OREGON STATE UNIVERSITY
OREGON AGRICULTURAL EXPERIMENT STATION

Plan of Work

Annual Report of Accomplishments and Results

Oregon Agricultural Experiment Station
Oregon State University

Federal Fiscal Year 2003

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National Goal #1:

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

OVERVIEW

Oregon Agricultural Experiment Station (OAES) has 171 projects with 19 key themes under the National Goal #1 in the CRIS database. We selected 24 projects from 11 key themes to highlight in this year's report. The major selection criteria are the quantifiable outcome and impact. We provide only the summary output data in this section, and will present outcome and impact information under individual key themes below. Review comments from last year's report indicated a redundancy in reporting our outcome and impact statements. Therefore, we have decided not to present the outcome and impact statements in the overview section. Those units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. Details of the calculations used to derive the economic impact are presented to substantiate the claim.

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

- Published 203 refereed journal articles, 20 proceedings papers, and 69 abstracts.
- Made 92 presentations at national, international, and professional meetings.

ASSESSMENT:

All units in the Oregon Agricultural Experiment Station are required to conduct annual performance evaluation of their faculty members. These annual reviews are conducted based on goals established during previous year's reviews. Since all faculty members with OAES FTE are required to establish their station projects, annual performance evaluation serves a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals.

TOTAL EXPENDITURES: $18,994,819
Hatch- $1,011,881
Multistate- $507,602
State- $17,475,336

TOTAL FTE: 127.5

ACCOUNTABILITY:

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

http://oregoninvests.css.orst.edu

There are currently over 372 reports contained in the database, searchable by selected criteria. Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate.

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

Key Theme: **Agricultural Competitiveness**

ISSUE OR PROBLEM

Several commercial oyster hatcheries used MBP broodstock in 2003 to produce large numbers (millions) of spat for the West Coast industry and foreign markets. The **Coastal Oregon Marine Experiment Station** has determined that if a 9.5% improvement in yield was obtained for all oysters planted by the West Coast oyster industry, this would result in an increase in production valued at $6.5 million, assuming that the total annual harvest is valued at $68 million. The U.S. West Coast oyster production has an annual dockside value of $68 million.

Impact

Research that the **Coastal Oregon Marine Experiment Station** has established that faster-growing oysters from selected broodstock could increase this return by 10%, or $6.8 million/year. In Oregon where oyster production is worth about $1 million/year, such an increase would bring in another $100,000/year in revenue. And this genetic improvement is likely to be cumulative over generations, resulting in increased production value year after year. Product quality could also improve, i.e., better tasting, better appearing oysters. Faster-growing oysters will mean more rapid production cycles, and, in turn, better economic use of grounds and other facilities. And with shorter production cycles, production costs would decrease. Also, as a result of the oyster broodstock project, oyster exports to Asia and shipments to the U.S. East Coast may increase, benefiting Oregon's economy. On another project, microencapsulated diets promise to substantially reduce costs for growers of various marine fish, crustaceans (shrimp and prawn), and all bivalves (oysters and clams).

SCOPE OF IMPACT - State, national, and international

SOURCE OF FUNDING - Hatch, State funds, Smith-Lever, Specific Cooperative Agreement between Oregon State University and U.S.D.A.-Agricultural Research Service, Commodity funds, OSU Foundation

Key Theme: **Animal Health**

ISSUE OR PROBLEM

Veterinary Medicine has found that alkaloids in endophytes are the number one plant-associated toxins in the U.S.; they are responsible for over $860 million in annual losses to the beef cattle industry. The Oregon Ag-Fiber Association also ships over 500 million tons of tall fescue and perennial ryegrass straw overseas as livestock feed which represents a $60 million industry in Oregon and a $350 billion industry in the western U.S. Pyrrolizidine alkaloids in the common weed tansy ragwort (Senecio jacobaea) are responsible for $20 million in economic damage to livestock in the Pacific Northwest alone.

The human food supply demands that all foods be wholesome and free of environmental toxic chemicals. In poultry, the presence of selected environmental toxic chemicals known as dioxin and polychlorinated hydrocarbons have been reported to induce the formation of fluid-filled sacs in developing chick embryos. A line of chickens developed by the Department of **Animal Sciences** was observed with these lesions. The objective of this project was an attempt to determine the cause of this abnormality in developing chicken embryos. Working with a group of scientists at the Oregon Agricultural Experiment Station, the cause for this lesion was determined to be the result of gene expression. Evaluations of the feeds fed to the birds and the eggs produced did not contain any of many known toxic chemicals.

The Department of **Microbiology** has determined that infectious hematopoietic necrosis virus (IHNV) is a serious pathogen that can cause losses as high as 90% in trout farms and hatcheries. Outbreaks usually require the complete destruction of all fish in a hatchery in order to control the spread of the virus. In the Columbia River Basin IHNV has caused the destruction of an estimated 300 million fish since 1985, not counting the mortalities in private rainbow trout farms on the Columbia River tributaries.

IMPACT

Veterinary Medicine believes that the right anaerobic ruminal microbes will degrade the nitrogenous-ring toxic endophyte and pyrrolizidine alkaloid molecules after they are diffused out of the plant fiber and before they penetrate the rumen wall to go systemic. This will prevent livestock toxicosis from the ingestion of tansy ragwort and endophyte- infected grasses. Further, rumen microbial degradation of the nitrogenous ring structure of TNT may make it possible to detoxify soil environments contaminated with munitions; this is an agricultural solution to a $30 billion clean-up problem.

The results of this **Animal Sciences** research indicates that changes in normal genes found in a healthy bird can produce lesions similar to those if a toxic chemical was present. The findings provide the scientist with information as to what genes a toxic chemical may be attracted to. An estimated 11% of birds possess a lethal gene(s) preventing some eggs from

hatching. Assuming that 11% of the 72,000 breeder hens in Oregon possess this mutant gene and that each hen loses 16 chicks/year to the mutation at a value of 35¢/chick or $5.60/year/hen, then if this research is successful, producers will be able to determine which breeder hens possess the mutant gene and remove these carriers from their stock. Some eggs that previously would not hatch because of gene mutation will no longer be present; in their place will be good eggs. Also no longer present will be eggs produced by hens with the deleterious genes that express the condition, not in the first, but in subsequent generations. Therefore, in Oregon, benefits of application amount to at least (11% x 72,000 hens x $5.60/hen) $44,000/year, as producers recapture revenues lost from unhatched eggs. Of course, these estimated Oregon savings represent only a minute portion of the amount that chicken breeders will benefit worldwide. Benefits from this aspect of the research began in the late 1990s. In the course of this study, other unrelated genetic disorders that result in embryo deaths have been identified. With their elucidations, primary poultry breeders can improve genetic breeding stocks for both egg- and meat-type chickens. Improvements result in increased numbers of incubated eggs that hatch and can be sold, increasing the estimated benefits from the project to, perhaps, $500,000/year.

A very effective DNA vaccine against IHNV has been developed, but since it must be administered by injection of individual fish, its use in hatcheries and trout farms is limited. The Department of **Microbiology's** efforts to develop baculoviruses for immersion or oral delivery of DNA vaccines to fish could have a significant impact on hatcheries, the trout farm industry, and on consumers. To get an idea of the potential economic benefits, consider that U.S. trout farmers produced $65.2 million worth of trout in 2002. Total losses of all trout intended for sale were 35.0 million fish with 83% of the loss due to disease (mostly viral infections). If commercially viable vaccines were to become available, a high percentage of the 35 million fish now lost might be salvageable.

SCOPE OF IMPACT - National and international

SOURCE OF FUNDING - Hatch

Key Theme: **Animal Production Efficiency**

ISSUE OR PROBLEM

The Department of **Animal Sciences** has found that sheep are excellent tools for harvesting forage, whether winter growth on saturated grass seed fields or invading weed species in forests, and marketing it as high quality meat and wool. However, Oregon's sheep numbers are declining due to several factors including marginal industry profitability. Increasing reproductive efficiency is the surest means of making U.S. lamb competitive with imported lamb.

Jersey cattle will be used as a model in an **Animal Sciences** study to determine factors that control feed intake prior to parturition. Identification of these unknown factors will lead to development of feeding strategies to minimize the depression in feed intake of Holstein cattle commonly observed near parturition. The benefit to the dairy industry will be improved animal health and productivity in the subsequent lactation.

IMPACT

It is anticipated that results of this **Animal Sciences** study will show producers how to increase productivity by 10% or more without significant change in production costs or management practices. The 2002 Oregon ewe population (190,000 head) grazes about 250,000 acres of permanent pasture, while the 60,000 lambs finished each year in the Willamette Valley graze another 40,000 acres of grass seed fields. The breeding and management changes being studied are applicable to about 60% of Oregon's ewes. The current average number of lambs marketed is 1.1 per ewe. Incorporation of East Friesian breeding is expected to increase that figure by .25 lambs/ewe for a potential increase of over 25,000 lambs produced annually. At a market value of $80/lamb, the gross return to the Oregon sheep industry could be increased by as much as $2 million/year. While raising more prolific sheep requires more management skills, it does not greatly increase costs of the ewe flock to weaning. And in addition to producers having more lambs to market, carcasses should increase in value due to their heavier weight. Meanwhile heavier carcasses should mean that processing, transporting, and marketing costs will decline on a cost/pound-sold basis. So, when the research is applied by Oregon producers, their net benefits should amount to at least $2 million/year. Note that contrary to the national trend, Oregon's sheep numbers have been on the increase, and increased ewe productivity will support that growth.

The Department of **Animal Sciences** research has determined the economic impact of preventing feed intake depression in late gestation through niacin supplementation is not known, but is under investigation. The additional cost associated with supplementing niacin during the last three weeks of gestation is $10 ($0.48 per cow per day). The benefit is increased feed intake after parturition and improved energy balance. Were the pronounced decline in Holstein cows' feed intake prior to parturition prevented, cow health and early lactation would improve significantly. In 2000, Oregon's 88,505 head of dairy cows produced an average of 193 cwt/head, sold at $13.12/cwt. As an estimate of potential economic benefits, consider that this early lactation improves yield by, say, 5 cwt/head for half the state's herd, then benefits would amount to [5 cwt x (88,505/2) x $13.12/cwt] = $2.9 million/year.

SCOPE OF IMPACT - National, and international

SOURCE OF FUNDING – Hatch, State funds

Key Theme: **Aquaculture**

ISSUE OR PROBLEM

The **Coastal Oregon Marine Experiment Station** believes the management of fishery subjects is often limited by insufficient identification and statistical power for identification of independent stocks. Emerging techniques in molecular genetics and statistics hold great promise to allow more refined stock discrimination allowing more effective management of fisheries and protection of endangered species.

IMPACT

The impact of the **Coastal Oregon Marine Experiment Station** research has substantial financial and political consequences. For example, altering fresh water pumping strategies to

southern California in response to our individual-based identification of endangered salmon species, can result in loss or gain of water worth several million dollars a day. Likewise closing, opening or redirecting ocean fisheries in response to individual based stock identification for harvest has resulted in management changes of fisheries resources worth several hundred thousand dollars. The political and financial worth of applications of our findings will only increase as we better resolve stocks and life history discrimination in Oregon and neighboring states and gain better hatchery and wild discrimination. Our research also has direct application and relevance to the long-term viability of Oregon and West Coast fisheries in general with obvious linkages to the Oregon Plan and NOAA Fisheries Recovery Plans. Better life history and breeding unit description among groundfish stocks is critical to the success of rebuilding plans. Likewise, native oyster restoration with improved water quality and rearing habitat for juvenile salmon and groundfish, has significant implications for coastal ecosystems and their economies.

SCOPE OF IMPACT - Alaska, Washington and Oregon

SOURCE OF FUNDING – Hatch, State funds

Key Theme: **Biotechnology**

ISSUE OR PROBLEM

Research in the **Health and Human Science** Department has found that current chemical or mechanical disinfestation methods used on cotton textiles are either inefficient in killing the microorganisms and their spores or unsafe to the materials, user, and the environment. This research explores the possibilities of using environmentally clean techniques such as ultraviolet and infrared radiations for cotton textile decontamination where the growth of mildew would be especially problematic.

IMPACT

The results achieved by the **Health and Human Science** research will greatly benefit the museums around the world, textile conservation centers, art gallery, and even cotton industry because the techniques used are non-chemical, and non-destructive, convenient and safe.

SCOPE OF IMPACT - National and international

SOURCE OF FUNDING – Hatch, State funds, National Institutes of Health, The National Science Foundation, Fulbright grant, USDA Special Grant, Commodity groups

Key Theme: **Diversified/Alternative Agriculture**

ISSUE OR PROBLEM

The Department of **Rangeland Resources** have determined that integrating productive pastures and tree plantations on Pacific Northwest hill lands provides the basis for more financially and ecologically stable production systems. The combination of long-term tree income with the shorter-term income from livestock or hay sales increases farm income and reduces risk. Biomasss production of silvopastures is approximately 50% greater than forests or pastures alone. Evergreen trees with pastures, ties soil to hill sides and maintains a protective

surface grass sod that reduces soil loss and maintains nitrogen and other nutrients on site where they contribute to future plant production rather than become off-site pollutants. Joint forage/tree production on hill-lands maintains pasture production equivalent to open pasture during the first five years, then tapers off gradually until about 20 years after tree planting.

IMPACT

The Department of **Rangeland Resources** believe most benefits from agroforestry are to the timber industry in the future, but some immediate benefits can be claimed by Oregon agricultural producers on about 1,000 acres of Willamette Valley hill land: Weed suppression by sheep is saving $75-100/acre in herbicide cost ($87.50 x 1,000 acres) = $87,500. There is also considerable value to the sheep industry in having additional good grazing area. And feed costs are lower, as livestock gain more weight under the trees protection from summer heat and winter rain and cold. These factors add substantially to the immediate benefit. Another benefit to Oregon farmers is the possibility of trading of carbon credits. Although trading of carbon credits is still in its infancy, estimates of carbon sequestration credit value range from $23/ metric ton (U.S. government) to a high of $4,000/ ton currently being paid in Norway. Carbon credit sales from Oregon's agroforests could, therefore, increase farm income by $14-$240/hectare/year (or, $5.66-$97/acre). Were those 1,000 acres of Willamette Valley hill land to trade carbon credits, these farmers could earn an additional, say, $50/acre (1,000 acres x $50) = $50,000/year. All these possible and actual benefits could amount to at least $1 million/year to Oregon woodland/sheep farmers. Meanwhile, more major benefits will accrue to the timber industry including: Pruning trees planted in rows or clusters ($230-$460/acre, six to eight times during the first 40 years of a 60-65 year rotation) will produce clear wood four times more valuable than unpruned second-growth logs. KMX hybrid pines show promise to cut the rotation length from the 65 now required for Douglas-fir plantations to 25-30 years, thus doubling income from timber production. Early returns from grazing increase the internal rate of return from KMX agroforests to 29% (not including land value) compared to KMX forestry plantations at 19%. Both KMX and pruned Douglas-fir should displace imported radiata pine logs, while high quality logs from agroforestry may expand log and milled clear timber exports.

SCOPE OF IMPACT –National

SOURCE OF FUNDING – Hatch, State funds

Key Theme: **Plant Genomics**

ISSUE OR PROBLEM

The Department of **Crop and Soil Science** determined the Oregon potato industry generates more than $350 million annually after processing. Current varieties leave much to be desired. Most are highly susceptible to viruses, late blight and other diseases and have various weaknesses affecting their utility for processing and/or fresh market use.

The Pacific Northwest is blessed with abundant natural resources. Soil and water are two fundamental resources that must be conserved and fairly apportioned, respectively. The Department of **Crop and Soil Science** believe their new barley varieties with greater cold tolerance will be able to survive the winter, provide better ground cover and thus reduce soil

erosion. In addition to soil and water quality issues, we are also addressing water apportionment issues by development of varieties that will require less irrigation. Crop diseases can be catastrophic to farmers and unhealthy for consumers. By developing barley varieties with durable broad spectrum resistance we will be able to reduce chemical use and stabilize productivity and quality.

IMPACT

The Department of **Crop and Soil Science** implements potato breeding and new varieties offer dramatic increases in disease and pest resistance as well as improved yields and quality; these improvements translate directly into improved profits for Oregon growers and processors. Wallowa Russet, for example, outyields (U.S. No. 1 basis) the leading variety, Russet Burbank, by more than 140 cwt/acre (approximately 51%) under production regimes highly favorable to Russet Burbank (see http://oregonstate.edu/potatoes/AO87277-6.pdf). Wallowa also processes better than Russet Burbank and is much more resistant to dark-end fries. Russet Burbank dark-end fries almost devastated the Treasure Valley industry in the early 1990's causing a 50% reduction in local acreage. Each of the new varieties listed above produces higher yields and better quality than current varieties under typical Oregon production regimes. Each therefore improves grower and processor income and improves the competitive status of the Oregon industry.

Efforts by researchers in the Department of **Crop and Soil Science** to characterize and use genetic resources are intended to guarantee the safety and security of agriculture, which depends on genetic diversity. Barley, the oldest crop, still has a lot to offer. Building quality, disease resistance, and winter hardiness into barley increases profitability and reduces risk. Varieties meeting domestic or export malting or food quality specifications could be worth at least 20% more than standard feed varieties (i.e., 40¢/bu). Assuming that varieties with superior quality yield about the same as standard varieties and are planted on 20,000 of Oregon's 124,200 acres of barley (using the 1997-2001 average acreage, as well as price and yield), then growers of superior barley earn 20% (40¢/bu x 57.4 bu/acre x 20,000 acres) = almost $500,000/year additional. In terms of disease resistance, fungicide control of stripe rust costs an average of $25.00 per acre. On average, 30,000 acres of Oregon barley production could be considered at risk to barley stripe rust. The production of stripe rust-resistant varieties on these acres would save Oregon growers (30,000 acres x $25/acre) = $750,000 per year. Another savings is that winter barley offers risk management alternatives to growers who also produce winter wheat, because barley matures up to two weeks earlier than wheat. This maturity also allows for more efficient use of equipment at peak times of the year. Finally, the fact that there are currently no genetically modified varieties of barley grown commercially the United States puts Oregon barley producers in an enhanced competitive position to export certified GMO-free barley to Asian markets. Thus, total annual net benefits to Oregon growers easily amount to over $1 million/year.

SCOPE OF IMPACT - National and international

SOURCE OF FUNDING – Hatch, State funds, National Institutes of Health, The National Science Foundation, Fulbright grant, USDA Special Grant, Competitive national and regional grants, and Commodity groups

Key Theme: **Plant Germplasm**

ISSUE OR PROBLEM

Head smut is an important disease of sweet corn grown in the Pacific Northwest. The Department of **Horticulture** provides a head smut screening nursery for sweet corn breeding programs to evaluate their materials. Root rot of sweet corn in western Oregon is causing increasing economic damage, and has caused >50% yield losses. Horticulture researchers screen commercial hybrids for growers and vegetable processors to identify sweet corn hybrids that are better able to withstand diseases that occur in the Pacific Northwest.

IMPACT

Horticulture researchers consider sweet corn is a 'keystone' crop for vegetable production in western Oregon because of its acreage and use in rotations. If its production were to decline, we would likely see a decline in all vegetable production in the Willamette Valley. Low yields caused by sweet corn decline have made sweet corn production unprofitable for growers and reduced the quality of ears coming into the processing plant. Root rot trials assist in identifying high yielding, root rot tolerant hybrids. Willamette Valley sweet corn production area was down to 27,470 acres in 2001, from 31,330 acres in 2000, 43,390 acres in 1999; corresponding sales values were $17 million in 2001, $21 million in 2000, and $29 million in 1999. When vegetable growers reduce acreage in sweet corn, they grow some other vegetable instead, but, nevertheless, restoring this valuable crop to their mix could net them several million dollars a year.

SCOPE OF IMPACT - Regional and international

SOURCE OF FUNDING – Hatch, State funds, USDA CSREES**,** Commodity groups

Key Theme: **Plant Health**

ISSUE OR PROBLEM

Alien weeds pose some of the most serious threats to agriculture and to biological diversity, and many are amenable to biological control using insects and pathogens. The purpose of the Department of **Botany and Plant Pathology's** proposed work is to develop safe and effective biological controls for harmful non-indigenous plant species in the Pacific Northwest.

The Department of **Botany and Plant Pathology's** Field experiments with wheat stripe rust will be conducted to determine if epidemics spread at a constant or in an increasing manner in time and space, and how rates of disease spread are impacted by disease management practices (such as use of cultivar mixtures) in small experimental field plots versus larger-scale commercial production.

White rot disease, a fungus which permanently infests field soil, threatens to eliminate both garlic seed and onion seed production within this region within 10 years as it becomes more widespread in the region. This situation is repeated in other areas of Oregon, the Western U.S. and the world. The purpose of this **Central Oregon Agricultural Research Center** project is to learn how to control and/or eliminate white rot disease on Allium crops, such that infested fields may be replanted to Allium crops without fear of uneconomical losses.

IMPACT

Biological control of ragwort has yielded an estimated $6 million plus of economic benefits to Oregon farmers/ranchers that have been passed through to consumers of beef, dairy, mint, honey, grass seed, and other products in the form of lower prices. However, this is just one of many success stories. The work of the **Botany and Plant Pathology** lab is ongoing, tackling noxious weed control statewide. Currently, some 31 Oregon weeds are being researched; one program is against an invader of wetlands, purple loosestrife; another is a threat to dryland crops and rangeland, rush skeletonweed. So, assuming that at least half of the benefits calculated for controlling ragwort at its peak can be attributed to our research, then annual benefits to Oregon growers and livestock producers amount to $3 million/year. Other social benefits related to improved wildlife habitat and the conservation of native biodiversity. Both social and economic benefits arise from controlling noxious weeds invading wetlands. Wetlands provide important ecological and societal services (e.g. maintaining biodiversity, improving water quality, preventing or mitigating floods). These services are imperiled by direct loss and modification of wetland structure and function caused by urban development, invasion by non-indigenous species, and regulatory practices that permit mitigation to compensate for wetland loss. One example of economic benefits from successful biological weed control: In 1976, at the height of ragwort's infestation in western Oregon, about 2% of the cattle and horses were poisoned with a total value of roughly $3.7 million, forage losses from unimproved pasture and improved dry and irrigated pastures totaled $1.27 million, and crop losses in grass seed and mint amounted to (at an average of $500/acre) $600,000, for a total loss of $5.6 million. Biological control of ragwort has restored these estimated losses to western Oregon and has reduced farmers' herbicide costs against ragwort by another $850,000.

Results of the **Botany and Plant Pathology** research suggest that control of many plant diseases may be greater in commercial production than in small-scale experimental plots. Further, disease control may increase as a control practice is deployed over increasing area. In the 2000-2001 winter wheat season, 14.8% of the common soft white winter wheat area in Oregon was sown to variety mixtures, a total of 103,000 acres. Without this technology (i.e., using variety mixtures), all of this acreage would have been planted in a single variety, thus more vulnerable to production stresses. Six site years of on-farm trials under highly stressful conditions showed an average yield increase of 5.8%. Using a more conservative average of a 3% yield increase, an additional 183,855 bu of wheat were produced. [The average yield in the area was 59.5 bu/acre in 2001 (3% x 59.5 bu/acre x 103,000 acres)]. At the average 2001 price of $2.63/bu, this represents an increased farm gate value of $483,538. There is no increase in input cost, so the net benefit estimate is almost $500,000/year. As more area adopts the technology (as is already happening in state and beyond), the benefit should, at least, double.

Research on white rot disease at the **Central Oregon Agricultural Research Center** may provide fungicide and/or novel and non-toxic soil disinfestation tools so that white rot infested land may be replanted without disastrous crop loss. High risk of such losses currently prevents previously infested land from being replanted. In Central Oregon, perhaps 100 or more fields of onion and garlic seed have become infested. Without successful treatment, it is likely that the seed industry would leave the area entirely. The value of this research to Central Oregon garlic and onion seed production is about 2,500 acres of garlic are under contract, yielding an average of 16,000/lbs/acre at 15¢/lb for a gross of $2,400/acre or $5.76 million/year. Some 600 acres produce onion seed worth some $4,800/acre or $2.8 million. By keeping these growers in such

high value crops, this research continues to be worth a few million/year to them and their contractors.

SCOPE OF IMPACT - Pacific Northwest and National

SOURCE OF FUNDING – Hatch, State funds, National Institutes of Health, The National Science Foundation, Fulbright grant, USDA Special Grant, and Industry grant

Key Theme: **Plant Production Efficiency**

ISSUE OR PROBLEM

Growers and packers can manage post-harvest decay in pears more effectively by implementing multiple tactics throughout the production system. This **Southern Oregon Research and Extension Center** project identified tactics for integration into decay management programs.

Wheat is Oregon's major cereal crop with annual production averaging (1997-2001) 48 million bushels/year with a gross farm-gate value of $145 million. Department of **Crop and Soil Sciences** is working to develop new varieties with improved grain yield, disease resistance, end-use quality, and novel traits, such as herbicide tolerance to improve the economic returns to Oregon growers.

The **Columbia Basin Agricultural Research Center** is working on the development of resistance management strategies for downy brome control in direct-seeded winter wheat cropping systems.

Malheur Experiment Station researchers believe onion, potato and sugar beet producers lack herbicides to effectively control weeds. Weeds escaping control compete with the crops and reduce yields. Increased labor cost and reduced worker availability limit the opportunity to control weeds by hand. In 2002, an emergency exemption for dimethenamid-p use in sugar beet was granted and is estimated to provide producers a $23 million benefit from improved weed control and improved crop yields. A full registration for dimethenamid-p is expected for use in onion, potato, and sugar beet in 2005.

Researchers at the **Mid-Columbia Agricultural Research and Extension Center** worked to increase efficiency in farming operations and greater safety for farm workers.

Researchers at the **Klamath Experiment Station** believe improved potato varieties and management practices are needed for the Pacific Northwest industry which produces over 60 percent of U.S. potato crops. This project compliments extensive multi-state efforts to develop new superior potato varieties and improve cultural management and disease and pest control practices.

IMPACT

Southern Oregon Research and Extension Center researchers have developed and are continuing to develop diverse techniques that additively reduce post-harvest fungal decay. Improvements have been gradual since 1985, but are constantly gaining as new techniques are found. Results thus far are being rapidly adopted in the Rogue Valley and in other pear-growing regions in the state. Oregon winter pear production in 1999 was 160,000 tons worth over $75 million (in the Rogue Valley area, $24 million). Benefits from the research will be in reduced losses from 5%-10%, of the crop would otherwise be lost to rot; thus saving 7.5% of the state's

winter pear crop amounts to $5.6 million/year in increased revenue. The estimated cost of control is 5¢/45-lb box x 7 million 45-lb boxes = $355,555. Bio-control costs will probably be offset by reduced fungicide costs. Substantially lower packing costs occur because of less repacking needed to eliminate rotten fruit. If methods adopted from this research project save one-third of the potential losses, estimated benefits amount to $1.5 million/year. Benefits will increase in the future as new techniques are developed and used on a higher percentage of the pears that now rot in storage. Lower incidence of fruit decay will lead to a better quality, higher-priced, lower-unit-cost product, strengthening the bargaining position of sellers (the farm price could increase by 3-4¢/lb). Also, exports could increase when bio-control agents are adopted, particularly to those countries not now importing U.S. pears treated with chemical fungicides.

The Department of **Crop and Soil Sciences**' contribution of improved varieties for yield maintenance in the face of ever-changing pathogens and increasingly variable environmental stress is as important to consider as are the yield increases attributed to this program. Previous estimates have suggested that 5 bu/acre of current yields, or 4.25 million bushels on 850,000 acres, can be attributed to yield-maintenance aspects of the OSU cereals breeding, genetics and pathology research efforts. Based on yield trend analyses in similar production areas, the OSU wheat breeding program can claim responsibility for 67% of the increases in average wheat yields and at least 50% of yield-maintenance results. Using the average acreage and real prices for 1997-2001, the economic benefit to Oregon wheat growers from this program is:
Increased yield (67% x 7.6 bu/acre x 850,000 acres x $2.84/bu) = over $12 million/year.
Yield maintenance (50% x 5 bu/acre x 850,000 acres x $2.84/bu) = $6 million/year.
Thus, the total estimated economic benefit to Oregon wheat growers is $18 million/year and should remain at this, or even greater, levels in the future.

New crops out of the **Columbia Basin Agricultural Research Center**, such as winter malting barley, spring wheat, winter pea, and lentil are being tried as rotational crops for management of problem weeds and for their benefit to winter wheat grown in rotation. Among these, spring wheat acreage is projected to increase by 2,000 acres/year, adding increased net revenues of $250,000/year to those farmers rotating in spring wheat. However, the statistics used above include all wheat, so no addition to the benefits estimate is made. While the cost of production for winter wheat increases under the recommended management changes, intensified cropping practices (including adding rotational crops) help to offset this increase. Thus, net benefits to wheat farmers amount to, at least $1 million a year. As other Oregon wheat farmers adopt these practices, benefits to Oregon wheat farmers should increase.

The **Malheur Experiment Station** research with Spartan in potato has supported the registration of sulfentrazone for use in potato, and a full registration is pending for 2004. The additional registration of herbicides will increase grower productivity and help them remain profitable in increasingly competitive markets. Effective herbicides are estimated to reduce labor costs by $100-200/acre on 30,000 acres of onions, sugar beets, and mint; by $50-100/acre on 15,000 acres of alfalfa seed and potatoes. Thus, total estimated labor savings in the local area amounts to {[$150 x 30,000 acres] + [$75 x 15,000 acres] - [$25/acre (the estimated cost of herbicide applications) x 45,000 acres]} = $4.5 million/year. Many crops simply cannot be grown if dependent on hand weeding. This project provides data and support for EPA registration. Also, with better weed management, yield increases of 25 -30% are experienced. This is a joint research project with the U. of Idaho, plus support from chemical companies. If even one-third of the $4.5 million labor cost savings, not counting the value of help with

registration and the increased yields obtained, is attributed to this project, then benefits to Oregon growers amount to at least $1.5 million/year. This ongoing research will find new herbicide treatments as weed species change or present ones become resistant to herbicides being used. Savings to growers will continue to increase as they become more efficient and knowledgeable about the correct use of herbicides (rates and application techniques) identified and proven effective by this research.

Researchers at the **Central Oregon Agricultural Research Center** believe the varieties released by the Tri-state research group have had, and will continue to have, a positive impact on the Northwest potato industry. Recently released varieties are now produced on over 100,000 acres and value to growers is placed at $135 million in farm gate value. A recent economic analysis of the program revealed that for every dollar invested in the TriState potato variety development program, a $39 return can be expected. Umatilla Russet, an Oregon selection, was released by the TriState program in 1998. Seed growers in the United States produced Umatilla Russet on 3,000, 1,300 and 2,000 acres in 2001, 2002 and 2003, respectively. This improved potato variety yields 21% more U.S. No. Ones than Russet Burbank under approximately the same fertilizer regime, has 10% less hollow heart/brown center than Russet Burbank and is immune to net necrosis, a tuber flesh blemish caused by leafroll virus infection. Seed of Umatilla Russet sells at a $1.00/cwt premium to Russet Burbank. These improvements have resulted in an estimated additional $14 million and $6 million in farm gate value for the 2002 and 2003 crops, respectively. Seed acreage of other Oregon-sponsored new potato variety releases continue to expand. These include Mazama (86 acres of seed grown in 2003), Winema (40 acres), Modoc (1 acre), Wallowa Russet (41 acres), Century Russet (7 acres) and Klamath Russet (2 acres). Improvements in farm gate receipts are expected when seed of these new varieties are planned in the spring of 2004.

Mid-Columbia Agricultural Research and Extension Center researchers have found that some rootstocks under trial promise to shorten this pre-bearing time from seven to four years, significantly reducing this formidable cost. If the precocious rootstock is also dwarfing and produces larger-sized, better quality fruit, it begins to look more attractive to replace aged orchards. In the meantime, these and previous trials have saved growers that formidable cost of $25,000/acre from planting and waiting-for-bearing of a promising, but actually problematic, rootstock (i.e. the BP series of rootstocks from South Africa revealed a high susceptibility to pear decline). Just considering the value of finding a rootstock with greater precocity that is suitable to the area say it is commercially bearing in four, instead of seven years. The recovered net income over those three, now productive years is estimated to be worth about $5,000/acre. Using 2002 figures, gross sales of winter pears in Hood River brought $2,720/acre (13.6 tons/acre at $200/ton), so in three years, the recovered gross income would be $8,160/acre. Suppose 5% of Hood River Valley's 8,270 acres in winter pears are replanted using a precocious rootstock, then the value of recovered income net of production costs (say, $5,000/acre) from the precocity characteristic alone would amount over $2 million over the three years, or $689,166/year.

Sugarbeet research at the **Klamath Experiment Station** (KES) contributed to profitability of this crop during the period of production through 2000. Growers implemented variety selection and fertility practices and avoided economic losses by not replanting damaged stands too late to achieve profits. Several of the Oregon potato variety releases have gained significant grower acceptance. Umatilla Russet has been accepted as the 4th leading French fry processing

variety in the Northwest and was grown on over 50,000 acres in one or more years. Limited seed supplies have slowed growth of other varieties but growers in Oregon and California are very interested in the red-skinned varieties Mazama, Winema, and Modoc, and the Klamath Russet variety. Control of root-knot nematode infections in potato with Vydate C-LV appears to be feasible based on two years of KES research results. Significant cost savings could be achieved compared with current practices. Research on the effects of PVY on Russet Norkotah indicated minor yield reductions in the short season Klamath Basin but very significant losses in the Columbia Basin for seed lots with high virus content. Growers use these findings for seed aquisition decisions. KES reports on watershed hydrology and water quality are being used to protect irrigation interests in the Klamath Basin. An interim report by the NAS committee investigating biological opinions that denied irrigation water to the Klamath Project in 2001, agreed with KES interpretation of multiple studies which failed to provide a scientific basis for withholding irrigation water to protect listed species. When seed is infected 60% or more with PVY, Norkotah yields are reduced 40% ($1,300/acre) in the Columbia Basin, 20% ($800/acre) in Tulelake, and 12% ($550/acre) in Klamath Falls. This certainly justifies spending more to obtain seed with very low virus content. (Results are similar with Shepody; less dramatic with Russet Burbank). Seed treatment to control rhizoctonia may increase yields of No. 1's by 20-50 cwt/acre; to prevent fusarim seed-piece decay, by 50 to 100% when problems are severe, by 10-30%, more generally. Seed treatment to control silver scurf has no effect on yield but prevents quality deterioration in storage and downgrading to dehydration or cull status. A survey found on average that less than half the seed-pieces in 18 lots were ideal size. The average for three varieties over three years testing showed No. 1 yield increases of 46 cwt/acre when seed size was increased to 1.75 oz; 69 cwt/acre with seed size of 2.25 oz. Additional seed costs ranged from $160/acre for Russet Burbank to $200/acre for Norkotah and Century Russet, but the greater proportion of No. 1s, increased the net crop value by $170/acre (average over the three varieties). Benefits from using high quality seed, effective seed treatment fungicides, and optimum seed-piece size increase net returns by $100 to $200/acre for the Klamath Basin crop (where acreage is down from drought and water cutbacks). But benefits from this project extend to much of the rest of the state's 47,440 acres in potatoes (in 2001). Were only one-fourth of that acreage benefiting, benefits to Oregon potato growers amount to $1.8 million/year.

SCOPE OF IMPACT - State and regional

SOURCE OF FUNDING – Hatch, State funds, Local grower groups, OSU Foundation, Agricultural Research Foundation

Key Theme: **Rangeland/Pasture Management**

ISSUE OR PROBLEM

Studies conducted at the **Eastern Oregon Agricultural Research Center** were designed to develop fire prescriptions and time tables that consider biological thresholds, fuel loading, and meeting target objectives relating to plant community structure and composition at the landscape level. Data collected from these studies are also needed to justify specific action or non action in the use of prescribed fire.

Rangelands are being impacted by a variety of uses and users. The **Eastern Oregon Agricultural Research Center** project, "Economic and Policy Analysis of Rangeland

Management Options," examines the economic impacts of alternative management and policy options.

IMPACT

Researchers at the **Eastern Oregon Agricultural Research Center** believe some 5 million acres in eastern Oregon are being invaded by juniper. About 700,000 animal unit months (AUMs) are authorized for grazing use on federal lands, 65,000 on state lands, plus additional units on Indian reservations, wildlife refuges, etc., bringing the total to about 800,000 AUMs in eastern Oregon, plus another 200,000 on private lands. The average acre/AUM in eastern Oregon is 10 to one. Juniper encroachment on these lands amounts to a 10 to 12% loss of carrying capacity. However, this loss will accelerate with continued expansion and increased density of juniper. Assuming the net return above cash costs to ranch households is $5/AUM, the encroachment represents a $550,000 loss (1 million AUMs x 11% x $5), not counting the value of lost water quantity and quality, soil fertility, and wildlife habitat. Commercial harvest of juniper in the near future will likely occur on 10,000 to 20,000 acres/year, plus additional private acreage treated, i.e., cut. With proper post-harvest management (attributable to guidance from this research project), some of the lost AUM value can be restored on these lands each year. While the direct economic value of restored AUMs, net of treatment costs, is not large, there are considerable additional economic benefits in restored watershed integrity (soils, water) and wildlife.

Economic ranch models being developed at the **Eastern Oregon Agricultural Research Center** will help to predict the overall outcome of a change in management strategy or policy. These models are customized to specific issues being analyzed to improve their usefulness. The economic analysis of improving management of livestock on both upland and riparian areas will help in decisions that result in reduced soil erosion, better water quality, better timing of water flows, and improved wildlife habitat. Improved management practices enhance or help maintain family ranching operations and thereby also better conditions in rural ranching communities. Identifying the indicators for rangeland sustainability will provide a framework to evaluate the impacts of management decisions. The initial part of this project covered 350,000 acres (56% private) and included over 1,000 range improvement practices. Optimal strategies on private land returned profits of $17.07/acre compared to an average of $7.92/acre at suboptimal strategies; on public land, the optimal net return was $5.80/acre compared to $3.82/acre for the only other strategy-level tested. Thus, net benefits on the project land amount to {[350,000 acres x 56% private x ($17.07/acre - $7.92/acre)] + [350,000 acres x 44% public x ($5.80/acre - $3.82/acre)]} = $2 million/year.

SCOPE OF IMPACT - State and regional

SOURCE OF FUNDING – Hatch, State funds, OSU Foundation, Agricultural Research Foundation, and Local grower groups

National Goal #2:

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

OVERVIEW

Oregon Agricultural Experiment Station (OAES) has 18 projects with two key themes under the National Goal #2 in the CRIS database. We selected three projects from one key theme to highlight in this year's report. The major selection criteria are the quantifiable outcome and impact. We provide only the summary output data in this section, and will present outcome and impact information under individual key themes below. Review comments from last year's report indicated a redundancy in reporting our outcome and impact statements. Therefore, we have decided not to present the outcome and impact statements in the overview section. Those units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. Details of the calculations used to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops.

- Published 22 refereed journal articles, 2 proceedings papers, and 8 abstracts.
- Made 10 presentations at national, international, and professional meetings.

ASSESSMENT:

All units in the Oregon Agricultural Experiment Station are required to conduct annual performance evaluation of their faculty members. These annual reviews are conducted based on goals established during previous year's reviews. Since all faculty members with OAES FTE are required to establish their station projects, annual performance evaluation serves a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals.

TOTAL EXPENDITURES: $2,041,304

Hatch- $205,008
Multistate- $43,596
State- $1,792,700

TOTAL FTE: 14.7

ACCOUNTABILITY:

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

http://oregoninvests.css.orst.edu

There are currently over 372 reports contained in the database, searchable by selected criteria. Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate.

Examples of search topics for Goal 2: fiber, food system, food quality, and food safety

Key Theme: **Food Quality**

ISSUE OR PROBLEM

The Department of **Bioengineering** understands that improved storage systems and practices are important aspects of the grower to consumer effort necessary to keep U. S. fruit industry competitive. Bioengineering researchers are documenting bin placement patterns that will improve air flow distribution uniformity throughout the storeroom will reduce fruit quality losses and save energy, thereby increasing profits.

A major effort for this **Coastal Oregon Marine Experiment Station** project is the development of new value-added products from albacore tuna and shellfish, such as oysters. This project demonstrated the feasibility of using new product development techniques such as Culinology in developing new products. Two new products are being introduced into the marketplace. We expect that these products will be successful over the next few years. An additional expected outcome will be a wider recognition of the project and the value-added process by small and mid-size businesses. We expect that there will be increased opportunities and interaction amount the project partners and businesses for future product development activities.

IMPACT

The financial impact of these findings is difficult to assess. However, **Bioengineering** researchers know that as fruit quality decreases, so does attainable price. Lowering the grade of fruit one or two levels may drop price to where profit margin has been eliminated. These findings will help operators reduce fruit quality losses while in storage. Analysis of controlled-atmosphere (CA) fruit storages estimate that between 50% and 55% of the total energy use is due to evaporator fan operation. A common sized facility capable of storing 16,000 to 25, 000 bins of fruit uses about 50 kWh/bin per year if energy conservation measures are not adopted. Fan cycling can reduce evaporator coil electrical energy consumption from 50% to 67% depending on the aggressiveness of a refrigeration manager's control strategy. Realistic energy savings for an entire fruit storage warehouse can be 35% or more. Based on total CA storage capacity in Oregon, this would represent an annual reduction in energy use of approximately 9.5 million kWh. At a typical fruit storage rate rate of 5¢/kWh, this would amount to $472,500 saved/year in Oregon. (kWh saved in Washington state could potentially amount to $7 million/year.) Tight-

stacking bins in existing storerooms is a viable alternative to added construction if floor dimensions are sufficient and the rooms are equipped with enough evaporator coil capacity. In the one facility that has adopted this option, research has shown that fruit quality is not adversely affected. This Oregon facility increased capacity by over 5,700 bins. With refrigeration systems costing about $42.00 per bin and structure construction $100.00, this facility saved over $800,000 in construction costs. Additional savings are realized from more efficient removal of field heat from the fruit. Counted together, these innovations are already worth, perhaps, $2 million/year. As more adoption occurs, benefits should increase.

The **Coastal Oregon Marine Experiment Station** project demonstrated the feasibility of using new product development techniques such as Culinology in developing new products. Two new products are being introduced into the marketplace. We expect that these products will be successful over the next few years. An additional expected outcome will be a wider recognition of the project and the value-added process by small and mid-size businesses. We expect that there will be increased opportunities and interaction amount the project partners and businesses for future product development activities. project, a new management plan for the whiting fishery entailed spreading out the season from one to seven months and decreasing fishing in the southern area, resulting in a 10% greater yield (about 10,000 mt additional in Oregon), and more and larger fish. By the mid-1990s, the increased yield from following this plan was worth (10,000 mt x 2,204.662 lbs/mt x 3¢) = about $660,000/year. The main market products from whiting are surimi and fillets. The bioeconomic model that links fisheries management and processor behavior to product quality shows that moving from early- to late-season fisheries generates significantly higher benefits through higher recovery (meal up 6%, fillets 12%, surimi 20%), higher biomass harvested (up 7%, or about 7,000 mt), quality (surimi gel strength up 15%), prices (surimi prices up 4¢/lb, fillets 2-4¢). As recommendations based on this model are implemented, industry profits are increasing significantly, by as much as $2 million/year. Research has also shown that improved market development of alternative product forms can increase both profits and stability by improving overall performance of 'Portfolios' of products produced by the industry.

SCOPE OF IMPACT - National and international

SOURCE OF FUNDING – Hatch, State funds, Northwest Center for Small Fruit Research, USDA Germplasm Repository, USDA Human Nutrition Laboratory, Commodity groups

National Goal #3:

A healthy, well-nourished population. Through research and education on nutrition and development of more nutritious foods, enable people to make health promoting choices.

OVERVIEW

Oregon Agricultural Experiment Station (OAES) has 13 projects with two key themes under the National Goal #3 in the CRIS database. We selected three projects from two key themes to highlight in this year's report. The major selection criteria are the quantifiable outcome and impact. We provide only the summary output data in this section, and will present outcome and impact information under individual key themes below. Review comments from last year's report indicated a redundancy in reporting our outcome and impact statements. Therefore, we have decided not to present the outcome and impact statements in the overview section. Those units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. Details of the calculations used to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops.

- Published 7 refereed journal articles, 1 proceedings paper, and 2 abstracts.
- Made 3 presentations at national, international, and professional meetings.

ASSESSMENT:

All units in the Oregon Agricultural Experiment Station are required to conduct annual performance evaluation of their faculty members. These annual reviews are conducted based on goals established during previous year's reviews. Since all faculty members with OAES FTE are required to establish their station projects, annual performance evaluation serves a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals.

TOTAL EXPENDITURES: $649,193

Hatch- $62,141
Multistate- $63,158
State- $523,894

TOTAL FTE: 6

ACCOUNTABILITY:

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

http://oregoninvests.css.orst.edu

There are currently over 372 reports contained in the database, searchable by selected criteria. Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate.

Examples of search topics for Goal 3: human health, and human nutrition.

Key Themes: **Human Health**

ISSUE OR PROBLEM

Each year 500,000 persons in the United States die from cancer. Although epidemiologists have linked one/third of these deaths to dietary imbalances, the specific factors in our foods that may provide protection against this disease, or increase the risk of developing the disease, are not well understood. An **Environmental & Molecular Toxicology** project examined the dose-response efficacy and molecular mechanisms by which three classes of food-borne phytochemicals -- indoles, chlorophylls, and tea antioxidants -- protect against cancer in experimental animals and humans.

Thirty-five percent of all cancers may be prevented by diet. The fetus is very susceptible to cancer caused by exposure to chemicals during pregnancy. No information is available on the potential for phytochemicals in the mother's diet to prevent cancer in her offspring. In this **Environmental & Molecular Toxicology** project, we examined the potential for three of the major phytochemicals known to prevent cancer in protection of the fetus against liver and lung cancer caused by maternal exposure to chemical carcinogens.

IMPACT

These Environmental & Molecular Toxicology studies have greatly improved our understanding of the role of natural chlorophylls, chlorophyll derivatives, indoles, and tea antioxidants in human cancer prevention. Based on biomarker studies in China, chlorophylls alone may reduce liver cancer by over 50%. In addition, the transplacental I3C chemoprotection studies initiated will provide for the first time an indication of the potential for maternal dietary supplementation to mediate the toxicity of chemicals to which the fetus is exposed in utero.

The National Institute of Health estimates the overall annual health care costs for cancer in the United States at $107 billion, while estimated yearly costs in Oregon are $1.3 billion. Currently, the phytochemicals under test are those found in cruciferous vegetables, green and leafy vegetables, and tea. But, in the future, the research may include crops of greater importance to Oregon agriculture, such as hazelnuts, mint, and small berries. A strong cancer chemoprotective effect could add greater market value to these food products.

SCOPE OF IMPACT - State and national

SOURCE OF FUNDING - Hatch, State funds

Key Themes: **Human Nutrition**

ISSUE OR PROBLEM

Young adults do not eat enough fruits and vegetables to promote optimal health. A **Health and Human Sciences** project is developing and testing a Stages-of-Change based nutrition education intervention to increase fruit and vegetable consumption among young adults.

IMPACT

By increasing fruit and vegetable consumption among young adults it has the potential to decrease rates of chronic illness in this age group throughout adulthood and in their children as well as to increase the market for produce.

SCOPE OF IMPACT - State and national

SOURCE OF FUNDING – Hatch, State funds

National Goal #4:

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

OVERVIEW

Oregon Agricultural Experiment Station (OAES) has 60 projects with 15 key themes under the National Goal #4 in the CRIS database. We selected seven key themes with16 projects to highlight in this year's report. The major selection criteria are the quantifiable outcome and impact. We provide only the summary output data in this section, and will present outcome and impact information under individual key themes below. Review comments from last year's report indicated a redundancy in reporting our outcome and impact statements. Therefore, we have decided not to present the outcome and impact statements in the overview section. Those units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. Details of the calculations to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops.

- Published 67 refereed journal articles, 7 proceedings papers, and 23 abstracts.
- Made 30 presentations at national, international, and professional meetings.

ASSESSMENT:

All units in the Oregon Agricultural Experiment Station are required to conduct annual performance evaluation of their faculty members. These annual reviews are conducted based on goals established during previous year's reviews. Since all faculty members with OAES FTE are required to establish their station projects, annual performance evaluation serves a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals.

TOTAL EXPENDITURES: $6,251,830

Hatch- $493,151
Multistate- $253,962
State- $5,504,717

TOTAL FTE: 55.8

ACCOUNTABILITY:

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

http://oregoninvests.css.orst.edu

There are currently over 372 reports contained in the database, searchable by selected criteria. Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate.

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

Key Theme: **Biodiversity**

ISSUE OR PROBLEM

Most microorganisms in nature are new species which have never been cultured or studied in laboratories. Understanding these organisms is the key to understanding geochemical cycles and the discovery of new pharmaceuticals. The purpose of this **Microbiology** project is to isolate new microorganisms.

IMPACT

The high throughput cultivation (HTC) project in **Microbiology** has had a broad impact on scientific and industrial perceptions of microbial cultivation, leading to renewed and more sophisticated efforts to pursue the cultivation of microorganisms for the purpose of understanding their roles in bioremediation, ecology, and their uses as sources of novel pharmaceuticals and agrochemicals.

SCOPE OF IMPACT - Oregon, national**,** and international

SOURCE OF FUNDING – Hatch, State funds, U.S. Environmental Protection Agency, National Science Foundation, U. S. Bureau of Reclamation

Key Theme: **Endangered Species**

ISSUE OR PROBLEM

Our planet's large whale species are still endangered despite the current moratorium on whaling. Anthropogenic issues such as ship strikes, fishing entanglement and pollution continue to threaten their recovery. It is vital to protect the habitats most important to their recovery, yet for many species, these critical habitats are not known. The purpose of our **Coastal Oregon Marine Experiment Station** project is to determine and characterize the critical habitats of endangered whales in order to enable wise management decisions and assist in the survival and recovery of depleted populations.

Many of the uncertainties surrounding conservation of Oregon fishes are associated with a simple inability to define, describe, or otherwise delineate the organisms. This **Fisheries and Wildlife** project seeks to strengthen the infrastructure and to provide the primary research needed to better describe Oregon fishes, including its un-recognized fish fauna. The long term goal of the project is a description of the fish fauna of Oregon.

IMPACT

Hard data regarding whale movements and migrations had a major conservation impact this year. In June 2003, Canada shifted its Bay of Fundy shipping lanes 4 miles to the east in order to reduce ship collisions with right whales. This shift, the first time shipping lanes have ever been altered for an endangered species, was accomplished in part because of **Coastal Oregon Marine Experiment Station** location data -- which showed exactly how often right whales were moving across the shipping lanes. The impact of our research is that our ability to learn where whales go translates into a better ability to protect them.

Research through the Department of **Fisheries and Wildlife** in regards to the Klamath sucker work is showing the importance of being able to identify all life stages of fishes. The disconnect between survival of one life stage and relative abundance of a later stage has implications for Endangered Species Act (ESA) jeopardy decisions.

SCOPE OF IMPACT - Oregon, national**,** and international

SOURCE OF FUNDING – Hatch, State funds, U.S. Environmental Protection Agency, National Science Foundation, U. S. Bureau of Reclamation

Key Theme: **Integrated Pest Management**

ISSUE OR PROBLEM

Pears, apples and sweet cherries account for a total value of $129,176,000 (average last three years; 2000-2001 Oregon Agriculture & Fisheries Statistics) of Oregon's agricultural economy. Economically viable production of pears, apples and cherries depends on annual control programs to prevent unacceptable pest damage. The **Mid-Columbia Agricultural Research and Extension Center** studied selective pest management as a sustainable alternative to conventional pest control on tree fruits with broad-spectrum pesticides.

Alien weeds pose some of the most serious threats to agriculture and to biological diversity, and many are amenable to biological control using insects and pathogens. The Department of **Botany and Plant Pathology** is developing safe and effective biological controls for harmful non-indigenous plant species in the Western USA.

Managing pests in a cost-effective and environmentally friendly manner is an important component of a profitable and sustainable tree fruit industry in Oregon. The goal of this **Southern Oregon Research and Extension Center** research is to develop and implement an integrated pest management program in tree fruit, which minimizes the use of disruptive, broad-spectrum pesticides and maximizes the benefits of naturally occurring biological control agents through the use of selective pest management techniques.

The Department of **Horticulture** investigated the use of a variety of IPM strategies for pest management in vegetable production systems in Oregon. Strategies include cover crops and raw and composted manure for management of snap bean and sweet corn root rots and snap bean white mold; and monitoring, sanitation, novel chemistries, and region-wide spatial management for control of cabbage root fly.

The **Hermiston Agricultural Research and Extension Center** is working on ecologically based control mechanisms for potato insects and diseases vectored. Emphasis is on green peach aphid, Colorado potato beetle, wireworm and two-spotted spider mite. Research on developing knowledge of the seasonal distribution of alate aphids, correlation of seasonal distribution of aphids with virus transmission, verification of potential vector relationships, identification of the plant species on which the aphid populations develop, study of factors affecting migratory behavior, and exploration of methods for suppression of vectored viruses.

IMPACT

With the help of this **Mid-Columbia Agricultural Research and Extension Center** project, growers are steadily moving towards safer, environmentally friendly and more selective pest control tactics and are replacing traditional broad-spectrum chemical controls with selective options including mating disruption techniques and biological controls. These changes will mean reduced incidence of toxic chemical drift and runoff to water sources and less farm worker exposure to broad-spectrum neurotoxic chemicals, especially organophosphate insecticides. Without effective pest control based on recommendations from this project, the Mid-Columbia apple, Bartlett, winter pear and cherry crops would be worth much less due to unacceptable pest damage to trees and fruit and even complete crop loss. A conservative estimate of the economic benefits to northern Oregon fruit growers from this project is one-tenth of the total $67 million annual average sales value of pears, apples and cherries.

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

The reduction in integrated pest management programs using mating disruption that occurred in 2002 was halted in 2003. **Southern Oregon Research and Extension Center** faculty determined that approximately 40% of the local tree fruit acreage (3,000 acres) is currently utilizing mating disruption based IPM programs with minimal use of problem insecticides (e.g. organophosphates, carbamates, pyrethroids), with at least one-third of the acreage using no organophosphates or carbamates in 2003. An additional 50% of the tree fruit acreage (3,600 acres) employs monitoring of pest populations and use of weather data and phenology models to predict pest development, together these data are used to reduce the number

of unnecessary pesticide applications. Access to these weather data and phenology models has been facilitated by the Pest Alert web page, which has had over 20,000 hits. Over 50 acres of orchards began the transition to organic fruit production in 2003, utilizing organically approved pest management tactics such as mating disruption, codling moth granulosis virus and kaolin particle films, which were first tested locally at the Research Center. Growers representing two-thirds of the tree fruit acreage attended the biweekly pest management forums and discussed monitoring methods and results, and used this information to improve their pest management programs. Grower expenditures for arthropod controls were substantially reduced under the Codling Moth Areawide Management Project (CAMP). Over the five-year period expenditures in the CAMP orchards averaged $213/acre, including the costs for codling moth mating disruption dispensers, compared with $423/acre in conventionally treated blocks. This average reduction of almost 50% ranged from a low of 45% in 1996 to a high of 55% in 1998. The number of applications, i.e., equipment travel, was about the same under both management types. So, growers on the 1,800 acres now under CAMP are saving ($423 - 213) x 1,800 acres = $378,000/year. As the recommendations are more widely adopted these savings in pesticide costs should increase. However, the cost of increased monitoring of pests and pest damage needed for new softer methods of control will likely offset most of these savings. Note that unfinished aspects of this now-complete CAMP project are being continued in two new research-Extension projects described in this database, Building a Multi-Tactic Pheromone-Based Pest Management System in Western Orchards and Pear Pest Management to Reduce or Eliminate Organophosphates and Synthetic Pesticides. Economic benefits may increase as the work continues and as other areas of the state adopt the management recommendations.

Root rot of sweet corn affects more than 50% of the 30, 000 acres of sweet corn planted each year in the Willamette Valley. Jubilee, the historically most important variety, is not tolerant to the disease and yield losses of up to 50% have been reported. The **Horticulture** project demonstrated that root rot severity could be reduced in field soils by approximately 50% after manure amendment. Container studies indicate that oats and sudangrass green manures may also reduce root severity. The cover crop work is now being validated under field conditions. If successful, organic amendments and suppressive cover crops could be adopted by growers along with other cultural strategies to reduce root rot and improve corn yields and profitability. Statistics on sweet corn for processing show that Willamette Valley yields are, in fact, down sharply since the mid-1990s: The 1998-2000 average was 8.3 tons/acre versus 9.13 tons/acre for 1994-1996, or an average of 0.83 tons/acre less. Part of this loss is surely due to root rot. If changes in management strategies are successful in stopping root rot, so that the average yields increase by, say, 0.4 tons/acre, then Willamette Valley sweet corn growers would gain (0.4 tons/acre) x $82/ton (in 2000) x 31,300 acres = over $1 million/year. This estimate does not include the value of restored health to the Valley's important vegetable processing industry.

The **Hermiston Agricultural Research and Extension Center** project has been instrumental in bringing about a revolution in potato insect control moving from broad-spectrum insecticides to regimens using target-specific, 'softer' control materials that last only a short time in the environment and leave no residue on food. The project's focus has been Colorado potato beetle and green peach aphid control. Environmental benefits from this project, and the associated pest control revolution to target-specific, environmentally softer insecticides extend throughout Washington, Oregon, and Idaho. They include: (1) reduced use of the predator-damaging permethrin insecticide; (2) improved monitoring that enables growers to identify periods when insecticides need to be applied; (3) registration of Admire, Platinum, Gaucho,

Genesis and Fulfill that reduce pesticide application to potato in Oregon, Washington and Idaho and (4) encourage improved predator populations throughout the northwest potato crop. This project demonstrated that spiders and other generalist predators are as important to aphid control and virus suppression in commercial production. All of the alternatives developed in this project for better insect and other-pest control benefit farmers and applicators by reducing their exposure to toxic chemicals, and consumers by reducing pesticide residue on potatoes. Conventional control for Colorado potato beetle and green peach aphid once took 5.5 applications costing growers $110/acre. These materials, however, generally eliminated predators, so that another 1.5 to 2.5 treatments were needed, costing $30 to $50/acre. So, controlling just these two pests cost an average of $150/acre. In comparison, recent materials cost less, achieve superior control, and increase yields. For example, the new target-specific products cost about $80/acre, plus a usually-needed foliar application at $10/acre, for a total of $90/acre savings to Umatilla and Morrow county growers of some $60/acre (30,000 acres x $60/acre) = $1.8 million/year. (Taking account of inflation, this savings in material costs are much greater in nominal dollars.) However, because the new systems, while more effective, are complex and require more grower monitoring and planning, management costs are considerable greater under the new regimens. But another tremendous advantage is that under the various new treatments, yields increase an average of 4.5 tons/acre. Because of many factors, including the effects of this research project, yields in Morrow and Umatilla counties actually surpass the average in the rest of the state by 12 tons/acre (32 tons/acre vs 20 tons/acre). At $5.22/ton in 2001, this higher yield brings growers [12 tons/acre x $5.22/ton x 30,000 acres in the two counties] = $1.9 million more in farm-gate receipts. Given both the savings in pesticide materials costs and the value of these higher yields, and, attributing a portion of these gains to this project, this research continues to benefit Umatilla and Morrow county potato growers at least $2 million/year.

SCOPE OF IMPACT - Local, state, and national

SOURCE OF FUNDING – Hatch, State funds, Commodity groups, USDA, EPA

Key Theme: **Nutrient Management**

ISSUE OR PROBLEM

The sustainability of Oregon's agricultural production systems depends on the ability of growers to increase production efficiency and meet crop quality standards while protecting soil and water resources. Field and laboratory research will be conducted by the Department of **Crop and Soil Science** to develop tools and practices that farmers can use in managing fertilizers applied to cereal grains and specialty crops.

Certain agricultural practices contribute to the problem of nitrate in water. A **Botany and Plant Pathology** project examines the basic underpinnings of the microbial processes involved in nitrate production. Worldwide, about 8 x 1013 g of industrially produced N are applied to croplands annually. Fertilizer N production, primarily as NH3, requires large inputs of natural gas and H2. In croplands fertilized with ammonia-based fertilizers, ammonia oxidizers contribute to the mobilization of this N by the production of NO2-, which is rapidly converted to NO3- by nitrite-oxidizing bacteria. NO3- is readily leached from these soils into ground waters (often to levels rendering the water unfit for human consumption) and surface waters (contributing to their eutrophication). Furthermore, NO3- is a substrate for denitrification, resulting in the conversion

of this plant-available N to N2 and a waste of the energy initially used to produce the NH3. In contrast, ammonia oxidizers are beneficial in the treatment of wastewaters and they show potential for bioremediation of soils contaminated with chlorinated aliphatic hydrocarbons. Mitigation of the negative effects and exploitation of the beneficial effects of ammonia oxidizers will be facilitated by a thorough understanding of their metabolism.

IMPACT

Crop and Soil Science research results show that growers can reduce N fertilizer rates (cost) by 50lb N/a ($15/a) while avoiding under- or over-fertilization with N. Using the Nmin soil test and direct-seeding of winter wheat offers growers the chance to reduce N input costs, reduce fuel costs, and shorten crop rotations while reducing surface runoff that causes erosion and deterioration of water quality. Small grains are grown on nearly 923,000 acres in Oregon, with production primarily in the North Central (717,000 acres), Eastern (110,000 acres), Willamette Valley (57,000 acres) and South Central (30,000 acres) cropping districts. Oregon's diverse environments and large acreages provide many opportunities to increase economic return to growers. For example, by using a recently developed soil test for mineralizable nitrogen, Willamette Valley producers could increase yield by 20 bu/acre with the same or less N fertilizer. At the current market value for soft white wheat ($3.81 per bu), the increase in yield would be worth over $4.3 million per annum. The new technology is currently being applied on over 6,000 acres with an estimated economic return of $470,000/year (valuing the increased grain yield at $434,000 and decreased N fertilizer use at $36,000).

The attempt of researchers in the Department of **Botany and Plant Pathology** to grow N. europaea on organic compounds was successful, now new possibilities are feasible for mutational analysis of NH3 catabolism (e.g. site-directed mutagenesis of AMO). While our focus is on N. europaea, we expect that the results will extend to other ammonia oxidizers. Besides environmental benefits, there could be savings to Oregon producers in fertilizer costs. If nitrification is effectively controlled, nitrogen fertilization could eventually be decreased by about 25%. Some 150,000 tons of nitrogen are used commercially in Oregon annually. At 25¢/lb, this cost is $75 million. If the amount used could be cut by 25%, Oregon farmers would save nearly $19 million/year.

SCOPE OF IMPACT - Local, state, and national

SOURCE OF FUNDING – Hatch, State funds, Commodity groups, USDA, EPA

Key Theme: **Soil Quality**

ISSUE OR PROBLEM

Agriculture faces continued pressure to reduce application of chemicals in an effort to protect the environment. Natural systems are commonly used as filters to protect waterways from human activity. Natural systems are inherently structured to permit rapid transport of fluids. One **Crop and Soil Science** research program focuses on identifying mechanisms that generate fast paths through the unsaturated zone and characterizing the conditions under which they prevail or can be ameliorated.

Many wells contain trace pesticides and excessive nitrate. One **Bioengineering** project addresses which practices are contributing to these problems and what practices might reduce these impacts. The focus of this program is on the movement of water and chemicals above aquifers. The non-point-source component of this research is directed to the identification of potential contaminant sources and development of preventative and remedial methods to maintain and improve groundwater quality. Consideration of irrigation and drainage issues falls within these objectives as many of the agriculturally driven contamination problems are propelled by problematic irrigation practices. The regional hydrologic scale research is a new avenue of investigation directed to the development of practical tools for water resource management at the Watershed scale, presently expressed through projects in Oregon (the Walla Wall River at Milton Freewater), and Chile (The Secano Interior).

IMPACT

This **Crop and Soil Science** study has elucidated two distinct fluid movement modes across intersections and a first-order mathematical model has been developed to predict the type of transport that should be expected under various conditions. Results published in two internationally leading water resources journals (Advances in Water Resources, and Water Resources Research), have been presented at the American Geophysical Union, and will be presented at the upcoming Dynamics of Flow in Fractured Rock conference. Furthermore, the PI has been invited for a roundtable discussion on the results of this research with the Earth Sciences Group at the Lawrence Berkeley Laboratory. About one-fifth of Columbia Basin potato farmers are experiencing restricted infiltration of their irrigation water so that plants become water stressed. In response, they apply irrigation water in excess of what the plants would use if they were able to absorb what already has been applied. This extra irrigation costs farmers between $65 and $78/acre. Should this research succeed in developing technologies and agronomic practices that enhance water filtration in potato rows, these farmers would save an estimated [30,000 acres (in Umatilla and Morrow counties in 2001) x 20% x $70/acre] = $432,000/year. These farmers will also save on fertilizer applications as there would be much less nitrate runoff and deep percolation. Counting any additional cost of the new techniques, the net savings should amount to at least $500,000/year. As the techniques expand to the rest of Oregon's potato acreage (47,440 acres in 2001), the net benefits to Oregon potato farmers could amount to $750,000/year. This estimate does not count benefits to potato farmers in Washington's Columbia Basin.

The farmers of Oregon are responsive to research findings. The Department of **Bioengineering** will continue to provide guidance to Oregon Farmers to improve the management of their soil, water, and nutrient resources to provide full yield and protect the quality of groundwater. The benefits of increased understanding of the fate of water and chemicals in soil are immediately applicable as engineers use this information to better protect groundwater resources. About 20% of the wells in the Willamette Valley exceed the 10 ppm EPA standard for nitrogen (or about 20,000 wells). This research/education project should lead to saving at least 20% of them (or 4,000 wells) over the next 20 years. A typical farmer will spend about $50/farm for soil testing, plus the costs of more intensive management, but these added costs will be offset by reducing nitrogen applications an average of 30% (100 lbs/acre). The alternative of drilling new or deeper wells is expensive (average $10,000 each), making the effort to save existing wells very economically beneficial. If the project succeeds in saving 4,000 wells at $10,000 each over the next 20 years by soil testing and recommending changes in

production practices (e.g., the use of cover crops), then farmers will be ahead some $2 million/year.

SCOPE OF IMPACT - Local and regional

SOURCE OF FUNDING - Hatch, State funds, USDA-SARE

Key Theme: **Sustainable Agriculture**

ISSUE OR PROBLEM

The **Mid-Columbia Agricultural Research and Extension Center** (MCAREC) believes proper use of 1-MCP treatment of Anjou pears can extend the shelf life and control scald disorder during marketing season and thus maximize the cash return to the pear growers. Costs of Controlled Atmosphere (CA) storage are higher than for regular storage, but CA storage allows excellent quality fruit to be sold throughout the year, rather than just six months/year as was the case 50 years ago.

IMPACT

The steady improvement in CA technology is due to research by **Mid-Columbia Agricultural Research and Extension Center** personnel and other research projects at UC Davis, Washington State University, and elsewhere. Without CA storage, fruit decay control, and other post-harvest handling improvements, the harvest would have to be sold during a much shorter season at lower prices. To get a ball park idea of the value of this type of research, consider that without it, growers would have to sell their winter pear crop during the few months after harvest along with the crops from Jackson County, Washington state, and California. Instead of an average of $205/ton (in 2000), they would receive, perhaps, an average of $50/ton less. For the 2000 Hood River pear crop (114,713 tons), this would mean that growers would gross some $5.6 million less/year. Attributing 20% of the gain to MCAREC research, yields benefits of $1.2 million/year.

SCOPE OF IMPACT - Local and regional

SOURCE OF FUNDING – Hatch, State funds, USDA Western Region Integrated Pest Management Grants, Special grants, Agricultural Research Foundation

Key Theme: **Water Quality**

ISSUE OR PROBLEM

Research through the Department of **Agricultural and Resource and Economics** focus on helping Oregon farmers improve their water management. In particular, the research thrusts are in the area of water markets, economic-based irrigation scheduling, and other approaches to improving the efficiency of irrigation.

IMPACT

Agricultural and Resource Economics faculty have developed long-term management options for the water management agencies, fish and wildlife agencies, and agricultural interests. For example, the NRC Klamath report has been cited by the agencies as the basis for development of a water bank in the Klamath basin in 2002. Because of the long time horizons in the study (up to 100 years), the economic benefits/costs are only speculative. However, with respect to the research on ENSO events (El Ni–o Southern Oscillation), there is substantial economic benefit to agriculture and water resource management from using currently available climate forecasts in management policies. Using numbers drawn from dynamic (nonlinear programming) models of agriculture under differing information states of the world (related to probabilities of ENSO events), the values to agriculture exceed $250 million/year nationwide. A model of about 40% of Mexican agriculture (i.e., the commercial sector) was recently completed (with Bruce McCarl of Texas A&M). Values of $70 million/year were attributed to appropriate planning for ENSO events. Adoption possibilities for both U.S. and Mexican agriculture include changing crop mix and irrigation scheduling.

SCOPE OF IMPACT – Local, state, and national

SOURCE OF FUNDING - Hatch, State funds, USDA competitive grants, Industrial commodity commissions

Goal 5:

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

OVERVIEW

Oregon Agricultural Experiment Station (OAES) has 10 projects with 5 key themes under the National Goal #5 in the CRIS database. We selected three projects with three key themes to highlight in this year's report. The major selection criteria are the quantifiable outcome and impact. We provide only the summary output data in this section, and will present outcome and impact information under individual key themes below. Review comments from last year's report indicated a redundancy in reporting our outcome and impact statements. Therefore, we have decided not to present the outcome and impact statements in the overview section. Those units which conducted the research with quantifiable impacts are identified within each key theme to encourage our units to write better outcome and impact statements in future years. Details on the calculations used to derive the economic impact are presented to substantiate the claim.

Research results have been shared through refereed journal articles, abstracts, books and book chapters; theses, local, regional, national and international meetings, symposia and workshops.

- Published 5 refereed journal articles and 2 abstracts.
- Made 2 presentations at national, international, and professional meetings.

ASSESSMENT:

All units in the Oregon Agricultural Experiment Station are required to conduct annual performance evaluation of their faculty members. These annual reviews are conducted based on goals established during previous year's reviews. Since all faculty members with OAES FTE are required to establish their station projects, annual performance evaluation serves a good vehicle to assess our progress toward the goals in our plan of work. OAES has made good progress in meeting these goals.

TOTAL EXPENDITURES: $440,216

Hatch- $5,708
Multistate- $58,175
State- $376,333

TOTAL FTE: 1.8

ACCOUNTABILITY:

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

http://oregoninvests.css.orst.edu

There are currently over 372 reports contained in the database, searchable by selected criteria. Each report undergoes systematic professional review with analysis of projected economic, environmental and social effects, as appropriate.

Examples of search topics for Goal 5: rural, low-income families, community development, and employment.

Key Themes: **Agricultural Financial Management**

ISSUE OR PROBLEM

Policymakers, researchers, farmers and individuals in the agribusiness sector often lack a complete understanding of market processes for farm assets. Research in the Department of **Agricultural and Resource Economics** examines markets for durable assets in detail to understand the factors that influence asset values.

IMPACT

The **Agricultural and Resource Economics** researchers estimate coefficients published in the equipment depreciation paper will likely be adopted as the standard by the ASAE. They will then be used in enterprise budgeting activities across the country, as well as other studies where depreciation estimates are needed.

SCOPE OF IMPACT - National

SOURCE OF FUNDING – Hatch, State funds, B.E. Knudson Endowment for Family Policy, Sub-contract from the Oregon Child Care Research Partnership funded by the USACF Child Care Bureau

Key Themes: **Children, Youth, and Families at Risk**

ISSUE OR PROBLEM

Across Oregon and the nation, communities face increasing demands for accountability in programs for children, youth and families, especially those at risk of poor outcomes. These accountability demands arise externally from public and private funding agencies, and internally, from the need to invest wisely in effective programming. This **Health and Human Sciences** project expands earlier work on an AES research project which resulted in a state and nationally implemented model for tracking the outcomes of prevention programs to larger social goals and benchmarks.

IMPACT

The results accountability model and related resources are the basis of the performance measurement policies and practices for the Oregon Commission on Children and Families and all 36 county commissions, the Oregon statewide planning processes for children, youth and families under SB555 (2000 Oregon Legislative Assembly); the Oregon Child Care Bureau; and the Oregon Tobacco Prevention and Cessation Program (Oregon Health Division). The model has been adapted for use by the University of Illinois - Champaign; US Child Care Bureau; National Association of Child Care Resource and Referral Agencies; and Untied Way agencies in several states. The model and related resources are the foundation of a computer-based outcome assessment system now being voluntarily implemented across Oregon by non-profit organizations and human service agencies.

SCOPE OF IMPACT - National

SOURCE OF FUNDING – Hatch, State funds, B.E. Knudson Endowment for Family Policy, Sub-contract from the Oregon Child Care Research Partnership funded by the USACF Child Care Bureau

Key Themes: **Impact of Change in Rural Communities**

ISSUE OR PROBLEM

Rural people want to understand how to improve labor market outcomes and to prepare for changes in demographic trends affecting rural America. They also want to understand how to revitalize economies and to decide what investments are most effective in improving rural economic well-being. The Department of **Agricultural and Resource Economics** is working on a project which will provide a strengthened national network of policy analysts to examine specific policies affecting rural areas and information for policy makers on strategies to improve income for low-income workers and on investments to improve community economic well-being.

IMPACT

Local job growth appears to lead to higher earnings and more employment for the working poor. Findings from the **Agricultural and Resource Economics'** study of Oregon low-income workers suggest that local job growth has a weaker effect on earnings and employment of the working poor in rural areas. This study using a national sample of households suggest that, holding demographics constant, changes in welfare and social policy during the 1990s contributed to the employment increases but not to poverty reduction for both rural and urban single mothers. They suggest that demographic differences between urban and rural single mothers in age, race, and education resulted in the policy changes having less effect on rural single mother work and poverty. As policymakers have gotten access to our research through Rural Poverty Research Center publications, conference presentations and personal consultation, the research has helped shape policy discussions of reauthorization of welfare reform and of the Workforce Investment Act.

SCOPE OF IMPACT - Local, statewide and national

SOURCE OF FUNDING – Hatch, State funds

B. Stakeholder Input Process

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

1. OSU/CAS faculty were invited to outline plans for educational efforts on hunger and poverty. Participants included single mothers, low income worker advocates, food bank workers, community activists, community action agency staff, and state human services workers. The purpose of the session was to solicit "grass roots" input regarding projects around the state that deal with hunger and poverty issues.
2. OSU/CAS faculty participated in a regional (Linn, Benton, Lincoln & Lane counties) workforce development task force created to find ways of linking low income workers and local employers. This task force was comprised of local business leaders, community college staff, community action agency staff, and OSU. The purpose of OSU participation was to seek ways we could be appropriately involved in this effort to link workers and employers.
3. The Agricultural and Resource Economics Department, through its Rural Studies Program, pursued stakeholder input from a variety of individuals and groups including:
    - Elected officials/community leaders – county commissioners from four counties that have experienced some of the greatest economic distress over the last 30 years.
    - General public – economic development forums and conferences in Umatilla, Crook and Lake counties, and an on-campus Social Change Conference which involved students and the public.
    - Businesses – Interviews with critical businesses in Wallowa and Union counties to determine the accuracy of an economic input-output model.
    - Industry associations – Irrigation cooperatives in Crook, Jefferson & Deschutes counties to considered economic impacts of a proposed critical habitat designation for bull trout.
    - Government agencies – USDA Forest Service on economic impacts of restoration contracts, Oregon Watershed Enhancement Board on how to estimate economic impacts and which different groups to involve in evaluating the benefits of local project coordinators, the Oregon Legislative Revenue Office on the need to modify the Oregon Tax Incidence Model, and the Oregon Child Care commission, and Child Care Research Roundtable on the appropriate level of analysis to determine the economic impacts of the child care industry in Oregon
    - Nonprofit agencies – Collaborated with the Northeast Oregon Economic development District, Wallowa Resources, and the Oregon Center for Rural Policy, Research and Service to consider individual projects and program direction.

4. The Mid-Columbia Agriculture Research and Extension Center solicits input from growers and industry through the 12 members of an advisory board. The board members consist of environmental advocates, county commissioners, and Port commissioners. These officials represent the interest of their electorate and give advice that is not necessarily the mainstream thinking in the industry.
5. The Horticulture department organized a stakeholder meeting of the nursery industry and related organizations including Oregon Department of Agriculture, USDA, Oregon Association of Nurserymen, Chemeketa, Horticultural Research Institute and the Oregon Garden.
6. Crop & Soil Science faculty annually discuss departmental priorities with commodity commissions through informal commission meetings and formal special sessions held during grower association meetings. Several faculty work with metro-based businesses (biosolids, cereal breeding, grain dealers, and milling/baking companies).
7. The Coastal Oregon Marine Experiment Station rotates their Board meetings to different locations along the coast and advertises the meetings in local newspapers. A partnership with ShoreBank Enterprise Pacific has formed the Community Seafood Initiative (CSI). The mission of this partnership is to foster entrepreneurship, and to help small and mid-size enterprises in the seafood industry to develop products and enter new markets. Engaging stakeholders of various sectors will ensure successful delivery of the program goals. A web site called "Heads-Up" disseminates information about the program as well as giving timely research information.
8. Klamath Experiment Station faculty hold a "Field Day" for forage producers to observe research in progress. In addition, growers are invited to the screening/selection of specialty potato breeding material. Grower meetings are held to seek input on research needs. Advisory board meetings are held to discuss current research programs and future research direction and needs. The Klamath Tribal Council has been present at various tours and participated in the Klamath Watershed conferences. There is an ongoing effort to reach the Native American youth through the 4-H program. OSU President Edward Ray met with the Klamath Tribal Council in November (2003) and requested their input and participation as members of the OSU community.

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

How Input Was Considered: Pertinent feedback is received from various stakeholders on a wide range of research and program initiatives which are currently in progress. As a result of the input received, OSU faculty modify work plans to improve the design of research projects and provide specific opportunities for continued feedback. For example, mail surveys have been used to solicit information from businesses and organizations as part of a USDA grant to determine keystone sectors within communities. Information is disseminated to communities through newsletters, local newspaper coverage, and radio programs. Administrators and faculty use input to prioritize resource allocations, inform other researchers and policy makers of trends and concerns. Recommendations from various advisory boards represent key constituent views, and are useful in the developing extension programs which reach the agroproduction sector.

Example: A task force was assembled to focus on the low-income healthcare workforce and develop career pathways for entry-level workers in the healthcare industry (Certified Nursing Assistants, for example). A direct result of the input received in this process has been OSU involvement in a federally-funded pilot project to improve the job opportunities for entry level healthcare workers and to increase the stability of the low-wage health care workforce. OSU's part in this project is a study of the turnover rates of this workforce and the effect of various educational programs on worker stability and wage advancement.

C. Program Review Process

There have been no significant changes in our program review processes since our 5-Year Plan of Work was submitted.

D. Evaluation of the Success of Multi and Joint Activities

The Oregon Agricultural Experiment Station currently has 108 scientists who contribute to 83 multistate projects under the five National Goals. Each multistate project submits an annual report on the group's activities, accomplishments and plans for the future. The OAES makes no attempt to evaluate any of the multistate research activities as that is accomplished through the efforts of the scientists and administrative advisors in each of those programs. The Western Research Coordination and Implementation Committee is responsible for evaluating each new or revised proposal for projects, and the AES directors approve or disapprove of them based on recommendations from the RCIC.

The Oregon Agricultural Experiment Station contributes to 83 multistate projects:

- National Goal #1 (W-006, W-106, W-112, W-128, W-150, W-171, W-192, W-195, W-1004, W-1133, W-1147, W-1168, W-1177, W-1185, W-1186, WCC-011, WCC-027, WCC-039, WCC-043, WCC-055, WCC-058, WCC-060, WCC-067, WCC-069, WCC-072, WCC-077, WCC-081, WCC-089, WCC-093, WCC-097, WCC-099, WCC-101, WCC-109, WCC-110, WCC-204, NC-131, NC-1142, NCR-022, NCR-097, NCR-131, NCR-173, NCR-180, NCR-189, NCR-190, NE-124, NE-132, NE-183, NE-1011, NE-1012, NE-1018, S-290, S-1000, S-1004, S-1007, NRSP-3, and NRSP-6).
- National Goal #2 (W-150, W-1122 and WCC-023),

- National Goal #3 (W-1002, W-1003, W-1122, WCC-027, WCC-103, NC-136, and NC-219),
- National Goal #4 (W-045, W-128, W-150, W-170, W-187, W-190, W-1133, W-1147, W-1185, W-1186, WCC-040, WCC-043, WCC-058, WCC-060, WCC-077, WCC-081, WCC-089, WCC-091, WCC-097, WCC-099, WCC-102, WCC-103, WCC-205, WCC-1003, NC-140, NCR-059, NCR-193, NE-103, NE-132, S-285, S-1000, NRSP-3),
- National Goal #5 (W-128, W-167, W-192, W-194, WCC-055, WCC-058, WCC-207, WCC-208, WCC-1001, NC-1011, and NE-1012).

The OAES is actively encouraging our scientists to participate in multistate activities. We continue to monitor our progress.

E. Integrated Research and Extension Activities

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

Title: Forage Information System on the World Wide Web

Issue: The Forage Information System contains considerable information about proper species selection and improved management techniques for fertilizing, irrigation, pest control, harvesting, quality testing, marketing, and utilization. When forage producers follow the recommendations appropriate for their locale, they should enjoy greater yields of high quality forages, fewer seeding failures, and reduced use of external inputs like irrigation, fertilizers, and pesticides. The outcome is a better product to use or sell, grown at a greatly reduced input cost, while preserving the environment. This is a global forage information resource designed to become the premier comprehensive information system for all aspects of forage production. It links people and information in a work-sharing and access-on-demand environment. This effort vividly demonstrates how Extension, research, teaching, industry, and farming and ranching experts can work together to develop a knowledge base of value to all participants. The FIS is the most efficient way to disperse forage information to endless numbers of people around the world.

What has been done: The FIS website contains thousands of pages and various types of information and receives hundreds of "hits" per day from around the world, more than 50,000 per year. The Forage Information System World Wide Web project contributes positively to the environment by providing information on (1) reducing soil erosion (by use of cover cropping, converting highly sloped land to permanent pasture, and improving grazing management); (2)

improving water quality (through recommendations about appropriate fertilizer levels and how to reduce silo runoff); (3) reducing water usage (through improved irrigation scheduling); (4) reducing pesticide usage (through systems approaches that include alternative techniques and recommendations about proper rates for application of needed pesticides); and (5) promoting sustainable farming and ranching practices .

Impact: Social benefits of the FIS website include enhanced availability of information to users worldwide; considerably more effective outreach (more than 50,000 contacts per year) than traditional Extension outlets; the possibility of global collaboration that creates a community of scientists and producers with a mutual interest; and, because of this close community that shares information, duplication of effort is reduced.

Title: Electronic Information Delivery for Potato Growers

Issue: The economic value of instantly available on-line information related to production, and all other aspects of potato cropping, are obvious, but difficult to quantify. The Potato Information Exchange (PIE) site offers information on cultural management, pest and disease control, market prices (terminal, shipping point, and futures), storage and processing, announcements of upcoming meetings, related websites, and a list of OSU potato experts in Crop and Soil Science, Botany and Plant Pathology, Entomology, and Food Science and Technology (including their e-mail addresses). Similarly, the website for the OSU Foundation Potato Seed Program offers information to Oregon's seed potato growers. Besides websites, Extension's two mailing lists, POTATONET (for professionals) and SPUDNET (for growers) convey economically valuable information, including making people more aware of available websites.

What has been done: The team has developed and maintains the Potato Information Exchange (PIE), a website found at http://www.css.orst.edu/potatoes. PIE is the first such potato website and largest of its kind with more than 3500 external links. Although its main users have been academics and other professionals, growers are discovering the site and finding it a useful source of production information valuable for improving their bottom line, while minimizing any adverse environmental impacts. Certainly, the internet medium offers the most efficient use of Extension resources and the most effective information delivery system with potential to reach the broadest possible audience. Thus, while maintaining and improving the site, efforts are being directed to increasing grower awareness of its availability and its usefulness to them.

Impact: Information at the Potato Information Exchange website helps growers become aware of potentially adverse impacts of production practices on the environment and how to adjust operations to minimize these effects. As a result of this and other Extension efforts, potato growers are refining their pesticide, fertilizer, and water usage downward, while adjusting tillage practices to be more environmentally benign. The PIE website offers links to information pertinent to the environment, including endangered species protection, water quality issues, and prudent pesticide use. In addition, production recommendations presented in the body of the website, and in many linked sites, are designed to minimize environmental impacts of production. Adoption of the fertilizer, irrigation, and pest control recommendations offered are particularly important for environmental protection.

Title: OSU Foundation Potato Seed Program

Issue: Because the potato is asexually propagated, or cloned, diseases and pests are readily passed from generation to generation causing devastating yield losses in many instances and creating demand for high pesticide inputs. The OSU Foundation Potato Seed Program (FPSP) breaks this disease cycle by producing and distributing absolutely pathogen-free planting stock to all of Oregon's potato seed growers.

What has been done: The OSU Foundation Potato Seed Program is fully described in the associated website and in regular reports to growers via the Oregon Potato Commission website at http://www.oregonspuds.com. The FPSP works closely with Oregon seed potato growers and other customers throughout the year in taking orders, delivering planting stocks, and monitoring performance of the materials. The staff describes the program and fields questions at grower meetings, on-farm visits, and by telephone and email.

Impact: The value of Oregon's $129 million potato crop (in 2001) is multiplied to more than $300 million by instate processing; at least two-thirds of the crop goes into frozen fries and other products. The potato payroll approaches $60 million, larger than all other agronomic crops combined. However, diseased seed potatoes can reduce yields and quality drastically, totally eroding growers' profits and adversely affecting the entire industry. Seedborne diseases also increase the need for expensive pesticides. For example, late blight was almost certainly introduced to the Klamath Basin by infected Russet Norkotah seed from the Midwest in the early 1990s. As a result, pesticide costs increased by at least $100 acre for Klamath County's potato producers. To provide a conservative, but credible, estimate of the contribution of OSU's Foundation Potato Seed Program to the state's potato growers, consider only the savings in pesticide use. Using the above example of $100/acre cost in Klamath County in the early 1990s and the facts that the health of this large industry depends heavily on the use of disease-free seed provided by OSU's FPSP and there were 47,400 acres of potatoes harvested in 2001: ($100/acre x 47,400 acres) = over $4.7 million/year.

Title: Educational Programs on Diseases of Field Crops in Eastern Oregon

Issue: Diseases of field crops are a continuing problem in northcentral and northeastern Oregon. Educational programs provide growers and their advisors with up-to-date information regarding disease identification, the economic importance of diseases, and disease management options.

What has been done: Educational programs provide growers and their advisors with up-to-date information regarding disease identification, the economic importance of diseases, and disease management options. These educational programs are presented through discussions at public meetings or during one-on-one visits; identification of diseases on samples brought to the Columbia Basin Agricultural Research Center laboratory or observed in the field, along with related discussions; preparation of written materials; information-gathering visits with specialists in other regions or countries; and participation in field tours and meetings coordinated by Extension Service faculty and agribusiness.

Impact: This program is intended to assist growers maintain or increase profitability by reducing the risk from diseases. Over the past 60 years, research and technology have increased wheat yields by an average of 0.6 bushels/acre/year, with disease control contributing about 10% of this gain. Disease management practices can often be integrated to minimize the application of pesticides and to reduce the application of certain management practices that, while highly effective, are unacceptable to many members of society. As one example, Cephalosporium stripe is a serious disease of winter wheat. Acceptable control with minimal economic impact can be achieved by integrating several practices that are individually unacceptable.

Title: Optimal Forage Species Selection and GIS-based Mapping

Issue: The Optimal Forage Species Selection and GIS-based Mapping efforts for the USA and China involves the integration of digital elevation, climate, soil, and species adaptation information. Efforts now include participation by multiple departments and colleges within Oregon State University and other universities, agencies, and organizations in the USA, PRC, Canada, Australia, and the European Union. The goal is to utilize the technologies now available in various branches of science to help place the right plant in the right place for maximum growth while protecting natural resources and minimizing inputs which are costly.

What has been done: The project functions on two different planes that are merged together to provide maps that reveal specific information that can be easily modified or restructured. The first plane of work is the development of the computer technologies that will allow many factors to be blended into maps. Maps that can show temperature, topography, soil type, and precipitation can lead growers to select a productive species that does not tax the environment.

This project also set out to determine which grass species would grow best in China so that Oregon farmers could market their products there more successfully. The project has the most comprehensive data collection for climate and soil in China to be found in the world. The data has been meshed together with grass species information to produce very detailed maps that will assist the growing of grass in the People's Republic of China. The following URL will house the information gained from this project: http://forages.oregonstate.edu/is/ssis/ (The overall goal of the Species Selection Information System (SSIS) is to improve agricultural productivity, natural resource management and environmental protection using advanced computer technologies.)

Impact: (1) Collection, quality checking, and organization of Chinese agricultural data that was previously available on an item-by-item basis. This information has been made readily available to the scientific community. (2) Integration of topology, climate, soil, and agricultural species information into a decision-making prototype that uses the latest in information technologies. (3) Improved potential for targeting the marketing of U.S.-grown seeds, agricultural chemicals, equipment, and services. It provides essential information about topography, climate, soils, current land-use, and cropping systems, which is essential information for marketing US products within China. (4) Professional development of U.S. scientists, improvement of teaching, and improved international relations.

There are also many ways in which this project has benefiting the cooperating foreign country (China). These include: (1) Collection and quality checking of topography, climate, soils,

vegetation, land-use, and agricultural economics data for use in this and other projects. This information has been made more readily accessible to the Chinese scientific community. (2) Application of current and emerging technologies for integration of data and information resources, from many different sources, into decision-aid tools using current computer technologies. (3) Professional development and student educational programs for Chinese students. This program provided short-term exchanges for faculty and students. (4) Establishment of cooperative linkages among Chinese and U.S. agencies and institutions.

Title: Oregon Plant Diagnostic Clinic

Issue: The OSU Plant Diagnostic Clinic is a statewide resource for solving plant-related problems. It receives samples from Extension Service offices, growers, home gardeners, research faculty, government agencies, and other clients. This clinic identifies all manner of plant pathogens (there is no such thing as a routine sample). It is recognized nationwide as a center of excellence in plant disease diagnosis.

What has been done: Plant samples are examined to diagnose problems, determine their causes, and make appropriate control recommendations. The clinic receives samples with problems that Extension field agents and specialists, field representatives for chemical/fertilizer companies, and other specialists cannot identify. There is no such thing as a routine sample. Many new diseases are discovered each year that have not previously been documented. In addition, the clinic offers special testing services in response to the needs of growers, such as examining water samples for presence of certain pathogens harmful to production of nursery crops, testing fungi for susceptibility to certain fungicides, testing for fungal pathogens in seed crops of importance to Oregon's agriculture, and assaying soils for a destructive soil-borne pathogen that affects many crops.

Impact: This clinic identifies all manner of plant pathogens and is recognized nationwide as a center of excellence in plant disease diagnosis. The OSU Plant Clinic also acts as a regional resource for 10 western states for identification of certain pathogens. This activity is only one way in which the clinic is participating in national plant disease and pest detection work, constructed in response to the need to protect America's crops from intentional introductions of harmful pathogens. There are no private clinics in Oregon offering parallel services, so the OSU Plant Diagnostic Clinic, with its proper diagnosis of pests and other plant problems and appropriate recommendations for control, literally saves Oregon growers millions in lost crop revenues.

Title: Extension Water Quality

Issue: Besides being beneficial to the environment, water quality protection and stream restoration are also economically important throughout Oregon. This program plays an important role in identifying those remediation efforts that are most effective in relation to the investment involved. This program is an integrated research, education and Extension effort in Oregon and the Pacific Northwest. Supported by research, the program educates homeowners, farmers, ranchers, and dairies about ways to protect well water supply, manage cattle near riparian zones,

adjust nutrient application rates, improve animal management in the Tualatin Basin, and reduce fecal coliform in Tillamook Bay.

What has been done: A major activity of the Water Quality Program has been the training provided through the Watershed Stewardship Education Program. That particular program has trained over 600 people in the functioning of watersheds. Of these, 400 have become Master Watershed Stewards by following the training program with an independent project. They have contributed 16,000 hours of volunteer time in actually restoring watersheds. In addition, under this project, research is underway to harvest nutrients, nitrogen, and phosphorus, from animal wastes. This procedure will provide double economic benefits: (1) it will reduce the cost of land application and (2) it will allow a livestock producer either to sell nutrients or to grow crops on remotely-owned fields without buying commercial fertilizer.

Impact: As a result of this Extension educational effort bacterial concentrations have been reduced in Tillamook Bay; homeowners are working to protect their well water supplies; water quality in the Tualatin River is better, due to improved management of livestock; and Malheur County irrigators are using less nitrogen and pesticides. Watershed council members are an especially important audience for this water quality program in that they constitute one of the most active groups performing watershed restoration with the objective of restoring salmon and trout to streams where populations have declined. Tree planting and riparian zone management are critical to their success.

Title: Wallowa County Nez Perce Tribe Salmon Habitat Recovery Plan and Multi-Species Habitat Strategy

Issue: The Wallowa County Nez Perce Tribe Salmon Habitat Plan and Multi-Species Habitat Strategy is a management strategy that considers all environmental aspects of each watershed, ridgetop to ridgetop, and analyzes each stream, reach-by-reach. The result is a large scale plan that does small scale analysis.

What has been done: Under this comprehensive plan, over 400 watershed enhancement projects have been completed over the last nine years, including, 205 miles of fencing; 10 miles of road closures; 220 miles of road improvements; 20 miles of in-stream work, with 330 in-stream structures; 140 spring developments; six irrigation diversion structures; and 35,000 acres of land treated. Wallowa County's experience with the salmon plan is being picked up by other areas that have anadromous fish listed as threatened or endangered. The work has expanded beyond Wallowa County. Twenty workshops focused on preparing county governments to respond to, and work with, federal agencies included participants from 58 counties in four states. Williams makes presentations and consults in Oregon, Washington, Idaho, and California.

Impact: The salmon plan brought together a wide variety of interested parties to focus on obtainable improvements of salmonid habitat, while allowing continued access to and use of the natural resources. Practical solutions were, and are, offered to ecological problems. Due in a large part to Extension's efforts, the salmon plan has become the way of doing business in Wallowa County. State and federal agencies comply with the plan, while private landowners, as they become more aware, are beginning to "do the right thing." Such a consensus about what are

the right actions has social benefits far beyond solving the actual problems. Through county empowerment workshops, the process used by Wallowa County is being adopted by other counties in the Pacific Northwest. Lessons learned from the implementation process include: (1) Protecting local custom, culture, and economic stability is critical to the economic welfare of rural America. (2) County governments must lead in this process. (3) County governments must enlist a broad range of local people to participate in the process. (4) These local people must be committed to follow through with outcomes and efficient communication.

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

Institution: Oregon Agricultural Experiment Station
State: Oregon

Check one: ____ Multistate Extension Activities
__X__ Integrated Activities (Hatch Act Funds)
____ Integrated Activities (Smith-Lever Act Funds)

Title of Planned Program/Activity	Actual Expenditures USDA Goal	Hatch
An agricultural system that is highly competitive in the global economy	1	$ 455,845
A safe and secure food and fiber system	2	$ 74,581
A healthy, well-nourished population	3	$ 37,590
Greater harmony between agriculture and the environment	4	$ 224,134
Enhanced economic opportunity and quality of life for Americans	5	$ 19,165
Total		$ 811,315

Director Date