since it is rated as having superior end-use quality.

19. DEVELOPING SUPERIOR OILSEED AND MUSTARD CULTIVARS FOR BRASSICACEAE

Investigators: Brown, J.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Acreage of IdaGold condiment yellow mustard continued to increase throughout the region. High fertilizer costs and good pea prices caused a reduction in IdaGold acreage in 2003. However, although accurate acreage is difficult to obtain, there was over 15,000 acres of IdaGold grown in Idaho and Washington last year. PVP applications were successfully submitted for Pacific Gold oriental mustard and Athena winter canola. Pacific Gold, oriental mustard acreage increased around the Genesee area, where approximately 4,000 acres were planted. All commercial seed was shipped to Japan or Korea and the initial reports of quality are good. Over 45,000 lb of certified seed was sold and planted around Idaho. A new Dijon type mustard (Kodiak) was released. Certified seed was produced of Clearwater, a new Raptor herbicide resistant spring canola cultivar and Gem a new Raptor herbicide resistant spring rapeseed cultivar. Both cultivars will be released prior to planting the 2004 spring crop. The first winter canola lines with low 18:3 fatty acids and hence do not require hydrogenation which will reduce trans-fats in food fry products were field tested in Fall 2003. Initial studies to examine insect resistance mechanisms in B. napus and S. alba were completed and several hybrids backcross families identified with significant advances in insect resistance. Second year field studies to determine the potential for using Brassica crop seed meal for use in biofumigation of crop plants (strawberry, cabbage, onion, field beans, cherry, potato and corn) were completed and larger on-farm testing planned for 2004 in recrop orchards, vegetable and strawberry production.

Impact:
The aim of this breeding program has been to offer growers in the region greater flexibility on choice of crop and cropping rotation. Availability of yellow and oriental mustard has offered Pacific Northwest growers more crop rotation benefits and helped in increase export potential. Similarly, Athena winter canola has offered grower the opportunity to include a non-cereal fall planted crop into their rotations. Many growers in the region use Persuit herbicide on pea or lentil, which limits rotations as there is a five year plant-back restriction on either canola or mustard. The new Raptor resistant cultivars are highly tolerant to Pursuit carry over and will allow growers to include a legume and Brassica in a six year rotation with cereals. Field trials on efficacy of pest control and phytotoxicity of Brassica is highly promising and the potential for developing high glucosinolate intergeneric hybrids remains strong and could provide an alternative to highly toxic synthetic soil fumigation.

20. GENETIC MANIPULATION OF SWEET CORN QUALITY AND STRESS RESISTANCE

Investigators: Mohan, S. K.
Termination Date: 09/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
A multi-location seed treatment study was conducted with two varieties, How Sweet It Is (sh2) and July Gold (se), and 12 treatments. Results, as percent final stand at 4-6 leaf stage, from 16 locations in the U.S. and one from Japan were obtained. With How Sweet It Is, stand in the untreated check ranged from a low of 2 (Washington) to a high of 69 (Japan), and the highest stand ranged from 37 (Idaho) to 90 (Japan), depending on the location. Thiophanate methyl was equivalent to or better than imazalil in most of the locations. Insecticides clothianidin or thiamethoxam did not show any phytotoxicity when added to the fungicide mixtures. Adding azoxystrobin or difenoconazole to fludioxonil+mefenoxam did not result in increased stands. With the variety July Gold, stands in untreated check varied from a low of 5 (Georgia) to a high of 66 (Japan), whereas highest stands varied from 40 (Idaho) to 86 (Japan), among the locations. Results with other treatments followed similar trends as observed with the variety How Sweet It Is.

Impact:
Data provide the basis for seed companies and growers to choose seed treatments appropriate for different sweet corn genotypes and for each region or location to ensure high field stands. Data also indicate compatibility and phytotoxicity, if any, of various components in the treatment mixture.

21. SEED POTATO PERFORMANCE
Investigators: Olsen, N.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
At harvest, seed tubers of the cultivars Russet Burbank, Ranger Russet, Umatilla Russet, Shepody, and Russet Norkotah were placed in storage. Seed storage treatments included: a) 3.3C until planting, b) 3.3C followed by 1 month at 7.2C prior to planting, and c) 3.3C followed by 2 weeks at 15.6C prior to planting. Seed was planted in Kimberly, ID and the study was repeated over the three years. Combining all three years, Shepody and Norkotah, had significantly earlier emergence with the two aging treatments. Norkotah had greater stem number per plant with both aging treatments whereas Shepody had greater stem numbers with only the highest storage temperature treatment. Seed storage treatments did not impact Norkotah final yield or size profile. On average, storing Shepody for 15 days at 15.5C significantly increased yield of 170 to 283 g size (9.6 t/ha) compared to no aging (8.4 t/ha). Russet Burbank and Russet Umatilla showed earlier emergence with elevated storage temperatures. Although the highest storage temperature treatment significantly increased stem numbers of Russet Burbank and Umatilla, it did not influence yield or size distribution. Storage treatments had a limited affect on Ranger Russet emergence and no affect on stem numbers. In general, seed storage temperatures impacted early performance, but had limited influence on final yield and yield profile, and varied with cultivar. In a separate but similar study, specialty potatoes were evaluated for seed performance after being stored and aged at different temperatures. Preliminary studies and analysis in Southern Idaho indicated market acceptance and good production yields for Caribe (lavender skin/white flesh), NorDonna (red skin/white flesh) and Yukon Gold (yellow skin/yellow flesh) in Southern Idaho. Consumer tuber size preference differs by cultivar, therefore attempts were made to alter yield and size profile by physiologically aging the seed in elevated storage temperature treatments. Seed tubers were stored at a) 3.3C until planting (no aging), b) 3.3C and 30 days at 7.2C prior to planting, c) 3.3C and 15 days at 15.5C prior to planting. Seed pieces (71 g) were planted in field trials, grown for 110 days, and evaluated for performance in two years. Cultivar response to storage treatments varied between years. In 2002, all three cultivars had earlier emergence with the two aging treatments. Caribe average stem number per plant was not affected by seed storage treatments. Although the combined-years total yield (37.8 t/ha) was not significantly impacted by aging treatments for Caribe, the 2002 total yield was significantly higher with the aging treatments. NorDonna responded to both aging treatments with increased stem numbers, higher total (38.4 t/ha) and US1 yields and greater yield in the 170 to 283 g size range. Although seed aging significantly increased stem numbers for Yukon Gold, there was no impact on total yield (42.4 t/ha) or size distribution. In general, seed aging using these elevated storage temperatures did not substantially impact size distribution.

Impact:
This study has demonstrated that cultivars respond differently to the seed storage treatments and provides information on how to manage seed for early growth, yields and yield profiles. It also indicates the lessened impact of seed aging on final yield and tuber size for long-season cultivars. The seasonal affect on seed tuber physiology and age impacts how the seed responds to storage conditions and ultimate field performance.

22. ENVIRONMENTAL EFFECTS ON FORAGE QUALITY AND TESTING FOR THE DIFFERENCES

Investigators: Shewmaker, G. E.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Forage yield and quality functions can be developed from this study for each site and correlated with the AgriMet weather data. Cooperation with other states is being developed in order to do chemical forage quality determination and to share samples for Near-Infrared Reflectance Spectrophotometer calibration. This will allow more rapid and cost effective analysis of additional samples.

Impact:
The product of this research will be a decision aide for producers to evaluate whether their goal will be for high quality, high yield, or optimize both yield and quality of forage, given their management options, markets, and weather. Producers will be able to better determine profitability for forage production, and forage feeders will be better able to predict animal performance.

23. CHARACTERIZATION OF THE ACTIVITIES OF PLANT GROWTH PROMOTING STREPTOMYCES IN THE RHIZOSPHERE

Investigators: Crawford, D. L.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We characterized the legume growth promoting and antifungal compound producing abilities of Streptomyces from plant rhizospheres. In non-sterile soil, we showed that Streptomyces lydicus WYEC108, originally isolated from the linseed plant rhizosphere, colonizes the nodules and roots of both peas and soybeans. After colonizing nodules, the mycelium moves onto the roots. Hyphae penetrate the outer surface layers of the nodules. Compared to uncolonized controls, WYEC108 colonization leads to the production of larger and more numerous nodules in both plants. Nodule colonization leads to improved bacteroid health/lifespan, enhanced nitrogen fixation rates, and improved plant growth. We hypothesized that the actinomycete was secreting siderophores within the nodules. Iron bioavailability within the rhizosphere was thought to be limited. Increased siderophore production within colonized nodules aided their assimilation of iron and molybdenum required for nitrogenase and leghemoglobin production by the nitrogen-fixing bacteriods. Enhanced iron assimilation was responsible for the higher nitrogen fixation rates of WYEC108-colonized nodules A 300 bp WYEC108 specific gene probe was used to confirm that the actinomycete colonizing nodules in the non-sterile soil was S. lydicus WYEC 108, not other soil actinomycetes. We investigated if other siderophore-producing, root-colonizing Streptomyces had similar effects on peas. Some but not all of the Streptomyces had effects similar to WYEC108. Total siderophore production by a strain was found to be the best indicator of its ability to enhance nitrogen fixation and plant growth. Pea roots and nodules

collected from agricultural fields were found to be colonized by naturally occurring actinomycetes. This is the first report of such a beneficial plant-microbe rhizosphere interaction involving Streptomcyes and legumes, the first showing microbial siderophore production as a mechanism for aiding nodular assimilation of iron, and the first evidence to show that this is a natural beneficial plant-microbe interaction. We also studied the microbial populations of a previously unstudied habitat, the rhizosphere of desert sagebrush (Artemesia tridentata). This habitat is rich in previously undescribed actinomycetes that produce antimicrobial compounds with broad spectrum activity against fungal plant and animal pathogens. Most of the novel isolates are species of Streptomyces. We characterized the antifungal compounds produced by one sagebrush rhizosphere isolate, Streptomyces sp RG. Streptomyces RG species is novel, based upon its 16s rRNA gene sequence. It produced multiple low molecular weight, polar antifungal compounds. The compounds active against Saccharomyces cerevesiae were purified or partially purified One of the compounds was novel and had a molecular weight of 254. These data, along with results of ongoing research, show that the sagebrush rhizosphere is a source of previously undescribed actinomycetes that produce novel antifungal compounds of potential value as antimicrobial agents for treatment of fungal infections of plants and animals.

Impact:
Some of the rhizosphere isolates we have characterized will be developed into inoculants that promote legume growth and increase crop yields. Some of the novel antifungal compounds may be developed into antifungal biocontrol or therapeutic agents for use in agriculture and medicine.

24. BIOLOGICALLY BASED MANAGEMENT OF THE CABBAGE SEEDPOD WEEVIL ASSOCIATED WITH OILSEED RAPE IN IDAHO
Investigators: McCaffrey, J. P.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Assessment of canola-quality yellow mustard lines, Sinapis alba, for resistance to the cabbage seedpod weevil, Ceutorhyncus obstrictus was completed. The canola-quality lines were as resistant as mustard cultivars suggesting that canola-quality yellow mustard would be an appropriate tool for use in canola production in weevil impacted areas. Weevil resistance along with flea beetle tolerance and drought tolerance would also allow more cost effective production with fewer perturbations on the natural enemies of the weevil and other pests such as flea beetles and aphids, further enhancing biologically based pest management and economical production of this crop.

Impact:
This work enables expanded production of canola to areas with high insect pest pressure.

25. MANAGING HERBICIDE-RESISTANT PLANTS IN DIRECT-SEED DRY LAND WHEAT PRODUCTION SYSTEMS IN THE PACIFIC NORTHWEST

Investigators: Thill, D. C.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Imidazolinone resistant spring canola, spring wheat, and winter wheat, were direct-seeded in the third year of the rotation study. Imazamox was applied in the herbicide resistant treatment, and typically prescribed herbicides for the species present were applied in the standard herbicide treatment. Weeds were counted before and after application and total plant biomass by species at wheat heading was taken from three 0.5 sq m areas within each experimental unit. Crops were harvested at maturity to determine canola seed and wheat grain yield and wheat test weight. Total weed population was 23, 2, and 2.4 plants/sq m with standard treatments and 4, 1, and 1.6 plants/sq m with the resistant treatments for canola, winter wheat, and spring wheat, respectively. Weed population means between herbicide treatments were statistically different only for canola. Total weed population was 5 and 0.6 plants/sq m with the 3 year rotation, and 9 and 2.4 plants/sq m with the 2 year rotation for canola and winter wheat, respectively, although the means were not statistically different. Crop seed yield was similar between herbicide treatments and rotations in 2003. Final analysis will be in 2006 after three cycles of the 2-year and two cycles of the 3-year rotations. In the herbicide resistant enrichment study, imidazolinone-tolerant spring canola var. Clearwater was direct seeded into winter wheat residue May 22, 2003. Four plots were treated with the group two herbicide imazamox (on year) and one plot and the check plot were treated with pendimethalin + quizalofop (non-group two). Canola seed yield was highest (841 kg/ha) from the continuous group two treatment and lowest (595 kg/ha) from the control treatment, which has been treated with all non-group two herbicides. Herbicide resistant weed biotype selection will be determined at the end of the study in 2005. A simple, high throughput screening technique has been developed to enable wheat geneticists to rapidly select resistant seedlings and identify segregating populations. Ten seeds of four imidazolinone-resistant and three susceptible wheat cultivars and jointed goatgrass were placed on blotter paper soaked with twelve imazamox concentrations ranging from 0.25 to 500 microM. After seven days in a germinator, shoot height of each plant was measured and GR-50 values were determined. Imazamox concentrations reducing shoot height by 50% ranged from 0.3 to 0.8 microM for susceptible wheat, 3.4 microM for jointed goatgrass, 35.8 to 42.9 microM for single-gene-resistant wheat, and 71.2 microM for a two-gene-resistant wheat cultivar. Related whole plant assays ranked the cultivars similarly but data were more variable. This technique may provide a rapid way to screen large seed lots for a specified level of resistance to imazamox or to determine relative resistance between imidazolinone-resistant wheat lines.

Impact:
The recent commercial release of imidazolinone-resistant wheat cultivars will provide growers a unique opportunity to control weeds that previously could not be controlled selectively with herbicides. Thus, development of high yielding, imidazolinone-resistant wheat lines that are locally adapted is a priority of many wheat breeding programs. A simple, high throughput screening technique will allow wheat geneticists to rapidly select resistant seedlings and identify segregating populations, which will save time and resources. This technique also can be used to

identify suspected imidazolinone-resistant weeds.

26. INVESTIGATIONS OF WHEAT AND POTATO QUALITY AS A FUNCTION OF STARCH CHARACTERISTICS AND BEHAVIOR

Investigators: Huber, K. C.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Three experiments (designated 1, 2, and 3) contributing to project objectives are reported below. 1) Texture is a key quality determinant of white salted noodles (WSN). Grain hardness and protein content were examined for contribution to WSN texture using a combination of recombinant inbred lines (RILs) (n = 130). Both grain hardness and flour protein significantly contributed to noodle adhesiveness, cohesiveness, and chewiness. However, only grain hardness significantly influenced resilience and springiness, while flour protein was exclusively linked to hardness, suggesting differing roles for the two factors with regard to WSN texture. Increasing levels of grain hardness produced noodles that were more cohesive, resilient, springy, and chewy, but less adhesive. As flour protein levels increased, noodle texture became less adhesive, but more hard, cohesive, and chewy. While Granule Bound Starch Synthase (GBSS) class clearly remains a significant determinant of noodle texture, grain hardness and flour protein were shown to play important secondary roles. 2) The majority of isolated starch utilized in food applications is chemically modified to improve starch properties according to the intended use. Therefore, it is critical to understand factors that impact wheat starch reactivity. This work investigated the relative reactivities of normal, partial waxy, and waxy wheat starches and their respective A- and B-type starch granule fractions. Native starch isolated from four closely related soft wheat lines (normal, partial waxy, and full waxy) was modified through: A) substitution (propylene oxide analog), and B) cross-linking (phosphorus oxychloride) reactions to generate both types of modified starch products for each wheat line. In cross-linking reactions, B-type granules were slightly more reacted than A-type granules for all cultivars, while the waxy starch generally exhibited higher reactivity compared to normal and partial waxy starches. For the substituted starches, no differences in reactivity were observed among the cultivars or between the two granule types. 3) Though potato specific gravity is often used as a crude, routine predictor of cooked potato texture, it does not reliably predict textural characteristics across cultivar boundaries. With potato quality linked to multiple factors, rheological methods, such as the Rapid Visco Analyzer (RVA), have demonstrated potential to account for factors that influence potato quality. The objective of this study was to investigate potential relationships between RVA pasting attributes and textural quality (sensory scores) of baked and fried products of select potato cultivars. Six cultivars, representing a broad range of potato texture and specific gravity, were included in the study. Analysis of variance of baked and french-fried sensory data revealed significant differences among the selected cultivars with regard to both oral and non-oral sensory scores. In nearly all cases, RVA correlations were equivalent to or better than specific gravity correlations with baked and french-fried sensory data. Thus, the RVA may represent a potential tool for screening for potato end-use quality.

Impact:
Due to escalating competition in international commodity markets, issues of end-use quality and

functionality are becoming increasingly important factors that influence purchasing decisions of potential buyers. While quality is a relative term that varies according to a particular end-use, it will be necessary to identify critical factors that dictate "quality" for specific product applications, and to provide legitimate means for defining, gauging, and targeting "quality" and functionality of raw agricultural commodities. At the most basic level, identification of critical factors will facilitate in-depth screening of developing lines by providing plant breeders with information necessary for future selections. While the practice of selecting for favorable agronomic traits (disease/insect resistance, drought hardiness, yield, etc.) has been successfully implemented by breeders, the potential to effectively screen for end-use potential represents an additional mechanism for increasing selection efficiency. Only as critical factors governing quality and functionality are identified can the potential to manipulate or control these factors truly be increased. As traits responsible for functionality (i.e. starch properties) can be manipulated to minimize raw material inconsistency and improve end-use performance, the market value of agricultural commodities will be increased.

27. SHEEP GRAZING FOR NOXIOUS RANGELAND WEED MANAGEMENT IN IDAHO

Investigators: Launchbaugh, K. L.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Efforts at the University of Idaho continue to enhance our understanding of using sheep grazing as a tool to reduce the abundance of several exotic invasive plants in Idaho and western North America. In 2003, we studies effects of controlled grazing on: 1) Spotted Knapweed, 2) Yellow Starthistle, and 3) several common noxious weeds of Northern Idaho. SPOTTED KNAPWEED: We examined the value of sheep grazing for spotted knapweed control in a sagebrush grassland community of southeastern Idaho. The most profound effect of grazing was reduced flower production when grazing occurs during the bolting or flowering phenological stages. After 3 years of grazing, basal area of mature spotted knapweed plants was reduced when plants were grazed at the bolting or flowering stage. Sheep consumed spotted knapweed throughout the grazing season and preferred knapweed to native grasses in all seasons. Sheep showed greatest relative preference for spotted knapweed when it was in the bolting stage. Nutritional analysis of knapweed throughout the growing season revealed that the bolting stage corresponded with high nutritive value and low composition of cnicin, a secondary compound thought to reduced palatability. The proportion of spotted knapweed consumed by sheep was not strongly affected by stocking rate. YELLOW STARTHISTLE: We continued to examine response of yellow starthistle to grazing by cattle and sheep in the rosette, bolting, and flowering stages. Sheep and cattle both readily consumed yellow starthistle in the canyon grasslands of Northern Idaho. Grazing by both livestock species reduced starthistle density when the grazing occurred during the bolting stage. Differences in grazing preferences between cattle and sheep were most profound during the bolting stage when sheep expressed selective grazing pressure for yellow starthistle and cattle avoided starthistle in favor of grasses. SEVERAL COMMON WEEDS: A series of clipping studies were conducted to examine effects of herbivory on rush skeleton weed, meadow hawkweed, houndstounge, cinquefoil, and yellow starthistle. These studies are not yet completed.

Impact:
It has long been recognized that weed management systems on rangelands must incorporate grazing management plans to be effectively implemented. We propose a shift in emphasis from working weed control programs around grazing management plans to actively employing livestock in the battle against weeds. Making livestock grazing an active part of weed control programs will require specific prescription grazing guidelines that outline the appropriate number and species of animals and season of grazing. Our research is aimed at preparing grazing guidelines and prescriptions that will allow land managers to more carefully implement grazing in weed control efforts. This approach is being adopted by producers who are creating livestock enterprises based solely on vegetation management. Livestock employed in weed management can therefore reduce the environmentally damaging effects of noxious weeds and simultaneously create a new type of livestock enterprise and a new product of livestock grazing.

28. VARIABLE RATE NUTRIENT AND IRRIGATION MANAGEMENT FOR SUSTAINABLE CROPPING SYSTEMS IN SOUTHERN IDAHO

Investigators: Stark, J. C.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Increasing demands on growers to produce a superior potato crop with minimal inputs has produced a need to determine optimal N management requirements for new cultivars that are increasing in acreage. A field study was undertaken to evaluate different N rate and timing effects on yield and grade of Russet Burbank, Bannock Russet, Gem Russet, Summit Russet, Ranger Russet Alturas and A8893-1. Experiments were designed as a randomized complete block at two sites, Aberdeen and Parma, ID. At Aberdeen, N as NH4NO3 (34-0-0) was applied to Russet Burbank, Gem Russet, Bannock Russet and Summit Russet at 0, 100, 200, or 300 kg N/ha. Nitrogen was applied either 1) 2/3 pre-plant plus 1/3 in-season (early treatment), or 2) 1/3 pre-plant plus 2/3 in-season (late treatment). At Parma, N as NH4NO3 was applied to Alturas, Ranger Russet and A8893-1 at 0, 112, 224, 336, or 448 kg N/ha, with the same two seasonal applications. Bannock Russet required significantly less N than Russet Burbank, Gem Russet or Summit Russet, while the average optimal N rates for the latter three varieties were fairly similar. Nitrogen timing had relatively little effect on N utilization by Bannock Russet and Gem Russet, but Russet Burbank and Summit Russet used early-season N applications N more efficiently than late-season N. Alturas and Ranger also preferred split N applications with most of the N applied early. However, A8893-1 performed best with most of the N applied during tuber bulking. In an additional study, 6 potato varieties (Russet Burbank, Ranger Russet, Alturas, Russet Norkotah, Summit Russet and A9014-2) were grown under 5 seasonal patterns of water stress to determine relative drought tolerance of each variety. The drought treatments were designed to evaluate responses to different levels of continual stress as well as to early irrigation cut-off. The variety producing the highest marketable yields under all drought conditions was A9014-2, while Russet Burbank generally produced the lowest yields. Alturas showed the greatest relative yield reductions across the different drought treatments. Russet Norkotah produced yields that were slightly higher than those for Russet Burbank but the yields were fairly

stable across all drought treatments.

Impact:
Nitrogen and water management are two of the most important production factors affecting potato yields in southern Idaho. In the past, management recommendations for Russet Burbank have typically been followed in managing irrigation and nitrogen for other potato varieties. Our research has shown that some of the newer potato varieties use water and nitrogen more efficiently than Russet Burbank, allowing for significant savings to the grower as well as decreasing the potential for nitrate leaching. The economic analysis of the data is currently being conducted but it appears that our N fertilizer recommendations for most of the newer potato varieties will be 40 -100 kg N/ha less than current commercial recommendations.

29. GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, PEST RESISTANCE AND FOOD VALUE
Investigators: Singh, S. P.
Termination Date: 09/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The Western Regional Bean Trial (WRBT) with five breeding lines and three checks, and North American Cooperative Dry Bean Nursery (CDBN) with 18 breeding lines and seven checks were grown in a low-fertility soil at Kimberly. Data were recorded for response to soil zinc deficiency, and growth habit, seed yield, 100-seed weight, and maturity. In WRBT and CDBN, none of the breeding lines had significantly higher yield than the highest yielding check cultivars Montrose and Matterhorn, respectively. Approximately 500 F1 plants from three multiple-parent interracial populations were screened in the greenhouse for reaction to bean common mosaic virus and common bacterial blight. Subsequently approximately 300 resistant F1-derived F2 families were grown at Kimberly R & E Center. Data were recorded for plant type, maturity and seed characteristics. Plants within plot were bulk-harvested. The F3 families will be evaluated in replicated trials in 2004.

Impact:
Improved dry bean germplasm with resistance to bean common mosaic, common bacterial blight, and rust should be expected from this project. Also, very valuable data on yield, adaptation, seed quality traits, and reaction to diseases is generated on breeding lines from multi-location testing in the U.S.A. and Canada.

30. ENVIRONMENTAL FATE OF BIOPESTICIDES AND HERBICIDES IN IDAHO POTATO CROPPING SYSTEMS
Investigators: Hutchinson, P. J.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Imazamox environmental fate: A trial was initiated in Clearfield spring wheat spring 2001. Imazamox at 0, 0.032, 0.04, 0.064, or 0.08 lb ai/A was applied Spring 2001. Barley, potato, and

sugarbeet were planted into the trial for a 2nd plant-back season spring 2003. No crop injury was visible during the growing season and yields were not reduced from any treatment. Soil samples collected at application time, and periodically throughout all growing seasons from this trial and a trial initiated in Clearfield winter wheat fall 1999/spring 2000 will be analyzed for imazamox concentration to determine degradation. Sulfentrazone degradation: Sulfentrazone at 1X and 2X the proposed use rate was applied to potato spring 2002. Brassica green manure was planted into the trial area after potato harvest fall 2002. The brassica winter crop winter-killed before spring 2003. Sugarbeet was planted spring 2003. No visual injury or yield loss was observed in 2003. Another sulfentrazone degradation trial was initiated spring 2003 with 0, 0.094, or 0.188 lb ai/A applied preemergence to potato. Sugarbeet and spring planted brassica will be planted spring 2004. Soil samples collected immediately before and after spring 2003 application, and periodically during the 2003 and 2004 growing seasons will be analyzed for sulfentrazone degradation determination. Potato crop response to brassica green manures and biofumigant compound degradation: A Brassica green manure field trial was initiated fall 2003. The brassica crop was winter-killed before spring 2004 so no data were collected. Flucarbazone degradation: A flucarbazone herbicide degradation and remediation trial was initiated in spring wheat spring 2003. 0, 1X, and 2X flucarbazone rates were applied postemergence to the wheat. The wheat was harvested in August. Post-harvest irrigation of 1 or 4 inches was applied. The irrigation plots were split and tillage treatments of ripping, or plowed. Potato and sugarbeet will be planted into the trial area spring 2004. Soil samples collected 0 day, after wheat harvest, irrigation, and tillage treatments plus samples collected during the 2004 growing season will be analyzed for flucarbazone degradation.

Impact:
Imazamox and sulfentrazone follow-crop trial results will be used for plant-back restrictions and recommendations. Based on southeast Idaho trial results, these restrictions and recommendations may be different for the Pacific Northwest than what has been determined for these herbicides in other potato production areas. Determination of biofumigant compound degradation, and effects on potato planting timing and crop safety, will assist in developing best management practices for brassica green manures in potato cropping systems.

31. YIELD IMPROVEMENTS OF SPANISH SWEET ONIONS GROWN FROM PRIMED SEED OR FROM METALAXYL TREATMENTS AT PLANTING

Investigators: Geary, B. D.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
Effects of test results from the 2000 growing season indicated Ridomil was effective in reducing Pythium damping-off on yellow Vega onions when excessive moisture was applied to encourage Pythium populations. Red Flare, white Sterling, and yellow Vega onions were tested during 2001 under excessive moisture conditions and under normal grower practices. Again, Ridomil was effective in reducing Pythium damping-off by increasing stand counts and increasing yields under excessive moisture conditions for the yellow onions. However, there were no significant differences between the untreated checks in the red and white onions and the treatments under excessive moisture. There were no significant differences between the untreated onions and

those treated with Ridomil under normal grower conditions regardless of onion cultivar. One likely possibility for no differences among the treatments was the moderate to low Pythium populations in the soils where the onions were planted. In 2002, there were no differences between the untreated check plots and those treated with different formulations of Ridomil. The Pythium inoculum was not effective in raising soil Pythium populations or increasing damp-off in the onions. In conclusion after three years of study, Ridomil treatments are not recommended for use in the Treasure Valley area of Idaho and Oregon unless the Pythium soil population is high and excessive moisture is expected during the early growing months. Data from primed onion seed experiments in 2000, 2002 and 2003 suggested that priming the onion seed of the varieties Vision, Caballero and Vaquero was beneficial, but was not significantly better than unprimed seed. Each year the data suggests that primed seed may be beneficial in getting the onion plants going to a little better start than unprimed seed. However, these conclusions are rarely significant and at times the unprimed seed did better numerically. Primed seed in the lab definitely gets a head start on seed that is unprimed. But, for onions under field conditions, there are too many other variables that influence seedling survival and vigor. Due to the cost and process required to get primed seed, it is not recommended that onion seed be primed because of the inability to consistently provide higher stands and yield.

Impact:
Primed onion seed and chemical treatments such as Ridomil, are products that are advertised to boost plant stands and increase yields. Thus, leading to higher economic returns. Even though these products are beneficial to onions under greenhouse or laboratory conditions the results may not transfer to typical field conditions. Therefore, growers request help in determining if these products will benefit them when they are applied in the field under commercial growing conditions. If the tests indicate that the products will help the grower be more productive then the growers are willing to invest their resources to use the products effectively and judiciously. However, if these products do not prove to be beneficial, then growers want to know so resources are not wasted. Products such as primed seed and Ridomil cost $3 to $15 / acre, which increases the cost of production substantially. In the Treasure Valley where 18,000 acres of onions are grown annually, unnecessary products could cost growers thousands of dollars. Therefore, tests determining product efficacy are important.

32. POTATO VARIETY IMPROVEMENT, EVALUATION, MANAGEMENT, AND SEED INCREASES IN IDAHO

Investigators: Love, S. L.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Three new potato varieties are being prepared for release in 2004, including A7961-1 (Western Russet), A9014-2, and A90586-11. Western Russet is a long, russet type with excellent fresh market and processing quality. It produces high yield, good tuber size, and excellent processing quality under early harvest conditions. A9014-2 is an early to medium maturing variety with outstanding yield potential and tuber appearance. Initially, it is likely to be adopted for fresh market use, but A9014-2 also has good processing quality and is resistant to cold-temperature sweetening. A90586-11 is the first long white potato released in the US that combines French fry

processing quality with a high level of resistance to all strains of late blight endemic to Toluca, Mexico. It is being tested in areas where late blight is a consistent concern and under disease pressure should provide a four to five-fold reduction in fungicide applications. Seed of all three varieties, in the form of pre-Nuclear mini-tubers, is currently being produced for distribution to seed growers in the spring of 2004. In 2003, 34 trials were grown at seven locations throughout southern Idaho. Included were variety trials, management studies, germplasm enhancement studies, and seed increases. A paper was prepared for publication that demonstrates the need for variety specific nitrogen fertilizer recommendations. A management guide was published outlining management recommendations for Russet Norkotah and its related line selections. A third year of characterization was completed on a population segregating for resistance to corky ringspot that will be used to identify gene markers for resistance. Disease pressure this past year was exceptional and the characterization effective. Efforts on this project are now being directed at identifying AFLP markers associated with corky ringspot resistance. In a quality related study, it was determined that the viscoanalyzer can effectively detect differences in tuber quality as related to baked and fried product texture. Both before and after storage, a strong correlation emerged between viscoanalyzer measurements and consumer preference as determined by a sensory panel. The second year of a potato drought study, with an objective to determine whether variety choice is a viable management factor in dealing with irrigation water shortages, was completed. Results from the first year of the study show distinct differences among varieties for response to limited water availability.

Impact:
This research is the Idaho component of the Northwest Potato Variety Development Program (Tri-State). This project has had a positive influence on the Northwest potato industry through the release of new varieties that provide advantages of disease resistance, productivity, production efficiency, and tuber quality. Added value of variety releases is now estimated at approximately $135 million. Adoption of new varieties with resistance to many diseases and physiological problems is expected to provide positive environmental impacts through the reduction of pesticide usage and nitrate leaching. Increasingly rapid adoption of the varieties being released will increase the impact over the life of the project. The ultimate impact of the project will be to maintain the competitiveness of the Northwest industry in an increasingly competitive global market.

33. DEVELOPMENT OF IMPROVED WHEAT CULTIVARS FOR IDAHO
Investigators: Souza, E. J.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
In the past year our breeding program released two wheat cultivars for wheat growers of the Pacific Northwest. 'Jerome' is a hard red spring wheat (Triticum aestivum L.) developed by the Idaho Agricultural Experiment Station and released in 2004. Jerome was released for its superior grain yield and baking quality in the intermountain zone of the western United States. Jerome well adapted to both irrigated and rain-fed production systems and carries the H3 gene for Hessian fly resistance. Jerome is a stripe rust resistant, early maturing spring wheat, with an average heading date in Idaho of 172 days after January 1 in 22 field observations from 1998 to

2003. By comparison, Jefferson headed 2 days later ($p<0.01$) and Westbred 936 headed 1 day later ($p<0.05$) than Jerome. Jerome has excellent lodging resistance, similar to Westbred 936. In 21 Idaho yield trials, where lodging occurred, Jerome, Westbred 936, and Jefferson respectively had 17%, 16%, and 29% of plants lodged in a plot (Jerome and Jefferson different at $p<0.01$). In 48 yield trials grown across Idaho from 1998 to 2003, Jerome had an average grain yield 5740 kg ha-1, greater than Jefferson (5460 kg ha-1, $p<0.01$) and Westbred 936 (5477 kg ha-1, $p<0.01$). In the same yield trials, Jerome had an average grain volume-weight of 778 kg m-3, greater than Westbred 936 (769 kg m-3, $p<0.01$), yet less than Jefferson (784 kg m-3, $p<0.05$). The second wheat is Idaho 587, soft white winter wheat, for use by grain producers in the Pacific Northwest. Idaho 587 is a backcross derivative of the soft white winter wheat cultivar 'Stephens' with genetic tolerance developed by the BASF Corporation to the imidazolinone class of herbicides for use in controlling pernicious weeds of winter wheat and generically given the name 'Clearfield'.

Impact:
Jerome will provide a high-yield, hard red spring wheat public cultivar for irrigated production in the Pacific Northwest. Idaho 587, a soft white winter wheat with resistance to imidazoline herbicdes, will be a good tool for wheat producers to suppress annual grasses in areas where winter killing temperatures are typically not limiting to wheat production.

34. REGULATION OF FUNGAL MORPHOGENESIS AND MULTICELLULAR DEVELOPMENT

Investigators: Miller, B. L.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Recent studies indicate that the filamentous fungi, agents of plant and animal pathogenesis, possess a regulatory network linking signal molecules to cell differentiation events that differs from the budding yeast paradigm. This is consistent with the more complex life cycle of fungi that form diverse multicellular structures. This project's central hypothesis is that a study of organogenesis in Aspergillus nidulans will identify new genes and regulatory mechanisms that will provide novel models for eucaryotic multicellular development and reproductive biology. The specific goals of this project are to use key transcriptional regulators as entry points into pathways controlling the initiation of meiotic reproduction and the differentiation of sexual reproductive structures. SteA (Sterile) controls fertilization events and ascogenous tissue development. Two mating type genes matA-2 (encoding an HMG box protein) and matB-1 (an alpha box protein) control fertilization events, nuclear identity, and meiosis. SteA is being used as an entry point into pathways controlling the initiation of meiotic reproduction and the differentiation of sexual reproductive structures. The steA gene is constituitively expressed, indicating that SteA interacting proteins control SteA function in response to signaling pathways. Interacting proteins are being identified by co-immunoprecipitation of protein complexes (a proteomic approach) and by screening a yeast two-hybrid library expressing A. nidulans developmentally regulated cDNAs. Specific interactions with MpkB (ERK1 type MAPK) and cAMP-dependent protein kinases are also being tested. Direct SteA target genes representing the downstream effects of SteA activation, will be identified using chromatin co-immunoprecipitation (ChIP) analysis. This class of target genes likely represents key

components of the regulatory network controlling foci formation, fertilization and ascogenous tissue differentiation. Similar analyses is being applied to MatA and MatB function to identify mechanisms that control self/non-self recognition (sex) at the cellular and nuclear levels.

Impact:
Fungal species have a significant negative impact upon agriculture as plant and animal pathogens, and as agents of food spoilage and toxin production. They also make many important contributions to the fermentation industry and to food production such as the cheese industry. A study of development in Aspergillus nidulans will contribute valuable insights into the control of aerilly dispersed asexual spores (conidia) and sexually produced spores used for dispersal by both benefical and detrimental fungi.

35. THE EVOLUTION OF PROTEIN FLEXIBILITY
Investigators: Daughdrill, G. W.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The main goal of this project is to investigate the evolutionary constraints and patterns that govern the natural selection of dynamic flexible protein structures. To accomplish this goal we have selected a model system based on a conserved flexible linker from the 70 KDa subunit of replication protein A (RPA70). We have been using this model system to determine if and how natural selection works to preserve the structure and function of dynamic flexible proteins and protein domains. In the award period from 01/01/03-12/31/03, progress toward these goals included obtaining nuclear magnetic resonance (NMR) assignments for the flexible linkers of RPA 70 from H. sapien and O. sativa. In addition, NMR data characterizing the molecular dynamics of the flexible linkers from H. sapien, O. sativa, and S. Cerevisiae has been collected and is currently being analyzed. All three linkers appear to be highly dynamic in the absence of any context provided by the flanking folded domains, supporting our hypothesis concerning the evolutionary conservation of protein flexibility. We have also made significant progress toward developing an NMR based assay for linker function. This assay involves measuring the dependence of NMR chemical shifts for N-terminal domain (NTD) residues following the addition of increasing lengths of single stranded DNA (ssDNA). We observe an increase in the magnitude of the chemical shifts for NTD residues when the tandem ssDNA binding domains are attached by the flexible linker, indicating an increase in the equilibrium population of the NTD/ssDNA complex. This data supports the "local concentration effect" model of linker function described in the original proposal. We have also performed a mutagenic analysis of the context-dependent structure in the flexible linker from the 70 KDa subunit of human replication protein A (hRPA70). Several interesting observations were made during this study that impacts the direction of our work. A dynamic, but stable, interaction between a tyrosine in the flexible linker and the NTD is partially responsible for the context dependent structure of the linker. Three single amino acid substitutions were made, changing the tyrosine to alanine, phenylalanine, and serine. The serine mutant did not express well and was insoluble. The phenylalanine mutant had localized effects on the structure of the NTD, as determined by chemical shift analysis, and significantly perturbed the nanosecond timescale dynamics of the linker. The alanine mutant had global effects on both the structure and dynamics of the NTD and

limited effects on the dynamics of the linker. We are preparing a manuscript describing these results that will be submitted in Jan 2004. The tyrosine that is partially responsible for the interaction between the flexible linker and the NTD in hRPA70 is conserved in M. musculus, D. melanogaster, and X. laevis. We intend to investigate the presence of context dependent structure in the flexible linkers from M. musculus, D. melanogaster, and X. laevis.

Impact:
Our investigation into the structure, dynamics, and function of the flexible linker from the 70 KDa subunit of replication protein A (RPA70) marks the first systematic empirical test of the evolutionary conservation of protein flexibility. For the handful of sequenced RPA70 homologues the similarity of the linker varies significantly. It is unclear what selective processes have resulted in the observed sequence variation for the RPA70 linkers. It is also unclear how the observed sequence variation affects the structure and function of the linkers. Our preliminary data suggests that natural selection works to preserve dynamic flexible protein structures. Further testing of this hypothesis will facilitate an understanding of the rules governing the evolution of protein flexibility. An understanding of these rules will lead to a greater understanding of the role that protein flexibility plays in protein function. This work also has potential to enhance the predictability of models of evolution.

36. PREDICTION OF POTATO LATE BLIGHT AND CONTROL OF POTATO STORAGE DISEASES

Investigators: Miller, J. S.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Within-field weather data was collected from 8 locations in southern Idaho (Parma, Nampa, Wendell, Hansen, Burley, Rupert, Minidoka, Aberdeen, Rexburg). Weather variables recorded by these stations were entered into disease forecasting models. In addition to late blight forecasts, early blight forecasts were generated using the weather data. Plots were established at the Aberdeen Research and Extension Center where fungicides were applied based on disease forecasts. The early blight forecasts worked extremely well. The same level of disease was observed in plots receiving only 2 applications (initiated by forecasts) as the plots receiving 6 fungicide applications (weekly sprays). Late blight was observed late in the season, but unfortunately none of the weather stations were located close to the outbreak area. As in the past, data were collected from potato growers on general disease management practices that may influence the development of late blight. Along with collecting survey information, four teams of field scouts scouted fields for the presence of disease. Survey responses are currently being gathered and will be entered into a database containing information from the past three years. Weather data was summarized to develop a qualitative model that will predict whether growers will see late blight or not in a given year. We have already developed a forecast that has done reasonable well in predicting the time of late blight occurrence. A website was developed to help disseminate this information, as well as provide timely recommendations to growers on how to manage late blight. The efficacy of Ridomil application methods in controlling pink rot has been tested for the past three years. In 2001, applications made at hilling were the most effective. None of the application methods were effective in 2002. In 2003, the foliar applications were

more effective than hilling or in-furrow at planting applications in protecting tubers from pink rot. The survey of pink rot isolates for resistance to mefenoxam has continued. So far in 2003, we have evaluated 214 isolates. Of these, 80% are highly resistant and only 20% are sensitive. Most of the sensitive isolates were found in the Magic Valley region of Idaho and most of the resistant isolates came from eastern Idaho. Sensitive isolates in eastern Idaho were associated with fields that had not received applications of Ridomil in the 2003 season. Tests comparing the fitness of mefenoxam-sensitive and mefenoxam-resistant isolates have been completed over a range of temperatures. Mefenoxam-resistant isolates produce significantly more oospores from 50-77 F. At 86 F, insignificant numbers of oospores of either resistance type are formed. Radial growth on V8 agar is significantly faster for resistant isolates than for sensitive. At all temperatures resistant isolates grew twice as fast as sensitive isolates.

Impact:
Growers will be able to improve the timing of fungicide applications from this project. Currently applications are made too early in the absence of late blight. Results from this project will allow growers to delay the initiation of fungicide sprays until later in the year when late blight is not predicted. This will result in improved disease control and could result in a 50% reduction in foliar fungicide applications. This translates into a reduced fungicide load on the potato crop. Control of pink rot will be improved by switching from in-furrow applications to foliar applications. Many growers used in-furrow applications and were frustrated by a perceived lack of performance. Surveys of fungicide resistance will result in mefenoxam use being discontinued by some growers. While this does not help solve the pink rot problem, growers are no longer spending money on fungicide applications that do not provide any benefit.

37. PLANT AND SOIL TEST CALIBRATION FOR IRRIGATED CROPS IN SOUTHERN IDAHO

Investigators: Brown, B. D.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Soil samples for the second year were collected from harvested wheat fields previously cropped to alfalfa seed, alfalfa forage, and various rotation crops. The samples were then incubated in buried bags during the fall to determine the mineralizable N released. Samples have yet to be analyzed. Studies were also conducted for the final year to compare the yield response to residual P of spring barley, spring wheat, and winter wheat in high lime soil. Onions studies are continuing for the third year to determine the effects of biofumigants on N and P nutrient cycling.

Impact:
Residual N studies provide better estimates of the residual and mineralizable N available for cereal residue decomposition. Residual P studies will improve the P fertilizer recommendations for the irrigated small grains grown in southern Idaho. Biofumigant studies will improve N and P rate recommendations for onions following biofumigants.

38. PLANT VIRUS INFECTION-INDUCED VOLATILES AND VECTOR BEHAVIOR

Investigators: Eigenbrode, S. D.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
This project aims to identify the implications of recent discoveries by colleagues and myself that potato plants infected with *Potato leafroll virus* (PLRV) emit a blend of volatile compounds (hereafter termed virus-induced volatiles or VIVs) that influence the behavior of the aphid (green peach aphid, GPA), the principal vector of this virus. The work encompasses this system and a parallel system involving wheat, *Barley yellow dwarf virus* (BYDV), and its principal vector, the bird-cherry oat aphid (BCOA). The specific objectives are: 1) Identify the components causing GPA arrestment on PLRV-infected Russet Burbank, 2) Measure behavioral responses of two additional aphid clones to Russet Burbank and two other potato varieties, 3) Determine if volatiles produced and aphid responses change during the PLRV disease cycle, 4) Determine the responsiveness to PLRV-infected plants by alate (winged) aphids, 5) Determine the responsiveness of viruliferous aphids to PLRV-infected plants, 6) Confirm that BCOA is attracted to or arrested by BYDV-infected wheat plants, 7) Identify the changes in volatile profile associated with BYDV infection in wheat, 8) If indicated, identify the active components in the blend from infected wheat plants. Two additional objectives concern the *Pea enation mosaic virus* (PEMV), specifically, 9) Determine the effect of PEMV-infection disease in pea plants on pea aphid life history, 10) Examine the behavioral response of pea aphid to PEMV-infected peas. One study has been completed addressing Objectives 6 and 7. We showed that VIVs in the wheat-BYDV-BCOA system are attractive or arrestant to BCOA. We have also shown on a preliminary basis that GPA alate aphids are attracted to PLRV-infected potato plants, partially addressing Objective 4. Potato plants (Russet Burbank) are currently being produced at 5 stages of infection by PLRV for a large experiment addressing Objective 3 and set to begin in Jan. 2004. Collaborative work underway and linked to this project also includes investigations of the phenomenon using two other *Solanum* species in which active VIVs seem to be produced.

Impact:
Virus Induced Volatiles (VIVs) are heretofore unrecognized factors in the interactions between plant viruses and their vectors. The epidemiology of these viruses is potentially influenced by VIVs and their eventual manipulation could help limit virus spread in agroecosystems. Active attractants and arrestants for the aphids could have applications for monitoring. PLRV and BYDV are two of the most destructive viruses affecting crops worldwide. Wheat and potatoes are the two economically most important crops in Idaho. PEMV is the most important virus affecting dry peas, which are grown extensively in northern Idaho. Better understanding of the biology of spread of these viruses will have long-term potential benefits to consumers and producers.

39. MODELING OF STRESS-CRACKING IN FOODS AND BIOMATERIALS USING HYBRID MIXTURE THEORY AND EXPERIMENTAL VERIFICATION

Investigators: Singh, P. P.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Cracking of food and biomaterials occur due to interaction of several factors over a hierarchy of spatial scales--- non-uniform shrinkage at macroscale, forces exerted by the solids, vicinal and bulk phases at micro and mesoscales, and glass transition effects at microscale. To understand the interaction of biopolymeric matrix with the moisture transport mechanisms, it is important to image the moisture content distribution in a food. Significant progress was made in using nuclear magnetic resonance spectroscopy (NMR) for visualizing moisture movement in pasta. An NMR pulse sequence published in literature allows measuring moisture profiles in pasta only when its initial moisture content is greater than 60%. However, processing industry dries pasta with initial moisture content of 40%. There is a significant difference in pasta's mechanical and diffusive properties at 40 and 60% moisture contents. Therefore, a new pulse sequence was developed in collaboration with Center for NMR Spectroscopy at Washington State University. This technique allows measuring moisture profiles in pasta with initial moisture content in the range of 10 to 50%. Several achievements were made in the experimental work. First, NMR imaging of moisture profiles during drying requires drilling of holes in the tube containing the food sample to cause air flow. It was difficult to drill holes in the commonly used NMR glass tubes due to their brittle nature. Therefore, a new type of PTFE tube (a plastic material) was utilized successfully. Drying was performed by passing air through the tube in the temperature range of 25 to 50 C. NMR signal intensity was converted into the moisture content values using a calibration procedure performed with pasta samples with known amounts of moisture content. The developed method allowed determination of moisture distribution across the pasta cross-section. The preliminary results verified the hybrid mixture theory based model's predictions that fluid transport in foods is Fickian in glassy and rubbery states but non-Fickian near glass-transition. The effect of various drying strategies on moisture movement and crack initiation in foods was identified. A computer program was developed using Borland C++ Builder X to study the effect of various drying and sorption strategies on moisture movement and crack initiation. The program predicted that intermittent drying (performed by switching air on or off, or continuously changing its humidity) and sorption methods are more suitable for obtaining wholesome foods in comparison to the continuous methods. To validate the model predictions continuous and intermittent sorption experiments were performed in a controlled temperature/humidity chamber. The resulting pasta samples were imaged using a stereomicroscope. The preliminary experiments verified the model's predictions that by adjusting the temperature, humidity and air on/off time steps, pasta with minimum stress cracks can be obtained. Future work involves using the developed computer program and conducting further experiments to generate a large amount of information on various drying and sorption techniques.

Impact:
Stress-cracking during drying, storage and shipping causes a significant economic loss to food

and biomaterials in the U.S. The study allows determination of optimum drying and sorption strategies causing minimum cracks in foods. Implementation of these strategies during industrial processing will yield food and biomaterials with improved quality. Such materials are not easily damaged by micro-organisms and are preferred by the consumers.

40. EFFECTS OF NITROGEN RESOURCE AVAILABILITY ON CONIFER STRESS RESISTANCE

Investigators: Lloyd, J.
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
A two year assessment of nitrogen pools in disparate urban landscapes concluded in October 2003. The landscapes represented in the study were new landscapes in < 5 years old, old landscapes >50 years old, newly mulched soils < 2 years, old mulch soils >2 years, street side soils, and municipal park soils. Soil from eight replicates of each treatment were analyzed nine times from April through October of 2002 and seven times in 2003 for mineral N, organic N, microbial N, N mineralization, and litter soil organic matter (SOM), coarse particulate organic matter (POM), fine POM, and mineral-associated SOM. Mineral N concentrations fluctuated across all of the urban locations in 2003 (date* location interaction; $F=2.26$ $p<0.0001$), suggesting that as documented in natural and agricultural systems mineral N pools are incredibly variable and susceptible to a multitude of environmental influences. While dissolved organic N and microbial N pools fluctuated across collection dates in 2002 the rankings of the landscapes and differences due to location remained consistent in 2002 and 2003. The changes in concentrations during each season could be indicative of enhance microbial mineralization in early spring and late fall and immobilization in late spring and summer. Old landscapes, parks, and street locations consistently had 60% higher concentrations (>10ppm) of organic and microbial N than did their counterparts in both years. Fine POM varied over the growing season, but followed the same pattern and was consistent with the assessments of microbial and organic N. The location effects observed with the organic and microbial N were also evident with the fine fractions of POM. In addition the positive correlation between the fine POM fraction and microbial N ($R2= 0.31$ to 0.97) remained significant ($p< 0.05$) across collection dates. The results of this study clearly illustrate the variability of mineral nitrogen and the potential for utilizing fine POM as a method for assessing season long nitrogen availability of urban soils. It also suggests that urban landscapes do vary in their extant nitrogen pools. Established landscapes had significantly higher concentrations of N tied up in microbial biomass and higher percentages of POM than more recently developed landscapes, thus they had a reservoir of relatively labile nitrogen. This suggests that fertilizer recommendations in urban landscapes need to take into account the age of the landscape as well as the fine POM content of soil.

Impact:
The results of this study have direct application to the landscape maintenance industries in prescribing fertilization recommendations. Prescription fertilization will decrease over application of nitrogen in urban areas and thus reduce nitrate run-off and watershed contamination.

Allocated Resources IAES Program 1:

RPA	SY	PY/TY	Amount
102	1.19	1.81	881,388
121	0.00	0.00	35,278
123	0.00	0.00	56,810
133	1.64	1.0	487,577
201	.80	2.70	2,583,453
202	1.15	1.40	233,374
203	3.81	2.51	143,135
204	3.00	2.97	1,177,284
205	.20	.30	455,874
206	0.00	0.00	159,657
211	5.05	5.96	2,091,225
212	8.24	3.74	1,234,308
213	2.25	1.43	1,312,633
214	1.00	0.00	112,282
501	0.00	0.00	228,425
502	1.00	5.59	288,140
Total	29.33	29.41	11,480,843

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IAES Program 2: Animal Health and Well-Being (RPAs 301, 302, 305, 306, 307, 311, 312, 313, 315). Also under **REE GOAL 1**, IAES Program 2 is the third largest program area encompassing 16 active research projects and approximately 10.93 faculty SY.

Performance goals:
Improved animal management and the detection, control and treatment of infectious diseases of domestic animals in the Northwest and United States. Animal well-being and performance and livestock and dairy product quality and consistency will be monitored and maintained for the benefit of producers and consumers.

1. THE REGULATION OF BACTERIAL AUTOLYSIS
Investigators: Bayles, K. W.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
The most important facet of my research in the past five years was summarized recently in a review article where it was proposed that the Staphylococcus aureus lrgAB and cidABC operon

encode proteins that are functionally homologous to the eukaryotic Bcl family of proteins involved in the regulation of programmed cell death (apoptosis). The idea that programmed cell death exists in bacteria is still a much-debated topic but has recently enjoyed growing acceptance, probably related to our greater understanding of the role that multicellularity (primarily as biofilms) has in the bacterial world. Although the we have not yet tested whether the specific biochemical properties of the cid and lrg gene products, we have made great strides in understanding the regulation of these operons. First, recent studies have demonstrated a marked strain dependence of cidBC transcription. This was originally observed in a clinical S. aureus isolate where the 2.8 Kb cidBC transcript appeared to be dramatically overexpressed relative to our laboratory strain, RN6390. Given that RN6390 has a known defect in its ability to activate the recently characterized alternative sigma factor, Sigma B (involved in the stress response), we reasoned that Sigma B might be required for optimal cidBC expression. Indeed, the expression of the cidBC transcripts was dramatically enhanced in the SH1000 (a Sigma B active strain) at all time points analyzed compared to the isogenic 8325-4 strain that produces inactive Sigma B. Furthermore, the sigma B gene also appears to affect the sensitivity of the bacteria to antibiotics. Those cells containing an active sigma B response were more sensitive to antibiotic-induced killing compared to the corresponding sigma B defective strain. These data indicate that cidBC expression and antibiotic-induced killing are part of the Sigma B controlled response of the bacteria to stress. Second, we have found that growth of the bacteria in the presence of 0.5% glucose and other carbon sources significantly induce cidABC and lrgAB transcription as the cells approach stationary phase. Carbon sources that are not utilized by S. aureus (xylose) or nonmetabolizable glucose analogues (2-deoxyglucose) do not induce cidABC expression indicating that metabolism is important for induction. Indeed, experiments indicate that acetic acid, a product of carbohydrate metabolism, is the primary inducer of cidABC/lrgAB expression and that the addition of this compound, even during early exponential growth, dramatically induces the transcription of these operons. This regulation is mediated by a recently identified transcription factor, designated CidR, that is encoded by a gene adjacent to the cidABC operon. Interestingly, the third gene of the cid operon, cidC, encodes a pyruvate oxidase that contributes to the metabolism of the carbon source and affects the accumulation of acetic acid in the medium. These data suggest that the expression of the cid operon is intricately tied to the metabolic activity of the cells, although the precise biologically significance of these findings remains elusive.

Impact:
This research has a major impact on our understanding of the basic physiology of bacterial cells, specifically, that involving programmed cell death. Since the existence of programmed cell death in bacteria has only recently been identified, there remains a great deal of work to be done to elucidate the molecular mechanisms involved in effecting cell death and in regulating this process. As potential molecular components of programmed cell death in bacteria, the analysis of the molecular mechanism in which the cid and lrg gene products function could ultimately lead to a much greater understanding of the basis for cell death in bacteria.

2. VIRULENCE GENE MODULATION IN YERSINIA ENTEROCOLOTICA

Investigators: Minnich, S. A.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
Our basic goal is to understand temperature regulation in pathogenic bacteria. Our model is Yersinia enterocolitica. Pathogenic Yersinia vary among various phenotypes between 30 and 37 degrees Celcius. Part of this switch includes type III protein secretion systems. We have determined that this is necessary because secreted proteins from different type III systems can be cross-recognized. We have shown that a virulence protein, YopM, is recognized and secreted from the flagellar structure. We have also found cross-recognition extends to a third type III system (Ysa) regulated by high salt. Thus, the three type III systems are segregated by environmental cues to prevent cross-contamination. We focused on characterization of this new typeIII system. In addition, we initiated studies on DNA methylation involvement in virulence regulation and we have been conducting microarray analysis of temperature regulation studies in collaboration with investigators at the University of Illinois. Over the last year we have expanded our observations to two additional important human pathogens, Campylobacter jejuni and E. coli O157:H7. In collaboration with Dr. Mike Konkel, we have shown that C. jejuni secretes its cellular invasion antigens (Cias) using the flagellum. In collaboration with Dr. Peter Feng, we have shown that nonmotile strains of E. coli O157 being isolated from Germany and Italy have a 12 base-pair deletion in flhC (similar to Y. pestis) and we speculate that this may contribute to this strains apparent increased virulence as up to 40% of HUS patients in these countries harbor this strain of E. coli.

Impact:
These results have a broad impact both on human, animal, and plant pathogenesis. Type III systems are common to most Gram Negative bacteria. We have definitively shown that segregation of multiple type III systems is necessary, and most likely explains why flagellar biosynthesis must be regulated in the host and also suggests why some important pathogens have lost motility during their histories.

3. STUDY OF TRANSMISSION AND EARLY DETECTION OF SCRAPIE

Investigators: Bulgin, M. S.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The retropharyngeal, mandibular and mesenteric lymph nodes, third eyelid lymphoid tissue, tonsils and obex of brain were tested for the scrapie prion protein (PrPsc) using immunohistochemistry on 144 sheep exposed to scrapie. Fifty-two sheep tested positive by immunohistochemistry (IHC) and were codon 171 QQ genotype. Four sheep (7.7%) had positive brains only. Thirteen had both eyelids tested earlier; 6 tested positive. The third eyelid tissue of 17/144 (12.9%) animals had less than 5 required follicles necessary for evaluation. Of 32 positive animals with acceptable third eyelid samples, 6 (18.8%) were negative. Eight of 48 (16.7%) positive animals had negative tonsils, 9 (18.8%) had negative mensenteric nodes and 7

(13.7%) had negative retropharyngeal lymph nodes. Forty of 52 (76%) positive animals had positive mandibular lymph nodes. Specificity of the test for all tissues is 1.0. The sensitivity of the third eyelid is 0.69. The retropharyngeal lymph node sensitivity is 0.885. Brain tissue had a sensitivity of 0.865.

Impact:
There is no single good tissue for scrapie diagnosis. Increasing the number of lymphoid tissues tested increases the sensitivity of the diagnosis whether for live animal testing or for slaughter surveillance.

4. PHYSIOLOGY OF INSECT BEHAVIOR
Investigators: Klowden, M. J.
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
We have continued our search for specific cuticular hydrocarbons that change after mating by Anopheles gambiae female mosquitoes and their possible involvement in the control of the mated state. We have also identified cuticular hydrocarbons that appear to be transferred from the male, in addition to the ones that appear to be synthesized by the female. A novel sperm polymorphism that is present in A. gambiae males is absent in many other anophelines and aedines, and may be involved in the switchover of the female to the mated state. Smaller sperm are less likely to be transferred to the female and may serve some accessory function as in Drosophila. The spermatheca, when filled with sperm, appears to regulate oviposition behavior.

Impact:
This research will help us to better understand the reproductive behavior of one of the most important insect vectors in the world by understanding the basic physiology of their mating and egg-laying behaviors.

5. PHYSIOLOGY OF INSECT BEHAVIOR
Investigators: Klowden, M. J.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
The project demonstrated that the mating behavior of female Anopheles gambiae mosquitoes is not regulated by male accessory gland substances transferred during mating. We examined several other possibilities that might control mating behavior in these vectors, including changes in cuticular hydrocarbons that are expressed following insemination in both A. gambiae and Aedes aegypti females. Our work suggests that the spermathecal contents might be most important in triggering the mated state.

Impact:
The novel strategies proposed to control insect populations by genetic manipulation all require the genes to be distributed by mating. It has been presumed that all female mosquitoes mate

only once because of the action of male accessory gland substances, but the results of this research have suggested that anophelines have a different mechanism of control.

6. STRATEGIES FOR OPTIMIZING THE UTILIZATION OF ENERGY RESOURCES BY DOMESTIC RUMINANT ANIMALS

Investigators: Hunt, C. W.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report**:**
Four ruminally cannulated Jersey steers were used to evaluate diets containing alfalfa fed coarsely chopped or as pressed cubes. These diets were fed with or without substituted barley. For the barley-containing diets, dry rolled barley was included at 40 percent of the diet DM as a separate ingredient when fed with chopped alfalfa or as an incorporated ingredient with the cubed alfalfa. Steers were fed an amount equal to 1.2 times maintenance requirement. Substitution of barley into the diet reduced ($P < 0.05$) in situ DM and NDF disappearance of alfalfa for short incubation times (8, 16, and 24 h); however, DM and NDF disappearance was actually greater ($P < 0.05$) for longer incubation times (48, 72 and 96 h) when barley was included in the diet. In situ degradability and fluid pH data indicate that barley substitution did not have an enduring detrimental effect on the ruminal environment. Total tract digestibility of DM and NDF was greater ($P < 0.05$) for diets containing barley suggesting that providing a portion of the dietary ME as grain might have actually increased ruminal microbial fibrolytic activity. In a second study a 2 x 2 factorial treatment arrangement was utilized to examine the impact of ammoniation and exogenous fibrolytic enzyme on performance of cows fed bluegrass straw diets. Approximately four months prior to the calving season, 89 crossbred beef cows (mean initial BW 636 kg) were stratified by days-to-parturition and randomly allotted the following treatments: 1) bluegrass straw, 2) ammoniated bluegrass straw, 3) bluegrass straw with enzyme, or 4) ammoniated bluegrass straw with enzyme. Cows were offered grass straw treatments ad libitum. Cows fed ammoniated straw also received 4.6 kg alfalfa daily while cows fed non-ammoniated straw received about 6.1 kg alfalfa. The enzyme utilized contained xylanase and cellulase activity. BW and condition score were not different ($P > 0.10$) among treatments at 260 d of gestation or at 2, 30, and 45 (adjusted) d post-partum. Calf BW at 2, 30, and 205 (adjusted) d of age did not differ ($P > 0.10$) among dietary treatments. Pregnancy rate at 60 and at 90 d post-partum did not differ ($P > 0.10$) between treatments. Likewise, treatment differences were not detected ($P > 0.10$) for percentages of cows pregnant at weaning. Ammoniation of bluegrass straw may be cost-beneficial by reducing dependence on more expensive alfalfa hay to maintain proper body condition.

Impact:
Metabolizable energy can often be supplied more economically from grain than from forages, however logistics often preclude inclusion of grain in wintering beef cattle rations. Wintering beef cattle are typically fed forages, however results of this study indicate that energy requirements may be met by a partial (40%) substitution of grain for conventional forage. Ammoniation of low quality forages may also provide an economical alternative to more expensive conventional forages. The impact of this project will be provide beef producers (cow/calf and stocker operations) economical alternatives for meeting the energy requirements

of animals through the winter feeding period.

7. GASTROINTESTINAL DISEASES OF NEWBORN CALVES: SEARCH FOR ADDITIONAL CAUSAL PHENOMENA

Investigators: Anderson, B. C.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The study confirmed that the parasite Cryptosporidium andersoni continues to be present in low prevalence (about 4%) among weaned beef calves in Idaho. Recent samplings of weaned dairy calves at calf ranches in western Idaho have been negative. We have discovered a 2% prevalence of the parasitism in one of the nation's top Brown Swiss herds. These are lifelong infections acquired in calfhood. The affected cows are below average milk production in the herd, as expected. Attention to calfhood disease has focused this past year on Mycoplasma infections. We have discovered that some of the calves that appear to survive calfhood Mycoplasmosis have later manifestations. The main one is manifested when the animal gives birth for the first time. Generally, this animal is one that is older than average at first calving and is somewhat small for her age. Necropsy reveals that the animal has been a chronic pulmonary cripple (lung capacity reduced 20-30%) and Mycoplasma populates the chronically infected lung. Additionally, we have had two cases of adolescent cattle afflicted with bony abscesses of the middle ear, pressing on the brain and causing fatal outcomes. Mycoplasma is the culprit and we feel strongly that the process probably began in calfhood.

Impact:
Concerning C. andersoni there is some importance in confirming that the parasitism is low prevalence and thus low practical priority for beef and dairy producers. Mycoplasmosis needs to be understood in order to interrupt its serious damaging effects on udder of milking cows, and lungs and joints of young cattle. Though dairy animals seem to suffer relatively more from various forms of Mycoplasmosis, beef animals have problems too. Some of the worst problems in beef feeder cattle seem to be outbreaks of pneumonia subsequent to first time exposure to Holstein steers in the feedlot.

8. IMPROVING THE EFFICIENCY OF FEED PROTEIN UTILIZATION IN THE DAIRY COW

Investigators: Hristov, A. N.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Increasing crude protein (CP) content of dairy cow diets may result in greater milk production, but also leads to increased concentration of ruminal ammonia and blood urea nitrogen (N) and consequently higher urinary N losses and less efficient use of dietary N for milk protein synthesis. The objectives of the experiment reported here were to investigate the effect of two dietary ruminally degradable protein (RDP) levels in diets containing similar ruminally undegradable protein (RUP) and metabolizable protein (MP) concentrations and adequate in

ruminally available energy on ruminal utilization of ammonia N, microbial protein outflow from the rumen, nutrient digestibility, and transfer of ruminal ammonia N into milk protein in dairy cows. Four ruminally and duodenally cannulated Holstein cows were allocated to two dietary treatments in a crossover design. The diets (adequate RDP, ARDP and high RDP, HRDP) were based on alfalfa hay, triticale silage, cottonseed, corn grain, solvent-extracted or non-enzymatically brown soybean meal, and molasses and contained similar concentrations of RUP and MP, but differed in CP/RDP (dry matter basis): 6.4 and 6.7%, 10.8 and 10.8, and 15.8/9.4 and 18.3/11.6%, ARDP and HRDP, respectively. Ruminal ammonia was labeled with 15N and excretion of tracer in milk protein was determined for a period of 120 h. Ammonia concentration in the rumen tended to be higher ($P < 0.1$) with HRDP than with ARDP (10.9 and 8.7 mmol/L, respectively). Microbial N flow to the duodenum, ruminal digestibility of dietary nutrients, dry matter intake, milk yield, fat content, and protein content and yield were not different ($P > 0.05$) between diets. Total tract apparent digestibility of N was greater ($P < 0.05$) on HRDP than on ARDP. Urinary N excretion tended to increase ($P < 0.1$) with HRDP compared to ARDP (321 and 252 g/d, respectively). Blood and milk urea N concentrations were increased ($P < 0.01$ and $P < 0.05$, respectively) with HRDP compared to ARDP. Milk N efficiency (milk protein N/N intake) was decreased ($P < 0.05$) by HRDP. The cumulative excretion of ammonia 15N into milk protein, as proportion of 15N dosed intraruminally, was greater ($P < 0.05$) with the ARDP than with the HRDP diet (17.3 and 15.8%, respectively). The proportions of bacterial protein originating from ammonia N and milk protein originating from bacterial or ammonia N were not different ($P > 0.05$) between the two diets. This experiment indicated that excess of RDP in the diet of lactating dairy cows could not be utilized for microbial protein synthesis and would be lost to the environment, most likely via urinary N excretion. At similar MP supply, increased CP or RDP concentration of the diet would result in reduced efficiency of conversion of dietary N into milk protein and less efficient utilization of ruminal ammonia for bacterial and milk protein syntheses.

Impact:
The results reported here indicate that overfeeding of ruminally available nitrogen to dairy cows can lead to increased urinary nitrogen losses and less efficient use of dietary nitrogen for milk protein synthesis, thus contributing to nitrogen pollution by dairy operations.

9. IMMUNOSUPPRESSION BY SUPERANTIGENS: ROLE IN BOVINE MASTITIS
Investigators: Bohach, G. A.
Termination Date: 07/01/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The long term goal of this project is to evaluate the immunosuppression caused by staphylococcal superantigens (SAgs) in dairy animals using staphylococcal enterotoxin type C (SEC) as a model toxin. The specific objectives center around the characterization of bovine T cells activated by SEC in vitro and in vivo. We previously showed that the ACT3 marker was highly upregulated on bovine T cells exposed to SEC and then identified the molecule as the bovine orthologue of CD26. During the past year, we focused on characterizing bovine T cell subpopulations activated by SEC. We found that SEC induces CD26 T cell subpopulations expressing CD25 and CD45R0. In other systems, cells with these properties are designated T

regulatory cells and have been shown to have significant immunosuppressive properties. Further evidence that these T cells act similarly to Treg cells was provided by demonstration of their ability to express IL10. These observations were made using in vitro studies and two in vivo mammary models for delivery of SEC; surgically implanted osmotic pumps and a bolus infusion of SEC through the teat canal.

Impact:
These findings give us a better understanding of the molecular mechanisms of action of staphylococcal toxins. They also explains why certain strains encode superantigens. Specifically, in the bovine system, staphylococci can induce T cell subpopulations analogous to those that induce immunosuppression in other animals. This could explain why staphylococcal mastitis can persist long-term and have a major impact on animal health and well-being.

10. ANALYSIS OF INTRAFLAGELLAR TRANSPORT AND ITS ROLE IN CILIARY ASSEMBLY IN PLANTS, ANIMALS, AND PROTOZOANS
Investigators: Cole, D. G.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
In the past year, we have continued to advance toward completion of our goals in the study of specific components of the intraflagellar transport (IFT) machinery. We have added the cloning of two new IFT genes, IFT144 and IFT43, which are components of the IFT complex A. We have also completed the cloning of IFTA and discovered that it represents the IFT complex A subunit known as IFT122B. At this stage, all of the protein subunits of complex A, IFT144, 140, 139, 122A, 122B and 43 have all been cloned. The architecture of complex A, the structure of the individual complex A proteins and their biological function are currently under investigation. We also continue to characterize IFT complex B through a combination of yeast-based two hybrid analysis to identify protein-protein interactions and the use of a novel approach which combines chemical cross-linking with subsequent analysis using mass spectrometry. All of the above analyses have been performed with the unicellular biflagellate green alga, Chlamydomonas reinhardtii. Indeed, although the IFT proteins appear to be present in all ciliated organisms, the IFT complexes have only been purified from green alga. Therefore we have also made progress toward the purification of IFT proteins from the testes of rat and mouse. Once we have suitably purified these proteins, we will be able to identify all proteins present using mass spectrometry. This will be particularly significant because, although we know that IFT is necessary for the assembly of cilia and flagella in all animals, no one knows for sure which proteins will be present in the IFT complexes of higher animals. We will continue to pursue these studies using the testis because of the high concentration of the IFT machinery which is needed for the construction of billions and billions of sperm flagella.

Impact:
Intraflagellar transport (IFT) within cilia and flagella is necessary for the assembly and function of the organelle. Found in diverse organisms, cilia and flagella can generate movement and are often used as sensory organelles. It is partly because of this that we have been able to link intraflagellar transport with several human diseases. The most prominent of these are polycystic

kidney disease (PCKD) and retinal degeneration, both of which we have published on in the past three years. In addition, others have shown that the vertebrate IFT57 protein interacts with the Huntington-interacting protein, suggesting a link to Huntington's disease and that the vertebrate IFT172 is required for an early developmental signaling pathway involving the protein sonic hedgehog. We will continue to explore the links between IFT and human and animal disease as we continue our characterization of this intracellular transport process.

11. INCORPORATING ESTRADIOL CYPIONATE INTO THE TIMED ARTIFICIAL INSEMINATION BREEDING PROTOCOL TO IMPROVE PREGNANCY RATES IN CATTLE

Investigators: Ahmadzadeh, A.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Timed artificial insemination (Ovsynch; OVS) is a convenient method to facilitate artificial insemination, however GnRH administered during the follicular phase, as occurs in Ovsynch, causes a premature decline in estradiol secretion. It was hypothesized that administration of estradiol cypionate (ECP) coupled with the second GnRH injection would improve conception rate. The objectives were to determine the effect of ECP incorporation into the Ovsynch protocol on Serum estradiol (E2) and progesterone (P4) concentrations, time of ovulation, and ovulation rate in dairy cows. Twenty-three lactating Holstein cows averaged 58.7 days in milk (DIM) were synchronized with 25 mg Prostaglandin F2 alpha (PGF;d -10). Ten days later the conventional Ovsynch protocol was initiated and 100 ug gonadotropin releasing hormone (GnRH) was given (d 0) followed by 25 mg PGF on d 7. On d 9 cows were assigned randomly to receive either GnRH or 0.25 mg ECP (ECP group; n=11) or GnRH and 1 ml cottonseed oil (C group; n=12). Ovarian activity was examined by ultrasonography on d 0, 7, and 9. To determine time of ovulation, ultrasound examinations were conducted at 12 and 20 h post-treatment and then at least every 3 h until either 35 h post-treatment or ovulation was observed. Presence of a corpus luteum (CL) was determined on d 16. Blood samples were collected on d 0, 7, and 9, at 20 h post-treatment and on d 16 for serum progesterone (P4) analysis. Blood samples were collected at the time of treatment (d 9, 0 h) and at 6, 12, 20, and 28 h post-treatment for serum E2 analysis. Ovulation rate did not differ between groups (100% ECP vs. 92% C). Mean ovulation time relative to second GnRH administration was similar between groups (26.3 +/- 1.1 h ECP vs. 27.3 +/- 0.1 h C). Cows that ovulated exhibited CL on d 16. Serum P4 concentration did not differ between groups at any time. At 6, 12, and 28 h post-treatment mean serum E2 concentration was higher for the ECP group ($P<0.05$; P=0 .05; and P=0.07, respectively). Serum E2 was not different at the time of treatment (0 h) or at 20 h post-treatment. Incorporation of a low dose ECP into the Ovsynch protocol elevated the serum E2 for the first 12 hours after injection but did not adversely affect time of ovulation, ovulation rate, or subsequent luteal function.

Impact:
Estradiol plays an important role in fertility. For the purpose of estrous synchronization and breeding in dairy cows, GnRH is routinely used to induce ovulation. Exogenous GnRH may impair ovarian estradiol secretion prematurely. Therefore, administering of a low dose E2 where GnRH is used to induce ovulation may overcome the premature GnRH-induced estradiol

suppressions and improve fertility in dairy cattle.

12. REPRODUCTIVE PERFORMANCE IN DOMESTIC RUMINANTS
Investigators: Ott, T. L.
Termination Date: 09/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We have identified a uterine gene, Mx, is rapidly induced in response to the early embryo. We recently showed that Mx was expressed in the uterus of cattle, pigs and horses during early pregnancy. In cattle and pigs Mx expression was increased by the embryo whereas in mares, Mx expression did not increase. This is consistent with the findings that horse conceptuses do not secrete an interferon during early pregnancy. Therefore uterine Mx expression appears to be a general phenomenon during early pregnancy. We further characterized the effects of steroid hormones on Mx expression and showed, in vivo and in vitro that progesterone increased Mx expression in uterine derived cell lines, in cyclic female sheep uteri, and in peripheral blood immune cells from progesterone treated wethers. Results suggest that the steroid hormones could modulate the ability of the female reproductive tract to fight viral infections. Expression of the Mx gene in peripheral blood immune cells provides a unique opportunity to examine the timing of early pregnancy signaling and determine non-invasively when pregnancies are lost. Results should help reduce days open in the cattle (dairy an beef) industry.

Impact:
Infertility has the largest impact on profitability in animal agriculture. Understanding how embryos are lost and developing on farm methods for the early detection of these losses will help farmers and ranchers become more profitable and sustainable. An early pregnancy detection test based on the Mx protein has been patented and is currently being commercialized.

13. ENHANCING THE EFFICIENCY OF A ARTIFICIAL INSEMINATION IN DAIRY CATTLE THROUGH A MODIFIED SYSTEMATIC BREEDING PROTOCOL
Investigators: Dalton, J. C.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
As dairy producers manage larger herds to enhance their profitability through high volume, low cost production, labor efficient reproductive management strategies such as systematic breeding protocols, once-daily AI, and timed AI are becoming more common. OvSynch (GnRH-7d-prostaglndin-2d-GnRH-16 h-Timed AI) was designed to synchronize ovulation, thereby allowing timed AI of all cows without estrus detection. Nevertheless, OvSynch does not achieve 100% ovulation synchronization. Therefore, timed AI of all cows may not optimize conception rate per AI. Select Synch (GnRH-7d-prostaglandin-heat detection and AI) was designed to initiate a new follicular wave and lyse the corpus luteum to provide tighter synchronization of estrus than normally achieved through the use of prostaglandin alone. The primary limitation of Select Synch is the length of time recommended for heat detection (7 d), beginning one day prior to the prostaglandin injection and continuing for six days following prostaglandin administration. This

project directly addresses the limitations of these GnRH-prostaglandin based protocols and may provide a new, more efficient, less costly protocol in which the efficiency of AI in lactating dairy cattle is increased. Two commercial dairies utilizing daily lock up, tail chalk, and once daily AI have completed the study. Cows (N = 432) were administered GnRH (100 ug) on d -7 and received tail chalk daily. Cows detected in estrus according to chalk removal (roughened tailhead hair) prior to d 0 received AI immediately. Cows not detected in estrus by d 0 were administered prostaglandin (PGF; 25 mg) and continued to receive tail chalk daily until d +2. All cows detected in estrus prior to and including d +2 received AI immediately and were considered treatment 1 (T1; n = 46). Cows that were not detected in estrus and not inseminated by d +2 were assigned randomly to one of three treatment groups: GnRH on d +2 and timed AI 16 h later (T2; n = 132), GnRH and timed AI 64 h after PGF (T3; n = 127), or timed AI 64 h after PGF (no GnRH) (T4; n = 127). Pregnancy was diagnosed 38-45 d after AI by rectal palpation. Median days in milk were 112, 120, 128, and 119 for T1, T2, T3, and T4, respectively. Mean milk yield was 39.2, 39.5, 39.0, and 38.2 kg for T1, T2, T3, and T4, respectively. Conception rates (adjusted proportion pregnant) were 25.4%, 29.8%, 21.2%, and 16.5% for T1, T2, T3, and T4, respectively. The conception rate (adjusted proportion pregnant) was higher for T1 and T2 compared to T4 (P = .06). The conception rate (adjusted proportion pregnant) was not different between T3 and T4.

Impact:
When completed, this research may provide a new, less costly protocol in which the efficiency of Artificial Insemination (AI) in lactating dairy cattle is increased.

14. REPRODUCTIVE PERFORMANCE IN DOMESTIC RUMINANTS
Investigators: England, J. J.
Termination Date: 09/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
30 head of normal calves in the test herd were sampled at 30 and 180 days of age in 2003 via guarded endotracheal swabs to define the natural flora of the respiratory tract in beef calves 30-210 days of age. Typical respiratory microorganisms were recovered; unexpectidally, mycoplasmas and Pasteurella trehalosi were isolated from many of the test animals. Both microorganisms are potential pathogens; P. trehalosi is associated with respiratory disease in wild ruminants. No ill animals in the test herd were observed or sampled during the same time span.

Impact:
Definition of the significance of the mycoplasmas and the P. trehalosi organisms may permit vaccine development or recommendations for management changes.

15. MECHANISM OF ALTERED NUCLEO-CYTOPLASMIC TRAFFICKING IN RHINOVIRUS-INFECTED CELLS
Investigators: Gustin, K. E.
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
This work is still at a very early stage, having been funded five months ago. Below is a list of accomplishments pertinent to the achievement of the objectives described in the research grant proposal. 1. Designed and ordered the primer sets necessary for the amplification of all 11 viral open reading frames (ORFs). 2. PCR Amplified the ORFs corresponding to 2A and 3C (the viral proteases), sequenced to confirm accuracy of amplification. 3. Subcloned 2A and 3C ORFs into dicistronic vector for expression in HeLa cells under the control of the Tet inducible promoter. 4. Transfected 2A and 3C constructs into HeLa Tet-On cells and examined the effect on localization of EGFP-NLS. Results: Very few EGFP-NLS expressing cells were observed, suggesting that only a few cells were being transfected. This makes it difficult to draw any firm conclusions regarding the effect of the viral ORFs on the distribution of nuclear proteins (EGFP-NLS). Current efforts. 1. Work to optimize transfection efficiencies in HeLa Tet-On cells. We are examining a variety of transfection reagents to determine which gives the best results. This will be very important for the completion of objectives 1-3. 2. Use PCR to amplify the remaining viral ORFs, sequence and subclone into dicistronic vector.

Impact:
This project is still in its infancy and consequently has not had a discernable impact.

16. MOLECULAR MECHANISMS REGULATING SKELETAL MUSCLE GROWTH AND DIFFERENTIATION
Investigators: Hill, R. A.
Termination Date: 09/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Study 1. We are characterizing primary bovine myogenic cells (BMC) and mouse Sol8 myogenic cell lines to determine signaling interactions between the insulin and leptin axes. In the first series of studies, insulin signal transduction has been characterized. BMC provide a model of mild insulin resistance, while Sol8 provide a model of normal insulin sensitivity. We are using new technology, dual infrared laser scanning (Odyssey, Li-Cor, Lincoln, NE) provided by an NRI Equipment Grant (2003) to quantify specific insulin signaling cascade proteins in Western blots. Bovine myogenic cells (BMC) or mouse Sol8 cells were grown in culture to retain mononuclear (undifferentiated) morphology. Cultures were then incubated in a defined medium in the presence of 100 nM insulin for 0, 1, 10 or 30 min. Cells were lysed and insulin signal cascade proteins immunoprecipitated (IP) using specific antibodies bound to protein A sepharose, immunoblotted (IB) using specific antibodies and quantified. Results: 1. IRS-1 recruitment to the Insulin Receptor (IR). In BMC the response was rapid and of short duration, while in Sol8 the response was not as immediate and peaked after 10 min of insulin stimulation ($p < 0.05$). 2. PI3-K recruitment to IRS-1. In BMC the response appeared to be more prolonged

than determined for IRS-1 recruitment to IR, remaining elevated above basal, while in Sol8, the apparent higher basal recruitment was numerically but not significantly increased by insulin treatment. 3. PI3-K recruitment directly to IR. Similar to recruitment of IRS-1 to IR, recruitment of PI3-K to IR in BMC and Sol8 showed a consistent response being rapid in BMC (1 min) and slower in Sol8 (10 min, $p < 0.05$). 4. Recruitment of PI3-K to IR and PII3-K to IRS-1. BMC appear to exist under basal conditions in an insulin resistant state, with almost a 10-fold partitioning of PI3-K to IR over IRS-1. Following insulin stimulation, this ratio is rapidly decreased but remains above a 2-fold excess, indicating that an insulin resistant state is maintained. Conversely, in Sol8 the ratio of recruited PI3-K to IR over IRS-1 rose slightly above basal, but was never above unity indicating that these cells retain insulin sensitivity, despite stimulation by a supraphysiological concentration of insulin. These data indicate that direct recruitment of PI3-K to IR, a mechanism well known in insulin resistant models contributes to insulin resistance in primary bovine myogenic cells. Mouse Sol8 cells are a typical insulin-sensitive myogenic cell line in which direct recruitment of PI-3 K to IR appears to invoke at most, a mild and transitory insulin resistant state. Study 2. Paracrine interactions between bovine adipocytes and myogenic cells: modulation of the leptin axis by leptin binding proteins. This study is conducted in close collaboration with the Washington Station (please see Washington report) and also forms part of an NRI-funded project. Conditions for bovine adipofibrobalst differentiation have been established. In the next phase, we will examine the interaction of the adipocyte as a source of leptin and leptin binding proteins, with muscle.

Impact:
The ability to understand and finely manipulate intracellular signaling pathways has enormous potential for exploitation. The single most important driver of profitability in primary production is the control of cost of production. Improvement in the efficiency of utilization of nutrients/energy will have a major effect on profitability of all beef production sectors.

Allocated resources IAES Program 2:

RPA	**SY**	**PY/TY**	**Amount**
301	3.47	0.00	688,715
302	.75	2.00	418,616
305	0.00	0.00	63,959
307	.67	1.00	342,640
311	4.45	3.41	4,581,783
312	1.20	0.00	213,104
313	.39	0.00	0
315	0.00	0.00	254,018
Total	10.93	6.41	6,562,835

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IAES Program 3: Crop and Livestock Production Systems (RPAs 102, 308, 404, 405). IAES Program 3 also contributes to **REE GOAL 1** and includes 3 active research projects and approximately 4.17 SY of effort by faculty project leaders.

Performance Goals:
To develop marketing alternatives and product quality and consistency to meet consumer's demands. Loss of natural resources (e.g. soil and water) and agricultural inputs (e.g. chemicals) by Idaho food producers will be decreased.

1. INTEGRATION OF NEW TECHNOLOGIES FOR IMPROVED WATER MANAGEMENT
Investigators: King, B. A.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The vast majority of center pivot irrigation systems in Idaho are equipped with an end gun to increase irrigated acreage of rectangular field areas, a significant portion are equipped with a corner watering system to further increase irrigated acreage. Constant rate chemical injection into center pivots equipped with an end gun and/or corner watering system results in systematic chemical application errors of 12 to 42% due to system flow rate variations caused by the variable wetted radius of these center pivot systems. Proportional chemical injections systems for center pivots currently on the market utilize a flow meter to adjust chemical injection rate and account for changes in irrigation system wetted radius. The typical installed piping arrangement for center pivot systems is not conducive to accurate and reliable flow rate measurement with flow meters. A proportional injection system which uses real-time direct measurement of end gun operating pressure and control status of valves along a corner watering system to calculate system flow rate for controlling chemical injection flow rate was developed and field tested. This approach overcomes reliability problems associated with using flow meters. Operation and performance of the proportional chemical injection system was tested with N fertilizer application through a commercial center pivot equipped with an end gun and corner watering system. The proportional chemical injection system reduced the coefficient of variation in N concentration in the applied water by 61% compared to conventional constant rate chemical injection. On average the measured N concentration in the applied water was within 2% of the calculated theoretical N concentration. The results show that the new proportional chemical injection system is effective in reducing systematic chemical application errors with a center pivot system equipped with an end gun and corner watering system. Further research and development are needed to confirm these results on additional center systems and package the control system for easy field installation and operation.

Impact:
The new proportional chemical injection control system for center pivot systems equipped with an end gun and/or corner watering system can greatly reduce systematic chemical application errors. This new proportional chemical injection control system eliminates reliability issues with commercial proportional chemical injection systems by eliminating the need for a flow meter while reducing control system cost. These improvements will increase the willingness of

producers to adopt proportional chemical injection with center pivot irrigation systems. Adoption of this technology will reduce chemical over-application that can result in groundwater contamination and increase production efficiency by increasing chemical application precision.

2. MODIFYING MILK FAT COMPOSITION FOR ENHANCED MANUFACTURING QUALITIES AND CONSUMER ACCEPTABILITY

Investigators: McGuire, M. A.
Termination Date: 09/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Intravenous infusion of conjugated linoleic acid (CLA) was evaluated as a simpler method compared to abomasal infusion to examine milk fat depression caused by trans-10, cis-12 CLA, an isomer identified to possess an inhibitory effect on milk fat synthesis. Four midlactation multiparous Holstein cows were randomly assigned to treatments in a 4 x 4 Latin square design. Catheters were inserted into the jugular vein for infusions and blood sampling. Treatments consisted of intravenous infusions of 0, 2, 4 and 6 g/d CLA (>95% trans-10, cis-12 CLA). Infusates contained 72 g/d of a parenteral solution, saline and CLA to 90 ml. Periods were of 5 d duration with a 7 d wash out. Dry matter intake, milk yield and protein percent of cows were not affected by treatment; however, milk fat percentage was reduced linearly with increasing doses of CLA. Milk fat percentage was 4.17, 3.53, 3.29 and 2.92% on d 5 for treatments 0, 2, 4 and 6 g/d CLA, respectively. Concentrations (4.2 mg/g fat) of cis-9, trans-11 CLA in milk fat were not affected by treatment. However, an increase in the trans-10, cis-12 CLA content of milk fat was observed. Plasma NEFA concentration increased linearly with the dose of the trans-10, cis-12 CLA. Intravenous infusion of the trans-10, cis-12 isomer of CLA depressed milk fat in a linear manner over the range of infusion studied and, therefore, is an alternative to abomasal infusion. Isomeric CLA exhibit several significant biological activities in animals and humans and are easily isomerized to their corresponding t,t-CLA isomers during methylation with various acid-catalyzed reagents. To minimize such isomerization and provide a valid quantification of human plasma CLA content, several methylation methods were tested. Plasma neutral lipid, NEFA, and polar lipid classes were separated into the following fractions: (i) cholesteryl ester (CE, 1.2 mg/12 mL, 37.5% lipids), (ii) TAG (0.8 mg/12 mL, 25% lipids), (iii) NEFA (0.2 mg/12 mL, 6.2% lipids), (iv) MAG/DAG/cholesterol (0.3 mg/12 mL, 9.4% lipids), and (v) phospholipid (PL, 0.5 mg/20 mL, 15.6% lipids). Data showed that c9,t11-CLA found in TAG, MAG/DAG/cholesterol, and PL fractions were converted to methyl esters with sodium methoxide within 2 h at 55 degrees C. However, the c9,t11-CLA in the CE fraction could not be completely converted to methyl esters by sodium methoxide/acetylchloride in methanol or methanolic KOH; instead, CE was treated with sodium methoxide and methyl acetate in diethyl ether for 1 h. NEFA were converted to methyl esters with trimethylsilyldiazomethane. All reaction mixtures were monitored by TLC prior to GLC analysis. The highest enrichment of c9,t11-18:2 (% FA) was in TAG (0.31%), followed by CE (0.14%) and PL (0.13%). The above methylation methods were then applied to a subset of nonfasting plasma lipid fractions to confirm the applicability of these data. Results from this subset of samples also indicated that the greatest enrichment of c9,t11-CLA was present in the TAG fraction (0.39%), followed by CE (0.27%) and PL (0.22%). These data indicate that different plasma fractions have different c9,t11-CLA contents.

Impact:
Intravenous infusion of CLA can be utilized as an alternative to abomasal infusion in order to study the mechanism of action without having to install rumen cannula in cows. Accurate methylation of plasma lipid classes will allow correct evaluation of the metabolism of CLA in humans.

3. PHOSPHORUS, ZINC, IRON, MANGANESE, AND COPPER INTERACTIONS IN EAST-IDAHO POTATO CROPPING SYSTEMS
Investigators: Hopkins, B. G.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
This project has growth chamber, greenhouse, and field components. The second year of field trials was completed with results similar to the first year. These results confirm the negative effect of high rates of fertilizer phosphorus on potato yield, tuber quality, and zinc nutrition in vines and leaves. Although this effect has been previously identified in other soil and environmental conditions, it is significant that the phosphorus induced zinc deficiency has been confirmed in conditions typical in the Pacific-Northwest. In addition to the field component of this study, a greenhouse study was attempted in order to evaluate various ratios of broadcast and banded phosphorus and zinc fertilizers. The study was completed with mixed success. The findings of the greenhouse study corroborate the field study results, but the effect of various ratios were not elucidated due to poor growth in many of experimental units. The experimental conditions need to be modified substantially to result in tuber and vine growth more consistent with what is experienced under field conditions. The hydroponics growth chamber studies are in process as well. The first study failed due to problems with plant growth. Nutrient solution and growth chamber conditions were modified and, as a result, successful growth of potato plants in the chelator buffered nutrient solution/growth chamber technique was achieved. Once a successful growth chamber/hydroponics technique was proven, various levels of zinc and phosphorus in the nutrient solution were tested separately in order to define deficient, optimum, and toxic solution levels. To date; deficient, optimum, and toxic levels of zinc have been identified. However, only deficient and optimum levels of phosphorus have been identified. Further work is needed to identify the toxic level of phosphorus in these solutions. Once the various solution levels have been identified, ratios of these two nutrients will be tested to determine optimal rates in relation to one another. This will reveal whether or not ratios of these nutrients are important from a physiological perspective.

Impact:
The impact of phosphorus induced zinc deficiency is impacting large portions of the majority of potato field in the Pacific Northwest. It is estimated that uniformly fertilized fields (as opposed to variable rate fertilization) have 10 to 40% of the field impacted by this problem. Net yield loss is estimated at 2-10% in these localized areas. The economic impact is estimated at $10-$100 per acre for the average grower. Although management options have not been fully defined at this time, growers are encouraged to: 1) base phosphorus fertilization on soil test results, 2) apply zinc in conjunction with phosphorus, and 3) variable rate apply fertilizer based on intensively

soil sampled management zones.

Allocated Resources IAES Program 3:

RPA	SY	PY/TY	Amount
102	1.19	1.81	881,388
308	2.18	2.88	283,391
404	.80	1.00	129,512
405	0.00	0.00	0
Total	4.17	5.69	1,294,291

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IAES Program 4: Farm business management, economics and marketing (RPAs 402, 511, 601, 602, 603, 604 and 606). IAES Program 4 also contributes to **REE GOAL 1** and includes 10 active research projects that incorporate approximately 4.11 SY of faculty research effort.

Performance Goal(s):
Provide information to policy makers and to people dealing with ranch property concerning economic values and the part that is played by public grazing rights held by ranchers. Obtain greater knowledge of international trade as it is affected by policies and trade agreement combined with a better understanding of export practices to enhance the opportunity for Idaho and the Pacific Northwest to maintain a strong export market for agricultural products. Increase availability of production and market information for organic niche products, to help modest sized farms increase income potential. Develop a model for wheat price outlook for wheat producers in the Pacific Northwest and information permitting these farmers to market wheat more effectively and/or reduce price risk. Wheat quality will be increased through development of improved storage conditions.

1. GLOBAL TRANSPORTATION AND TECHNICAL BARRIER IMPACTS ON PACIFIC NORTHWEST EXPORT COMPETITIVENESS
Investigators: Jones, J. R.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 06/30/2003

Termination Report:
The Pacific Northwest Wheat Shipment (PNWSHIP) spatial model was revised and tested using applications involving technical barriers and user charges that increase the cost of shipping wheat in international markets. All applications tested reinforced basic economic trade and welfare public finance theory and provided quantitative measurements of the gains from removing trade barriers while internalizing transportation costs. Side analysis included political and equity issues.

Impact:
The studies provided an information basis to support legislators and other policy makers.

2. NICHE FOR ORGANIC FOOD
Investigators: Foltz, J.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Work continues on USDA IFAFS grant - Understanding, Evaluating, and Improving Direct Marketing Strategies of Small Farms in the PNW. Six of the 12 whole farm case study that the University of Idaho is studying as a part of the project will be organic farms. Interviews have been completed with 4 Idaho farms. Producer interviews are being conducted in Washington and Oregon. As a part of the project, the following farmers' market assessments have been completed: Idaho - 4 total (1 in '02 and 3 in '03); Oregon -8 total (3 in '01, 3 in '02 2 in '03); Washington - 7 total (3 in '02 and 4 in '03).

Impact:
This project will demonstrate the impact of organic food production on Idaho's economy and other parts of the Pacific Northwest.

3. TRADE REFORMS, MARKET POWER, AND EFFECTS ON PROCESSED FOOD AND PRIMARY COMMODITY MARKETS
Investigators: Devadoss, S.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
Trade reforms strongly influence the U.S. food processing industries and agricultural commodity markets. Examining the characteristics of the food manufacturing sector is critical in analyzing the trade reform effects on processed foods industries and bulk commodity markets. Particularly, the noncompetitive behavior of the food processing firms needs to be considered. We undertook theoretical and empirical analyses of market size and consumer preference asymmetries to examine the implications of trade and trade polices for imperfectly competitive food manufacturing sectors. The results showed that the effects of trade reforms on imperfectly competitive product trade are counter intuitive if a significant portion of food trade is attributed to market size and preference asymmetries. For example, countries with smaller markets gain relatively more from trade liberalization than countries with large markets because export market opportunities are greater for small countries than for large countries. In a theoretical study, we examined the curvature of production possibility frontier (PPF) of a model consisting of two final goods (one good is a processed food), one intermediate good (raw agricultural commodities), and two primary factors. One final good and the intermediate good are produced using primary factors, labor and capital. The second final good (processed food) is produced using labor and the intermediate input. Producers of the second final good exert oligopsonistic market power on the intermediate input purchase. This model reflects the real world phenomena of oligopsony power exerted by some industries (e.g., food processing industry) in the intermediate good purchases. This study generates results that are not adherent to the standard two-sector Heckscher-Ohlin model. Some of the results that deviate from the H-O model are the

relationships between factor prices and commodity prices, price-output effect, tangency between price line and PPF, and the curvature of PPF. We examined the validities of traditional trade theorems and the pattern of trade for an economy with an oligopsonistic intermediate input. Our analysis shows that the traditional trade theorems and H-O trade pattern are likely to be overturned if the factor intensity of the competitive sector is in between those of oligopsony and intermediate good sectors and if the degree of oligopsony power varies. In a another study, we compared the trend in the growth of the processed food sector to that of farm sector.

Impact:
This study will help to ascertain the market conduct for primary commodities and processed foods and identify the gains and losses from the trade reforms to agricultural raw commodity producers and food processing firms. Thus, the result of this research will also be useful to farmers, food processing and affiliate industries, export and import firms, and government agencies involved with trade policies.

4. ENGINEERING OPPORTUNITIES TO ENHANCE AGRICULTURAL PROFITABILITY
Investigators: Peterson, C. L.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Crushing facility: Seed processed included Dwarf Essex rapeseed (0.5 tons, 45% oil), Sunrise canola (1.25 tons, 48% oil), Ida Gold mustard (3 tons, 25% oil) and Pacific Gold mustard (5 tons, 37% oil). The meal had a residual oil content of 11% showing that extraction efficiency declined with decreasing oil content of the seed. Vehicles operated: The Vandal Trolley (B20) is a popular vehicle for campus events and allows for testing biodiesel in typical bus service. The 1999 Dodge pickup (B100) has accumulated 32,120 miles and has averaged 15.8 mpg. The 2001 Volkswagen 1.9 L TDI beetle (VW)(B100) has 14,370 miles operating on biodiesel. The VW has been prominently displayed at numerous demonstrations, conferences and fairs. Used Vegetable Oil from Delis: A refrigerated produce trailer on a 10% blend of raw used oil and 90% diesel has accumulated 988 hours. The fuel shut-off valve failed during the past year and was replaced. During cold weather, the inlet screen to the transfer pump will occasionally clog and require cleaning. Lubricity: It has been reported that Ultra Low Sulfur Diesel (ULSD) does not meet lubricity standards. Rapeseed, canola, mustard and soy, and their esters were blended at 0.5, 1 and 2% by volume with ULSD and evaluated for lubricity. In the HFRR test used, more than 450 microns is unacceptable. The ULSD had a score of 297 and thus passed. Only the 2% blends made an improvement in the lubricity of the USLD fuel -- 212 for the ester and 246 for the raw oils. With 100% raw rapeseed oil, yellow mustard oil, and yellow mustard ester, the raw oils and the ester samples had very similar HFRR readings (approx. 150). Biodiesel Survey: A survey to obtain an understanding of the attitudes towards biodiesel was administered at a public station, which exclusively sells biodiesel, and at a regular diesel station. Nearly half of those surveyed, even though they were purchasing B20, had never heard of biodiesel, and over half, 56%, did not know it was available in the area. There was a high percentage of agreement that biodiesel can reduce dependence on foreign oil (72%), that it is cleaner for the environment (63%), and biodiesel is better since it uses renewable resources (91%). Although some respondents

disagreed with the idea that it is worth paying extra for biodiesel (26%), it was found that most people (53%), were willing to pay from one to ten cents per gallon extra. These findings confirm that a more aggressive advertising campaign is needed to promote more awareness of biodiesel before a demand for biodiesel will be present in southwestern Idaho. Residue Management: A hydraulically powered residue management tool (PRMT), which has the capability of removing residue from the narrow strip in front of the disk furrow opener using a shovel and a hydraulically rotating blade, was developed. In high residue conditions, this tool increased germination 65%, in medium residue 22%, and no difference in low residue plots compared to conventional tillage. The very high stubble conditions resulted in occasional plugging, however, staggering the openers on several ranks should solve this problem in all but the heaviest residue conditions.

Impact:
Research on biodiesel at the University of Idaho has pioneered the biodiesel industry in the United States and contributed to expansion of use abroad. Biodiesel is now produced commercially and is available in all 50 states. Yellow mustard is a feedstock which has potential to reduce the cost of biodiesel and thus add to the potential commercialization effort. Work related to lubricity will assist in making biodiesel more attractive as a blend with diesel as ultra low sulfur diesel comes to market.

5. ECONOMIC ANALYSIS OF AGRICULTURAL PRODUCTION, SUPPLY AND POLICY IMPACTS
Investigators: McIntosh, C. S.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Continued efforts in the area of rural development/educational opportunities show that some characteristics of educational delivery impact the efficiency with which education is delivered. These results are especially important for chronically under-funded rural schools. Other research into viral disease impacts on potato yield and quality continues. Preliminary results show that the impact of increasing seed-borne viral loads is different than widely believed with yield decays occurring in a linear rather than exponential fashion. Research on best management practices and producer risk under drought conditions for potatoes is ongoing. Models of available irrigation water are being developed in an effort to predict drought conditions. Grower concerns over USDA potato mop-top virus testing were addressed in several publications and presentation. These addressed the appropriateness of the testing protocol, as well as helping growers, packers and shippers understand the meaning of a negative finding.

Impact:
Continued drought conditions in Idaho have had major impacts on most aspects of agricultural production. Research into best management practices under drought conditions, including predicting short water conditions, benefit growers by making information on water supply conditions widely available along with advice on growing practices under varying severity of drought. Research into the impact of seed-borne viruses will lead to an economic model of seed value given known levels of infection.

6. STUDY OF IDAHO FARMLAND VALUES, TRENDS, EXPLANATIONS, IMPLICATIONS

Investigators: Nelson, J.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Analysis of how development pressures affect farmland values was continued. There is considerable interest in protecting existing agricultural economic bases in areas of rapid suburban sprawl by establishing protection for farmland from non-agricultural development. Policy makers addressing this concern need information about which lands are under the most pressure. Econometric models were used to determine the effects of development related characteristics on values of agricultural lands that were thought to have development potential in South-Central Idaho. Results indicate that the value of development increments for agricultural parcels (the difference in actual value of a parcel and its agricultural value) could be explained with development related variables such as distance to roads and distance to towns (Wright, et al.). Efforts were begun to test the conceptual model developed in South-Central Idaho (of how development pressure affects farmland values) in other geographic areas. Early results from research in the rapidly developing rural area adjacent to Boise (South-West Idaho) indicate that the farmland valuation methods developed and tested in South-Central Idaho can be used in areas under more substantial development pressure (Nelson and Schumaker). This research will continue in 2004. In addition, results of farmland value research are being combined with regional economic models to evaluate total local economic benefits derived from farmland relative to the land's value for development (Nelson, et al.).

Impact:
Research results discussed here were used to assist land-use policy makers in several Idaho counties. This information facilitated more well informed decisions and educational programs about land-use policy and practice.

7. EVALUATING RISK MANAGEMENT ALTERNATIVES FOR THE PACIFIC NORTHWEST

Investigators: Makus, L.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Risk management decisions of a typical PNW wheat producer have been modeled under three different production regimes. The regimes are: 1) a winter wheat/summer fallow rotation; 2) a winter wheat/spring barley/summer fallow rotation; and 3) a winter wheat/spring barley/dry pea rotation. The model uses utility maximization of the selected portfolio of risk management alternatives for the decision-making framework. A variety or crop insurance products, hedging with futures, and government programs are included as risk management tools. Sensitivity of portfolio selection to crop insurance premium subsidies and premium loading along with transaction costs of hedging has been conducted. Model results suggest insurance products are

generally included in the risk management portfolio. Futures are not used unless transaction costs are eliminated. However, government program payments dominate all risk management portfolios for dryland wheat producers in the PNW. Crop insurance products are sensitive to premium subsidies and premium loading. Elimination of the subsidy or even modest increases in premium loading significantly reduce the use of crop insurance products. Additional modeling work has been completed to address the impact of the FSRI Act's counter-cyclical payments on the use of market-based risk management tools (futures). Model results suggest government program payments added under the 2002 FSRI Act tend to crowd out the use of hedging as a risk management tool. Additional work is being conducted to analyze the impact of cross hedging PNW wheat on alternative futures market, including Kansas City hard red winter wheat and Minneapolis Grain Exchange hard spring wheat.

Impact:
Crop insurance is identified as a valuable risk management tool for PNW dryland wheat producers. Providing research-based evidence of this value should encourage PNW wheat producers to increase utilization of these products, and help stabilize farm income. Analyzing alternative cross hedging opportunities for PNW wheat producers should also improve risk management capabilities, and provide additional stability to farm income. Evidence of the crowding-out impact of additional farm payments can provide useful information for farm policy decisions. Producer sensitivity to premium subsidies and premium loading provide valuable information for designing and pricing crop insurance products.

8. FRUIT AND VEGETABLE SUPPLY-CHAIN MANAGEMENT, INNOVATIONS, AND COMPETITIVENESS
Investigators: Guenthner, J. F.
Termination Date: 09/30/2003
Reporting period: 01/01/2003 to 09/30/2003

Termination Report:
This project analyzed markets for genetically modified potatoes in developed countries as well as developing countries. Slow consumer acceptance inhibited the market for GM potato products in North America and Europe. Logistic growth functions were used to develop a consumer acceptance model based on market development patterns for three comparable products -- diet sodas, frozen potatoes and microwave ovens. The model predicts that consumer acceptance of GM potatoes in the US will be in the introduction stage of the product life cycle for about 14 years. The predicted growth stage of acceptance will begin in 2009 and last for two decades. The timeline may be compressed or lengthened depending on the influences of the biotechnology industry and anti-GM activists. An analysis of the benefits of potatoes genetically modified for resistance to Potato Tuber Moth (PTM) in Egypt and South Africa was conducted to analyze the situation in lesser developed countries. An ex-ante benefit-cost model with a probability distribution was used to estimate the benefit of investing in the development of the PTM-resistant potato. Categories of benefits included increased yield, reduced PTM control costs, improved quality and reduced post-harvest losses. The net present value of the GM potato in Egypt and South Africa was estimated at US $93.7 million, with a benefit/cost ratio of 31 and internal rate of return 21%. Results are sensitive to assumptions about government approval, development costs and grower adoption rates. The total value of the PTM-resistant potato would

increase with adoption by other countries.

Impact:
More knowledgeable potato industry leaders.

9. IMPACT ANALYSIS AND DECISION STRATEGIES FOR AGRICULTURAL RESEARCH

Investigators: Araji, A. A.
Termination Date: 09/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The Idaho Agricultural Experiment Station database is adjusted to acreage, production, and price changes in 2002. Personal interviews were conducted with scientists in several departments to account for new projects and renewed old projects during the last five years to complete phase two of the database. The economic impact of the development and transfer of genetically modified potatoes to developing countries was analyzed for Egypt and South Africa. The results show high B/C ratios and high potential rate of return. The waste utilization project is completed and radius and acres needed to dispose of manure by different size of feeding operations at least cost were estimated. The cost, effect on yield and nitrogen and phosphorous levels in the manure are being analyzed for several different ratios.

Impact:
The results of this study show the benefit of continued investment in agricultural research. The results of the waste utilization study will help farmers to reduce synthetic fertilizer use and lower the cost of production and help the agricultural industry to reduce phosphorous run off and environmental pollution.

10. NOVEL PROCESSING AND ISOLATION PROCESSES OF HIGH ERUCIC ACID OILSEEDS FOR VALUE-ADDED INDUSTRIAL PRODUCTS

Investigators: He, B.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Four projects are in progress: Project 1: Continuous-flow biodiesel production with a novel reactive distillation column reactor. Project 2: Glucosinolates (GLS) extraction from HEA seed meals for detoxicated meal and GLS concentrate. Project 3: High temperature oil seed pressing to increase oil yield and to denature the enzyme that is responsible for toxic chemicals formation. Project 4: Enzymatic process for selective transesterification of erucic acid and biodiesel production. Preliminary results have been achieved from Project 2 as summarized below. Glucosinolates (GLS) are a group of compounds whose hydrolytic products are toxic especially for non-ruminant animals. This limits the wide use of seed meals as animal feed. However, what has attracted researchers is the potential use of GLS for products, such as pesticides and food flavors. It will be of great significance to isolate and concentrate GLS from seed meals to produce two valuable products: seed meals for animal feed and concentrated GLS for other uses.

Three solvents, water, ethanol, and ammonium chloride, were tested to extract GLS from yellow mustard meal. It was found that ammonium chloride solution had the best extraction effect. Experiments showed that pH did not have a significant effect on GLS extraction. Temperature significantly affects the hydrolysis of GLS when water is present in the GLS extraction process. More than 30% of the GLS was hydrolyzed if process temperature was below 85C. A study was also conducted to reduce the GLS residual solvent in the extracted meal after solid-liquid separation. After being washed by fresh water, the GLS content in the treated meal was reduced to 13.7 micromol/g. It was found that water could effectively remove GLS from yellow mustard meal at low meal-to-water ratios. Spraying fresh water on meal cake removes the residual solvent, which significantly reduces the GLS content in the product meal and possibly avoids a two-stage extraction. The optimal working conditions should be based on the consideration of the overall process and concentration of GLS.

Impact:
Biodiesel from vegetable oils is a viable substitute for fossil-based fuels. The sustainability of biodiesel, requires integrated processing and utilization of oil seeds. Upon the accomplishment of the project, we would be able to (1) to extract the toxic chemicals contained in the meal, which could be used as natural pesticides as replacement for synthetic ones, (2) to isolate erucic acid from high erucic acid oils, which could be used as a raw material for over 200 industrial products bearing biodegradability such as lubricants, surfactants, engineering plastics, and (3) incorporate advanced techniques for biodiesel production to reduce cost and enhance the sustainability of biodiesel.

Allocated Resources IAES Program 4:

RPA	SY	PY/TY	Amount
402	0.00	1.10	143,361
511	0.00	0.00	47,363
601	.88	0.00	340,813
602	0.00	0.00	66,859
603	1.60	0.00	127,940
604	0.00	0.00	46,763
606	1.63	0.00	151,233
Total	4.11	1.1	924,332

REE Goal 2: A Safe and Secure Food and Fiber System

Impacts for REE Goal 2

IAES Program 5: Food Safety and Quality

Food borne infectious disease research complements animal health and well being work described above. Many food borne infections are zoonotic in origin. Research sponsored by IAES addresses issues with E. coli O157, staphylococci, Yersinia, Campylobacter, and Listeria.

The CDC estimates that as many as 76 million cases of food-borne disease occur in the US each year, causing 5,000-9,000 deaths and an economic impact of approx. $8 billion. Being able to detect and eliminate pathogens in food would significantly reduce these impacts. The presence of pathogens, even injured ones, in foods that are to be consumed without further treatment is unacceptable. It is important to detect severely injured cells which might evade detection by current methods. One approach being taken by IAES involves use of a growth-stimulatory protein produced by a Pseudoaltermonas strain. This protein has the prospect of being used as a repair agent for the metabolically-injured food-borne pathogenic bacteria. Another approach is to more accurately assess the effects of temperature on microbial killing. One ongoing study is developing a computer model to compare the effects of different nonisothermal temperature histories on microbial destruction. Processors could use these models to determine the efficacy of any new thermal process. Certain zoonotic food borne illnesses could be reduced by eliminating them from their animal reservoir. One such pathogen is E. coli O157. Idaho researchers have shown that the bacteria's Shiga toxins selectively eliminate lymphocytes expressing bovine leukemia virus and do not harm normal lymphocytes. They also showed that the antiviral activity is in the enzymatically active A subunit, which alone is not toxic. In addition, some of the IAES work targets the organism persistence. Our researchers have shown that it is possible to reduce bovine colonization by altering the fiber content of the diet. This work has broad implications for understanding why cattle carry Shiga toxin-producing E. coli and for the use of non-toxic Shiga toxin fragments as antiviral agents. Our economic studies suggest that this technology has an annual gross benefit to Idaho at over $585,000.

This goal also focuses on improved crops. We are testing chemical and radiological methods for inhibiting potato sprouting during storage. This information benefits processors, fresh product shippers, commercial and seed producers and other IAES units working on long term potato storage. In addition, we have been accumulating stakeholder input from the Idaho Minor Crop Alliance, County Extension Educators, state Specialists from Idaho and other Western States, to prioritize new pesticide needs for the minor crops in our region. Pest Management Strategic Plans were also utilized, when available. The data generated from this field program has been utilized for Section 18 and Section 24c registrations. These registrations provide a new tool for the producer, some of which are reduced risk pesticides or are resistance management tools. They also could prevent minor crop loss or damage in the region from uncontrolled pests. Minor crops are a key part of our economy and American diet, and would not have adequate pesticides available to them without this program.

RESEARCH PROJECT ANNUAL REPORTS

IAES Program 5: Food Safety and Quality (RPAs 501, 503, 702, 711, 712). IAES Program 5 is the only contribution to **REE GOAL 2**. This program area included 5 active research projects and accounts for approximately 1.7 SY of faculty research effort.

Performance Goal(s):

A better understanding of flavor chemistry as related to sensory properties of selected red cultivars of grapes used in Idaho wines. Obtain additional information on the occurrence, effects and mechanisms of action of toxicants and antitoxicants in food. Improve diagnostic tests for microbial pathogens present in food and better education of the public on food safety issues.

1. A NATIONAL AGRICULTURAL PROGRAM: CLEARANCES OF CHEMICALS AND BIOLOGICS FOR MINOR AND SPECIAL USES

Investigators: Hirnyck, R. E.
Termination Date: 09/30/2003
Reporting period: 01/01/2003 to 09/30/2003

Termination Report:
Stakeholder input was solicited annually from the Idaho Minor Crop Alliance, County Extension Educators, state Specialists from Idaho and other Western States, for the purpose of prioritizing new pesticide needs for the minor crops in Idaho and other western states. Pest Management Strategic Plans were also utilized, when available. The PI presented information about the IR-4 program and the results of Idaho projects at grower meetings, annually. The PI and Field Center Director participated in Western Region, National IR-4 meetings and trainings. The Field Center tested 10-15 new pesticides, annually. Most of these pesticides are reduced risk and considered important as a new tool for the commodity, once registered by EPA. Data may be utilized for Emergency Exemption pesticide registrations.

Impact:
The data generated from this field program, has been utilized for Section 18 registrations and Section 24c registrations in Idaho and regionally. These registrations provide a new tool for the producer, some of which are reduced risk pesticides or are resistance management tools. These new registrations prevent millions of dollars of minor crop loss and/or damage in Idaho and the region from uncontrolled pests. Minor crops, served by this program, are an important part of the economy and American diet, and would not have adequate pesticides available to them, without this program.

2. ANTIVIRAL ACTIVITY OF SHIGA TOXIN TOWARDS BOVINE LEUKEMIA VIRUS

Investigators: Bohach, C. H.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Direct evidence that Escherichia coli Shiga toxin (Stx) acts against bovine leukemia virus (BLV)-expressing cells was obtained. The active A subunit of Stx type 1 (StxA1) targeted a selected population of permeable cells expressing BLV and inhibited BLV replication in a culture of bovine peripheral blood mononuclear cells. Cells were cultured with and without StxA1 and at various times cells expressing BLV were identified by staining with MW1 monoclonal antibody specific for the BLV protein gp51. Before culture, permeable cells were tagged by uptake of one of the following: acetoxymethyl of 2', 7'-bis-(2-carboxyethyl)-5-(and 6)-carboxyfluorescein (BCECF), BCECF conjugated to 70kD dextran, or 70kD dextran conjugated to fluorescein. The tagged cells co-staining with anti-gp51 were selectively eliminated in StxA1-treated cultures. Electron microscopy analysis of purified B lymphocytes showed sharply reduced numbers of BLV particles in StxA1-treated cultures.

Impact:
For the first time we have shown that Escherichia coli Shiga toxins selectively eliminate lymphocytes expressing bovine leukemia virus and do not harm normal lymphocytes. In addition, we showed that all of the antiviral activity of Shiga toxin is in the enzymatically active A subunit, which alone is not toxic. This work has broad implications for understanding why cattle carry Shiga toxin-producing E. coli and for the use of non-toxic Shiga toxin fragments as antiviral agents.

3. STORAGE MANAGEMENT FOR IMPROVED POTATO QUALITY
Investigators: Kleinkopf, G. E.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
Partial year research on alternative means of sprout suppression in potato was continued with Biox A and high-energy electron radiation. Biox A received a label for application for organically produced potatoes in eight states during 2003. The linear accelerators for electron radiation of vegetables are potentially cost effective, as new industrial uses have increased. Consumer acceptance of irradiated foods has not been evaluated recently but governmental uses for irradiated institutional foods have increased gradually. Potato storages equipped with variable frequency drives for fan motors have decreased shrinkage losses and reduced power requirements substantially. Retrofitting frequency drives on existing storages have the potential for saving energy and increasing tuber quality in long-term storage.

Impact:
Information derived from this project benefits potato industry personnel, including processors, fresh product shippers and commercial and seed producers and other University academic units in solving problems in long term potato storage.

4. CHARACTERIZATION OF A GROWTH-STIMULATORY PROTEIN WITH PROSPECTIVE USE IN THE REPAIR OF METABOLICALLY-INJURED FOOD-BORNE PATHOGENIC BACTERIA
Investigators: Yuksel, G. U.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Characterization of the growth-stimulatory protein at the biochemical and molecular level: The biologically active microbial metabolite from Pseudoalteromonas sp. strain MMM18 was purified by precipitation using ammonium sulphate, desalting, gel-filtration, ultrafiltration and anion exchange chromatography. At each step of the purification, biological activity of the microbial metabolite of interest was determined using seed germination of Brassica juncea and confirming the statistical significance of the data. The native PAGE analysis of the purified protein sample indicated the overproduction of one particular protein in the form of a single and intense protein band. Some very minor protein bands were also observed with the native PAGE

analysis of the partially purified protein. The exposure of the native PAGE gel to 3% of H2O2 resulted in the release of oxygen gas bubbles where the purified protein sample was located, indicating that the biologically active microbial metabolite of interest is a catalase. An identical bubbling reaction was observed with a protein marker that contains pure bovine liver catalase. The migration patterns of the pure bovine liver catalase and the bacterial catalase from Pseudoalteromonas sp. strain MMM18 were identical. The SDS PAGE analysis of the purified protein sample revealed the presence of a single protein band with a molecular weight of about 82 kDa, suggesting that the catalase from Pseudoalteromonas sp. strain MMM18 has three identical subunits. Similar to the catalase enzyme from Pseudoalteromonas sp. strain MMM18, the catalase from bovine liver also positively influenced seed germination of Brassica juncea, however bacterial enzyme shows a statistically higher biological activity ($P<0.05$) than the bovine form. The biostimulatory effect on seed germination disappeared when these enzymes were inactivated by exposure to heat (60-90C for 5 minutes). The amount of excreted catalase by the strain MMM18 varied depending on temperature of growth and NaCl concentration in growth media. When a 1.5-L culture supernatant obtained from bacterial growth in SAM medium (a medium specially adapted for marine bacteria) containing 27 g/ml NaCl was subjected to gel-filtration using Sephadex G-150, the total amount of protein in catalase-active fractions was determined to be 3.8 mg. When SAM medium with 2.7 g/l NaCl was used, however, the total amount of protein in catalase-active fractions increased to 6.7 mg. Remarkably, when the strain MMM18 was subjected to incubation at 10-12C prior to cultivation at 30C, the amount of total protein increased to 24.2 mg. Microbial identification: Phylogenetic trees were generated based on the 16S rRNA sequences from Pseudoalteromonas sp. strain MMM18 and other marine bacteria. The analysis of the complete 16S rRNA sequence (1535 bp) from Pseudoalteromonas sp. strain MMM18 indicated a 93-99% homology to the 16S rRNA sequences from other Pseudoalteromonas strains. The highest homology (99.46%) was observed with the 16S rRNA sequence from Pseudoalteromonas porphyrae.

Impact:
The CDC estimates that at least 6.5 million and as many as 76 million cases of food-borne disease occur in the US each year, with 325,000 hospitalizations. Estimates of the annual number of deaths caused by food-borne disease in the US range as high as 5,000-9,000. Food-borne disease incurs substantial costs to ill people, food companies, and the US economy, a cost estimated at $7.7 to 8.8 billion annually. Clearly, the presence of highly infective pathogens, even injured ones, in foods that are to be consumed without further treatment is considered unacceptable, particularly where susceptible groups in population are at risk or there is a chance of further microbial growth in the food. In such cases, it is very important to detect even severely injured cells. Current resuscitation methods do not allow full recovery of injured cells that require strictly anaerobic conditions for repair or those needing very long repair times or growth-stimulatory substances. Therefore, the importance of repair processes in recovering injured bacteria and significance of severely injured cells need clarifying. Our current research aims to obtain a good understanding of a growth-stimulatory protein that has the prospect of being used as a repair agent for the metabolically-injured food-borne pathogenic bacteria. Our research has the prospect of ensuring safety of foods and thus helping reduce the number of food-borne illness related hospitalizations, deaths, and economical loss due to medical expenses, lost income and productivity, cost of litigation and penalties, and loss of trade.

5. ENHANCING FOOD SAFETY THROUGH CONTROL OF FOOD-BORNE DISEASE AGENTS

Investigators: Smith, D. M. and Singh, P. P.
Termination Date: 09/30/2005
Reporting period: 10/01/2003 to 12/31/2003

Progress Report:
Ground beef and turkey were obtained from a local supplier. Proximate composition and pH were determined. Meat was vacuum packaged, irradiated at 10 kGy, and stored at -20C. Irradiated meat was checked for sterility. The Salmonella cocktail contains S. Thompson (FSIS 120), S. Enteritidis phage type 13A (H 3527), S. Enteritidis phage type 4 (H 3502), S. Typhimurium DT104 (H 3380), S. Hadar (MF 60404), S. Copenhagen (8454), S. Montevideo (FSIS 051) and S. Heidelberg (F5038BG1). The Listeria cocktail contains eight strains of different ribotype patterns isolated from retail ground meat. Ground meat was inoculated to contain about 10-9 CFU/g. Thermal inactivation experiments under isothermal conditions are being performed in a water bath between 50 to 75C. Nonisothermal inactivation experiments are being performed in a programmable thermocycler using cooking protocols based on USDA safe harbor guidelines using controlled heating and cooling rates. The equation parameters of Salmonella, L. monocytogenes and E. coli O157:H7 in beef and turkey determined in the isothermal experiments will be used to devise a systematic procedure for predicting microbial inactivation in nonisothermal processes using the Weibull distribution (log S = -b t^n). The parameters, b and n, of the Weibull distribution will be estimated by performing nonlinear regression of the equation with experimental data on microbial decay collected at isothermal temperatures. The parameters obtained from the isothermal experiments will be used to solve the equation for nonisothermal microbial decay.

Impact:
Successful completion of this study will yield a computer model that can be used to compare the effect of different nonisothermal temperature histories on microbial destruction. Processors could use these models to determine the efficacy of any new/modified thermal process. A better understanding of microbial lethality and better process control will ultimately lead to a safer food supply, fewer illnesses and deaths, and reduce economic losses to the food industry.

Allocated Resources IAES Program 5:

RPA	SY	PY/TY	Amount
501	0.00	0.00	228,425
503	.75	.89	247,955
711	.20	0.00	546,108
712	.75	1.75	726,803
Total	**1.70**	**2.64**	**1,749,291**

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REE Goal 3: A Healthy, Well Nourished Population

Impacts for REE Goal 3

IAES Program 6: Human Health and Nutrition

One area of emphasis for IAES is nutrition especially for neonates and children. The CDC reports that 9 to 11 per cent of children under age six are overweight. This number is rising, and has implications for older children where overweight statistics show epidemic proportion (30%). IAES activities are directed toward team nutrition classes, focus group discussions, and understanding dietary practices of children in group settings such as school cafeterias. A major impact of this research was the development and implementation of our Feeding Young Children in Group Settings satellite course, which was down linked in nearly every state, as well as in Puerto Rico. Along with the four satellite broadcasts (now available into videotape and compact disk formats), we offer a website that contains site coordinator materials and appropriate web links on feeding young children. The web site has had over 25,000 hits, with downloads of materials for training child care providers and Head Start staff. In addition it is critical to reach the Hispanic community, Idaho's largest underrepresented group. Idaho has an estimated 52,927 low-income Hispanic families. Our research showed that staff members in the centers directly influence eating habits by influencing social interactions and conversations during mealtimes. The results serve as the basis for practical strategies related to feeding young children. We disseminated these strategies through publications and workshops to childcare providers and Head Start staff, as well as those who train childcare workers. These findings have implications for reducing diseases such as diabetes, heart disease and cancer. WIC dietitians can now educate Hispanic women more effectively about breastfeeding. They have easy access to a web site (www.ag.uidaho.edu/infantfeeding) that is in both English and Spanish. Furthermore, little is known about what nutrition education strategies should be used with the Hispanic group that will result in an increase in fruit and vegetable consumption. One additional study identified behavior perceptions, environment, and personal attitudes that influence the decision to increase fruit and vegetable consumption of low-income families. Significant numbers of low-income families participated in the education program with a positive change in attitude toward increased consumption of fruit and vegetables. The results also show that each family could save a minimum of $70 per year in medical and food costs. The 52,927 low-income Hispanic families will realize a gross annual savings of over $3.3 million with a net present value of over $20 million.

One related study was designed to develop childrens' skills at mealtime. The objective was to improve child nutrition and reduce doctor visitation for children under the age of six years. Idaho has 115,030 children under the age of six years. The results of the study show that participating families in the study have helped children to develop skills at mealtime relative to the quantity and quality of their diet. The results also show that participating families saved a minimum of $50 per child per year in medical and food costs. The estimated annual gross benefit to Idaho families with children under the age of six years is over $1.4 million with net present value of over $5 million.

Our researchers are also impacting basic knowledge of disease progression in children and the elderly. New findings regarding the potential role for p53 in viral replication are important for our overall understanding of the subversion of the host cell carried out by Cytomegaloviurs. The more we understand about the mechanisms of viral replication, the better

chance we have for designing useful antivirals. Our findings regarding the inability of the infected cell to repair exogenous insult to the cellular DNA is potentially very important to understanding birth defect development in congenitally infected infants. Many human diseases, such as Alzheimers disease and cystic fibrosis result from protein folding defects. Molecular chaperones are proteins that are normally present in the cell and help proteins reach their properly folded state. Recent evidence obtained from IAES research suggests that the molecular chaperone Hsp90 is required for the folding of Ssl2, yeast homolog of the human protein XPB. Mutations in XPB cause the xeroderma pigmentosa, Cockaynes syndrome and trichothiodystophy. In particular we have evidence that mutation in Hsp90 may affect the ability of cells to respond to DNA damaging agents.

RESEARCH PROJECT ANNUAL REPORTS

IAES Program 6: Human Health and Nutrition (RPAs 504, 701, 703 and 722). IAES Program 6 represents the IAES contribution to **REE GOAL 3** and includes 8 active research projects enrolled in CRIS involving approximately 1.54 SY of research effort.

Performance Goal(s):
Increase understanding of motivators and barriers, attitudes and knowledge about consumption across age, gender, and selected minority groups. To obtain a better understanding of how natural chemicals in the diet interact with cancer processes.

1. STAFF ROLES AT MEALTIMES IN GROUP CARE FOR CHILDREN

Investigators: Fletcher, J. W.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
A study of adult roles at the mealtime with children in child care was completed. Significant differences were found when teachers sat and ate with children and when they did not sit and eat with the children. There were significant differences between treatments for mean length of meal, number and type of children's passing events, and number and quality of children's verbal utterances. Results suggest that adults play an influential role in social interactions and conversations during mealtimes with preschool children. A second study to survey child care providers about their feeding practices is underway. Focus group results of providers were analyzed and videotapes observations in 30 child care centers were made. A protocol for video analysis was developed and a forth of the videotapes have been transcribed to the protocol. Atlas TI will be used for analysis. A random sample of child care centers was selected to include of 3000 licensed centers in Idaho, Colorado, Nevada, and California. A questionnaire for directors, including demographic data and policy data was developed, and piloted using think aloud technique. A questionnaire for providers is in final draft stage and will be piloted using the think aloud technique. The survey will be carried out in early spring 2004.

Impact:
The CDC reports that 9 to 11 per cent of children under six years old are overweight. This

number is rising, and has implications for older children where overweight statistics show epidemic proportion with 30% of older children and teens being overweight. How America feeds it children is under scrutiny. With over 14 million children eating meals in childcare or Head Start centers each day, staff that provide these meals play a role in the healthy weight and nourishment of children. Staff in these centers directly influence children's eating habits and health. The research in this project examines factors that influence application of nationally accepted feeding guidelines by caregivers for feeding young children.

2. CHILDHOOD FEEDING PRACTICES
Investigators: Branen, L.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
The overall purpose of this research is to expand the knowledge base for determining best practice for feeding young children in group settings. The purpose of the first study was to identify developmental characteristics of a toddler in childcare during the group meal setting and strategies she used to get her needs met. The child was videotaped over a seven month period. Videotapes were analyzed for critical incidents. Adults played a key role by giving auditory and visual cues to the child and serving as models. To further investigate adult roles at the table, we videotaped children ages 4-5 eating with and without adults at the table during 14 snack sessions. There were significantly more verbal utterances when the teacher was not present; however the length and quality of utterances was less, with more self-talk and non-directed utterances. The results of both studies support the premise that adults should eat with children in group settings. A study was conducted for six weeks with sixteen 3-5-year-old children in a preschool program during snack time to compare food intake and waste with and without background music. No significant differences were found. Two studies were conducted to investigate food neophobia. In the first, we videotaped young adults as they tried Ghanaian foods. Content analysis revealed eight factors related to trying new foods: familiarity with a particular food: exposure to other novel foods; information about the food; peer modeling; health concerns; anxiety; expectations; and sensory factors. Familiarity, exposure, information, and positive modeling increased willingness to try the food. Negative, modeling, health concerns, anxiety, and negative expectations decreased their willingness. The second study replicated a novel foods study by Dr. Leanne Birch. One group of preschool children looked at novel foods; the other group looked at and tasted the food. Tasting and looking increased the preference for a novel food, though after five exposures, the effect decreased. These results differ from Birch, who found that 15 tasting exposures were needed in order to increase preference. An understanding of food neophobia is essential, since it has been shown to reduce dietary variety and impact nutritional status. We replicated our 1989 survey on weight preoccupation by sending questionnaires to 1000 undergraduate females at the University of Idaho. Respondents identified themselves as weight preoccupied or non-weight preoccupied. The Eating Attitudes Test (EAT) was imbedded within the questionnaire. Results indicated that the incidence of self-identified weight preoccupation increased from 25% to 36% in this population during the ten-year period. EAT scores of weight preoccupied females were not significantly different for the two surveys. Results indicate that while the incidence of weight preoccupation has increased over the past ten years, the severity has not. Weight preoccupation affects a relatively high percentage of college females and should

be addressed with prevention programs.

Impact:
The results of these studies serve as the basis for practical strategies related to feeding young children. We have disseminated these strategies through publications and through workshops to childcare providers and Head Start staff, as well as those who train childcare workers. A major impact of this research was the development and implementation of our Feeding Young Children in Group Settings satellite course, which was down linked in nearly every state, as well as in Puerto Rico. Along with the four satellite broadcasts (now available into videotape and compact disk formats), we offer a website that contains site coordinator materials and appropriate web links on feeding young children. The web site has had over 25,000 hits, with downloads of materials for training child care providers and Head Start staff. A credit course is offered which includes the videotapes and a WebCT portion containing assignments and activities. These workshops, videotapes, website and course impact feeding practices used by caregivers, and ultimately impact the eating habits of thousands of young children.

3. EFFECT OF TEAM NUTRITION CLASSES ON SELECTION AND CONSUMPTION OF SCHOOL LUNCH ITEMS
Investigators: Raidl, M.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Analysis was completed on current Team Nutrition classes. Team Nutrition education materials on fruits and vegetables were modified to incorporate information from the new 5-A-Day, the Color Way program. The first class is an overview of the Color Way program and the remaining five classes will each cover an individual color group: blue/purple, red, green, white/brown, and yellow/orange. The goals of these classes are to: (1) increase knowledge of the 5-A-Day, the Color Way program; (2) increase fruit and vegetable choices, (3) taste a wide variety of fruits and vegetables from each of the color group; (4) Improve the Healthy School Nutrition Environment; and (5) Link the School Food Service and School lunch program to the 5-A-Day, the Color Way program. Evaluation tools include: (1) pre, post, and follow-up surveys to measure changes in fruit and vegetable choices; (2) determining if students can correctly categorize fruits and vegetables into the correct color groups; (3) determining if students will taste a variety of fruits and vegetables and if they will consume these items during the School Lunch meal or at home; (4) determining which activities are the most effective in teaching students about fruits and vegetables. Three 5-A-Day, the Color Way classes have been developed along with evaluation tools.

Impact:
Students who learn to consume fruits and vegetables throughout their life time are less likely to be overweight or obese or develop heart disease or cancer in their lifetime.

4. THE ROLE OF CULTURE IN INFANT FEEDING PRACTICES
Investigators: Houghton, M.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Though Hispanic women have a high rate of breastfeeding in their native countries, there is a marked decline when they move to the United States. This project tries to retain the practice of breastfeeding through effective education. In that effort, Hispanic women who participate in WIC were surveyed to determine their infant feeding practices and their beliefs about breastfeeding. WIC dietitians at the same clinics were also surveyed to determine their observations of the Hispanic population related to infant feeding. The results of the survey were used to create a web site containing educational materials in Spanish that addresses specific concerns and problems identified in the study population. In the Hispanic survey, 59% of the mothers reported that they breastfed their infants, while 22% combined breastfeeding with bottle-feeding. Seventy-four percent stated that breastfeeding is best for the baby and 78% said it was the most convenient way to feed the baby. Those who did not breastfeed gave several reasons: Insufficient breast milk; had to return to work or school; sore nipples. Most reported (55%) that the infant feeding practices are different in the US compared to their homeland. Most felt that while everyone breastfeeds their infants in Mexico, it is not a common practice in the USA. Many also observed that infants in the USA are given a bottle immediately after birth in hospitals. Several felt they needed more information about how to hold an infant while breastfeeding and many also requested weaning information. The WIC dietitians had similar observations. Fifty-one percent of the dietitians reported that breastfeeding was preferred among their Hispanic clients and 63% stated that Hispanic mothers consider colostrum to be good for their infants. When asked what traditional beliefs the Hispanic mothers had regarding infant feeding, several were reported. Many observed that mothers stop breastfeeding and wean their infants immediately if there is trauma or illness. They also reported that their Hispanic clients believe that breast milk goes bad when mothers are angry or that if a mother is sad when breastfeeding, she will pass the sadness to the infant who will then fall sick. This is only a sampling of some of their beliefs. It is clear that Hispanic women need to be educated about these specific myths and misconceptions. To address these issues and other problems identified in the study, an educational web site was developed, in Spanish and English. Basic information about breastfeeding was included, plus advice on how to hold the baby, weaning information, a FAQ page to address many of the myths and misconceptions, links to other Spanish web sites on breastfeeding, and a list of other resources was provided. The pages are printable so that WIC dietitians will be able to give these as handouts in Spanish during counseling sessions. The WIC dietitians were asked to review the web site for feedback and suggestions or corrections. Their input was incorporated into the web pages. The web site was finalized in May 2003 (www.ag.uidaho.edu/infantfeeding) and is now in use at WIC sites as well as by individual women.

Impact:
WIC dietitians are now able to educate Hispanic women more effectively about breastfeeding. They have easy access to a web site www.ag.uidaho.edu/infantfeeding that is in both English and Spanish with information that can be printed out and used as a handout for Hispanic clients.

Hispanic women can also access this information on their own. The web site specifically addresses myths and misconceptions that Hispanic women tend to have about breastfeeding. With these web pages tailored for this population, more appropriate breastfeeding information can be provided, with the expectation that Hispanic women will continue to breastfeed at a high rate.

5. PARENTS' INTENTIONS AND BELIEFS TOWARDS ENCOURAGING THEIR CHILDREN'S PARTICIPATION IN THE NATIONAL SCHOOL LUNCH PROGRAM
Investigators: Lambert, L.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Project 1: Research using focus group discussions with elementary school teachers, students and parents to determine perceptions, practices, and barriers to implementing a healthy school nutrition environment and participate in school breakfast is completed. Parents and teachers have some misconceptions about the nutrition integrity and quality of the school breakfast and lunch programs. To alleviate some of these misconceptions it would be beneficial for school foodservice directors to include parents and teachers in planning and marketing of the school menus or to implement nutrition advisory councils whose role would be to give advice and support of school meals. Parents favor non-food rewards in the classroom and would support restrictions on types of foods allowed for snacks and school parties in the classroom. Daily physical activities for elementary students are important to parents but would require school administrators and teachers to be creative in incorporating this into the curriculum. Information obtained from the focus groups is being used to develop questions for continuing research on the healthy school nutrition environment. This research will be conducted through focus group discussions with foodservice directors and staff of school meal programs and Child and Adult Care Food Programs. Project 2: Research using a Nutrition Education Survey Instrument designed to measure school foodservice directors, elementary teachers and principals perceptions, practices, and barriers to providing nutrition education to elementary school students is completed. It was found that for nutrition education to be successful in the school setting, it has to be implemented in an environment that fosters a team approach involving all stakeholders including foodservice directors, teachers, school administrators, parents, and students. Directors should take a proactive approach by positioning themselves professionally as the nutrition expert through marketing their nutrition skills and knowledge in the school setting and/or additional training. Information provided from this research is being used to assist State Child Nutrition Directors in planning and administering nutrition education programs to be implemented by members of their child nutrition staff. ASFSA is using information from this research to develop future education sessions at their Annual National Conference.

Impact:
Results from the focus group discussions are providing child nutrition professionals a greater understanding of barriers to developing and implementing a healthy school nutrition environment in Idaho's elementary schools. Information developed from this research is being used by state agencies and professional organizations in developing and administering present and future nutrition education goals, programs, and educational training sessions for child

nutrition professionals.

6. IMPROVING CONSUMER FOOD SAFETY HABITS: REMOVING BARRIERS TO THERMOMETER USE
Investigators: McCurdy, S. M.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
An informational, full-color brochure, Now You re Cooking--Using a Food Thermometer, and five full-color recipe cards featuring food thermometer use with thin or small meat items (ground beef patties, sausage patties, turkey burgers, chicken breast, and pork chops) were produced in cooperation with an aligned CSREES National Integrated Food Safety Initiative project, Reducing Risk with Food Thermometers: Strategies for Behavior Change. A Food Thermometer Survey consisting of thirteen questions about practices and knowledge when cooking meat and about thermometer use was developed. Pre- and post-test versions were prepared. A random sample of 300 Idaho households was purchased from Survey Sampling Incorporated. One hundred persons of the sample agreed to participate in the pre-test survey and to receive an informational package of materials about food thermometer use. The package contained a brochure, set of five recipe cards and an instant-read digital food thermometer. The post-test survey was administered by phone 1 month to 6 weeks after the package of materials was received. Prior to receiving the informational package, 76% of respondents reported they did not use a food thermometer when preparing small or thin meat items. After receiving the package, 71% reported using a thermometer. Questions related to frequency of use and attitudes about thermometer use are still being analyzed.

Impact:
This project and the aligned CSREES National Integrated Food Safety Initiative project, Reducing Risk with Food Thermometers: Strategies for Behavior Change will inform consumers about why and how instant-read thermometers should be used in the cooking of smaller cuts of meat, and particularly for ground beef patties. Extension Educators and Family and Consumer Sciences teachers in Idaho will use the materials to educate consumers and students.

7. HUMAN CYTOMEGALOVIRUS-INDUCED CHROMOSOMAL DAMAGE: POTENTIAL ROLE IN SENSORINEURAL MANIFESTATIONS OF THE CONGENITALLY INFECTED INFANT
Investigators: Fortunato, E. A.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We have been pursuing two offshoots of Specific Aim 3 this past year. Since our initial proposed studies stemmed from the observation that p53 was sequestered into the viral replication centers (RC), we have begun investigating the possibility that there might be a function for p53 in both viral replication and DNA repair in two ways: targeted mutagenesis of p53 and by performing

HCMV infections in p53 null cells. The p53 mutants we constructed can be grouped into two categories: 1) post-translational modifications that occur to p53 and 2) mutants in the coding sequence of key functional domains. The mutant p53/GFP fusion proteins were transfected into human foreskin fibroblasts and then superinfected with HCMV. After 4 days, cells were collected and p53/GFP localization was examined. We looked for GFP+ cells which also clearly displayed RC staining (as judged by counterstaining with the viral UL44 protein). If RCs were visible, the sequestration level of the p53/GFP fusion protein was assessed. The transfections were scored versus a WT p53 construct, as WT gave us a clear, strong GFP staining pattern within the RCs in better than 50% of the GFP+/UL44+ cells. Background levels were set by using an EGFP alone vector as control. Sequestration of the constructs fell strictly within our two categories above. All of the post-translational modification mutants gave the same percentage of highly + staining as the WT construct (with greater than 45% high level sequestration). However, all of the mutants that affected DNA binding or transactivation were drastically reduced in the level of sequestration observed and were down to EGFP background levels (with less than 5% high level sequestration for any of the constructs). It appears clear from our data that there is a need for an intact DNA binding domain (and/or a transactivation function) in order for the p53 to be sequestered into the viral RCs. To address the question of whether or not p53 is essential for a fully permissive infection, we have turned to a p53 knockout line. Although not essential, we see dramatic viral growth changes. Firstly, we see two log drops in titers in these p53 null cells at 72 and 96 hpi when compared to normal fibroblasts. Contributing to this is a dramatic decrease in the amount of DNA replication in the null cells at all times pi. We also observe delays in some key viral early and late protein synthesis. Lastly, we have developed a new technique for labeling viral particles, which was just submitted (Rosenke and Fortunato, 2003). This method capitalizes on the fact that at late times pi, only viral DNA synthesis occurs. Therefore, incubation of infected cells with BrdU 2 days prior to supernatant harvest results in media containing labeled viral particles. These particles are useful for viral entry studies, but also in visualization of very early events in the viral life cycle, such as deposition of the viral DNA within the host cell nucleus. We are using these labeled viral DNA/particles to examine the very early interactions of host cell p53 with the viral DNA.

Impact:
Our new findings regarding the potential role for p53 in viral replication are important in our overall understanding of the subversion of the host cell carried out by HCMV. Clearly, the more we understand about the molecular mechanisms of viral replication, the better chance we have for designing useful antivirals. Our findings regarding the inability of the infected cell to repair exogenous insult to the cellular DNA is potentially very important to our understanding of the mechanism of the development of birth defects in the congenitally infected infant

8. ROLE OF YDJ1 AND STI1 IN THE HSP90 MOLECULAR CHAPERONE PATHWAY

Investigators: Johnson, J. L
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
Molecular chaperones are a diverse group of highly conserved proteins that transiently interact

with partially folded polypeptide chains during normal cellular processes such as protein translation, translocation of proteins across membranes and assembly and disassembly of protein complexes. Hsp90 is a very abundant cytosolic chaperone that is essential in yeast and drosophila. Hsp90 recognizes and binds only a small subset of cellular proteins and the mechanism for this specificity is unknown. Hsp90 interacts with these client proteins along with a set of co-chaperone proteins in an ordered ATP dependent pathway. Little is known about how Hsp90 and these co-chaperones interact and whether individual co-chaperones may help target client proteins to interact with Hsp90. I am using the budding yeast Saccharomyces cerevisiae as a model organism to study the function of Hsp90 and co-chaperones. Most of the co-chaperones found in mammalian cells are also found in S. cerevisiae and studies have shown that the functional interaction of steroid receptors, such as the estrogen receptor, with Hsp90 and co-chaperones may be recapitulated in yeast. The beginning focus of this project has been constructing mutations in the Hsp90 co-chaperone Sti1, which functionally and physically interacts with Hsp90 and other proteins within the Hsp90 pathway. We will now begin to analyze the effect of these mutations on the activity of a number of proteins that require Sti1 for function in order to better understand the contribution of Sti1 to the Hsp90 pathway. An additional project that has been undertaken since the beginning of this project is to determine whether Sti1 and Hsp90 are required for the function of Ssl2, an ATP-dependent DNA helicase that functions in transcription and DNA repair. Mutations in the human homolog of Ssl2, XPB cause the human diseases xeroderma pigmentosa and Cockaynes syndrome. We have genetic evidence that Sti1 and Hsp90 are required for the function of Ssl2 in vivo and are working to establish that Hsp90 and Ssl2 physically interact. In particular we are focusing on Hsp90 modulates the function of Ssl2 in DNA repair in response to UV exposure. These studies are the first to provide evidence for a direct role for Hsp90 in DNA repair and transcription.

Impact:
Many human diseases, such as Alzheimers disease and Cystic Fibrosis are a result of protein folding defects in the cell. Molecular chaperones are proteins that are normally present in the cell that help proteins reach their properly folded state. Certain human diseases are caused by mutations in proteins that prevent their proper folding. By learning about how molecular chaperones help proteins fold within the cell, we hope to eventually be able to overcome the folding defect of mutant proteins, thus overcoming the defect that leads to human disease. Hsp90 has already been found to associate with many proteins whose activities are upregulated during cell growth. A drug that inhibits Hsp90 has potent anti-tumor activity and is in clinical trials as and anti-cancer drug. Recent evidence obtained in my lab suggests that the molecular chaperone Hsp90 is required for the folding of Ssl2, yeast homolog of the human protein XPB. Mutations in XPB cause the diseases xeroderma pigmentosa, Cockaynes syndrome and trichothiodystophy. In particular we have evidence that mutation in Hsp90 may affect the ability of cells to respond to DNA damaging agents.

Allocated Resources IAES Program 6:

RPA	SY	PY/TY	Amount
504	0.00	0.00	37,634
701	0.00	0.00	13,114
703	1.54	1.00	392,224
723	0.00	0.00	274,252
Total	1.54	1.00	717,224

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REE Goal 4: Greater Harmony Between Agriculture and the Environment

Impacts for REE Goal 4

IAES Program 7: Soil, Water and Air Quality Conservation and Sustainable Agriculture Practices

IAES researchers use several approaches to facilitate efficient water use and minimize negative impacts on water quality. We developed a GIS database for the Palouse Basin that identifies recharge potential. This is a valuable resource for planners and those attempting to better model regional groundwater supplies and recharge. One project developed an algorithm for remote sensing of Idaho water resources. This project will enable improvement of numerical weather forecast models. It will also allow the models to begin incorporating remote sensing data such as satellite surface temperature measurements. Pollutant transport models have helped to determine critical source areas in watersheds. The Soil Moisture Routing model, a physically-based distributed hydrologic model created at Cornell, was modified to fit conditions of northern Idaho and eastern Washington. These studies will provide database parameters for predicting the pollution potential of site-specific areas in the watersheds and modeling tools to assist TMDL development and evaluation of Best Management Practices in Idaho. Recently, this work played a role in watershed assessment related to fish habitat.

Irrigation research is essential to promote efficient water use, particularly in areas facing water shortage. An IAES economic analysis of water use efficiency estimates that 40% of potato growers over-irrigate by 3 inches or more while another 20% under-irrigate. Optimal irrigation could increase U.S. No 1 potato production in over-irrigated fields by 20 percent, or 20 cents per cwt, and improve specific gravity by 0.01, or 20 center per cwt. For under-irrigated fields, increasing irrigation to optimal levels will increase U.S. No. 1 potato yield by 6 percent or 6 cents per cwt. with no change in specific gravity. In addition to quality improvement, optimal water use will increase yield for over-irrigated fields by 42 cwt. per acre and for under-irrigated fields by 60 cwt. per acre. Optimal water use in potato production will reduce water use by 480,000 inches per year and improve farm income by over $12 million. The net present value for potato producers by using water at an optimal level is estimated at over $69 million. Recent field research in Idaho has compared drip and sprinkler systems on fruit orchards, sugar beats, potatoes and grass. Certain drip irrigation systems were cost-competitive with other methods. Buried drip produced 25% savings in water and energy plus damage from wildlife is minimal. In potatoes, tuber quality improved despite using less water. Minimum revenue improvement was

$130/ac, with maximum of about $400/ac. With proper grass selection, water and nutrient management, summer municipal water use in Southern Idaho can be reduced by about 10%.

On-farm studies are being conducted to assess impacts of tillage and earthworms on carbon. Soil analysis indicated there is a decrease in surface soil pH in non-till relative to conventional systems, possibly influencing nutrient availability and microbial communities. Although total carbon and nitrogen were higher in no-till fields, the portion of nitrogen that is plant-available was lower. Earthworms were more numerous in no-till fields, especially in peas which were previously planted to wheat. The expected impacts of this project include, 1) developing improved nutrient and residue management in no-till systems, 2) acquiring data to help Idaho growers participate in carbon credit trading systems, 3) maintaining or increase non-thermally managed Kentucky bluegrass acreage to improve soil, water, and air quality, and 4) avoiding court cases and economic loss for Idaho bluegrass seed producers.

A related project was conducted to gain a better understanding of the decomposition process in Kentucky bluegrass seed production systems with the potential to develop non-thermal residue management practices. Several sites throughout Northern Idaho were developed and treated with various procedures. At one site a new production system developed by a grower cooperator chemically or mechanically fallowed the field for one year rather than burning, and then harvested in the next year. At that site, residue levels decreased by an average of 14 percent between the fall and spring samplings in harvest 02 (Fallow 03 plots). During the same time period, residue in fallow 02 (Harvest 03 plots) decreased between 35 and 49 percent. The average C:N ratio of biomass from the mechanically treated plots at an alternate site was higher (lower N content) compared to the burned treatments. Despite the lower N contents of biomass in the fall, the N concentration of biomass in the spring was similar in all treatments. Data show that approximately 33 to 37 kg N/Ha are lost from the soil/plant system through baling and burning while 14 to 21 kg N/ha are removed from baling alone. These values indicate the amount of N that would be returned to the soil through decomposition if the residue were left in the field to decay. Process oriented research into the phosphorus kinetics in manure-amended soils by our soil chemistry program advances understanding of how chemicals react in soils. This information allows scientists to discover new remediation strategies and make more accurate predictions of mobility and bioavailability. Our results are providing direct, molecular level evidence that metal sorption on clay minerals is not simply a matter of cations attracted to negative charge via a cation exchange-type mechanism. Instead IAES research is showing that clay mineral characteristics, as well as solution conditions, impact the type of sorption complex occurring. These may be outer-sphere complexation, inner-sphere complexation, or formation of multinuclear complexes on the clay minerals surface. Another project developed a geometrical pore space evolution model to study swelling behavior of clay soils. Information from this study improves predictions of water flow and solute interactions in agricultural soils with appreciable amount of clay minerals. It could lead to improved salinity and sodicity management practices in irrigated agricultural areas. Furthermore, insights gained from this study will lead to improved guidelines for preventing soil erosion, and associated colloid facilitated transport of agrochemicals, saving millions of dollars annually. Another potential application is the development of design criteria for clay liners used to seal waste repositories to prevent leaching and migration of toxic contaminants to aquifers and other water resources.

IAES Program 8: Pollution control and natural resources

This program is aligned closely with Program 9 with which there is considerable overlap. Economic models are being developed and used to evaluate firm level impacts of pubic land grazing policies in Owyhee County, Idaho. Impacts were analyzed using a regional input-output model to examine grazing policy impacts on the region. A social assessment was also completed for Owyhee County and four southwestern Idaho counties. The influence of social and economic factors is being incorporated into the federal and local public land policy processes in Southwest Idaho. The economic importance of seasonal grazing on federal lands and the social connection ranching provides the area communities are both considered.

RESEARCH PROJECT ANNUAL REPORTS

IAES Program 7: Soil, Water and Air Quality Conservation and Sustainable Agriculture Practices (RPAs 101, 102, 104, 111, 112, 132, 133, 135, 215). IAES Program 7 contributes to REE GOAL 4 and is the IAES's second largest research program area. This program area has 21 active research projects and encompasses approximately 8.33 SY of faculty research contribution.

Performance Goals:
Reduced erosion, nutrient depletion, salination and toxification of agricultural soils coupled with increased adoption of precision soil and crop management techniques. Efficient application and utilization of water, fertilizer, pesticides, and other crop and soil amendments for biological control of pests. To meet the water quantity and quality needs of different constituents on a scientific basis through sustainable practices.

1. POLLUTANT TRANSPORT MODELS TO DETERMINE CRITICAL SOURCES AREAS IN WATERSHEDS

Investigators: Boll, J.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Termination Report:
The Soil Moisture Routing model, a physically-based distributed hydrologic model created at Cornell University was modified to fit conditions of northern Idaho and eastern Washington. Modifications were based on data from a small research watershed in Troy, ID, using a dense piezometer network, a circular flume at the watershed outlet, and an 18 m x 30 m research plot. The distribution of the lateral saturated hydraulic conductivity (Ks) with depth using a hillslope plot was measured. Ks values were an order of magnitude higher than small scale measurements or values reported in the Soil Survey. A highly conductive 0.10 surface soil layer was followed by an exponential decrease in Ks with depth below the soil surface. This confirms what has only been hypothesized and inferred to by the calibration of distributed hydrologic models in other watersheds. A snow accumulation and melt model was developed incorporating snow drifting and the snow surface temperature to close the energy mass balance. Results showed good agreement between perched water depth measurements and predictions when the measured vertical distribution of Ks was incorporated into the modified SMR model applied to a grass-

covered watershed. These results confirm the relationship derived by the hillslope-scale field experiment. This study revealed that the inability to determine how connected and therefore how active macropores are in a hillslope poses some real challenges when interpreting small-scale measurements. Methodologies were developed using GIS to estimate erosion and sediment delivery from agricultural lands and roads in watersheds of the Clearwater Basin in Idaho. These methodologies assisted state agences in sediment budget analysis for TMDL development. While these methodologies are in great demand, actual validation was not performed. Computer simulation of soil loss and yield with the Revised Universal Soil Loss Equation showed that areas that yield high soil loss do not always coincide with areas that generate high runoff, and vice versa. Field experiments and theoretical analyses of soil erosion resulted in a coefficient for soil erodibility for different tillage and land management conditions. Phosphorus (P) research showed that under anaerobic conditions, which occur during spring snow melt, phosphorus release to surface waters is extremely high. Relationships for the P enrichment ratio and the P extraction coefficient in Central Idaho were similar to those found in the eastern USA despite much higher soil P in the study area. Laboratory research using flumes showed that flow pathways and biogeochemical conditions can explain the release of P from sloping land. The level of interaction of water with a mixing layer is critical in the release of dissolved phosphorus from agricultural soils. Laboratory studies revealed that two pathogens (Cryptosporidium parvum and Giardia lamblia) most likely travel with water and are not attached to sediment particles. The attachment of these pathogens was linked to surface charge and hydrophobicity, where adhesion of C. parvum was most influenced by surface charge and adhesion of G. lamblia by hydrophobicity.

Impact:
These research findings provide database parameters for prediction of the pollution potential of site-specific areas in the watersheds and modeling tools to assist TMDL development and evaluation of BMPs in anticipation of current and future needs in Idaho. Recently, this work has played a role in watershed assessment related to fish habitat. Results from laboratory studies in this project have implications for farm level management decisions to reduce transport of potential pollutants.

2. POLLUTANT TRANSPORT MECHANISMS AND CUMULATIVE EFFECTS MODELING
Investigators: Boll, J.
Termination Date: 06/30/2008
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
This project has two main objectives: to study the transport mechanisms of water and pollutants (e.g., sediment, nutrients) in a laboratory and/or field setting including lateral water flow in tillage and organic layers, rill initiation, and phosphorus enrichment in runoff; to develop the framework for a GIS-based approach for the evaluation of disturbances in agricultural and forest watersheds in the state of Idaho and the greater Pacific Northwest focusing on spatial and temporal aspects. Activities in this project mainly consisted of data collection in two study watersheds. In Paradise Creek watershed, near Moscow, Idaho, data are being collected from three stream monitoring stations: one at the edge of forest and agricultural land use, one at the

edge of agricultural and urban land use, and one at the edge of urban land use just upstream of the waste water treatment discharge point. Each station measures stage height, turbidity, temperature, electrical conductivity, and suspended solids. Rating curves are being established for discharge and stage height and for turbidity and suspended solids. Four automated weather stations are located in the watershed. One weather station is equipped to monitor air temperature, humidity, solar radiation, precipitation, wind speed and wind direction. Three other weather stations are equipped to monitor air temperature, precipitation, wind speed and wind direction. Stream cross sections and nutrient data are also being collected. Mica creek watershed near Coeur d'Alene, Idaho, has been instrumented since 1990 by Potlatch, Inc. for discharge measurements, suspended sediment sampling on a flow proportional basis, bedload sampling, water temperature, particle size distribution, channel shape, canopy cover, and channel gradients at 32 permanently marked stream cross-sections, and precipitation at 4 locations and a cooperative SNOTEL site. An extensive data record starting in 1990 exists including establishment of a rating curve for discharge and suspended sediment. We have added instrumentation including transects of automated shallow wells and two weirs collecting discharge and sediment from disturbed areas. Measurements of soil depth and degree of disturbance were made. Initial simulations were ran using the one-dimensional numerical model for flow and sediment transport in channel networks CCHE1D developed by the National Center for Computational Hydroscience and Engineering of the University of Mississippi. These simulations used data from Mica Creek watershed.

Impact:
A thorough understanding of pollutant transport and cumulative effects (e.g., storage of pollutants in streams), will assist in interpretation of stream monitoring data which are used to assess progress in water quality management. Results from this work will assist in prediction of pollutant loading for a water body of interest and, more importantly, evaluation of site-specific Best Management Practices (BMPs). Particularly the long-term effects of BMPs are targeted in this research.

3. WATER USE, GROWTH, NUTRITION, AND FRUIT QUALITY AS INFLUENCED BY IRRIGATION SYSTEMS IN 'FUJI' AND 'GALA' APPLES, AND BY ROOTSTOCK IN 'GALA'

Investigators: Fallahi, E.
Termination Date: 06/30/2007
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
Fruit quality and yield are affected by the quantity of water and rootstock. Also, water usage is becoming very important as the world population increase, and many fruit producing areas are facing water shortage. This project will examine the effects of different irrigation regimes in 'Fuji' and effects of drip and sprinkler irrigation systems and five rootstocks in 'Gala' apple on fruit quality, yield, nutrition, and storability. We have found that sprinkler system uses more water than double drip system while not having major effect on the tree growth during the first two years after planting. At the peak of summer, each tree with sprinkler used about 14 gal/day while each tree with double drip used about 4 gal/day. Quality and mineral nutrition of trees from this experiment are being measured at this time. 'Gala' trees on Supporter 4 were largest

followed by those on Bud 118, G30, RN 29, and Bud 9.

Impact:
This experiment will assist growers to use minimum amount of water to produce high quality 'Fuji' and 'Gala'. Also, the interaction of each of the tested rootstock with drip and sprinkler system will be determined for 'Pacific Gala' apple.

4. INFLUENCE OF VOLCANIC ASH AND LOESS ON THE FORMATION, PROPERTIES, AND MANAGEMENT OF IDAHO SOILS
Investigators: McDaniel, P. A.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
This project focuses on wind-blown silt and volcanic ash parent materials. We have completed a major study looking at perched water tables in the Palouse region. Through a combination of site-specific research and soil survey information, we have developed a near-surface hydrological model for the Palouse basin. Our research has shown that much of the eastern portion of the basin has soils that dramatically affect redistribution of precipitation. Saturation excess surface runoff and subsurface lateral flow above relatively impermeable subsoils redistribute significant quantities of water within landscapes. Pore water retention times in these subsoils as derived from Cl- mass balance technique indicate recharge rates are less than 3 mm/year. Through development of a GIS, we have been able to model the areal distribution of these slowly permeable soils. This model represents the first comprehensive attempt to combine readily available geological and soil databases to extrapolate site-specific research data. We are continuing to work with the Natural Resources Conservation Service (NRCS) and the US Forest Service to develop an Andisol database linking productivity to andic influences in forests of northern Idaho. It was shown that up to 40% of applied sulfur is sorbed and rendered unavailable to plants in forested volcanic ash soils of the region. We are cooperating with the US Forest Service to examine the effect of management (harvesting, fertilization) on wood decomposition rates in soils across the region that have varying degrees of volcanic ash influence. Current work with the NRCS is examining the physical, chemical, and mineralogical characteristics of volcanic ash in various climatic zones across the region. Through creation and analysis of a large regional database, we are working to establish base line information about these soils, information that is needed to better assess management impacts. I serve as the Idaho Agricultural Experiment Station representative the National Cooperative Soil Survey program. Current involvement includes review of state soil survey activities.

Impact:
We have developed a GIS database for the Palouse Basin that identifies recharge potential. This is a valuable resource for planners and those attempting to better model regional groundwater supplies and recharge mechanisms. This information is necessary for sustainable used of water resources. In forests of the Inland Pacific Northwest region, productivity is closely related to the degree to which volcanic ash has influenced soil profiles. Our work with sulfate sorption in these soils has important implications for forest fertilization practices. Additionally, baseline data obtained through our work will help foresters determine impacts of management practices.

This, in turn, is needed to assess sustainability of forest resources across the region.

5. BIOCHEMISTRY OF SULFUR CYCLING IN THE SOIL ENVIRONMENT
Investigators: Morra, M. J.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Soil is a primary component in the biogeochemical sulfur cycle, mediating oxidation state changes and acting as a source and sink for various sulfur species. Despite this importance, we know very little about sulfur pools and transformations in soil. Our ability to provide adequate amounts of S for optimum plant growth and ensure environmental quality is severely limited by this lack of understanding. We are addressing agricultural and environmental aspects related to the soil sulfur cycle to 1) define the important sulfur pools and 2) delineate the most significant transformations occurring among those pools. Our current project is focused on determining the fate and biological activity of sulfur-containing allelochemicals. Work with allelochemicals has centered on glucosinolates, sulfur-containing compounds of interest in pest control strategies. Glucosinolates contained in members of the Brassicaceae release a number of allelochemicals of potential value in controlling plant pests. The highest glucosinolate concentrations in plants are found in the seed or seed meal that remains after the oil is removed. We are using this seed meal as a source for a biopesticide. Our goal is to control a wide variety of plant pests in agricultural and horticultural crops using seed meals obtained from different mustards. Current efforts are directed at controlling fungus gnats and black vine weevils in horticultural crops and weeds in organic farming systems. We have determined that glucosinolates contained in Brassica juncea meal are most effective against insect and fungal pests, whereas glucosinolates in Sinapis alba meal are most effective against weeds. Bioassays showed 2-propenyl isothiocyanate released from B. juncea meal provides effective control of fungus gnats when homogeneously mixed in potting soil at a rate of 3%. However, tests for phytoxicity are necessary to determine any negative effects on the plants in which fungus gnats are a problem. We also showed that top dressing reduced fungus gnat populations to the same or an even greater extent than homogeneous incorporation of the meal into the potting mix. In contrast, 4-OH isothiocyanate released from S. alba meal has no effect on fungus gnat survival, but does behave as a very effective herbicide. The lack of a biological response with S. alba meal was puzzling given the fact that this meal contained the highest glucosinolate concentration. We tested the pH stability of 4-OH benzyl isothiocyanate in buffers with pHs ranging from 3.0 to 7.0 and determined that 4-OH benzyl isothiocyanate was not stable even at pH values of 3.0. The half-life decreases with an increase in pH from 3.6 h at pH 3.0 to less than 5 min at pH 7.0. Thus in a soil environment 4-OH benzyl isothiocyanate will be produced in S. alba meal but because it is unstable, will hydrolyze rapidly to form SCN-. It thus is likely that the lack of a negative effect on insects, nematodes, and fungi is caused by the rapid hydrolysis of 4-OH benzyl isothiocyanate to SCN-. Our results also indicate that SCN- is phytotoxic and thus of likely importance in weed inhibition.

Impact:
Our work will lead to the effective use of mustard meal as a biopesticide to control insects and weeds in agricultural and horticultural crops. The meal will be used to replace synthetic

pesticides thereby, decreasing our dependence on petrochemicals and reducing the associated generation of hazardous chemicals required or produced in the synthetic process.

6. MICROIRRIGATION TECHNOLOGIES FOR PROTECTION OF NATURAL RESOURCES AND OPTIMUM PRODUCTION

Investigators: Neibling, W. H.
Termination Date: 09/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Tests were performed in Custer County to evaluate the effectiveness of several tape spacings on wetting pattern from buried drip tubing. The surface 6-8 inches of silt loam soil were underlain by a number of layers of mixed silt and gravel. Based on tests, a spacing of 30 inches along the tape and 42 inches between tapes when buried 6-8 inches deep gave wetting patterns acceptable to the cooperator. Wetting fronts at the surface were separated by about a 6-10-inch dry soil strip. The dry strip was narrower at the tape depth. About 90 acres of tape were installed. Winter precipitation should germinate grass seed in this area and water from the drip system will be sufficiently close to support grass growth in this initially dry zone. This site can now be used as a demonstration site for those interested in a similar application, and as a resource for various system evaluations. Tape spacing was also evaluated at a second site on a Portneuf silt loam near Twin Falls. Tape spacings for irrigated pasture were 24 and 48 inches. After about 7 days of run time, the initially very dry soil was completely wetted at the surface for the 24-inch spacing. On the second portion of the area, near complete wetting on the 24-inch spacing was achieved in 3 days with a 12 hour on- 12 hour off cycle. The wetting fronts are still far apart at the surface on the 48-inch spacing . Five grower fields were selected and irrigation scheduling modified during the 2003 growing season based on soil moisture sensor readings. Three growers who have been using these recording meters and soil moisture sensors for irrigation scheduling have agreed to participate in the Snake River Sugarbeet Conference and share their experiences and the increased return they've calculated as a result of this program. These are growers who have worked with several team members in this project in past years and have adopted the practice in their operations. One of the major keys to grower usage was a set of laminated cards. These cards show remaining usable soil water in inches and as % available, and the water depth required to refill each foot of soil to field capacity for a range of watermark readings for 4 soil textural classes. A cooperative study with on optimization of irrigation / fertility variables was initiated at Kimberly and Parma. Crop yield and quality data, soil moisture data and soil fertility data were collected from each field. Irrigation method was surface drip irrigation. Results will be presented this winter. A lawn irrigation project was initiated to determine grass species selection, irrigation and fertility management under buried drip irrigation.

Impact:
Drip irrigation was cost-competitive with other appropriate irrigation methods at a tape spacing of 42 inches. By using buried drip, about 25% savings in water and energy will be achieved, and system damage due to wildlife will be minimal. In potatoes, growers were pleased with the equipment and most did change irrigation practices. Tuber quality was better than last year with less water. Minimum revenue improvement was $130/ac, with maximum of about $400/ac. The potato packer involved with these fields ordered equipment for every field that supplies his

packing house this year. With proper grass selection, water and nutrient management, summer municipal water use in Southern Idaho can be reduced by about 10%.

7. CHARACTERIZATION OF THE ACTIVITIES OF PLANT GROWTH PROMOTING STREPTOMYCES IN THE RHIZOSPHERE

Investigators: Crawford, D. L.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We characterized the legume growth promoting and antifungal compound producing abilities of Streptomyces from plant rhizospheres. In non-sterile soil, we showed that Streptomyces lydicus WYEC108, originally isolated from the linseed plant rhizosphere, colonizes the nodules and roots of both peas and soybeans. After colonizing nodules, the mycelium moves onto the roots. Hyphae penetrate the outer surface layers of the nodules. Compared to uncolonized controls, WYEC108 colonization leads to the production of larger and more numerous nodules in both plants. Nodule colonization leads to improved bacteroid health/lifespan, enhanced nitrogen fixation rates, and improved plant growth. We hypothesized that the actinomycete was secreting siderophores within the nodules. Iron bioavailability within the rhizosphere was thought to be limited. Increased siderophore production within colonized nodules aided their assimilation of iron and molybdenum required for nitrogenase and leghemoglobin production by the nitrogen-fixing bacteriods. Enhanced iron assimilation was responsible for the higher nitrogen fixation rates of WYEC108-colonized nodules A 300 bp WYEC108 specific gene probe was used to confirm that the actinomycete colonizing nodules in the non-sterile soil was S. lydicus WYEC 108, not other soil actinomycetes. We investigated if other siderophore-producing, root-colonizing Streptomyces had similar effects on peas. Some but not all of the Streptomyces had effects similar to WYEC108. Total siderophore production by a strain was found to be the best indicator of its ability to enhance nitrogen fixation and plant growth. Pea roots and nodules collected from agricultural fields were found to be colonized by naturally occurring actinomycetes. This is the first report of such a beneficial plant-microbe rhizosphere interaction involving Streptomcyes and legumes, the first showing microbial siderophore production as a mechanism for aiding nodular assimilation of iron, and the first evidence to show that this is a natural beneficial plant-microbe interaction. We also studied the microbial populations of a previously unstudied habitat, the rhizosphere of desert sagebrush (Artemesia tridentata). This habitat is rich in previously undescribed actinomycetes that produce antimicrobial compounds with broad spectrum activity against fungal plant and animal pathogens. Most of the novel isolates are species of Streptomyces. We characterized the antifungal compounds produced by one sagebrush rhizosphere isolate, Streptomyces sp RG. Streptomyces RG species is novel, based upon its 16s rRNA gene sequence. It produced multiple low molecular weight, polar antifungal compounds. The compounds active against Saccharomyces cerevesiae were purified or partially purified One of the compounds was novel and had a molecular weight of 254. These data, along with results of ongoing research, show that the sagebrush rhizosphere is a source of previously undescribed actinomycetes that produce novel antifungal compounds of potential value as antimicrobial agents for treatment of fungal infections of plants and animals.

Impact:

Some of the rhizosphere isolates we have characterized will be developed into inoculants that promote legume growth and increase crop yields. Some of the novel antifungal compounds may be developed into antifungal biocontrol or therapeutic agents for use in agriculture and medicine.

8. ALGORITHUM DEVELOPMENT FOR REMOTE SENSING OF IDAHO WATER RESOURCES AND FIELD BURNING

Investigators: Qualls, R.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
During the reporting period, we analyzed data from our second field experiment which included more detailed canopy radiation information. We validated our radiation model, demonstrating excellent agreement with the data. Next we coupled the turbulent flux model to the radiation model. The results show that the total flux leaving the canopy as sensible and latent heat agree with the measurements, but the modeled and measured vertical distribution of skin temperatures within the canopy do not coincide. We developed a hypothesis that this was due to a non-uniform distribution of stomatal conductances within the canopy. I procured grant funding in order to purchase a $38,000 instrument to measure stomatal conductance (as well as many other photosynthesis related processes) at the leaf level. The instrument has been ordered and should arrive in March. I can use this instrument to validate my hypothesis and to develop an algorithm to model the vertical stomatal conductance behavior. I will conduct another field experiment this summer to test my hypothesis. One of the important scientific outcomes of this research will be to determine the characteristic behavior of the canopy temperature profiles, how radiation interacts with vegetation structure and density and how stomatal conductance interacts with canopy turbulence to generate these profiles.

Impact:
This project will enable modifications to be made to numerical weather models, such as those used to generate the 10-day weather forecast, which will improve their accuracy. Furthermore, it will allow the models to begin incorporating remote sensing data such as satellite surface temperature measurements. This latter accomplishment will produce models with much finer spatial resolution, thereby improving the weather forecast for individual small communities.

9. RATES AND MECHANISMS OF CHEMICAL REACTIONS IN SOILS

Investigators: Strawn, D. G.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The release of phosphorus from manure-amended alkaline soils is controlled by desorption and dissolution processes, and is impacted by organic P speciation. Our study provided results on the release kinetics of phosphorus from manure-amended soils, and discovered that the predominant process controlling P release from the soils is octa-calcium phosphate mineral dissolution. We hypothesized that the formation of these metastable minerals is due to the high organic matter content of the manure-amended soils. We also discovered that adding manure to soils in the form

of liquid slurry, as opposed to solid manure, promotes orthophosphate enrichment in the subsurface. Investigation of the speciation of the phosphorus in the manure and amended soils revealed that the predominant organic P species present is phytic acid, and that the surface of the soil has a higher fraction of phytic acid than the subsurface. This year we completed our investigation of copper sorption mechanisms on montmorillonite and initiated research on copper and lead sorption mechanisms on vermiculite. Using XAFS spectroscopy we discovered that there are two types of copper sorption complexes that occur on montmorillonite; dimer multinuclear complexes and hydrated copper adsorbed in the interlayer. Ionic strength was found to be the sole factor controlling the adsorption mechanism, so long as the pH was controlled such that the system remained undersaturated with respect to oxide or hydroxide precipitates. On vermiculite we are discovering unique inner-sphere sorption complexes for copper that have not been observed before, although previous research has inferred the sorption mechanisms. Our results are providing direct, molecular level evidence that metal sorption on clay minerals is not simply a matter of cations attracted to negative charge via a cation exchange-type mechanism. Instead we are finding that clay mineral characteristics as well as solution conditions will impact the type of sorption complex occurring, which may be outer-sphere complexation, inner-sphere complexation, or formation of multinuclear complexes on the clay minerals surface.

Impact:
Accomplishments this year provided new information on reaction processes of copper with clay minerals and the release and speciation of phosphorus in manure-amended soils. The process oriented research conducted in our soil chemistry program advances the basic understanding of how chemicals react in soils, which will allow scientists to discover new remediation strategies and make more accurate predictions of mobility and bioavailability.

10. MANAGEMENT AND MANIPULATION OF THE C CYCLE TO INCREASE YIELDS AND SOIL QUALITY IN NO-TILL SYSTEMS
Investigators: Johnson-Maynard, J. L.
Termination Date: 06/30/2007
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
On-farm sites were sampled during the summer of 2002 and 2003 to study the impact of tillage and earthworms on C. Twelve fields (three CT wheat; three CT peas; three NT wheat; and three NT peas) were used. Soils and macrofauna were sampled at multiple locations along each transect. Analysis of 2002 soil samples indicates that there is a decrease in pH in the surface soil in NT relative to CT systems, which may influence nutrient availability and microbial communities. Although total C and N tended to be higher in NT fields, the portion of N that is plant available was lower. Earthworms tended to be more numerous in NT fields, especially in peas which were previously planted to wheat. Soil samples from 2003 are still being analyzed. Together the preliminary data suggest that both tillage and crop rotation will influence soil invertebrates and the amount of C stored in soil. A second portion of this project is conducted on the University research farm. This experiment includes replicated CT and NT plots with a wheat, pea, barley rotation. The lowest earthworm densities were found in plots that were previously planted to pea. 2003 data correspond well to previous years and suggest that crop rotation will have a large influence on earthworm density. Although soil C and N in the upper horizons tended

to be higher in NT soils, no significant differences were detected in 2002 data. Soil samples from 2003 are still being analyzed for chemical and physical properties. The second portion of this project deals with gaining a better understanding of the decomposition process in Kentucky bluegrass seed production systems. Data will be used to develop non-thermal residue management practices. Sites were developed in both Lewis and Kootenai Counties in Idaho. Treatments at the Kootenai Co. site are full-load burn; bale and burn; bale/mow/harrow; and a system plot which incorporates all three treatments. At the Lewis Co. site a new production system developed by a grower cooperator is being studied. In this system, instead of burning, the field is chemically or mechanically fallowed for one year and harvested in the next. At the Lewis Co. site residue levels decreased by an average of 14 % between the fall and spring samplings in harvest 02 (Fallow 03 plots). During the same time period, residue in fallow 02 (Harvest 03 plots) decreased between 35 and 49%. Further study of these plots over successive seed harvest/fallow cycles will help determine if this rate of decomposition is sufficient to economically sustain seed production. The average C:N ratio of biomass from the mechanically treated plots at the Kootenai Co. site was higher (lower N content) compared to the burned treatments. Despite the lower N content of biomass in fall, the N concentration of biomass in the spring was similar in all treatments. Data show that approximately 33 to 37 kg N/ha are lost from the soil/plant system through baling and burning while 14 to 21 kg N/ha are removed from baling alone. These values indicate the amount of N that would be returned to the soil through decomposition if the residue were left in the field to decay.

Impact:
The expected impacts of this project include, 1) the development and implementation of improved nutrient and residue management in no-till systems, 2) development of data sets which will help Idaho growers participate in C credit trading systems, 3) the maintenance or increase in non-thermally managed Kentucky bluegrass acreage which will lead to improved soil, water, and air quality, and 4) avoided court cases and economic loss for Idaho Kentucky bluegrass seed producers.

11. CHARACTERIZATION OF FLOW AND TRANSPORT PROCESSES IN SOILS AT DIFFERENT SCALES

Investigators: Tuller, M.
Termination Date: 09/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
After development of a geometrical pore space evolution model linked to hydration state, and introduction of hydrostatic and hydrodynamic considerations to model liquid retention, hydraulic conductivity, and swelling behavior of clay soils we conducted a comprehensive experiment series to evaluate effects of clay type, clay content, solution chemistry and solution concentration on swelling behavior and hydraulic properties. We employed a latest technology flexible wall permeameter and volume change apparatus to measure hydraulic conductivity and swelling properties of bentonite-sand mixtures. We used solutions varying in molarity and ion valence to investigate the effects of solution concentration and type. The measurements were performed for bentonite contents ranging from 0 to 100%. The measurements were used to refine our pore-scale model, and to develop a statistical upscaling scheme to predict sample-scale hydraulic

behavior. In this context we started measurements at the new WSU Computed Tomography (CT) facility to resolve and introduce anisotropic hydraulic behavior. A recent collaboration with the INEEL Geocentrifuge facility in Idaho Falls allows access to a relatively large centrifuge that allows measurements on large specimens. These measurements will lead to the development of and upscaling concept for prediction of profile-scale properties. These efforts are partially supported by a NSF-EPSCoR and an USGS-IWRRI grant. We continued to work on flow phenomena in structured soils that led to a refereed publication in Advances in Water Resources, and conducted KC135 flight experiments in Houston, TX to investigate liquid behavior in porous plant growth media under microgravity. The flight experimental data are used in combination with physically based models to design root modules and growth chambers suitable to support plant growth at the International Space Station and for other space exploration. This project is supported by NASA. Research findings were disseminated through 2 refereed journal articles, 4 refereed book chapters, and numerous presentations at national and international symposia and meetings.

Impact:
The project on swelling soils will significantly contribute to improved predictions of water flow and solute interactions in agricultural soils with appreciable amount of clay minerals, and lead to improved salinity and sodicity management practices in irrigated agricultural areas. Furthermore, insights gained from this study will enhance understanding of clay dispersion and surface sealing, and lead to improved management guidelines for prevention of soil erosion, and associated colloid facilitated transport of agrochemicals. In extreme cases, improved ability for prediction of the onset of surface runoff from clay soils at the field and watershed scale can prevent catastrophic events, such as flooding and could provide early warning and save lives and property. Besides agricultural and environmental applications the project also provides new insights for geotechnical engineering. Structural damage to buildings and roads due to active clay soils is an important economic factor. Improved predictions of swelling behavior could prevent such damages and save millions of dollars every year. Another potential application is the development of design criteria for clay liners used to seal waste repositories to prevent leaching and migration of toxic contaminants to aquifers and other water resources.

12. PEROXIDASE-SUBSTRATE INTERACTIONS AS A MODEL FOR DESIGN OF BIODEGRADABLE COMPOUNDS

Investigators: Crawford, R. L.
Termination Date: 06/30/2003
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
We have been studying biodegradation and biotransformation of azo and other dyes as a model for examining microbial degradation processes in soil. During this project period we have employed this model in the highly innovative approach to the detection of life in soil, with particular emphasis on its use to detect life in extraterrestrial soils such as those of the planet Mars. Detecting microbial life in extraterrestrial locations is a goal of space exploration because of ecological and health concerns about possible contamination of other planets with earthly organisms, and vice versa. Such contamination of Earth could potentially cause problems for

the agricultural industry should a foreign organism become established in earthly soils. Previously we suggested a method for life detection based on the fact that living entities require a continual input of energy accessed through coupled oxidations and reductions (an electron transport chain). We demonstrated using earthly soils that the identification of extracted components of electron transport chains is useful for remote detection of a chemical signature of life. The instrument package developed used supercritical carbon dioxide for soil extraction, followed by chromatography or electrophoresis to separate extracted compounds, with final detection by voltammetry and tandem mass-spectrometry. Here we used Earth-derived soils to develop a related life detection system based on direct observation of a biological redox signature. We measured the ability of soil microbial communities to reduce artificial electron acceptors. Living organisms in pure culture and those naturally found in soil were shown to reduce 2,3-dichlorophenol indophenol (DCIP) and the tetrazolium dye 2,3-bis(2-methoxy-4-nitro-5-sulfophenyl)-2H-tetrazolium-5-carboxanilide inner salt (XTT). Uninoculated or sterilized controls did not reduce the dyes. A soil from Antarctica that was determined by chemical signature and DNA analysis to be sterile also did not reduce the dyes. We concluded from this work that observation of dye reduction, supplemented with extraction and identification of only a few specific signature redox-active biochemicals such as porphyrins or quinones, provides a simplified means to detect a signature of life in the soils of other planets or their moons.

Impact:
This work may lead to the development of novel instruments that can remotely monitor microbial processes within soil, including agricultural soils.

13. GENETIC AND BIOCHEMICAL ANALYSIS OF ZINC TOLERANCE IN ARABIDOPSIS AND RICE
Investigators: Caplan, A. B.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
The goal of this research is to enhance the tolerance of plants to toxic metals such as zinc in order to improve their performance as bioremediative agents. In the pursuit of this goal we are attempting to augment the tolerance of rice and tobacco by overproducing two rice genes that are strongly induced by metal treatments. Secondly, we are attempting to develop metal-chelating proteins targeted to different organelles to trap metals as they come into the cell. Finally, we are attempting to isolate genes that suppress an unusual zinc sensitivity shown by one of the yeast strains with which we have been working. Over the last 3 years, we have generated approximately 20 lines of rice transformed with constitutively expressed sense or antisense copies of the rice salT or rezA genes. The copy number of the transgene in each line has been estimated by Southern analysis and plants are currently being selfed to obtained homozygous plants for physiological assessment. Many of the transgenic lines do not grow as tall as their wild-type parents. Although this has made studies of growth under sodium- or zinc-stressed conditions more challenging, we believe some show increased sensitivity, but none show enhanced tolerance. Northern analysis and more detailed phenotypic scoring will be done once homozygous lines have been obtained. We have also generated chimeric zinc-binding

proteins and are testing their ability to improve the growth of yeast on zinc-containing medium. The effects we have seen so far seem small (as expected), but promising as a starting point for further improvements. However, during the course of these experiments, we also observed that the variety of yeast we have been using became hypersensitive to zinc when grown on medium with galactose as the sole-carbon-source. Other strains of yeast showed equal sensitivity to zinc on all media tested. In order to understand the cause of this zinc sensitivity better, we are currently screening a yeast library for clones that will suppress the effect.

Impact:
Recent interest in phytoremediation of metal-contaminated soils has stimulated an interest in the biochemistry of plant tolerance for toxic contaminates. Tolerance depends in part on repairing the cellular damage that inevitably results from the accumulation of metal ions like zinc that can denature or otherwise inactivate a broad range of proteins. Tolerance can also be improved by chelating ions as they enter each compartment before any damage can ensue. Our initial investigations into how plants coped with excess zinc led to the isolation of two rice genes. We found that the expression of antisense transcripts from each reduced the tolerance of plants to both zinc and salt showing that both genes were involved in an abiotic defense process.

14. QUANTIFICATION METHODS FOR WATER RESOURCES MANAGEMENT AND PLANNING

Investigators: Allen, R. G.
Termination Date: 06/30/2004
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Evapotranspiration (ET) in time and space is predicted for large areas using the METRIC satellite-image processing software (Mapping EvapoTranspiration at High Resolution with Internalized Calibration) of the University of Idaho. Work during 2003 improved prediction of ET for city and residential areas by improving means to predict aerodynamic roughness. Prediction of ET for Idaho sagebrush desert areas was improved by incorporating an excess aerodynamic resistance term to account for the impact of the sparse desert vegetation in shielding the surface from wind and aerodynamic transfer of sensible heat but allowing the penetration of solar radiation and resulting heating of soil. ET maps produced by METRIC have been used by the University of Idaho to predict water consumption from the Snake Plain aquifer of southeast Idaho and incidental recharge to the aquifer from irrigation diversions from the Snake River. Water consumption maps have been used by the Idaho Department of Water Resources (IDWR) to improve water management of irrigation systems along the upper Salmon River to maintain higher in-stream flows for Salmon fish recovery. IDWR has used the ET maps to calibrate the MIKE-SHE hydrologic model to predict localized interaction between surface and groundwater systems. Crop coefficients (Kc) were derived from the METRIC-based ET maps for specific crop types in the Magic Valley area of south-central Idaho. Populations of Kc were analyzed by crop for about 4000 fields. Comparison of mean Kc curves by crop from METRIC with Kc curves reported in literature for southern Idaho showed good agreement for some crops and indicated the need to revise literature values for other crops to reflect current cropping practices and varieties. Water quality samples were collected

during 2003 from points along the Snake River of central southern Idaho and from return flow channels entering the Snake from surface-irrigated tracts. Analyses include forms of nitrogen and phosphorus as well as sediment, pH, oxygen and temperature. Results are archived at http://www.kimberly.uidaho.edu/midsnake/ Results show trends in water quality of the Snake River within and among years.

Impact:
Improvements in predicting evapotranspiration improve how we manage consumption and manipulation of water resources and how we produce food. Better irrigation management reduces impacts to water quality and quantities of river discharge. Derivation of ET crop coefficients from METRIC provides the means to describe mean coefficients and ET for large field populations of the same crop as well as population variance. This information improves how we schedule irrigation of individual fields and has modernized our inventory of crop coefficient curves. Monitoring of the Snake River has provided a baseline for comparing changes in water management practices over time. Verification and refinement of the METRIC satellite-image processing software provides the means for predicting evapotranspiration at high resolution for large land areas.

15. ASSESSMENT AND DEVELOPMENT OF METHODOLOGIES TO RAPIDLY ASSESS BMPS TO REDUCE SEDIMENT AND NUTRIENT RUNOFF FROM AGRICULTURE IN IDAHO
Investigators: Mahler, R. L.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
To support the state of Idaho's TMDL effort a macroinvertebrate biological assessment of the Orofino Creek watershed was conducted in 2003. The results of this study indicated that the watershed was in fair condition, which indicates that much of the watershed is under a minor degree of stress. The overall analysis indicated that while much of the stream appears to be physically unimpaired, there are sources of stress present in the insect assemblage that cannot be detected by cursory observation. This study showed the need to implement BMPs on certain stream segments within this watershed. This watershed will be evaluated again in five years. Several fertilizer guides were revised to improve nitrogen and phosphorus management in watersheds where TMDLs are being implemented.

Impact:
This project will help the state of Idaho target its limited resources to watersheds most impacted by human activities. The biological assessments will allow us to rank watersheds from most to least impaired. Revised fertilizer guides will allow improved nutrient (N and P) management in the impacted watersheds.

16. APPLICATION OF COUPLED ABIOTIC/BIOTIC PROCESSES FOR THE REMEDIATION OF CONTAMINATED SOILS

Investigators: Hess, T.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Previous work with degradation of hazardous compounds has led to research in areas using molecular biological techniques. An externally funded project (Army Research Office), In Situ Genetic Modification Of Natural Microbial Communities with Genes of Value for Bioremediation, has been under way since March 2000 to examine natural transformation of bacteria for use in degradation of trichloroethylene (TCE) and carbon tetrachloride (CT). Preliminary results in bench-scale in the laboratory showed that model DNA constructs (containing antibiotic resistance genes) could transform bacteria with resultant expression of function. Current work focuses on the use of genetic algorithms to optimize environmental conditions for promotion of gene transfer in addition to studies on in situ electroporation protocols to encourage gene transfer. An additional NSF-funded molecular biological-based project, Life at Interfaces and Biocomplexity of Extreme Environments, was initiated in February 2002 with the objective of determining the molecular basis of energy flux in biofilms in thermophilic environments. Current work is investigating biofilm structure and function in relation to temperature. Work is also planned to study microbial-mediated arsenic reduction and its role in both toxicity abatement and energy production.

Impact:
The work is expected to lead to cost-effective methods for remediation of contaminated soils beyond those currently available. Investigation of molecular mechanisms of contaminant use, energy flux and gene transfer, using current molecular biological techniques, is expected to add to the development of remediation technologies.

17. CHEMICAL PROPERTIES AND BIOLOGICAL FUNCTIONS OF PYRIDINE-2, 6-DITHIOCARBOXYLIC ACID (PDTC), A METAL CHELATOR PRODUCED BY PSEUDOMONAS SPP.

Investigators: Paszczynski, A. J.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Halogenated solvents mainly chloromethanes, chloroethanes, and chloroethenes are recalcitrant environmental contaminants. They are produced in mass quantities and are typically used in metal degreasing operations, textile processing, dry cleaning, and manufacturing of organic chemicals and pharmaceuticals. Large quantities of these chemicals like carbon tetrachloride (CT), chloroform, dichloromethane, chloromethane, perchloroethene, trichloroethene, dichloroethene, and vinyl chloride were released to water and land at many sites throughout the country or are stored in underground tanks. Our research has shown that bacteria of the Pseudomonas genus have potential for use in bioremediation of chlorinated solvents. These

bacteria produce numerous siderophores, small organic molecules with strong affinity for iron and other metal ions. The Pseudomonas stutzeri KC and Pseudomonas putida siderophore pdtc (pyridine-2,6-bis(thiocarboxylic acid)) and its copper complex are capable of catalyzing complete mineralization of CT without producing chloroform and methylene chloride, partially reduced, toxic intermediates. Therefore, in this research we further evaluated physico-chemical properties of pdtc. Pdtc chelates many transition metals, including iron(III), iron(II), copper(I), copper(II), cobalt(III), zinc(II), nickel(II), manganese(III), chromium(III), and scandium(III), some heavy metals, including lead(II), gold(III), cadmium(II), and mercury(II), some lanthanides such as neodymium(III) and actinides such as uranium(VI) in the form of UO2(II). In general, metals that are micro-nutrients are chelated by pdtc, and their complexes are water soluble while toxic heavy metals form water insoluble precipitates with pdtc (Stolworthy et al., 2001. Biodegradation, 12:411-418). Four of these complexes, Fe(pdtc)2, Co:(pdtc)2, Mn:(pdtc)2, and Cu:pdtc can cycle between redox states. Pdtc chelates iron(III), copper, and cobalt with very high affinities (Kd = 10 E34) and iron(II) with an affinity 21 orders of magnitude smaller (Kd = 10 E13), (Brandon et al., 2003. Biodegradation, 14:73-82). The pdtc ferric/ferrous affinity ratio change suggests that pdtc functions as an iron transporter into Pseudomonas cell.

Impact:
Determination of binding constants of the microbial metabolite pdtc (pyridine-2,6-bis[thiocarboxylic acid]) and certain metal ions can potentially be used to better understand this compound's behavior in subsurface environments contaminated with chlorinated solvents. The pdtc:Cu(II) complex catalytically degrades carbon tetrachloride (CT); this property of pdtc holds great promise for contributing significantly to solutions for certain CT contamination problems.

18. MICROBIAL ECOLOGY APPLICATIONS FOR PEST MANAGEMENT AND ENVIRONMENTAL PROTECTION
Investigators: Knudsen, G. R.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Experiments continued to evaluate combinations of a microbial biological control agent and glucosinolate-producing amendments for disease control in production conifer nurseries. The Palouse River watershed in the vicinity of Laird Park, Idaho, was monitored monthly at several sites for presence and quantity of fecal coliform and other bacteria. Samples of E. coli bacteria from water samples are being compared with a database of E. coli ribotypes obtained from fecal samples from several animal sources, including human, bovine, avian, and equine. We currently have a collection of more than 1000 isolates. Similar sampling was done at two alpine lakes in the Seven Devils Wilderness area of Idaho. Results will be used to track and predict sources of fecal coliform pollution of these waters.

Impact:
Plant disease control using microbial agents will help reduce chemical pesticide usage and associated detrimental environmental impacts. Tracking sources of bacterial pollution in natural

watersheds will provide a management tool to help minimize health and environmental risks from E. coli and other bacteria in recreational waters.

19. RELATIONSHIPS BETWEEN GEOCHEMICAL REACTIVITY AND WATER CONTENT IN HETEROGENEOUS VADOSE ZONE GEOMEDIA

Investigators: Smith, R. W.
Termination Date: 06/30/2007
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
This project is a collaborative effort between the University of Idaho (UI) and the Idaho National Engineering and Environmental Laboratory (INEEL) with the goal of developing a better understanding of the relationships between reactivity and water content for vadose zone geomedia. The research goal is being accomplished through the use of unsaturated one- and two-dimensional reactive tracer experiments conducted in the environmental geocentrifuge facility at the INEEL. The INEEL centrifuge capabilities include an Unsaturated Flow Apparatus (UFA, model J6-UFA Beckman Coulter, Inc.) and a two-meter radius geocentrifuge (model C61-3 Actidyn Systems). In addition, to centrifuge experiments, traditional bench top unsaturated column experiments are being conducted at the UI, Idaho Falls, ID campus. Three accomplishments characterize the performance period. First, unsaturated column (10 cm diameter and 30 cm lengths) experiments were conducted using the geocentrifuge at accelerations of 10 and 20 time earth's gravity. Tracer (potassium bromide) breakthrough cures were determined by in flight electrical conductivity measurements and occurred in less than 2 hours. Breakthrough times were found to be proportional to applied centrifugal acceleration and occurred in a fraction of the time that would be required for traditional bench top experiments. The breakthrough curves were evaluated using a version of HYDRUS-1D modified for consideration of varying gravitational acceleration. The experimental results demonstrate the applicability of centrifuge approaches to evaluate unsaturated transport in significantly less time than is required for traditional approaches. Second, the fundamental equations for fluid flow in a centrifuge were derived. These equations, which included both continuum- and pore-level derivations, suggest that the Darcy equation is not strictly valid in centrifuge experiments. The range of experimental conditions over which the Darcy equation represents a reasonable approximation of fluid flow is the subject of ongoing research. Third, a simple method was developed to describe reactive chemistry in unsaturated media. In this approach, chemical partitioning between the solid and liquid phases can be represented by the product of two functions, one dependent on interfacial processes (i.e., chemistry) and the other dependent on moisture content, but independent of chemistry. This approach allows the derivation of a 'relative Kd' (analogous to relative permeability) that is a function of the saturation state of the geomedium but is the same for all reactive species. Experimental validation of the 'relative Kd' approach will allow the integration of saturated batch sorption experiments for species of interest with unsaturated column experiments using model tracers to define reactivity as a function of moisture content for chemical species of interest.

Impact:
The coupled biogeochemical and hydrological processes that influence the migration of contaminants and other chemicals through the vadose zone are poorly understood. This project

improves the understanding of transport and transformation of chemicals in the vadose zone by assessing the effects of changing water content on sorption and transport processes. With this improved understanding agricultural, industrial, mining, and energy operations as well as waste disposal activities can be better managed to provide enhanced protections of groundwater resources.

20. CONVENTIONAL AND ECOLOGICALLY BASED CONTROL PRACTICES FOR POTATO INSECTS AND PLRV TRANSMISSION

Investigators: Alvarez, J. M.
Termination Date: 06/30/2007
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
1) Implementing biological control as part of an IPM program in Idaho: The first step in my IPM program was to identify and investigate potential natural enemies of Colorado potato beetle (CPB) and aphids in southeastern Idaho. After two years of field experiments it was determined that Pterostichus melanarius (Illiger), an introduced European species, is the predominant species in southeastern Idaho accounting for 88 % of all individuals caught and also that CPB damage appeared to be less severe in the fields where newer insecticides had spared populations of P. melanarius. Laboratory tests showed that P. melanarius responds to different aphid and CPB densities in a functional manner (the number of prey consumed per predator increases as prey density goes up). The carabid was observed killing and feeding on all instars of CPB and three species of aphid vectors of potato viruses. Given the rate of consumption of eggs and the estimated rate of oviposition by the CPB, one P. melanarius adult could potentially stop the total reproductive potential of three to five CPB adults. 2) The evaluation of weeds as potential inoculum sources for aphid-mediated transmission of Potato Leafroll Virus (PLRV): PLRV is one of the most serious aphid-transmitted diseases that affect yields and quality of potatoes. The green peach aphid (GPA) is considered to be by far the most effective vector of this virus. Even the most intense aphid control may not prevent spread of PLRV unless measures are also taken to keep virus-source plants at a minimum. Nightshades are one of the four most prevalent weeds in Idaho and are one of the preferred weed hosts for GPA. Laboratory and field experiments demonstrated an increased preference of GPA to hairy nightshade over potato, an increased preference of PLRV-infected plants over non-infected plants and also that host preference of GPA remained the same under light and dark conditions, confirming the original hypothesis of an involvement of olfactory cues in host selection. The final objective of this research is to isolate what is attracting the aphids, so we could potentially use that as a trap. 3) The optimization of insecticide applications to reduce virus transmission in the field: All insecticides treatments reduced aphid numbers significantly from the untreated checks through the entire study period in Russet Burbank fields (this virus susceptible variety is planted in more than 75% of the potato acreage in Idaho). Although plots treated with aldicarb and methamidophos presented higher number of alate GPA than plots treated with more selective chemistries at two different dates, these differences were not significant. However, these insecticides do not prevent virus transmission because they do not prevent other infected aphids flying from nearby fields. Besides, when OPs are eventually lost as a control option due to the FQPA, growers will have to transition to other pest control chemicals. ELISA data is being processed to determine the amount of virus transmission for each treatment.

Impact:
According to the Food Quality Protection Act, broad-spectrum insecticides, especially the organophosphates, will be eventually eliminated from the market. Growers in Idaho and the Pacific Northwest will have to find alternatives to these insecticides. The alternative could be the use of more selective pesticides, which could potentially maximize the effectiveness of biological control agents of potato pests. P. melanarius could be a potential biological control agent of potato pests, and since is already present and abundant in southeast Idaho, it can be used in conjunction with soft chemistries for the control of potato pests. Once growers adopt this research, the total chemical input could be reduced. Saving even one pesticide application per year would result in a substantial savings to growers and would greatly reduce the use of organophosphates. For virus management, even the most intense aphid control may not prevent spread of PLRV unless measures are also taken to keep virus-source plants at a minimum.

21. REWETTING TRANSITION EFFECT ON COLLOID TRANSPORT AND COLLOID-FACILITATED TRANSPORT IN THE VADOSE ZONE
Investigators: Williams, B. C.
Termination Date: 06/30/2007
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
Under task 2 of this work, we are completing column experiments to measure the downward migration of bacterial spores in sand. Spores that are approximately 1 micron are colloidal; that is, they are small enough that their role in a suspension is more influenced by diffusion, electrostatic, and surface chemical forces than gravity. The species Bacillus cereus has been selected because it is nearly genetically identical to B. anthracis. This research will be used by those who predict how vulnerable shallow groundwater resources are to naturally or maliciously applied bacterial spores. The number of spores retained in the column and the number eluted completely through the column are monitored to calibrate a computer code for particle transport now under development at the USDA-ARS Salinity Laboratory. As the work under this task was only initiated in June of 2003, we have no accomplishments to report at this time. Under task 4 of this work, laboratory experiments are nearly complete to assess whether passive wick samplers provide representative samples of colloid concentrations in vadose zone pore waters. This issue is important for agricultural soil questions (e.g., pesticide movement through the soil profile) as well as environmental problems. A series of experiments assessing breakthrough versus retardation of colloids on fiberglass wicks transporting flow at various matric suctions are now underway. Preliminary results indicate that if the soil is not saturated, and the fiberglass wick is transporting water at intermediate moisture content, some attenuation of colloids does occur. If these findings are reproducible, these results will be of interest to many investigators nationally.

Impact:
Normally, contaminants that are chemically attracted to soil do not move with groundwater. Their movement is retarded with respect to the groundwater movement. It was a surprise to groundwater scientists when chemicals with high retardation parameters were found to move large distances! Mobile small particles such as clays and humic acid molecules were discovered

to be the carriers. These studies will help elucidate when small particles are mobile and when they are not. We can better protect drinking water from specific contaminants.

Allocated Resources IAES Program 7:

RPA	SY	PY/TY	Amount
101	1.72	0.00	121,907
102	1.19	1.81	881,388
104	0.00	0.00	176,401
111	1.47	0.00	496,342
112	1.31	1.0	599,234
132	0.00	0.00	2,784
133	1.64	1.0	487,577
135	0.00	0.00	168
215	1.00	0.00	419,684
Total	**8.33**	**3.81**	**3,185,485**

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IAES Program 8: Pollution control and natural resources (RPA 605). IAES Program 8 represents the IAES's contribution to **REE Goal 4** and includes 2 research projects and approximately .2 SY of faculty research effort.

Performance Goals:
One of the primary projects in this program deals with the economic costs of soil erosion and methods to reduce erosion. Both income effects and health concerns are addressed. A second major goal is to provide a safe environment for the public.

1. THE ECONOMICS OF RANGELAND MANAGEMENT, IMPROVEMENTS AND CHANGES IN LAND USE POLICIES
Investigators: Rimbey, N. R.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
A project detailing the social and economic situation in Owyhee County was completed in cooperation with the Bureau of Land Management. Ranch-level economic models were completed for 4 model ranches in the county. Regional Input-Output models were constructed and used to assess potential economic impacts of grazing policies. A social assessment was also completed for four southwestern Idaho counties (Owyhee, Canyon, Ada and Elmore). Ranch sales data were gathered from Farm Credit Services and other appraisers in Idaho, Nevada and Oregon. Data is being used to develop hedonic ranch value models in a cooperative project with New Mexico State University and U.S. Forest Service Research (Rocky Mountain Station).

Impact:
Social and economic assessment is being used to formulate public land policy in SW Idaho. Ranch value modeling effort suggests that ranch values have changed through time and ranches are not as dependent on livestock carrying capacity in determining value.

2. RURAL COMMUNITIES AND PUBLIC LANDS IN THE WEST: IMPACTS AND ALTERNATIVES
Investigators: VanTassell, L. V., Rimbey, N., Wulfhorst, J.
Termination Date: 09/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Economic models were used to evaluate firm level impacts of pubic land grazing policies in Owyhee County, Idaho. Firm level impacts were analyzed using a regional input-output model to examine public land grazing policy impacts on the region. A social assessment was also completed for Owyhee County and 4 southwestern Idaho counties (Owyhee, Canyon, Ada and Elmore).

Impact:
The influence of social and economic factors is being incorporated into the public land policy process in Southwest Idaho by federal policy makers and local governments by taking in consideration the economic importance of seasonal grazing on federal lands and the social connection ranching provided the area communities.

Allocated Resources IAES Program 8:

RPA	SY	PY/TY	Amount
605	.20	0.00	172,776
Total	.20	0.00	172,776

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REE GOAL 5: Enhanced Economic Opportunity and Quality of Life for Americans

Impacts for REE Goal 5

IAES Program 9: Economic Enhancement, Improved Quality of Life

Researchers, mainly in the Department of Agricultural Economics and Rural Sociology, work closely with county agents and extension faculty to address economic and social issues of Idaho citizens. Presentations of research results are frequently made to the state legislature and other agricultural leaders. Impact models were designed and are being used to assess the impacts of agricultural and natural resource policies and Idaho's agricultural economy. One published bulletin on farm income was our most widely circulated publication in a number of years. Another study was designed to assist workforce development considering the different types of potential work, family structures, and finances. Analyzing the issues facing our citizens enables development of an extension curriculum that promotes competence in work and family for

middle school children. One study developed a comprehensive data set on the motivation that led older persons (50 and over) to immigrate to Idaho. The goal was to obtain information from older immigrants about how they have developed a "sense of place" in their new community. This information is important to community leaders to assist them in their policy decisions to prepare for older immigrants to their communities. It is estimated that more proper policy decisions resulting from this study will increase senior citizen migration to Idaho with the potential of over $3 million annually in new income to Idaho communities.

Other research addresses the relationships between rural communities and environmental health. This program studies the relationship between Idaho National Engineering and Environmental Laboratory and citizens of nearby rural communities. Results during the past year analyzed mistrust that citizens have for this government facility and their health concerns. One impact of this research is the public clarification of the historical and cultural contexts of Indian nations in the Intermountain West when dealing with government agencies or commercial enterprises wording with radioactive waste materials. In addition Kentucky Bluegrass seed producers documented the perceived relative effects to their operations as well as livelihoods, identity, and domestic stress in the potential scenario of a policy change to end burning field residue. IAES studies showed that current production methods for bluegrass seed production decreases land erosion and positively affects the sustainability of current farmland. In comparison to other crops, many farmers in northern Idaho recognize and utilize bluegrass to help decrease the erodability of their land more susceptible to the degradation in comparison to their other crops. Within their farm, thirty-nine percent of farmers grow 91-100% of their bluegrass on acreage that is more erodible than other parts of their farm. An additional 30% of producers grow 51-60% of their bluegrass on land susceptible to erosion. Bluegrass also helps to maintain land that is more erodible because it has a five to ten year stand life.

A final impact is that rural communities in Owyhee County have documentation based on social and economic data that will substantiate likely effects to rural communities in the area if federal land management changes continue to allow rapid and large scale recreational impacts from a neighboring urban population. A complementary program is examining differences between collaborative water quality planning efforts associated with EPA's TMDL program in Montana and Idaho. Research findings will increase understanding of how outcomes and public perceptions result from different collaborative approaches, and legal and administrative constraint. Armed with this knowledge, state agencies, local watershed groups and EPA can make more informed water quality planning decisions.

RESEARCH PROJECT ANNUAL REPORTS

IAES Program 9: Economic Enhancement, Improved Quality of Life (RPAs 608, 801, 802, 803, 901, 903). IAES Program 9 contributes to **REE GOAL 5**. This program area includes 4 IAES research projects and accounts for approximately 4.17 SY of faculty research effort.

Performance Goals:

1. To improve the social and economic well-being of rural communities in Idaho by providing data and information on local demographics, interactions between components of the community, and planning for economic growth of the geographic unit
2. Determine how work factors (e.g. time, support, and control) enhance or impede family performance and well-being

3. Explain the consequences of family/work interaction for family members and workplace
4. Increase understanding of parents' feeding of infants and young children and the development characteristics of eating skills for young children
5. Increase understanding of culture and the mealtime environmental factors that facilitate development of self-feeding skills.

1. INTEGRATED SOCIAL, ECONOMIC, AND FISCAL MODELS FOR RURAL IDAHO

Investigators: Taylor, R. G.
Termination Date: 06/30/2005
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Impact models have been constructed for several regions in Idaho. These models are being used to assess the impacts of: (1) agricultural policy and Idaho's agricultural economy, (2) natural resource policies such as the salmon recovery and water allocation in the Snake River Plains. Valuation and demand for natural resources such as recreation, water, and fishing were derived. The role of externalities in Idaho's water wars is being researched.

Impact:
The bulletin on farm income projects was the most widely circulated publication by CALS in a number of years. Presentations were made to the state legislature and other agricultural leaders through out the state. In regard to the impact models, after making a presentation to a group of legislators and county commissioners, one extension educator remarked to me that this research was one of the highly visible extension programs that he has been involved with in his thirty years with extension in Idaho.

2. FAMILY AND WORK IDENTITIES DURING TIME OF TRANSITION

Investigators: Schmiege, C. J.
Termination Date: 09/30/2005
Reporting period: 01/01/2002 to 12/31/2002

Progress Report:
Data collection was expanded to include the Moscow area. Quantitative data was collected from an additional 40 participants. The data were entered and analyzed, and the graduate student on the project successfully completed her thesis from the data. The findings were that family identity was significantly related to well-being, but that work identity had no significant relationship with the reported well-being of the participants. The additional results suggested that in preparing workforce development programming attention must be paid to the diverse demands of different types of work, as well as different family structures.

Impact:
Bonner County Extension professionals shared the results of the research findings in three public seminars in Sandpoint, Idaho. These presentations included 'The Impact of Poverty', a Bonner County Democracy Forum, 'Have a Heart Bonner County' a conference for social service agencies and providers, and a poverty simulation for county commissioners and the public. By analyzing the specific issues faced by our participants we will be developing an extension curriculum to promote planful competence in work and family for middle school children in Bonner County.

3. RURAL COMMUNITY WELL-BEING AND ENVIRONMENTAL HEALTH
Investigators: Wulfhorst, J. D.
Termination Date: 06/30/2006
Reporting period: 01/01/2003 to 12/31/2003

Progress Report:
Progress from this project in the past year include the following as examples of data collected: 1) Nearly 50% of those surveyed in a 25 county region in southeastern Idaho view radioactive waste as "very important" to human health problems. Only about 20% of the same community sample strongly agree that the Idaho National Engineering and Environmental (INEEL) Laboratory communicates honestly with people in the region. 50% of those surveyed indicated that INEELs mission of nuclear energy development as "very beneficial." This point is especially telling in that the Labs mission has recently been redefined toward a greater focus on this mission. An example of qualitative feedback gathered during fieldwork is described in the following passage from a local businessman that lives downstream from the INEEL: "We live upstream of Thousand Springs. We have the tail end of the drain. We are irrigators. We have this sense of what is happening on the surface and the kind of geology we live in. We see the manifestation of our agricultural practices. In terms of INEL, that seldom is an honest relationship to acknowledge our concerns. It is always "YOU ARE THE DUMB HICKS FROM THE STICKS, AND WE ARE THE EDUCATED EXPERTS; this is the way it is." 2) A socioeconomic assessment in Owyhee County, Idaho revealed ongoing negative impacts to social cohesion and collective identity that characterizes the area. The following passage indicates the tone and sentiment of many interviewed as a part of this fieldwork: "This community continues to get more and more alienated. If the ranchers here are not making any money, and they are not, then no one is. The grocery store, gas station, and restaurant here, they are all hurting. Cows are our main crop, and prices have been down. I have seen some have to get out of the business and I do not like what I see that it is doing to them. They have turned angry and do not know how to deal with it. Ranch communities are at risk for becoming dysfunctional places now where we turn on our own just like in the ghettos. I see more abuse, more alcoholism; all those same things that happened to the forest-dependent communities. We are not the healthy community we were 20 years ago. You cannot see a future for children here. We are hanging on now, but our industry is hurting and some do not even see how they will be able to retire after a full life of hard work." 3) Using current production methods for bluegrass seed, land erosion is decreased which positively affects the sustainability of current farmland. In comparison to other crops, many farmers in northern Idaho recognize and utilize bluegrass to help decrease the erodability of their land more susceptible to the degradation in comparison to their other crops. Within their farm, thirty-nine percent of farmers grow 91-100% of their

bluegrass on acreage that is more erodible than other parts of their farm. An additional 30% of producers grow 51-60% of their bluegrass on land susceptible to erosion. Bluegrass also helps to maintain land that is more erodible because it has a five to ten year stand life.

Impact:
Results from this project during the past year will translate to the following impacts: 1) Public clarification of the historical and cultural contexts of Indian nations in the Intermountain West when dealing with government agencies and/or commercial enterprises needing to store/dispose/treat radioactive waste materials; 2)Kentucky Bluegrass seed producers have documented the perceived relative effects to their operations as well as livelihoods, identity, and domestic stress in the potential scenario of a policy change to end burning field residue; 3) rural communities in Owyhee County have documentation based on social and economic data that will substantiate likely effects to rural communities in the area if federal land management changes continue to allow rapid and large scale recreational impacts from a neighboring urban population.

4. WATER, WEEDS, FORESTS AND FARMS: EVALUATING AND DEVELOPING TOOLS FOR COMMUNITY RESOURCE PLANNING AND MANAGEMENT IN IDAHO
Investigators: Higgins, L.
Termination Date: 06/30/2008
Reporting period: 07/01/2003 to 12/31/2003

Progress Report:
While watershed planning efforts have been the focus of a fair amount of research around the West, those planning processes designed to address Clean Water Act compliance have not. Specifically, this research examines differences between collaborative water quality planning efforts associated with EPA's Total Maximum Daily Load (TMDL) program in two states, Montana and Idaho. This research is currently in the data collection stage. More than twenty qualitative interviews have been conducted with participants in collaborative watershed planning efforts, and documents associated with these processes have been analyzed. Meetings and conferences focused on TMDL planning have been observed in both states as well. Preliminary findings suggest legal constraints that exist for Montana and Idaho state agencies charged with TMDL planning are inhibiting progress, different organizational histories and collaborative strategies adopted by the two agencies result in different public perceptions, and the increasing technical complexity and inflexible regulatory framework within which the state agencies must operate decreases participant satisfaction with TMDL planning. Numerous states and EPA are now under court-ordered time frames for completing TMDL plans. Both Montana and Idaho are to have plans for all water quality impaired waters by 2007-2008. Due to the short time frames for completion, state agency personnel and citizen participants in planning efforts report that the best science is not always used for assessing sources of impairment, funding once dedicated to on-the-ground projects is being diverted to the creation of plans, and meaningful public involvement is not possible. Funding differences between the states have resulted in the use of two different approaches to collaborative planning, with the Idaho state agency exerting more control over the citizen-based TMDL planning groups. While stakeholders in Idaho have concerns about the processes in which they participate, they appear to be more satisfied with the

state agency and the results of planning than citizens in Montana. More clearly conveyed expectations for the collaborative process and fewer administrative shifts by the Idaho state agency are two reasons for this difference. Finally, EPA is reportedly requiring the states to create ever-more technically complex TMDLs, which, combined with looming court-ordered deadlines for TMDL completion mean, less time for citizen groups to gain a full understanding, or translation, of technical materials. A number of citizens in both states report being alienated by the process for this reason. Future research will include additional field work, surveys to test qualitative research findings, and assessments of environmental outcomes.

Impact:
Research findings will increase understanding of how outcomes and public perceptions result from different collaborative approaches, and legal and administrative constraint. Armed with this knowledge, state agencies, local watershed groups and EPA can make more informed water quality planning decisions.

Allocated Resources IAES Program 9:

RPA	SY	PY/TY	Amount
608	.88	0.00	93,806
801	.43	0.00	31,015
802	0.00	0.00	2,651
803	.97	0.00	157,624
901	1.63	0.00	48,266
902	0.00	0.00	22,326
903	.25	0.00	0
Total	4.16	0.00	355,688

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Summarized Personnel and Fiscal Information by Federal REE Goal

Goal	SY	PY/TY	Amount
1	**48.54**	**42.61**	**20,262,301**
2	**1.70**	**2.64**	**1,749,291**
3	**1.54**	**1.00**	**717,224**
4	**8.53**	**3.81**	**3,358,261**
5	**4.16**	**0**	**355,688**
Total	**64.47**	**50.06**	**26,442,765**

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Multi-state Research Activities

Research activities of the IAES that contribute to organized multi-state projects/programs approved by CSREES are designated as Regional Research Projects. Regional/multi-state research supported by Section 3(c)3 of the Hatch Act is appropriate for support of research when: 1) the research focuses on a specific and important problem of concern to two or more states, and 2) the research is planned and conducted as a concerted effort in which the participating scientists are mutually responsible for accomplishing the objectives. Multi-State (Regional) Research Projects Outlines in which the University of Idaho participates are subject to peer review and approval as stated in the policy manual of Western Association Agricultural Experiment Station Directors (WAAESD) or those of the other SAES Regions if the multi-state project originated outside of the Western Region.

WAAESD delegates responsibility for review of Western Coordinating Committees (WCC's) to the Regional Coordination and Implementation Committee (RCIC). The purpose of WCC activities is to bring research and extension (and to a limited extent academic) faculty together to coordinate related research without the need for a formal Multi-State Research Project outlines. WCC's have the authority to organize technical conferences, work groups, task forces and symposia.

In the Western Region, Multi-State (Regional) Research Fund projects must be reviewed by a maximum of four outside peer reviewers in addition to the Research Coordination and Implementation Committee (RCIC) which is appointed by the WAAESD in cooperation with the Western Extension Directors and Western Academic Program Directors. RCIC reviews the proposal and makes a recommendation to the WAAESD. If the proposal is approved, WAAESD Chair with assistance from the WAAESD Executive Director's Office transmits the project to CSREES. The RCIC also appoints Administrative Advisors to guide and administer projects and committees.

In summary, the procedures for scientific peer review employed for all IAES research projects, which have been in place for more than a decade (coupled with those of WAAESD for official Multi-State Research projects), more than comply with the peer review requirements specified in the Agricultural Research, Extension, and Education Reform Act (AREERA) of 1998.

The University of Idaho is a relatively small Land-Grant institution and one whose location is relatively remote. In this context, faculty at the university have been very active in multi-state programming for a number of years as a means of interfacing with other colleagues in specialty areas of their disciplines and building the critical professional mass needed to be competitive in research programming. This is especially true of research faculty affiliated with the Idaho Agricultural Experiment Station and is reflected in our current participation in formal Multi-State (Regional) Research Projects, Western Region Coordinating Committees, and the less structured multi-state and multi-discipline collaborations that are imbedded in the majority of IAES Hatch research projects. The IAES's current Multi-State (Regional) Research Project portfolio involves participation of 23 IAES faculty in 21 different approved Multi-State Research Projects. Of these, 14 projects originate in the Western Region, four in the North Central Region, two in the Southern Region, and one in the North East Region. In virtually all cases, IAES faculty participation in the multi-state research program has provided benefit to the IAES and to the citizens of Idaho as well as to the multi-state project and Nation in terms of productivity and providing research capacity that otherwise would not be possible. Currently,

the IAES is spending over 27% of its Federal Hatch formula funds ($589,420) in support of these Multi-State Research Projects plus $462,897 in state funds. The following figures detail the IAES resource allocation to multi-state activities:

Multi-state Summary of Resources* Allocated by Federal REE Goal

Goal	SY	PY/TY	Amount
1	**5.75**	**5.66**	**577,468**
2	**.45**	**.75**	**81,757**
3	**.14**	**0.00**	**13,357**
4	**0.00**	**0.00**	**150,822**
5	**2.40**	**0.00**	**104,822**
Total	**8.74**	**6.41**	**928,226**

*** Includes federal appropriation of $589,420 and state dollars of $462,897.**

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Summarized Multistate Research Project Impacts

During 2003, IAES researchers actively participated in multi-state research projects. The following is the reported impacts/successes for fourteen projects on which our investigators have been very active.

W-1122: Beneficial and Adverse Effects of Natural Bioactive Chemicals on Human Health and Safety

IAES research focuses on the dietary effect of a novel analogue of vitamin E, d-α-tocopheryl succinate, on colon cancer in young and old rats. Old rats were protected from colon cancer induction but younger rats were not. This is the first study to show that dietary administration of this vitamin E compound was effective in reducing cancer and that residues of the succinate analogue were present in a number of tissues. The residues were greater in older rats, as were levels of other vitamin E forms, which may be due to the higher body fat content which will retain this fat soluble vitamin. In addition, the bioactive chemical profile was characterized in 9 different species of western Vaccinium berries (blueberries, cranberries and huckleberries). Comparisons were between levels of anthocyanins, phenolic acids, catechins, flavanols and flavanoids and antioxidant capacity. Berries with the highest content of different classes of bioactive chemicals are currently being tested for their bioavailability and capacity to prevent or treat colon cancer in a rodent model.

W-192: Rural Communities and Public Lands in the West: Impacts and Alternatives

IAES faculty has worked jointly with researchers and extension personnel from other western states to develop ranch-level and regional economic modeling protocols. Ranch-level economic models (multi-period dynamic programming models) were developed and tested in Idaho, Oregon, Nevada, Wyoming and New Mexico. Regional economic models were also developed and tested in specific counties in these states. Social assessment protocols were

designed and only applied in Idaho, due to the lack of sociological personnel in the other states. Idaho economic models and social assessments were used to provide an analysis of public land policy alternatives in Owyhee County for county officials and the Bureau of Land Management. These same models were used with others in Oregon and Nevada to provide an analysis of ranch-level impacts of alternative sage grouse management strategies. Their contributions resulted in four publications.

W-112: Reproductive Performance in Domestic Ruminants

The University of Idaho's participation in this project has focused on understanding the regulation and function of the uterine Mx genes. The gene product is being incorporated into an early pregnancy assay that could provide an avenue to address early embryonic losses in animal agriculture. Additional research results from this project provide evidence for steroid hormone regulation of uterine antiviral defense. This work could lead to the development of more effective strategies to block or treat sexually transmitted viral diseases.

In a complimentary project by another Idaho investigator, respiratory tract organisms were identified in a test herd of beef calves. Although typical respiratory microorganisms were recovered, unexpectedly mycoplasmas and Pasteurella trehalosi were isolated from many of the test animals. Both microorganisms are potential pathogens and ongoing studies will define their significance toward reproductive performance and whether vaccine development or management changes are needed.

W-1147: Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture

Idaho's contribution to this multi-state research project was provided by an investigator with an interest in reducing dependence on chemical pesticides and in developing biodegradable microbial pesticides, specific microbial pesticides, and innovative approaches to improve soil quality and enhance agricultural sustainability. One project developed the use of a bacterium, Pseudomonas corrugata, as a biological seed treatment for fungal root disease management on legumes. Use of this technology increased yields of legumes by as much as 45%. A second project used two genera of mushrooms, Ganoderma lucidium and Laetiporus sulphureus, to obtain bioactive metabolites that function as plant growth hormones with bactericidal, fungicidal and heliminthicidal activities. Naturally produced, these may be novel compounds that may have agricultural applications.

S-295: Enhancing Food Safety through Control of Food-Borne Disease Agents

IAES food scientists roles on this project center around evaluating the use of various engineering models for predicting the lethality of food-borne pathogens during nonisothermal processing of ground beef, turkey or pork. In 2003, they reported their studies on undercooked meat, a frequent cause of E. coli 0157:H7 infection. Requirements for the processing of meat and poultry products, in Title 9 Code of Federal Regulations, include a lethality performance standard based on destruction of Salmonella (USDA-FSIS, 2002). Successful completion of this study will yield a computer model that can be used to compare the effect of different nonisothermal temperature histories on microbial destruction. Processors could use these models to determine the efficacy of a new/modified thermal process. A better understanding of microbial lethality and better process control will ultimately lead to a safer food supply, fewer illnesses and deaths, and reduce economic losses to the food industry.

W-188: Characterization of Flow and Transport Processes in Soils at Different Scales

During 2003, an IAES soil scientist was primary focused on objective 2 of this multi-state project, the development and evaluation of methods for analysis for characterization of flow and transport at different scales. Much of Idaho's work was done in collaboration with the University of Connecticut. After development of a geometrical pore space evolution model linked to hydration state , and introduction of hydrostatic and hydrodynamic considerations to model liquid retention, hydraulic conductivity, and swelling behavior of clay soils they conducted a comprehensive experiment series to evaluate effects of clay type, clay content, solution chemistry and solution concentration on swelling behavior and hydraulic properties. They employed a latest technology flexible wall permeameter and volume change apparatus to measure hydraulic conductivity and swelling properties of bentonite-sand mixtures. They used solutions varying in molarity and ion valence to investigate the effects of solution concentration and type. The measurements were used to refine their pore-scale model, and to develop a statistical upscaling scheme to predict sample-scale hydraulic behavior. In this context they began taking measurements at the new Washington State University Computed Tomography facility to resolve and introduce anisotropic hydraulic behavior. In other related activities, our researchers continued to work on flow phenomena in structured soils that led to a refereed publication in Advances in Water Resources, and conducted KC135 flight experiments in Houston, TX to investigate liquid behavior in porous plant growth media under microgravity. The flight experimental data are used in combination with physically based models to design root modules and growth chambers suitable to support plant growth at the International Space Station and for other space exploration. This work led to six refereed publications.

NC-136: Genetic Manipulation of Sweet Corn Quality and Stress Resistance

An IAES researcher at the Southwest Idaho Research and Extension Center conducted a study of 12 seed treatments on two supersweet corn genotypes. This information will help the seed companies and sweet corn growers choose treatments which ensure high and uniform stands of sweet corn in the field. His study was conducted a multiple locations including 16 sites in the U.S. and one in Japan and identified several effective seed treatment mixtures that provided high field performance.

W-006: Plant Genetic Research Conservation and Utilization

Research programs have assisted in evaluation of germplasm for biotic resistance/tolerance, abiotic tolerance and end-use quality in several crop species (beans, canola/rapeseed, mustard and wheat). The IAES representative to this multistate project evaluates wheat germplasm for desired traits. He is also involved in documenting use of wheat germplasm by public and private programs/companies and individuals. In 2003, Idaho research contributed to the report on the use of accessions from the national plant germplasm system by public programs and private individuals/companies.

W-128: Microirrigation Technologies for Protection of Natural Resources and Optimum Production

An Idaho researcher from the Twin Falls Research and Extension Center participated actively in research directly related to this project. His role has been to focus on evaluation of soil moisture sensing equipment and to determine how to effectively use sensors and data loggers in irrigation scheduling. He has made research presentations to alfalfa growers in Oregon,

Washington and Wyoming regarding scheduling irrigation and managing irrigation systems for optimum yield and quality.

W-150: Genetic Improvement of Beans (*Phaseolus vulgaris L.*) for Yield, Pest Resistance and Food Value

Idaho participated in the Western Regional Bean Trial and the National Cooperative Dry Bean Nursery. Each had approximately 30 entries evaluated in a replicated trial for yield, maturity, and seed weight. Also, we participated in the development and release of the first anthracnose resistant pinto bean germplasm line, USPT-ANT-1 with USDA-ARS and Michigan State University researchers. One of our investigators on the project was the Vice-Chair in 2003 and is currently the Chair of the W-150 multistate project. He is also coordinating the preparation of the project proposal for the next five years.

NC-2003: Impact Analysis and Decision Strategies for Agricultural Research

An Idaho agricultural economist contributes extensively to this committee. During 2003, he reported his investigation of the impact of public investments in biotechnology research. He has found that the economic and environmental impacts of using brassicaceae plant tissues as green manure to control nematodes in the production of potatoes and sugarbeets are extensive. For example, the gross annual benefit to Idaho sugarbeet producers is estimated at $13.9 million per year and potato producers at $18.5 million. In addition, the annual reduction in active toxic material on potato fields by eliminating the use of Tellone-II and Metam Sodium are estimated at over 5.5 million pounds. This investigator also estimated that organic nitrogen released from the brassicaceae tissue will reduce nitrogen use on potatoes by about 50 percent and on sugarbeets by about 92 percent and significantly reduce nitrate leaches.

An Idaho researcher on the committee also reported the impact of public investment in genetically modified food to developing countries. For this study, he used a genetically modified (GM) potato that is resistant to the potato tuber moth was developed in the United States for use in Egypt and South Africa. The adoption of the GM potato will increase potato productivity in Egypt by over 73 million pounds annually and South Africa by over 282 million pounds annually. Total annual benefit to Egyptian farming is in excess of $15.3 million annually and to South African farmers is in excess of $28.3 million annually.

W-167: Family and Work Identities During Times of Transitions

Our representative to this project focused on single parent families and identity issues. During 2003, she shared her research data with Extension professionals developing an Idaho version of the poverty simulation. One graduate student finished a thesis entitled, “Families in Transition: Work and Family Identities of Working Women”.

W-181: Modifying Milk Fat Composition for Enhanced Manufacturing Qualities and Consumer Acceptability

An IAES animal scientist contributes extensively to this committee’s research goals through independent and collaborative projects. His research is focused toward improving quality and marketability of dairy products. Most recently, he reported his work to evaluate the activity of the delta-9 desaturase enzyme in lactating cows. Stably-labeled fatty acids (myristic, palmitic and stearic acid) were infused abomasally and incorporation into milk fatty acids was

determined. All three fatty acids were desaturated by the enzyme. He is currently conducting the kinetic analysis of these experiments.

NC-136: Improvement of Thermal Alternative Processes for Foods

The Idaho station is conducting research under NC-136's Objectives C ("To identify and describe transport mechanisms occurring in food products") and D ("To develop mathematical models for analysis, design and improvement of food processes"). Idaho is involved in using multiscale hybrid mixture theory of porous media to model moisture transport and thermomechanical processes such as drying and sorption. Recently, we developed a generalized fluid transport equation that predicts that fluid transport in biopolymeric materials is Fickian in rubbery and glassy states and non-Fickian in the vicinity of glass transition. Newly designed NMR experiments for imaging moisture movement during drying of pasta validated these predictions. Solution of the fluid transport equation using computer simulations, helped to obtain insight into the involved physical mechanisms and develop optimum drying strategies, which cause minimum crack formation, greater moisture reduction and reduced energy consumption.

Multistate Extension Activities

Not applicable.

Integrated Program Activities

Long before AREEA and traditionally, the Idaho Agricultural Experiment Station (IAES) and the College of Agricultural and Life Sciences (CALS) have placed a strong emphasis on the integration of research and extension programming. This is evidenced by the fact that a large number of employees in the college have official joint research and extension responsibilities as codified in official position descriptions and combined appropriated funding from both research and extension for salaries. The IAES has 70.7 SY's distributed over approximately 110 faculty members. Of these, a total of 51 SY's representing 60 professionals are funded by a combination of research and extension appropriated resources and, accordingly, have official responsibility for both research and extension programming and the integration of these two domains of professional activity. Likewise, the IAES has a total of 143 PY's. Of this total, about 27 PY's distributed over 31 individuals are supported by both research and extension salary resources. In summary, of the 214 full-time positions in the IAES, 78 positions, in excess of 1/3 of the total professional positions, are supported by a combination of research and extension funds and have responsibility for the integration of research with extension programming. Additional integrated activities derived from stakeholder input are detailed in the next section. These are typically manifested in a number of "outreach"/technology events during the year that are primarily conceived, organized, and presented by IAES faculty. Many of the IAES faculty involved in these activities have joint research/extension appointments, but many have no formal extension appointment. As is detailed below, these integrated activities, which provide for robust stakeholder interaction, include commodity schools, field days at our twelve off-campus research centers, specific research program tours, and symposia organized around specific topics.

Stakeholder Input

Within the College of Agricultural and Life Sciences (CALS), the Idaho Agricultural Experiment Station (IAES) relies on the avenues of stakeholder input employed across the college. The IAES plan of work was derived with the input from and has been shared with a broad cross-section of stakeholders in Idaho. In brief, the major stakeholder groups providing input regarding the IAES's spectrum of research activities (as reflected in the portfolio of IAES research projects and the plan of work) include:

- The college's Agricultural Consulting Council (ACC) which was an 80 member organization composed of representatives selected by virtually every agricultural, food system, and family and consumer science organization within the state. This advisory group has traditionally been the primary stakeholder group with which the college and IAES have had significant interactions in terms of areas of program development and emphasis and, accordingly, the current plan of work. In 2001, CALS began reorganization of the Agricultural Consulting Council into a smaller more focused and dedicated group that will be know as the "Dean's Advisory Council". This new college level advisory group was instituted in 2002. Many members of the ACC have transitioned into serving on the departmental advisory committees that have been formed in all the academic departments of CALS (see below).
- Idaho Cooperative Extension has citizen advisory groups in 42 of Idaho's 44 counties. These committees, which are composed of a very diverse and broad mix of public interests, provide input regarding extension and research program priorities from the county perspective.
- Idaho's 17 agricultural commodity commissions and organizations provide advice specific to commodity based programs and appropriate disciplines and departments within the college. In addition, IAES researchers provide leadership and most of the content for several major commodity schools that are presented annually in the state. The commodity schools are well attended by stakeholders from Idaho and the region. These "schools", while primarily conducted as major outreach/technology transfer events to provide the latest research results to stakeholders, also serve as major sources of stakeholder input to IAES regarding research priorities and directions. Commodity schools are annually conducted for potato, cereal, sugar beet science and technology. As an example, the University of Idaho Potato School is a three-day event that annually attracts approximately 1,200 registrants who come from Idaho, the PNW region, virtually all other states involved in potato production as well as representatives from approximately 25-30 foreign countries.
- Beyond the commodity schools mentioned above, annually or semi-annually IAES faculty, both from campus and from out-state locations, actively organize and participate in "field days" at each of the IAES's twelve off-campus research and extension centers as well as a number of additional more focused "program" tours such as: weed identification, ecology, management and technology at several locations, potato storage research open-house, pomology program open-house and field day, and tours of the IAES's crop genetic improvement research programs for beans, potatoes, wheat, and the oilseed crops of rapeseed and mustard. Again, these stakeholder events function as

educational/technology transfer events as well as opportunities for stakeholder interaction. In addition, annually many IAES faculty are involved with organizing symposia that address special topics. In this reporting period, IAES have faculty have presented symposia on biofuels, water quality, and dairy waste and nutrient management technologies. All of these activities constitute significant opportunities for stakeholder interaction and input into our research programs concerning stakeholder needs and priorities.

- The IAES research project portfolio and an abbreviated version of the plan of work is annually shared and discussed with representative from the executive branch of state government including the Governor's Office, the Dept. of Agriculture, and to a lesser extent, the Dept. of Environmental Quality, Dept. of Health and Welfare, and the Dept. of Commerce as well as being shared/discussed with key committees and leadership of the Idaho Legislature.
- The faculty, staff, and students (both graduate and undergraduate) of the college have a vested interest in the development of appropriate research programs of high quality that are responsive to needs of the state and region. This university stakeholder group is an important source of valuable input to the IAES and play a major role in IAES program development and delivery. In the course of performing their research, the majority of researchers in the IAES have frequent and substantive contact with stakeholders in their research programs as has been indicated above. An array of inputs regarding program directions and priorities are more informally received in this manner and are subsequently considered and often implemented.

The college has expanded its involvement with stakeholders by forming advisory committees for each of the eight academic departments in CALS. As of 2002, all departments of CALS have established advisory committees. These committees (ranging between 6 to 12 members) are composed from a broad base of stakeholders sharing interest in the disciplines, programs, and strategic plans of the departments. These committees are now serving as a significant additional source of stakeholder input for the IAES and CALS. In addition, once a year in on-campus meetings the departmental advisory committees meet with the CALS and IEAS leadership as well as with the Dean's Advisory Council on program priorities and directions for the college, the experiment station and the departments.

Finally, in preparation for our next Plan of Work for both research and extension programming, the College of Agricultural and Life Sciences is currently conducting a large, random, state-wide survey of citizens/households regarding what our program priorities/areas of emphasis should be. When completed, the results of this survey, along with other inputs, will be used to help formulate our next Plan of Work for both research and extension programs.

Program Review Changes

None.

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