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Dr. John A. Michael
Montana Plan of Work Facilitator, and
National Program Leader in Social Science
CSREES
Room 3871 South Building
Washington, D.C. 20250-2217

Dear Dr. Michael:

The *Plan of Work* for Montana Agricultural Experiment Station has undergone substantial revision and is enclosed for your consideration. We discarded the original version and prepared the revision to focus on outlined federal guidelines.

Our current program is admittedly weak in Goals 2 (A Safe and Secure Food and Fiber System), 3 (A Healthy, Well Nourished Population), and 5 (Enhanced Economic Opportunity and Quality of Life for Americans). However, I am in discussion with the new Dean of the Education, Health and Human Development College and the Dean of the Extension Service to address these deficiencies and build collaborative programs among our units. Please note that I have been in this position for less than four months.

I appreciate your assistance and guidance in the revision process.

Sincerely,

Sharron S. Quisenberry
Dean and Director

ssq:dh
Office:POW/MichaelLtr

PLAN OF WORK

Montana State University

College of Agriculture
Montana Agricultural Experiment Station



Federal Fiscal Years
2000 to 2004

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Introduction

Preface

The College of Agriculture at Montana State University, headquartered in Bozeman, Montana, is comprised of the Montana Agricultural Experiment Station and the College's academic programs in undergraduate and graduate studies. It does not include the Montana Extension Service though Extension Specialists are housed within departments in the College of Agriculture. The College also does not have programs in Family and Consumer Sciences or Rural Development.

The Plan of Work is a comprehensive statement of the College's intended research activities for the next five years, as required by the Agricultural Research, Extension, and Education Reform Act of 1998 (AREERA), and as allowed under the U.S. Department of Agriculture's (USDA) "Guidelines for Land Grant Institution Plan of Work." The Plan of Work is based on the College's current Strategic Plan. The College's planning process was initiated in September 1998 and modified in August 1999. It is a collaborative effort by faculty, administration, and representatives of Montana's Agricultural Organizations. Student input will be solicited in the fall of 1999. The strategic planning process has been to set forth a plan for developing priority goals and objectives in the areas of instruction, research, and service. It is intended to be a dynamic plan that would change as various goals are completed.

The Montana State University Plan of Work consists of 10 programs in research. Research programs have been listed under the one most prevailing goal. Programs are developed on a five-year or greater than five-year timeline although many individual projects have critical short-term goals. Stakeholder input has been solicited in the strategic planning process and will continue to be solicited as programs are developed and dollars are allocated to programs (see Stakeholder Input Process, page 31).

Point of Contact

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Vision

The Montana State University College of Agriculture (COA)/Montana Agricultural Experiment Station (MAES) will provide focused and viable science-based education, research, and extension/outreach programs essential for providing knowledge and leadership in agricultural systems and natural resources to preserve the quality of the environment, improve the quality of life, and create added value from our resources for Montana and its people in a global economy.

Mission

As a land-grant institution, Montana State University-Bozeman provides instruction, research, and extension/outreach programs focused to meet the ever-changing needs of Montana and its people. In keeping with this mission, the COA/MAES provides science-based education, new knowledge, and leadership on agricultural and natural resource issues.

Values

- Provide visionary and responsive leadership based on scientific knowledge.
- Develop a community of scholars and learners committed to quality and excellence.
- Create a work environment of open communication, trust, honesty, and acceptance.
- Our conduct embraces the highest standards of ethics and citizenship.

Assumptions

- Plant and animal agricultural systems will continue to be important to Montana's economy.
- Natural resource and environmental concerns in Montana will increase.
- The needs of Montana's population will be more diverse and ever changing.
- Global concerns such as increased world population, depletion of fossil fuels, and loss of farmland will impact Montana.
- Montana must compete in the global economy and value-added exports will increase.
- Distance education's role will be increasingly important.
- Appropriated funds will be limited.
- COA/MAES must set priorities and focus programs.
- COA/MAES will provide proactive program leadership.

Program Focus and Overarching Goals and Objectives

COA/MAES program focus and overarching goals and objectives include generating and disseminating knowledge and providing quality educational and outreach activities. Montana agriculture, Montana students, and the people of Montana are a primary focus of COA/MAES programs.

Enhance Economically Viable and Sustainable Agricultural Systems

- Provide a scientific basis for developing viable and sustainable plant and animal systems.
- Enhance the fundamental understanding of plant and animal biology.

- Enhance the development of value-added agricultural products.
- Improve plant and animal health through integrated pest management and other sustainable practices.
- Improve food safety and quality.
- Contribute to commodity and product marketing and economic development.
- Create educational programs that address plant and animal systems and biology.

Improve Natural Resource Management and Enhance Environmental Quality

- Provide a scientific basis for developing land and water use policies and practices
- Enhance environmental quality and improve the sustainability of natural resource systems.
- Create educational programs that address natural resource needs and use patterns.
- Develop ecosystem improvement programs that promote sustainable management practices and are consistent with enhanced biodiversity.
- Provide programs to enhance understanding of disturbed, rural, and urban landscapes.

Strengthen the Quality of Life for Montana and Its People

- Enhance the development of educational programs and delivery systems, including distance learning, which improve basic learning and life skills among Montana's people.
- Improve recruitment and retention of students.
- Partnership with others to improve human nutrition and health, resiliency of families, and the viability of communities.
- Partnership with others to provide programs to enhance the development of new businesses and community development.
- Emphasize leadership development programs.

MAES Planned Programs

USDA REE Goals	MAES Research Programs	SYs	PYs & TYs
Goal 1	Program 1	23.3	56.1
Goal 1	Program 2	17.1	23.2
Goal 1	Program 3	3.8	1.0
Goal 2	Program 4	0.7	1.7
Goal 2	Program 5	0.0	3.0
Goal 3	Program 6	0.9	6.7
Goal 4	Program 7	5.5	18.0
Goal 4	Program 8	6.2	10.1
Goal 4	Program 9	2.3	0.8
Goal 5	Program 10	0.1	0.0

Goal 1. An Agricultural System that is Highly Competitive in the Global Economy

Program 1. Plant and Animal* Improvement

(RPAs 022, 158, 159, 173, 174, 179, 182, 183, 188, 194, 195, 197, 200, 201, 207, 216, 220, 224, 228, 230, 237, 240, 241, 242, 254, 296, 298, 307, 310, 313, 315, 336, 341, 342, 346, 348, 386, 392, 405, 406, 407, 410, 415, 419, 423, 428, 429, 505, 558, 708; See Appendices 1 and 2)

Statement of Issue

Plant Improvement. A key factor in the success of agricultural marketing is reliable production of a high-quality product. Several factors underlie the ability of a region to obtain reliable production. These include the existence of species and varieties adapted to the climatic conditions of the region, and a knowledge base providing control strategies for important insects, diseases, and weeds. The major cash crops in Montana and the surrounding region are wheat and barley, primarily because these species are able to thrive under chronic moisture stress conditions. Traditional crossing and selection programs need to be augmented with emerging tools of molecular biology to insure the continued development of competitive varieties. There is also a need for diversification of Montana's agriculture. This diversification includes the development of new crops, such as oilseed crops which perform well in the area. Adapted varieties, however, need to be grown in conditions that provide the best chance of success. Thus, there is a critical need for an increased understanding of the biology of cropland pests in order to develop suitable control strategies. Similarly, an understanding of beneficial organisms will provide a knowledge base to enhance their activity.

* Domestic and Wildlife Animals

Animal Improvement. The selection of breeding stock based upon quantitative genetic analysis and the prediction of breeding values continue to allow animal breeders the opportunity to develop systems to improve animals. The quality, consistency, healthfulness, and efficiency in which animal products are produced are under a significant amount of genetic control and, as such, investigative and descriptive genetic research projects must continue to be a high priority. Cross breeding systems offer the opportunity for the livestock producer to better match the genotype of the animal to the environment in which it must produce. Further, heterosis resulting from cross breeding systems significantly improves the efficiency of animal production.

Increasing efficiencies of producing food from animals, particularly, understanding physiologic mechanisms affecting reproduction, including the neonatal period and performance, is vital for an optimization of production efficiency and development of cost-effective production. Management of animals with high productivity capacities requires elucidation of factors regulating key biological processes, precise quantification of the nutrients required to support these processes, and development and evaluation of novel feedstuffs tailored to animal needs. Increased knowledge of microconstituents of plants, specifically minerals, feedstuffs, and animals and their possible regulatory role in function of cells and tissues are needed to enhance animal production. Evaluation of the plant-animal interface in more extensive production systems to better utilize forages and grasslands for food production is needed.

Infectious diseases cause millions of dollars in losses to the livestock industry in the context of reduced animal production. Reduced markets for meat products because infectious disease concerns cause additional financial losses to the livestock industry. Emerging infectious diseases found in wildlife populations, including bison, are becoming increasingly problematic for livestock producers. To reduce these losses, better vaccines, drugs, and diagnostic assays are needed for a number of infectious organisms of cattle, sheep, pigs, and other animals.

Performance Goals

Plant Improvement

- Improve agronomic traits for major crops grown in Montana and the region, providing increased profitability to growers.
- Improve the end-use quality of crops grown in Montana and the region, providing increased incentive for domestic and international markets to buy our products.
- Increase diversity of crops that can profitably be grown.
- Increase our scientific understanding of the physical and biological factors limiting crop production.
- Provide accurate and unbiased information to agricultural producers.

Animal Improvement

- Improve genetic mating systems, selection, and crossbreeding practices to increase efficiency of growth and production of meat and fiber.
- Improve production methods to increase reproductive efficiency of animals.

- Increase knowledge of the physiological mechanisms that will decrease neonatal mortality.
- Improve nutritional practices to increase efficiency of growth and production of meat and fiber.
- Decrease incidence of bovine coccidiosis.
- Reduce calf losses due to bacterial and viral scours.
- Increase fertility rates in cows by reducing trichomoniasis.
- Reduce incidence of mastitis.
- Increase effectiveness of vaccines.
- Develop new drug targets for equine protozoal myeloencephalitis, coccidiosis, and toxoplasmosis.
- Provide accurate and unbiased information to agricultural producers.

Output Indicators

Plant Improvement

- Improved varieties made available for agricultural producers.
- Higher quality varieties made available for the domestic and international markets.
- Development of new market uses for existing crops.
- Increase in the adaptability and profitability of producing crops besides wheat and barley.
- Publication of research results in scientific journals, and at national meetings.
- Publication of pertinent research findings to agricultural producers.

Animal Improvement

- Improved genetic basis for animal selection.
- Improved crossbreeding systems to better take advantage of heterosis and to better match the genotype to the environment.
- Improved physiological basis for reproduction of food animals.
- Improved nutrition for animal growth.
- Enhanced methods to define nutrient needs of animals.
- Improved animal production systems.
- New vaccines for enteropathogenic *E. coli*, *T. foetus*, *T. gondii*, and *E. bovis*.
- New drugs for *T. gondii*, *Sarcocystis*, *E. bovis*, and bovine rotavirus.
- Better attenuated bacterial and viral vaccine delivery systems.
- Better bovine lymphocyte-specific adjuvants
- New diagnostic assays for *E. coli*.
- Publication of research results in scientific journals, and at national meetings.
- Publication of pertinent research findings to agricultural producers.

Outcome Indicators

Plant Improvement

- Increased stability of the production of high quality crops.
- Increased market demand for our products.
- Significant advancement in the scientific fields.
- A more knowledgeable agricultural clientele.

Animal Improvement

- Improved tools and strategies for selection of superior breeding stock.
- Increased efficiency of animal reproduction.
- Superior recommendations for nutrient composition of diets for animals.
- Improved nutrient quality and consistency of foods of animal origin.
- Increased calf survival.
- Increased livestock production.
- Increased value of meat products.
- Better information on infectious diseases of livestock.
- More knowledgeable livestock producers with a greater understanding of animal biology, ecology, and production.

Key Program Components

Plant Improvement

- *Wheat curl mite*. Develop an understanding of the climatic factors that influence the prevalence of this vector for wheat streak mosaic virus. Understand cultural and management conditions that influence the movement of the wheat curl mite.
- *Curation of the MSU Entomology Collection*. Provide a resource for scientific and lay clientele to identify both beneficial and harmful insects.
- *Exploratory research in entomology*. Provide a basis for new research projects addressing emergent insect problems.
- *Miscellaneous plant diseases*. Provide a basis for new research projects addressing emergent disease problems.
- *Control of fungal disease by mating inhibition*. Determine the biochemical factors necessary for successful mating of fungal pathogens. Use this information to develop synthetic analogs to inhibit mating and thus disease development.
- *Mechanisms of plant virus transmission and assembly*. Understand the biochemistry of viral disease transmission, and use this understanding to develop control strategies.
- *Genetic improvement of biological control agents for weed control*. Use genetic selection strategies to enhance the activities of biological control strategies for weed species endemic to our cropping systems. Test the efficacy of the selected pathogens in field and greenhouse trials.
- *Population genetics of self-incompatibility in the Solanaceae*. Develop an improved understanding of the population genetic parameters influencing maintenance of self-incompatibility in the economically important plant family. Develop molecular techniques to allow analysis of self-incompatibility on a wider scale,
- *Genetically engineering plant light responses to improve crop quality*. Understand the genetic basis for control of plant response to light. Develop transgenic technologies to alter plant light response, with the aim of increasing crop yield and quality.
- *Exploratory research in plant, soil, and horticultural sciences*. Provide a basis for the initiation of new research projects related to these disciplines.
- *Winter wheat breeding and genetics*. Develop hard red winter wheat cultivars that combine reliable yield potential and excellent end-use quality. Develop a new class

of winter wheat, hard white, to capitalize on developing markets. Conduct, analyze and publish the results of statewide variety trials.

- *Quantitative genetics and cultivar development.* Devise selection methodology for breeding programs. Conduct experiments to understand the inheritance of traits important in the improvement of Montana's crops.
- *Phosphate assimilation in rhizobium bacteroids.* Develop an understanding of the molecular biology underlying the ability of *Rhizobia* to assimilate nitrogen in a symbiotic relationship with alfalfa. Develop management strategies for growers to maximize the use of biologically fixed nitrogen.
- *Alfalfa breeding, genetics, and cultural practices.* Develop alfalfa cultivars suitable for dryland production in Montana. Incorporate resistance to the major diseases limiting production. Conduct, analyze and disseminate the results of the statewide variety trials.
- *Spring wheat breeding and genetics.* Develop spring wheat cultivars with reliable yield potential and excellent end-use quality. Develop new types of spring wheat for emerging market opportunities. Conduct, analyze, and disseminate the results of statewide variety trials.
- *Seed biology and technology investigation.* Determine the factors that influence the ability of producers to achieve full stands of vigorous seedlings. Provide guidance as to suitability of seed lots for production.
- *Barley breeding and genetics.* Develop new barley cultivars with stable yield potential, and the ability to fit either the feed or malting markets. Conduct, analyze and disseminate the results of statewide variety trials.
- *Soil and plant nutrition for Montana agriculture.* Determine the limiting physical and biological properties of the diverse soils in Montana for supporting production of high quality crops. Disseminate management information based on scientific investigation to area producers.
- *Small grain quality and molecular biology.* Understand the molecular basis for quality attributes of cereal crops produced in Montana. Develop strategies for genetic engineering key genes to enhance end-use properties, and to target new markets.
- *Breeders seed purification and increase.* Produce pure and viable seed from new lines selected by plant breeders. Assist the breeders in the development of uniform lines. Provide clean seed to the Foundation Seed growers in Montana.
- *Weed biology and methods of control.* Develop an understanding of the complex interactions between weeds and crops under a range of climatic and management conditions. Use this information to develop comprehensive weed management strategies for area producers. Disseminate the information through written and oral presentations.
- *Breeding and improvement of oilseed crops for eastern Montana.* Select improved oilseed varieties for production in irrigated and dryland areas of eastern Montana. Use traditional and biochemical techniques to select oilseeds with improved nutritional quality. Disseminate varieties and information to area growers.

Animal Improvement

- *Breeding and improvement of agriculturally important animals.* Develop and test optimal selection and mating systems for genetic improvement.
- *Physiological basis of animal reproduction.* Determine genetic, neuronal, and hormonal mechanisms that enhance reproductive efficiency. Apply newly developed knowledge of animal physiology to optimize production efficiency.
- *Animal production response to nutrition.* Elucidate the bioregulatory roles of nutrition on performance of animals. Quantify the dietary nutrient requirements of animals. Enhance nutritional value and consumer demand for animal products. Identify, develop, and evaluate novel nutrient sources for animal production. Develop nutritional regimens to enhance the environmental integrity of animal production.
- *Exploratory research in animal and range sciences.* Provide a basis for the initiation of new research projects related to these disciplines.
- *Livestock and wildlife vaccines.* Develop new vaccines and adjuvants for cattle and sheep. Develop new vaccine strategies for wildlife diseases that are problematic in livestock.
- *Diagnostic assays.* Develop new assays to diagnosis disease in animals and to screen food products.
- *Genomics.* Develop genomic approaches to the study of infectious diseases of livestock.
- *New drugs.* Develop new drugs to combat infectious agents.

Internal and External Linkages (See Appendix 3)

- Scientists at Montana State University in Biology, Chemistry, Microbiology, Veterinary Molecular Biology, Animal and Range Sciences, Plant Sciences, Land Resources and Environmental Sciences, Entomology, and Research Centers are the primary investigators.
- State yield trials are conducted in concert with research centers and individual producers.
- Regional yield trials are conducted in collaboration with several surrounding states.
- Management and control strategies are tested in collaboration with growers.
- International and domestic marketing teams are consulted for end-use advice.
- Several private companies participate in variety development and testing.
- Federal agencies including USDA-NRI, USDA-ARS, USDA-APHIS, NIH, and NSF.
- State agencies/entities including Montana Board of Livestock and State Diagnostic Laboratory, and other universities.
- Private entities including local and regional biotechnology companies and larger pharmaceutical companies.

Target Audiences

Crop and livestock producers in Montana and United States, extension faculty and staff, scientific collaborators, agricultural consultants, commodity groups, agricultural and chemical seed industry, the public, and students.

Program Duration

Greater than 5 years

Program 2. Crop and Animal* Production and Management Systems

(RPAs 155, 161, 175, 176, 196, 198, 206, 372, 434, 443, 503, 504, 553, 557, 655, 703, 704, 710, 754, 755, 758, 804, 805, 853, 854; See Appendices 1 and 2)

Statement of Issues

Crop Systems. An ample, stable, and safe level of crop production forms the basis of the American standard of living. Montana landscape is dominated by dryland production of small grains and forages/range, though irrigated production is a significant component, particularly in the production of higher-value specialty crops. Because Montana producers contend with a highly variable landscape and climate, as well as a thin profit margin, sustaining the state's agriculture requires crop varieties and management systems that provide stability in yield and quality across these variables while maintaining environmental quality. Successful implementation of cropping systems requires complex agronomic decision-making and input optimization to reduce risk and maximize economic returns in rainfed environments. Management of applied nutrients is a key component in the development of profitable and environmentally sound systems. Recently, GIS, GPS, remote sensing and other sensors have characterized inherent field variability and provide a mechanism to match field variability with variable rate application of nutrients. Understanding how applied and residual nutrients are utilized in diverse cropping systems will lead to enhanced decision-making and improved profitability, while preserving environmental quality.

Animal Systems. Profitability and competitiveness of the range livestock industry depend on its ability to control costs per unit of output. Production costs for the cow/calf or ewe/lamb sectors of the livestock industry are high. One problem is that forage quality and nutrient requirements of grazing livestock are often not synchronized, thus requiring the feeding of supplements and/or harvested forages to compensate for low forage quality. Another challenge is managing the seasonal variability in the amount and nutritional quality of the forage supply. The result is that harvested forages and supplements are the largest component of total costs. Systems for grazing livestock production that make more effective use of standing forages by grazing should improve both the profitability and sustainability of the industry. Range management is commonly the weakest component of grazing livestock operations, thereby limiting enterprise profit and promoting other less environmentally desirable range management practices. Many studies have documented the largest proportion of costs in the grazing livestock system comes from harvested and purchased feeds. Because these costs often account for one-third or more of the total, it seems logical that a major reduction in harvested and purchased feed could enhance profitability of the grazing livestock system.

* Domestic and Wildlife Animals

Performance Goals

Crop Systems

- Develop management strategies that improve the efficiency of crop production while protecting the natural resource base.
- Develop and improve integrated pest management systems for cropping systems.
- Improve the production and utilization of forages.
- Improve reliability of crop production systems during severe climatic variability to gain increased production efficiency with higher average yields.
- Improve quality, uniformity, value, and marketability of agricultural products through variety development.
- Identify alternative crops for Montana with yield and quality characteristics for acceptable marketing potential.
- Improve nutrient management systems for efficiency of yield and quality response, effective utilization of inputs, and minimal environmental impact.
- Characterize the suitability of new technologies and increase the adaptation of appropriate technologies.
- Understand the basic mechanisms used for utilization of phosphorus by legumes.
- Provide accurate and unbiased information to crop producers.

Animal Systems

- Enhance forage production and grazing practices on range to increase efficiency of animal growth and production.
- Enhance understanding of the role of forage utilization and sustainable grazing systems in environmentally friendly approaches to livestock production.
- Improve understanding of strategic supplementation to improve the efficiency of livestock production.

Output Indicators

Crop Systems

- Provide information relative to sound nutrient management practices.
- Develop more efficient agricultural production systems. Increase the efficiency of nutrient and water resource utilization.
- Crop variety releases and recommendations.
- Recommendations to reduce the competitiveness and fecundity of pests.
- Increased communication of research productivity via the WWW.
- Enhanced adoption of research findings by the agricultural sector.

Animal Systems

- Better understanding of forage production systems.
- Improved methods to define costs of producing livestock using forage-based systems.
- Enhanced understanding of the role of plants and animals in food producing systems and adoption by the agricultural sector.

Outcome Indicators

Crop Systems

- Number of producers adopting pest, nutrient, crop, and forage management strategies that improve the efficiency of production and minimize environmental impact.
- Number of acres devoted to newly released/recommended crop varieties.
- Increased crop yields and quality.
- Greater attendance at field days and workshops; number of "hits" on relevant internet web sites.
- Number of research reports to the scientific community, technical reports and workshops for active producers, interpreted information for potential producers, the general public and schools, and cooperative services to state agencies
- Increased profitability and reduced inherent risks of crop production.
- Use of soil attribute information for management decisions.
- Increased producer and consultant collaborations.

Animal Systems

- Optimum interaction between animals and plants in grazing systems.
- Reduced costs of producing livestock using grazing systems.
- Greater public knowledge of the principles of range science, a greater public appreciation for the role of grazing systems in protecting the range ecosystem, and enhanced appreciation for the role livestock have in harvesting and converting forages to quality meat for human consumption.

Key Program Components

Crop Systems

The key component is field research of management practices and variety development directly applicable to Montana's crop production systems.

- *Small grains.* Develop varieties with improved yield, yield stability, grain quality, and pest resistance for Montana's growing regions; research on improving competitiveness in cropping systems for increased pest resistance. Develop nutrient management systems for improved yield and quality. Evaluation of tillage and seeding technologies for dryland production systems.
- *Forages.* Identify and characterize factors that limit the nutritive value of forage grasses and legumes. Develop systems and strategies for improving the seasonal distribution and utilization of forages, including harvest management and species/variety selection. Integrate forage production with small grain based cropping systems.
- *Canola and pulse crops.* Evaluate the introduction of these crops into small-grain based production systems. Characterize the effects of these crops on pest populations and soil nutrient and water status. Develop production guidelines.
- *Safflower.* Breed varieties with improved yields and market-requested characteristics, including healthier food oils, industrial oils, and value-added livestock feed quality.
- *Sugarbeet, potato and other vegetables, peppermint and other essential oil crops, and medicinal and culinary herbs.* Evaluate new species/varieties and management

systems for potential production of these high value crops under existing and expanded irrigated acreage in the state. Evaluate pest control technologies for these crops. Characterize crop quality components in these new crops under Montana growing conditions.

- *Impact of Russian Wheat Aphid on Wheat and Economic Benefit of Treatments.* Determine the economic injury and cumulative damages attributed to Russian wheat aphid on selected growth stages of winter wheat and the economic benefits of insecticide treatments.
- *Soil and Nutrient Management.* Characterize optimum nutrient management strategies for Montana cropping systems across variable landscapes; evaluate the potential for environmental impact. Refine the relationships between available water and nitrogen and crop response in yield and quality. Characterize the relationship between applied soil nutrients and crop yields and quality for economically important crops. Develop methods of sensing crop nutrient status for mid-season nutrient management decisions. Characterize phosphorus acquisition processes involved in phosphorus metabolism in the legume-rhizobium symbiosis.
- *Site-specific management.* Characterize the inherent variability of soil attributes and pest populations, and apply this information to site-specific management of system inputs. Develop site-specific nitrogen management systems based on protein mapping.
- *Pest management.* Evaluate strategies for pest control. Improve resistance of small grain production systems to weed infestations through seeding technologies. Determine the economic injury and cumulative damages attributed to Russian wheat aphid on selected growth stages of winter wheat and the economic benefits of insecticide treatments. Develop wheat varieties and cropping practices resistant to wheat stem sawfly. Improve weed control technologies for existing and potential crops important to Montana.

Animal Systems

- *Cattle grazing behavior.* Characterize the behavior and distribution of grazing cattle in a variable landscape. Manipulate herd behavior to more efficiently utilize the rangeland resource and minimize environmental impact of grazing.
- *Grazing systems and environmental quality.* Develop and evaluate concepts and systems for animal and grazing management to improve the profitability of livestock production. Specific objectives are to: Quantify production and economic impacts, including risk, of grazing livestock systems that better match animal nutrient requirements to the quantity and nutritional value of the forage supply; and improve the profitability and productivity of cow-calf systems by identifying alternative forage species and grazing management to extend the length of the grazing season.

Internal and External Linkages (See Appendix 3)

- Scientists at Montana State University in Microbiology, Entomology, Animal and Range Sciences, Land Resources and Environmental Sciences, Research Centers and Plant Sciences are the primary investigators.
- Advisory committees regularly review and recommend research priorities for each Research Center.

- State commodity organizations collect and disburse check-off funds to support their priorities for research.
- Field research activities conducted on cooperating farms.
- Farmer and consultant collaboration in the design and implementation of field activities.
- Agribusiness company participation through in-kind equipment and material donations.
- State/national crop and livestock commodity organizations.
- Farm service organizations.
- Media agencies and organizations.
- USDA agencies.
- State and federal extension services.
- State agencies.
- National and international scientific societies.
- Agricultural industries.

Target Audiences

Scientists, agribusiness, consultants, Certified Crop Advisers, and producers in Montana and the United States.

Program Duration

Greater than 5 years

Program 3. Agricultural Finance, Marketing, and Policy
(RPAs 075, 087, 088, 098; See Appendices 1 and 2)

Statement of Issue

In Montana and throughout the United States, the environment within which agricultural producers operate is becoming increasingly complex. Sources of this increasing complexity include the financial system, evolving marketing practices and systems, and the myriad government programs that influence producer behavior in agriculture. Agricultural producers, in dealing with financial and management issues, are presented with an increasingly complex set of tools with which to address the problems they face on a regular basis. This added complexity necessitates a continued academic effort that identifies and provides potential solutions for the continuously changing set of problems. With respect to marketing systems, the dynamics of changing foreign and domestic markets produces price volatility and marketing uncertainties to producers and agribusiness firms. These necessitate estimating price/production behavior, margin behavior, and developing appropriate marketing, financial and risk management strategies in an uncertain environment. Such information has the potential to improve the efficiency and competitiveness of the U.S. agricultural sector. Government policies affect every aspect of agricultural and natural resource economic activity through their impacts on consumer and producer welfare, the welfare of farm input suppliers and food processors, and on rural communities and taxpayers. Economic analysis of selected

policies under this plan of work will enhance the competitiveness and efficiency of U.S. agriculture.

Performance Goals

Model and estimate the market wide and farm level economic and financial effects of:

- domestic and international agricultural commodity programs and policies for livestock, wheat, barley and other crops;
- current and potential disaster, crop insurance, and price risk management programs for wheat, barley and other crops;
- agricultural commodity and livestock marketing systems;
- natural resource use and policies;
- alternative contractual arrangements for land tenure; and
- agricultural science and social science research policies.

Output Indicators

- Research papers published in professional journal articles, papers for professional meetings/ proceedings, and departmental research publications.
- Materials developed for extension and outreach activities to educate and further interact with producer groups and policy makers. Publications in popular and farm press daily and weekly newspapers and magazines.
- Presentations at professional meetings, to farm and agribusiness groups, to state legislators and congressional legislators and aides.
- MSU analysis of risk management tools provided by federal agencies to producers.

Outcome Indicators:

- Outputs used by producer groups and agribusiness groups in analyzing markets and developing policy positions.
- Publications and outputs used by professional colleagues as evidence by citations.
- Outputs used by policy makers at the state and federal level.
- Risk management tools implemented to modified by federal agencies based upon analysis from MSU.

Key Program Components

Research will be conducted on the following major agricultural finance, marketing practices and evolving issues, and government agricultural and natural resource policy.

- Proposed provisions of the forthcoming WTO multilateral trade agreements on wheat, barley and livestock markets in Montana and other states in the Northern Great Plains and Rockies region.
- Changes in domestic Canadian farm programs, bilateral trade policy actions, and NAFTA trade policies on the volume and prices o beef, wheat, and barley from Canada to the U.S.
- Market concentration and technical change on feeder cattle and fed cattle prices in the Northern Great Plains and Rockies region.
- Impacts of alternative crop insurance and other risk management strategies on farm financial indicators, resource utilization, market prices, and soil erosion in Montana,

the Northern Great Plains, and other regions of the U.S.

- Potential effects of the reintroduction of set-asides and other land use restriction programs for major commodities, including wheat, on land use, farm gate prices, and farm incomes.
- Alternative land tenure contracts on resource use and financial performance in Montana and other regions of the U.S.
- Alternative forms of information provided to cattle buyers and auctions of yearling breeding bulls.
- Investigation of the determinants of the choice between auctions and negotiated sales of standing timber and breeding bulls and commercial cattle.
- Alternative mechanisms for implementing farm level production quotas on farm incomes and agricultural commodity prices.
- Agricultural research and development policies on agricultural productivity.

Internal and External Linkages (See Appendix 3)

- Plant scientists, animal scientists and veterinary and medical scientists at Montana State University and other components of the Montana Agricultural Experiment Station system.
- Faculty and administrators in the Montana extension service and the extension services of other states, including North Carolina, Nebraska, and North Dakota.
- Faculty and graduate students in agricultural economics and economics departments, and agricultural science departments at other U.S. land grant universities, and Australian, Canadian, European and other universities.
- Producer groups in Montana and other states, including Montana Grain Growers Association, Montana Stock Growers Association, U.S. Wheat Associates, National Association of Wheat Growers, Montana Farm Bureau, and Montana Farmers' Union.
- Economists, social scientists, and research scientists and administrators at USDA, other government agencies, and Consultative Group on International Agricultural Research.
- State and congressional legislators and legislative aides.

Target Audiences

Agricultural producer's commodity groups in Montana and the United States, agribusiness groups and leaders, program administrators and research economists and scientists in the USDA, state and congressional legislators and legislative aides, domestic and international trade policy negotiators.

Program Duration

Greater than 5 years

Goal 2. A Safe and Secure Food and Fiber System

Program 4. Plant Genetic Resource Conservation and Utilization (RPAs 318, 396; See Appendices 1 and 2)

Statement of Issue

The science of plant breeding is responsible for approximately one-half of the dramatic yield gains experienced for most of our major crops over the past few decades. Additionally, genes for resistance to major insects and diseases have been incorporated into successful crop cultivars. The basis for plant improvement through breeding is the exploitation of genetic variability. In order for this variability to be accessible to plant breeders, plant collections must be developed, catalogued, and characterized. Finally, once superior varieties have been developed, it is vital that pure and healthy seed stocks be maintained throughout the seed production and commercialization process. Another source of important genes is the endophytes that live in association with plant species. Characterization of these species has led to the identification of medically and agriculturally important compounds.

Performance Goals

- Advise the Plant Introduction Station in Pullman, Washington in cooperation with representatives from 11 Western states.
- Determine species purity and health of small grains, legumes, and grasses for seed stocks from Montana and the region.
- Characterize medically useful compounds present in endophytes of plants. Clone the genes responsible for the compounds.

Output Indicators

- A viable strategy for collecting and maintaining germplasm for use in the Pacific Northwest.
- Increased use of novel germplasm by Montana State breeders and geneticist.
- Seed purity and germination analyses conducted for seed growers in Montana and the region.
- Identification of compounds and genes useful to the agricultural and medical communities.

Outcome Indicators

- Increased diversification of Montana cropping systems.
- Increased gains from plant breeding endeavors.
- Pure and highly viable seed resulting in weed-free and competitive crop stands.
- New products available on the market for medical and agricultural uses.

Key Program Components

- *Plant genetic resource conservation and utilization.* Provide scientific direction to the USDA Plant Introduction center in Pullman, Washington. Relay key information to scientists and clientele in Montana.
- *State seed testing laboratory.* Provide purity and germ analyses for seed growers in Montana and the region. Provide additional tests for diseases and viability as needed. This translates in greater production efficiency for area farmers.

Internal and External Linkages (See Appendix 3)

- Scientists at Montana State University in Plant Sciences are the primary investigators.
- Seed is tested from several hundred sources per year. Sources include public and private entities.
- Advice is given to the USDA Plant Introduction Center in Pullman, WA.
- Information shared with scientists in the region.
- Several private companies cooperate with the identification of economically useful compounds.

Target Audiences

Germplasm collection facilities, seed growers, seed and private industries and consumers.

Program Duration

Greater than 5 years.

Program 5. Food System Performance

(RPA 079; See Appendices 1 and 2)

Statement of Issue

The U.S. food and fiber system is responsible for providing consumers with adequate quantities, high quality, and safe food products at reasonable cost. Securing such a system requires responsibilities and efficiencies of relevant market players including producers of raw agricultural commodities, manufacturers/processors, and distributors and retailers. Factors such as flexible markets, price incentive structures, business organization structure and behavior, and public regulation and monitoring are essential to maintaining a progressive food and fiber system into the future.

Many of the market and non-market parameters essential to a healthy and secure food system are in a dynamic state such as market concentration, price discovery, value-added opportunities, food-borne illnesses, and regulation activities. Research in these areas is vital to examine economic effects on consumers and market participants from current and likely changes in the future.

Performance Goals

- Evaluate economic effects of market concentration changes in meatpacking and processing on packer marketing margins and producer price incentives.
- Evaluate economic causes and changing impacts of wholesale-retail meat margins on producers of livestock commodities and on costs of meat products to consumers.
- Determine the extent of technology changes in livestock finishing and meat processing and evaluate their economic impacts on producers and consumers.
- Investigate business strategies, value-added opportunities, and market access problems to ensure agribusiness activities consistent with market demands.
- Assess economic impacts of food safety regulation in the meat industry.
- Monitor developments in domestic and international trade policy and their implications for food safety regulation in the United States and other countries.

Output Indicators

- Greater understanding of economic efforts in meatpacking and processing.
- Better understanding of domestic and international trade policies and food safety regulations.
- Improved value-added opportunities.
- Publication of research results in refereed journals and professional presentations.
- Outreach activities and public presentations to producer and commodity groups of state and region.

Outcome Indicators

- Increased availability of information about concentration, margins, technology impacts, and policy useful to enhance public and private decision-making.
- Changes in business behavior regarding marketing opportunities to enhance efficiency, safe products, and quantities supplied to consumers via increased vertical alliances, value-added methods, and safety inspection adoption.

Key Program Components

- *Concentration and technology.* Estimate the joint effects of concentration and technology on meat packing margins, farm level prices, and output response.
- *Marketing margins.* Investigate economic causality of increasing real wholesale-retail margins for beef and pork and estimate impacts of welfare of producers and consumers.
- *Value-added products.* Analyze agribusiness opportunities including producer cooperative/alliance action to add value to Montana agricultural commodities (beef, grains, specialty crops) and production of high quality and safe products to Montana and regional consumers.
- *Food safety.* Review of relevant policy developments; analysis of economic impacts of regulations on industry cost of production.

Internal and External Linkages (See Appendix 3)

- Economists within the Department of Agricultural Economics and Economics and Montana State University Trade Research Center.
- State government, state and regional agricultural producer and commodity groups.

- National and international governmental and non-governmental agencies.
- Evaluate the importance and impacts of adding value to feeder cattle in international trade.

Target Audiences

Faculty colleagues of Land Grant Universities, USDA, in-state and out-of-state governmental and non-governmental institutions and producer organizations.

Program Duration

Greater than 5 years

Goal 3. A Healthy, Well Nourished Population

Program 6. Improving Human Foods and Health

(RPA 222; 335; See Appendices 1 and 2)

Statement of Issue

The end use of a cereal defines what quality attributes are desirable in the grain. The milling and baking attributes of cereal such as wheat and barley are unique. Several factors underlie quality parameters of wheat and barley. These include environmental, variation, interaction of genotypes with the environment, and varieties adapted to the climatic conditions of the environment. It is important to understand and improve the quality of all wheat and barley market classes.

Sources of new pharmaceutical chemicals have become limited. There is need to tap into the diverse array of microbes associated with plants that may prove to be a source of useful pharmaceutical compounds.

Performance Goals

- Develop coordinated approaches for development of barley and white wheat for domestic and export end use.
- Facilitate information exchange between interdisciplinary research groups and industry representatives on end use quality in all market classes of wheat and barley.
- Evaluate quality data of regional nursery entries and procedures for quality evaluation.
- Develop a set of Standard Operating Procedures (SOP) for research laboratory run quality tests and procedures.
- Identify new sources of pharmacologically important compounds through research on microbes associated with plants.

Output Indicators

- Improved stability of wheat and barley with desirable milling and baking quality.
- Increased market demand for our wheat and barley.

- Improved hard white wheat varieties.
- Advanced existing knowledge of environmental-wheat quality interactions.
- New organisms isolated that produce pharmacologically active compounds.

Outcome Indicators

- Identification of specific quality components desired by the milling and baking industry.
- Evolution of the hard white wheat market class.
- Better understanding of the environmental influences on wheat and barley quality.
- New pharmaceuticals available to combat human diseases and promote health.

Key Program Components

- *End use properties of wheat and barley.* Identify specific quality components that enhance wheat and barley milling and baking. Develop hard white wheat for domestic and export end use. Improve the quality stability of wheats by understanding environmental-wheat quality interactions.
- *Endophytes of plants: Their biology, economic value and potential use.* Collect a series of endophytes living in association with selected plant species. Characterize economically useful compounds with the goal of having new products on the market.

Internal and External Linkages (See Appendix 3)

Partnership will be continued with federal laboratories and other universities, and the private sector (i.e., millers and processors), as appropriate to this performance goal. We will focus on shared responsibilities for the agreed research objectives of projects and we will use joint ventures with industry to facilitate technology transfer.

Target Audiences

Citizens who can benefit from higher quality of wheat products, new pharmaceuticals, scientific collaborations, medical professionals, and pharmaceutical companies.

Program Duration

Five years.

Goal 4. An Agricultural System which Protects Natural Resources and the Environment

Program 7. Integrated Pest Management

(RPAs 147, 148, 153, 154, 160, 164, 167, 223, 264, 316, 323, 334, 394, 399, 806, 813; See Appendices 1 and 2)

Statement of Issue

Montana producers are continually challenged by myriad pests to produce crops and livestock in an efficient and economical way. Many of these competitive pests require pesticides to significantly reduce their direct impact on food and fiber production. Increasing public concern related to food quality, natural resource biodiversity, and sustaining the quality of soil, air, and water are mandating less reliance on pesticides and more on non-chemical pest control options. IPM seeks to optimize grower profitability and natural resource sustainability through development, selection and implementation of appropriate pest management tactics that are economically sound and environmentally acceptable. IPM systems are dynamic and the application of IPM is site-specific in nature; selection of individual tactics is determined by the particular crop-pest-environment scenario. IPM research and education programs need to integrate new technologies that are rapidly advancing agriculture production (e.g., remote sensing, molecular biology, chemical ecology) into improving existing pest management systems and developing new ones.

Performance Goal

- Conduct research and education programs in integrated pest management which promotes sustainable, productive, and environmentally sound systems.

Output Indicators

- Develop and improve non-chemical IPM control options integrating new technologies.
- Enhance decision-making guidelines and processes that are employed to select pest management recommendations.
- Advance our existing database and knowledge on pest biologies, ecology and physiology.
- Disseminate research results in peer publications and public media.

Outcome Indicators

- Increased pest management options to producers.
- Number of producers who are better informed and adopt non-chemical IPM practices.
- Number of research reports to the scientific community and workshops for those involved in agriculture and rangeland.
- Increase adoption of practices that protect the environment, producers and the public, and improve public education about agricultural and natural resource systems.
- More productive and profitable agriculture and rangeland systems.

Key Program Components

- *Integrated Management for Spotted Knapweed Infested Rangeland.* Utilization of integrated control practices (biological, chemical, cultural) to control a major noxious weed.
- *Biological and Ecological Basis for a Weed Management Model to Reduce Herbicide Use in Corn-soybean Rotations.* Evaluation of the need to incorporate multiple weed

interactions into the bioeconomic weed management module under development for corn.

- *Integrated Management of Annual Grass Weeds in Small Grain.* Model the emergence, seedling development, optimum herbicide application time and competitiveness with spring wheat for Persian Damel.
- *Ecology of Weeds in Small Grain Production Systems of Montana.* Characterization of wild oat populations and their impacts on small grain production in fields utilizing GPS and GIS technologies.
- *Biological Control of Rangeland Weeds and Insect Pests.* Evaluate habitat associations of flea beetles associated with leafy spurge, enhance the impact of a defoliating moth on Dalmatian toadflax, and develop a behavioral ecology model of the seed head flies on spotted knapweed.
- *Biological Control in Pest Management Systems of Plants.* Determine the physiological and ecological factors necessary for establishment of introduced natural enemies against spotted knapweed, houndstongue, and sulfur cinquefoil.
- *Wheat Stem Sawfly.* Develop non-chemical management tactics for the wheat stem sawfly, emphasizing the relationship between parasitoid/sawfly larvae densities, and investigate the chemical communication system used by sawflies and associated predators.
- *Ecology and Behavior of Rangeland Insects.* Determine the efficacy of insect pathogens for grasshopper and Mormon cricket suppression and examine the effectiveness of behavioral thermoregulation in compromising the effectiveness of these pathogens. Investigate how cattle grazing alters grasshopper community composition and relative abundance as a function of grazing induced changes in forage structure and microclimate.
- *Containment, Augmentation and Release of Exotic Biocontrol Agents through Quarantine.* Non-indigenous biological control agents are received, screened for host specificity, reared and considered for release against invasive noxious weeds and introduced insect pests.
- *Evaluation of Gall Mites as Biological Control Agents of Weeds.* Determine the host response and suitability for the development of four species of gall mites on diffuse knapweed, field bindweed, and hoary cress. Establish and monitor the dissemination of these agents in the field.
- *Natural Products Chemistry as a Resource for Biorational Methods of Insect Control.* The work is designed to take advantage of collaborative work on the basic chemistry, biology, chemical ecology, physiology, neurophysiology, and biochemistry of semiochemicals in selected insect pests in order to elucidate, develop, and implement new applications for insect control.
- *Biological Control of Rangeland Weeds.* Release of insect predators as biological control agents for introduced rangeland weed species. Characterizing life cycles and environmental adaptation of these insect species for application to release strategies. Evaluating the impact of these agents on weed population dynamics.

Internal and External Linkages (See Appendix 3)

- Research scientists, extension specialists, and students in Chemistry, Entomology, Land Resources and Environmental Sciences, and Plant Sciences from Montana State University.
- Partnerships with producers, commodity groups, agricultural associations, public research organizations.
- State and federal agencies, private industry, and consumers.

Target Audiences

Producers, students, educators, agricultural associations, Certified Crop Advisers, consultants, research scientists, extension specialists, state and federal agency employees, and the general public.

Program Duration

Greater than 5 years

Program 8. Improving Soil, Plant, and Water Resources in Ecosystems

(RPAs 127, 128, 184, 186, 199, 229, 243, 256, 300, 302, 326, 327, 398, 810; See Appendices 1 and 2)

Statement of Issue

Landscapes are diverse mixtures of biological, chemical and physical processes in soil, plant communities, and surface and groundwater systems. Land management practices impact these components and potentially change the quality and quantity of soil, plant, and water resources. As a headwater's state with multiple land uses, Montana is in a unique position to understand how land management practices, e.g. grazing of riparian areas, fate and transport of applied pesticides and natural constituents, impact ecosystems. From pristine to highly managed land uses, the multitude of practices that occur on the Montana land surface influence environmental quality, economic vitality, and, ultimately, quality of life. For example, rangelands comprise 70% of the land area in Montana. The greatest environmental challenge is better management of cattle grazing in concert with riparian habitats, wildlife, and clean water. Characterization and understanding of the complex interactive components will lead to improved soil, plant, and water resources in ecosystems.

Performance Goals

- Improve soil, plant, water resources, and ecosystem sustainability through improved management.
- Contribute to the restoration and reclamation of contaminated lands.
- Increase economic and societal benefits derived from diverse functioning ecosystems.

Output Indicators

- Greater understanding of the fundamental processes associated with land use practices and their impact on environmental quality and ecosystem sustainability.

- Knowledge required to restore plant communities to functioning components of ecosystems.
- Environmental assessment data for improved state and federal management programs.
- Research reports to the scientific community, interpreted reports to non-scientific community, and service activities to agencies.
- Enhanced understanding of the role plants and animals in production systems.

Outcome Indicators

- Adoption of management practices to improve ecosystem sustainability and streamside and wetland vegetation.
- Improved integration of site factors into pesticide management practices.
- Increased information on the fate and transport of organic and natural compounds that affect soil and water resources.
- Improved decision-making capabilities of agency personnel, land managers, and producers.

Key Program Components

- *Interactions of vegetation, grazing, and watershed processes on Montana rangelands.* Studies of the relationships among streamside and wetland vegetation, hydrology, water quality, and agricultural land management related to rangeland grazing and other land uses, livestock production facilities, and small town wastewater treatment systems.
- *Interaction of livestock and wildlife grazing on rangeland and riparian ecosystem.* Studies on how the social structure of livestock affects habitat use patterns and distribution on rangeland including riparian zones. Identification of the effect cattle grazing on elk winter range forage and evaluate cost-effective deer and elk depredation remedies. Composition of riparian soil seed bank under livestock grazing and describe the optimal conditions for germination. The effect of elk browsing on shrub, primarily sagebrush, recovery from fire.
- *Exploratory research in plant, soil and horticultural sciences.* Provides a basis for the initiation of new research projects related to these disciplines. With departmental reorganization, this will be renamed to Exploratory Research in Land Resources and Environmental Sciences.
- *Fate and transport of chemicals in soils.* An evaluation of the processes controlling the fate and transport of organic solutes in soils.
- *Soil water and soluble chemical dynamics.* Field and laboratory experiments to evaluate an apparatus for controlled solute and soil water characteristic determination.
- *Biogeochemistry and management of salts and trace elements in arid-zone soils, sediments and waters.* Quantification of the biogeochemistry of arsenic in contaminated soils and mine tailings.
- *Improved characterization and quantification of flow and transport processes in soils.* Evaluation of the potential for real-time monitoring of soil water and fertilizer salt distribution in crop root zones under transient flow conditions.

- *Pesticides and other toxic organics in soil and their potential for ground and surface water contamination.* Quantification of basic processes describing the fate of pesticides and other toxic organic compounds in soils, and refining modeling technique for predicting the fate and transport of pesticides.

Internal and External Linkages (See Appendix 3)

- Scientists at Montana State University in Animal and Range Sciences, Civil Engineering, Land Resources and Environmental Sciences, and Research Centers.
- Federal and state land and water management agencies. Environmental consulting firms, land managers, livestock industry.

Target Audiences

Federal and state agencies, scientists, agribusiness, citizens, and land managers.

Program Duration

Greater than 5 years

Program 9. Economics and Sustainability of Public and Private Lands

(RPAs 074, 089; See Appendices 1 and 2)

Statement of Issue

In Montana and throughout the U.S., the relationship between economics and the sustainability of ecological systems has become one of the critical issues in modern agricultural and environmental policy. The sustainability of alternative land uses is equally critical for public and private lands. Because private and public lands comprise common ecological resources (e.g., river systems, wildlife) it is also important to study these lands together. Current and future changes in economic conditions, agricultural policy, and environmental policy raise serious questions about agriculture. Understanding how the various land uses (e.g., farming, ranching, timber, recreation, mining, development and subdivision) are determined is crucial in determining the sustainability of these lands. In order for farmers, ranchers, forestland companies, and public land managers to adapt to changing conditions it is essential that they be provided with information in the link between economic decisions, government programs, land use, and sustainability. Economic analysis of these issues can provide this information.

Performance Goals

- Assess the economic sustainability of current public and private land use and the ecological sustainability of potential land use changes resulting from likely changes in economic conditions, agricultural policy, and environmental policy.
- Examine how the incentives of public land managers are affected by changes in public policy and how this in turn alters land use choices and impacts sustainability.
- Examine how federal crop insurance, federal disaster relief, and other government programs impact land use and specific environmental attributes (e.g., soil erosion, soil productivity).

- Examine how alternative landuse regimes affect landuse (e.g., conservation easements, restrictive zoning, public land ownership and administrative restrictions on use) and related sustainability issues.

Output indicators

- Analyses of the effects of public and private land policies (e.g., crop insurance, endangered species protections) on land use and sustainability.
- Research papers published in professional peer reviewed journals, papers for professional meetings/proceedings, and department research publications.
- Presentations at professional meetings, university seminars, and public policy conferences, and to agricultural and environmental organizations, to state and congressional legislators and aides.
- Materials developed for extension and outreach to educate and further interact with producer groups, professional colleagues, and policy makers.
- Awards of external competitive grants and other funding.

Outcome Indicators

- Changes in land use policies on public and private lands.
- Changes in land management and ecological sustainability of public and private lands.
- Use of output by stakeholders (including farmers, ranchers, public land managers, USDA and environmental regulatory agencies, state and congressional legislators and aides), and by the research community (through citations, invited presentations, etc.).
- Funding by external sources, research awards, and communications awards.

Key Program Components

- *Agricultural sustainability.* Assess the economic sustainability of agriculture by linking economic and biophysical models of crop production and using county-level data to assess the impacts of agricultural and environmental policy innovation on environmental indicators.
- *Conservation easements.* Assess the use of conservation easements and other private landuse tools to protect and sustain valuable environmental resources and simultaneously encourage traditional agricultural practices.
- *Endangered species protection.* Assess the landuse impacts of the Endangered Species Act and how it differentially affects public and private land.
- *Wildlife policy.* Assess the impacts of state wildlife agency policy on landowners' incentives to provide wildlife habitat and the sustainability of agricultural land use.
- *Crop insurance and soil erosion.* Assess the effects of federal crop insurance on landuse decisions and how this impacts soil erosion and sustained soil productivity by altering crop choices and cropping techniques. Provide estimates of marginal effects of different government programs on county-level soil erosion rates.

- *Grazing policy.* Assess the effects of alternative grazing fee systems and grazing regulations on the environmental attributes of public lands and on the economic sustainability of various types of landuse.
- *Archaeological resources.* Assess the impacts of different legal rules for discovering and excavating artifacts on public and private lands.

Internal and External Linkages (See Appendix 3)

- Joint cooperation of project investigators in the Department of Agricultural Economics and Economics at Montana State University.
- Scientists working in the area of biophysical agricultural model development; National Agricultural Statistical Service (NASS), federal and state data collection surveys; policy makers and state agricultural offices.

Target Audiences

Agricultural producer and agricultural landowners in Montana and the United States, other interested private landowners (e.g., forest landowners), program administrators and research economists and scientists in the USDA, state and congressional legislators and aides, state and federal environmental and public land agencies, and county and state extension agents and other farm advisors.

Program Duration

Greater than 5 years

Goal 5. Enhanced Economic Opportunity and Quality of Life for Americans

Program 10. Survey Methods to Estimate Economic and Social Interactions (RPAs 341, 481; See Appendices 1 and 2)

Statement of Issue

Family business owners in economically vulnerable communities face unique constraints that affects sustainability. Interactions among family, business, and community systems in economically vulnerable communities need to be understood. There is a need to develop sample surveys with reduced non-response error that can obtain information on farming practices, community needs, and interactions among community components.

Performance Goals

- Compare the interaction of family and business systems in economically vulnerable and non vulnerable communities.
- Identify effects of community structure and characteristics on families and their businesses.
- Estimate the economic and social contributions of family businesses to communities.

- Test procedures and develop conceptual models for surveys.

Output Indicators

- New surveys and models to accurately measure interactions and communities.

Outcome Indicators

- Conceptual models developed provide accurate economic and social information that can be used to address rural and community needs.
- Integrate and disseminate results to survey practitioners.

Key Program Components

- *Improvement of rural and agricultural sample survey methods.* Develop and test methods to reduce nonresponse error and to better understand and control the contextual factors that create measurement error in sample surveys. Characterize nonresponse error and measurement error to improve surveys.
- *Family business viability in economically vulnerable communities.* Survey random family businesses in economically vulnerable and nonvulnerable communities. Compare the interactions of family and business systems.

Internal and External Linkages (See Appendix 3)

- Scientists at Montana State University in Sociology and Agricultural Economics and Economics.
- Montana communities.

Target Audiences

Survey practitioners, state agencies, community governments, citizens, and businesses.

Program Duration

Five years.

Stakeholder Input

The Montana Agricultural Experiment Station (MAES) and College of Agriculture (COA) annually uses multiple approaches to obtain stakeholder input on programs conducted and actively solicits input on changes in program direction. Approaches include involvement with organizations and associations (see Appendix 3), meetings, conferences, and events. MAES faculty serve as liaison representatives to many traditional and non-traditional organizations within the state. Most MAES departments and all off-campus research stations hold biannual meetings with their Advisory Boards to discuss policy issues, programs, and program direction.

MAES/COA Advisory Committee. MAES and COA will continue to utilize the Dean's Advisory Committee. Membership on this Committee is balanced to represent the diverse geographical regions of the state, and the diverse agricultural interests of the

state. Members are selected from among the membership of the advisory committees for each of the Research Centers in Montana of which there are eight in the various geographical regions of the state. The membership will remain at the present size of 11. Meetings will be three to four times per year, with additional meetings called at the request of the Dean and Director. Additional *ad hoc* members may be added for any meeting, especially for an agenda that focuses on a special topic.

Montana Agricultural Experiment Station. MAES supports research at seven off-campus stations. Programs at the experiment stations are administratively responsible to the MAES Director and have joint programs with one or more departments. Experiment stations meet biannually with their Advisory Boards to discuss policy issues, programs, and program direction. Experiment Station Superintendents also meet three to four times a year with the MAES Director in a similar activity.

Council for Agricultural Research, Extension, Teaching (CARET). CARET members in Montana provide an avenue for MAES dialogue on a county and state level where issues and needs are discussed.

Extension. The Cooperative Extension Service manages the budgets for extension programs, however, colleges are responsible for extension programs outlined by their faculty. The Dean of Extension now meets on a regular basis with department heads and the Dean and Director of MAES to discuss programs and future joint priorities.

USDA - ARS. Joint research programs are conducted with USDA - ARS in Miles City (Fort Keogh Livestock and Range Research Laboratory) and Sidney (Northern Plains Agricultural Research Laboratory).

Listening Sessions. Each year the Dean and selected administrative staff and faculty will, in collaboration with Montana's Extension Service, hold six or more open-to-the-public, out-in-the-state listening sessions. The purpose of these sessions will be to gather stakeholder input and comments on past achievements, current activities, and proposed plans for our research programs. All listening sessions will be publicly announced through local and regional newspapers, appropriate newsletters, and through our county Extension offices. To better insure attendance by traditionally under served populations our special contacts with trade groups, commodity associations, agricultural suppliers, and state agencies will be used to request their assistance in extending invitations to a very broad community of stakeholders. In addition, "listening sessions" will also be held on campus to get input from faculty.

Under Served. Native Americans constitute the majority of those considered under served in Montana. The Native American population in Montana is more than 50,000. There are 11 tribal groups and 7 reservations (5.5 million acres). Programs have been initiated, such as "Agriculture in a Global Context" with Dull Knife Memorial and Fort Peck Community Tribal Colleges. MAES and the COA are in the process of increasing partnerships and programming efforts with the Tribal Colleges in Montana.

Program Review

Hatch Projects are subject to a peer review process prior to submitting projects to USDA - CSREES. The MAES Office is responsible for oversight and conducts the peer review. MAES administration selects the reviewers after consultation with department heads. The peer review committee includes the principle investigator (PI), department head, and three additional faculty external to the PI's department. Written comments are requested on the following items: relevance and importance; relation to previous research; objectives; approach and methods; scientific and technical quality; resources; and environmental, economic, and/or social impacts. Seminars are scheduled by the department with reviewers present. A meeting follows with the seminar reviewers, PI, Department Head, and MAES administrator. Written comments are summarized and shared with the PI. Projects are revised in response to the review process.

Multistate Research

The Multistate Research Program meets the multi-institution, -state, and -discipline requirement. Montana State University is a participating partner in numerous multistate projects. The Montana Agricultural Experiment Station participates in the following multistate projects.

Multistate Projects

1 An Agricultural system that is highly competitive in the global economy.

Regional Project	Project Title	Cooperators
NC-208	Impact analysis and decision strategies for agricultural research	AL-CA-FL-GA-Athens-ID-IA-LA-MI-MN-MO- MT-NE-NJ-NYC-TX-VA-WI
NC-213	Marketing and delivery of quality cereals and oilseeds	AR-IL-ID-IN-IA-KS-MI-MN-MT-NE-ND-OH-TX-WA-WI-USDA-ERS-USDA-ARS
NCR-021	Quantitative genetics	Multistate
NCR-174	Synchrotron x-ray sources in soil science	Multistate
NCR-180	Site specific management	Multistate
NCR-186	Body composition specification in beef	Multistate
W-102	Integrated methods of parasite control for improved livestock production	AZ-CA-IA-KS-MN-MO-MT-TX-UT-VA-WA
W-112	Reproductive performance in domestic ruminants	AZ-CA-CO-HI-ID-KS-MN-MO-MT-NE-NM-NV-OH-OR-TX-WA-WY
W-168	Seed biology, technology and ecology	AR-AZ-CA-FL-IA-IN-KS-KY-LA-MT-NC-NY-OH-OR-VA-WA
WCC-001	Beef cattle breeding research in western region	AZ-CO-IA-MT-NM-TX-WA-WY
WCC-039	Coordination of sheep and goat research and education programs for the western states	CO-AZ-CA-MT-ND-NM-NV-OR-TX-UT-WY
WCC-067	Coordination and support for sustainable agriculture research and education in the western region	CO-GU-ID-MT-NM-NV-OR-WA-WY
WCC-077	Biology and control of winter annual grass weeds in winter wheat	CO-ID-KS-MT-NE-NM-OK-OR-UT-WA-WY

Regional Project	Project Title	Cooperators
WCC-091	Improving stress resistance of forages in the western United States	AZ-CA-CO-HI-MT-NM-NV-OR-UT-WA-WY
WCC-092	Beef cattle energetics	CA-CO-ID-IN-MT-NE-NM-SD-TX-UT-WA
WCC-093	Western region soil survey and inventory	AK-AZ-CA-CO-HI-ID-MT-NM-OR-UT-WA-WY
WCC-094	Research and administrative coordination in animal science	AK-AZ-CA-CO-ID-MT-NM-NV-UT-WY
WCC-100	Implementation and strategies for national beef cattle evaluation	CO-FL-GA-IA-IN-KS-MI-MN-MT-NE-NY-OK-SD-WA
WCC-103	Soil, water and plant analysis for improved nutrient management and water quality	AK-AZ-CA-CO-HI-ID-MT-NM-NV-OR-UT-WA-WY
WCC-107	Adding value to western U.S. agricultural exports	CO-CA-HI-MP-MT-OR-UT-WA
WCC-110	Improving ruminant use of forages in sustainable production systems for the western U.S.	AZ-CO-HI-MT-ND-OR-SD-TX-UT-WA-WY
WCC-201	Enhanced use of barley for feed and food	CA-ID-MT-NY-ND-WA

2 A safe and secure food and fiber system.

Regional Project	Project Title	Cooperators
NE-165	Private strategies, public policies, and food system performance	AR-CA-CTS-FL-GA-IL-IN-IA-KS-LA-MD-MA-MI-MN-MT-NE-NH-NJ-NYC-NC-OH-RI-TX-VA-WI-USDA/ERS-USDA/RBS- USDA/AMS-USDA/PSA- CDCP- FDA-GAO
W-006	Plant genetic resource conservation and utilization	AK-AZ-CA-CO-ID-MT-NM-OR-UT-WA-WY
WCC-023	Textile and apparel research coordination	AZ-CA-CO-ID-MT-OR-UT-WA-WY
WCC-027	Potato variety development	CO-ID-MT-NM-OR-WA

3 A healthy, well nourished population.

Regional Project	Project Title	Cooperators
WCC-081	Systems to improve end-use quality of wheat	ID-MT-OR-UT-WA

4 An agricultural system which protects natural resources and the environment.

Regional Project	Project Title	Cooperators
NC-202	Biological and ecological basis for a weed management decision support systems to reduce herbicide use	CO-IN-IA-MT-MI-MN-OH-NE-SD-WI
NRSP-4	A national agricultural program: Clearances of chemicals and biologics for minor or special uses	AK-AZ-CA-CO-FL-GU-HI-ID-MT-NM-NV-OR-UT-WA-WY
SR-IEG-70	Economics and management of risk in agricultural and natural resources	Multistate
W-082	Pesticides and other toxic organics in soil and their potential for ground and surface water contamination	AR-AZ-CA-FL-HI-IA-IN-KS-MN-MT-NV-RI- WA
W-133	Benefits and costs of resource policies affecting public and private land	WM-CO-CA-CT-GA-IA-MA-ME-MI-MT-NH-NM-NV-NY-OH-OR-TN-UT-WA-WV

Regional Project	Project Title	Cooperators
W-147	Managing plant-microbe interactions in soil to promote sustainable agriculture	WR-AK-AZ-CA-ID-MT-NY-OR
W-184	Biogeochemistry and management of salts and trace elements in arid-zone soils, sediments and waters	CA-MT-NV-TX-UT-WA-WY
W-185	Biological control in pest management systems of plants	AZ-CA-GU-HI-ID-KS-MT-NM-NY-OR-UT-WA-WY
W-188	Improved characterization and quantification of flow and transport processes in soils	AZ-CA-CO-IA-IN-KS-MT-ND-NV-UT-WA-WY
W-189	Natural products chemistry as a resource for biorational methods of insect control	AR-AZ-CA-CO-FL-MN-MT-NV-TX-WA
WCC-060	Science and management of pesticide resistance	CO-AL-AZ-CA-FL-IA-IL-IN-KS-LA-MI-MN-MS-MT-NC-NE-NY-OK-OR-SC-UT
WCC-066	Integrated management of Russian wheat aphid and other cereal aphids	CO-CA-ID-KS-MT-NE-OK-OR-TX-UT-WA-WY
WCC-069	Coordination of IPM research and extension programs for the western United States	AZ-CA-CO-HI-MA-MP-MT-NM-OR-UT-WA-WY

5 Enhanced economic opportunity and quality of life for Americans.

Regional Project	Project Title	Cooperators
NE-167	Family business: viability in economically vulnerable communities	HI-IN-IA-IL-MN-MT-NE-ND-NY-CO-PA-RI-UT-VT-WI-CANADA
W-183	Improvement of rural and agricultural sample survey methods	AZ-CO-IA-ID-MT-NH-NY-OR-PA-WA

Integrated Research and Extension Activities

Most Montana State agricultural faculty have a dual appointment involving two of the three functional areas (i.e., extension, research, or teaching). Faculty in MAES holding joint extension/research appointments have an integrated extension and research program with time allocated to each area. Nine percent of the FTE is devoted to integrated research and extension activity. However, most of our MAES and COA faculty have extensive extension/outreach initiatives, but are not credited for these activities. MAES and the Montana Cooperative Extension Service are assessing future joint appointment needs.

Program Expenditure and Projection

1999 Budget

Hatch	\$1,352,358
Multistate (Regional)	662,443
Total Federal	<u>2,014,801</u>
Total State Match	2,014,801
Total Program	<u>\$4,039,602</u>

Current Multistate Investment as a Percentage of Hatch

Multistate	\$662,443
% of Hatch	49.0%

Current Multistate Investment as a Percentage of Hatch/Multistate Combined

Multistate	\$662,443
% of Hatch/Multistate	32.9%

Current Multistate Investment as Interpreted from FY98 Form 419

Multistate	\$613,273
% of Total Federal*	19.6%

*Includes Hatch, Grants PC89-106, Animal Health.

Additional Dollars Required to Meet 25%

\$0 Based on Hatch
 \$0 Based on Hatch/Multistate Combined
 \$167,064 Based on Total Federal

Federal Match

The state matches federal formula funds dollar for dollar. The MAES Director has discretion with the state dollars although a high percent of the dollars are committed to salaries.

Report Basis

The financial information is extracted from several sources and does not constitute an auditable document.

Projection (Scientific Year, SY)

	Goal				
	1	2	3	4	5
Year	SY				
2000	42.9	0.7	0.9	14.0	0.1
2001	42.3	0.7	0.9	14.6	0.1
2002	41.9	1.0	0.9	14.6	0.2
2003	41.7	1.0	0.9	14.6	0.4
2004	40.6	1.0	1.0	15.0	1.0

Scientific year projections based on the assumption federal funding will not exceed plus or minus 10%.

Financial Resources (\$)

	Goal				
	1	2	3	4	5
Year	SY				
2000	2,708,786	107,312	33,146	1,172,858	7,500
2001	2,668,786	107,312	33,146	1,212,858	7,500
2002	2,638,786	129,812	33,146	1,212,858	15,000
2003	2,623,786	129,812	33,146	1,212,858	30,000
2004	2,543,786	129,812	40,646	1,240,358	75,000

Montana Agricultural Experiment Station FY 98 and 99 Expenditures

Funding	Source	FY98	Percent	FY99
General Fund MAES	State	8,087,088	0.36	8,471,179
General Fund Interest	Interest	79,332	0.003	79,332
Hatch Funds	Federal Formula	1,875,993	0.08	2,014,801
Proprietary Revenue	Sales Income	964,019	0.04	774,905
Designated & Restricted Funds	Sales, Donations, Endowment Earnings	1,709,523	0.08	2,166,804
Grants & Contracts Activity*	External Agencies e.g., Federal (USDA, NSF, DHHS), Industry	10,066,513	0.44	11,884,041
		22,782,468	1.00	25,391,062

*Note: Total FY98 Grants and Contracts funds were over \$15 million which includes \$5.7 million for the Ag Bioscience Facility. Ten percent of the Ag Bioscience Facility has been included in the Grants and Contracts Activity since new agriculture buildings are only built occasionally.

APPENDICES

APPENDIX 1 – MAES Hatch Projects by Goal

Goals with Manpower Totals

1 An Agricultural System that is Highly Competitive in the Global Economy.

Department	Project #	Project Title	SYs	PYs	TYs
Veterinary Molecular Biology (VMB)	022	Miscellaneous investigations	0.5	0	2.5
Ag. Economics	075	Impact analysis and decision strategies for agricultural research	0	0	0
Ag. Economics	087	Agricultural marketing, price analysis and trade problems in dynamic markets	0.8	0.3	0
Ag. Economics	088	Agricultural policy	1.3	0.6	0
Ag. Economics	098	Agricultural finance and farm and ranch management	1.7	0.1	0
Entomology	155	Impact of RWA on wheat and economic benefit of treatments	0.5	0	0.2
Entomology	158	Curation of the MSU Entomology collection (service project)	0.8	1	0.5
Entomology	159	Exploratory research in Entomology	0.3	0	0
Entomology	161	Marketing and delivery of quality cereals and oilseeds	0.8	1	0
Animal & Range	173	Reducing neonatal losses in sheep production systems	0.1	0	0
Animal & Range	174	Selection for reproductive rate: evaluation of physiological parameters	1	0.3	0
Animal & Range	175	Systems analysis of livestock enterprises	0.8	0.3	0
Animal & Range	176	Winter grazing in Montana	0.5	0.3	0
Animal & Range	179	Evaluation and improvement of barley for food and feed	0.5	1	0
Animal & Range	182	Genetics of beef efficiency and tenderness	0.6	0.3	0
Animal & Range	183	Reproductive performance in domestic ruminants	0.8	1	0
Animal & Range	188	Exploratory research in Animal and Range Sciences	0	6.3	1.7
Animal & Range	194	Nutritional management of range beef cows and calves	0.2	0	0.2
Animal & Range	195	Sheep nutrition and lamb mortality	0.9	1	0
Animal & Range	196	Livestock behavior and performance	0.2	0	0
Animal & Range	197	Equine nutrition and feeds	0.2	0	0
Animal & Range	198	Wildlife and livestock interactions	0.3	0.2	0
Animal & Range	200	Influence of trace mineral supplementation on range beef cattle production	0.3	0	0
Animal & Range	201	Lamb survivability	0	0	0
Animal & Range	206	Influence of social hierarchy on distribution of rangeland cattle	0.2	0	0

Department	Project #	Project Title	SYs	PYs	TYs
Animal & Range	207	Copper and zinc for weaned calf production	0.2	0	0
Animal & Range	216	Evaluation and improvement of barley for food and feed	0.7	0	0
Plant Sciences	220	Miscellaneous plant diseases	0.3	2.3	0
Plant Sciences	224	Control of fungal disease by mating inhibition	0.8	0	0
Plant Sciences	228	Identification of defense related genes in a model plant defense system by serial analysis of gene expression	0	0	0
Plant Sciences	230	Mechanisms of plant virus transmission and assembly	0.8	0	1
Plant Sciences	237	Genetic improvement of biological control agents for weed control	0.8	0.5	0.5
Plant Sciences	240	Population genetics of self-incompatibility in the solanaceae	0.2	0	1
Plant Sciences	241	Genetically engineering plant light responses to improve crop quality	0.2	0	1.7
Plant Sciences	242	Studies of plants living in extreme environments within Yellowstone National Park	0.2	0	0.3
Land Resources and Environmental Sciences (LRES)	296	Exploratory research in plant, soil and horticultural sciences	1	1.1	0
Plant Sciences	298	Winter wheat breeding and genetics	0.9	1.2	1.5
Plant Sciences	307	Quantitative genetics and cultivar development	0	0.7	0
LRES	310	Phosphate assimilation in rhizobium bacteriods	0.9	1.5	0.7
Plant Sciences	313	Alfalfa breeding, genetics and cultural practices	0.8	1.6	0.1
Plant Sciences	315	Spring wheat breeding and genetics	1	1.8	5.5
Plant Sciences	336	Seed biology, technology and ecology	0	0.1	0
Plant Sciences	341	Evaluation and improvement of barley for food and feed	0.1	1.9	2
Plant Sciences	342	Barley breeding and genetics	0.7	0.7	2
LRES	346	Soil and plant nutrition for Montana agriculture	1	0	0
Plant Sciences	348	Small grain quality and molecular	0.8	2	0
LRES	372	Pedology and resource inventory methods for evaluating land use potentials, planning site-specific mgmt	0.8	1.5	1.5
Plant Sciences	386	Breeders seed purification and increase (service project)	0.5	0.8	0.1
Plant Sciences	392	Molecular approaches to weed physiology	0.9	0.3	1.5
VMB	405	Investigation of the functions of bovine rotavirus nonstructural proteins	0	0	0
VMB	406	Ultrastructure and biochemistry of toxoplasma gondii and hammondia hammondi	0.3	0	0.7
VMB	407	Development of diagnostic reagents and vaccines for equine protozoal myeloencephalitis	0	0	0

Department	Project #	Project Title	SYs	PYs	TYs
VMB	410	Molecular analysis of the bovine leukocyte NADPH oxidase	0.3	2	0.5
VMB	415	Mucosal immunity and salmonella vaccine delivery	0.3	0.2	0.1
VMB	419	Analysis of gamma/delta Tcells	0.9	0	0
VMB	423	Characterization of coccidian paranuclear body proteins using toxoplasma as a model system	0.3	0	0
VMB	428	Molecular basis of bovine trichomoniasis	0.5	0.2	0.2
VMB	429	Integrated methods of parasite control for improved livestock production	0.3	0	0.5
Biology	434	Population ecology of birds in the agricultural landscape of southwest Montana: phase III	0.1	0	0
Biology	443	Validation and use of multispectral radiometry to measure forage biomass in wildlife livestock studies	0.2	0	0
Central Ag Res Ctr	503	Field crop production	0.1	0	0
Central Ag Res Ctr	504	Forage crop production	1.9	1	3.1
Central Ag Res Ctr	505	Weed biology and methods of control	0.1	0	0
Eastern Ag Res Ctr	553	Small grain and forage production research for eastern Montana and western North Dakota	1	0	0.7
Eastern Ag Res Ctr	557	High-value and alternative crop production research for eastern Montana	0.7	0	1.2
Eastern Ag Res Ctr	558	Breeding and improvement of oilseed crops for eastern Montana	0.3	0	1
Central Ag Res Ctr	655	Irrigated and dryland crop production in south central Montana	1	0	0
Northern Ag Res Ctr	703	Innovating site-specific management for farming and ranching	1	0	1
Northern Ag Res Ctr	704	Dryland cropping practices	1	0	1
Northern Ag Res Ctr	708	Beef cattle improvement	1	0	0.5
Northern Ag Res Ctr	710	Efficiency and sustainability of beef cattle production from rangelands	1	1	0.4
Northwestern Ag Res Ctr	754	Weed and small grain management for western Montana	1	1	1.7
Northwestern Ag Res Ctr	755	Forage crop production and quality	0.5	0.5	0.8
Northwestern Ag Res Ctr	758	Miscellaneous and pulse crop	0.5	0.5	0.8
Western Ag Res Ctr	804	Horticulture crop production	0	0	0
Western Ag Res Ctr	805	Nutrient management in agricultural systems	1	0	1.5
Western Triangle	853	Field crop production	1	0	1
Western Triangle	854	Soils and cropping systems	1	1	0
		Sub-Total	44.2	39.1	41.2

2 A Safe and Secure Food and Fiber System.

Department	Project #	Project Title	SYs	PYs	TYs
Ag. Economics	079	Private strategies, public policies, and food system performance	0	0	0
Plant Sciences	318	State Seed Testing Laboratory (service project)	0	1.7	0
Plant Sciences	396	Plant genetic resource conservation and utilization	0.7	0	0
		Sub-Total	0.7	1.7	0.0

3 A Healthy, Well Nourished Population.

Department	Project #	Project Title	SYs	PYs	TYs
Plant Sciences	222	Endophytes of plants: their biology, economic value and potential use	0.9	3	0.7
Plant Sciences	335	End-use properties of wheat and barley	0	1	2
		Sub-Total	0.9	4.0	2.7

4 An Agricultural System which Protects Natural Resources and the Environment.

Department	Project #	Project Title	SYs	PYs	TYs
Ag. Economics	074	Benefits and costs of resource policies affecting public and private land	1	0	0
Ag. Economics	089	Climate change and the economic sustainability of Montana and Great Plains agriculture	1.3	0.8	0
Civil & Ag. Eng.	127	Constructed wetlands for water quality remediation	0.5	0	0
Civil & Ag. Eng.	128	Enhancing irrigation system performance with reclaimed water	0.5	0	0
Entomology	147	Biological control of rangeland weeds and insect pests	0.4	0.3	0.9
Entomology	148	Integrated pest management of Montana field and forage crops	0.2	0.5	0.6
Entomology	153	Wheat stem sawfly management	1	0	1
Entomology	154	Biological control in pest management systems of plants	0.4	1	1
Entomology	160	Ecology and behavior of rangeland insects	0.8	0	0
Entomology	164	Containment, augmentation and release of exotic biocontrol agents through quarantine	0	0.5	0.5
Entomology	167	Evaluation of gall mites as biological control agents of weeds	0.1	0.5	0.5
Animal & Range	184	Shrub ecology and forage relationships	0.6	0.3	0
Animal & Range	186	Characterization of successional processes in Western Montana riparian zones	0.6	0	0
LRES	199	Interactions of vegetation, grazing, and watershed processes on Montana rangelands	0.6	0	0

Department	Project #	Project Title	SYs	PYs	TYs
Plant Sciences	223	Ecology of phyllosphere and rhizosphere and their role in biological control of disease	0.4	0	0
Plant Sciences	229	Managing plant microbe interactions in soil to promote sustainable agriculture	0.8	0.5	0
Plant Sciences	243	The grass flora of Montana and integrating phylogenetic methods into studies of crop plants	0	0	0
Chemistry	254	Exploratory research in chemistry	0	0	0
Chemistry	256	Biosynthesis, structure, function, and regulation of metalloenzymes in denitrification	0	0	0
Chemistry	264	Natural products chemistry as a resource for biorational methods of insect control	0.4	0	0
LRES	300	Fate and transport of chemicals in soils	0.6	2.8	1
LRES	302	Soil water and soluble chemical dynamics	0.6	1.9	0
LRES	316	Integrated management for spotted knapweed infested rangeland	0.4	2.4	0.7
LRES	323	Biological and ecological basis for a weed management decision support systems to reduce herbicide use	1	0.4	0
LRES	326	Biogeochemistry and management of salts and trace elements in arid-zone soils, sediments and waters	0.1	0	0
LRES	327	Improved characterization and quantification of flow and transport processes in soils	0.1	0.3	0
Plant Sciences	334	Integrated management to reduce winter injury in woody ornamental plants	0.2	0	0.1
LRES	394	Integrated management of annual grass weeds in small grain	0.1	0	0
LRES	398	Pesticides and other toxic organics in soil and their potential for ground and surface water contamination	0.2	0.3	0
LRES	399	Ecology of weeds in small grain production systems of Montana	0.1	2.6	0
Western Ag Res Ctr	806	Biological control of rangeland weeds	0	0	0
Western Ag Res Ctr	810	Managing plant-microbe interactions in soil to promote sustainable agriculture	1	0	3
Western Ag Res Ctr	813	Biological control in pest management systems of plants	0	1	3.5
		Sub-Total	14.0	16.1	12.8

5 Enhanced Economic Opportunity and Quality of Life for Americans.

Department	Project #	Project Title	SYs	PYs	TYs
Health & Human Development	268	Family business: viability in economically vulnerable communities	0	0	0
Sociology	481	Improvement of rural and agricultural sample survey methods	0.1	0	0
		Sub-Total	0.1	0.0	0.0

			SYs	PYs	TYs
		Total	59.9	60.9	56.7

APPENDIX 2 – Staff Support by Program

Goal #1 An Agricultural System that is Highly Competitive in the Global Economy. Program #1 Plant and Animal Improvement.

Project Title	SYs	PYs	TYs
Beef cattle improvement	1	0	0.5
Influence of trace mineral supplementation on range beef cattle production	0.3	0	0
Alfalfa breeding, genetics and cultural practices	0.8	1.6	0.1
Selection for reproductive rate: evaluation of physiological parameters	1	0.3	0
Molecular basis of bovine trichomoniasis	0.5	0.2	0.2
Quantitative genetics and cultivar development	0	0.7	0
Winter wheat breeding and genetics	0.9	1.2	1.5
Phosphate assimilation in rhizobium bacteriods	0.9	1.5	0.7
Exploratory research in Animal and Range Sciences	0	6.3	1.7
Genetic improvement of biological control agents for weed control	0.8	0.5	0.5
Mechanisms of plant virus transmission and assembly	0.8	0	1
Molecular analysis of the bovine leukocyte NADPH oxidase	0.3	2	0.5
Ultrastructure and biochemistry of toxoplasma gondii and hammondia hammondi	0.3	0	0.7
Exploratory research in chemistry	0	0	0
Equine nutrition and feeds	0.2	0	0
Evaluation and improvement of barley for food and feed	0.5	1	0
Molecular approaches to weed physiology	0.9	0.3	1.5
Barley breeding and genetics	0.7	0.7	2
Evaluation and improvement of barley for food and feed	0.7	0	0
Reproductive performance in domestic ruminants	0.8	1	0
Curation of the MSU Entomology collection (service project)	0.8	1	0.5
Exploratory research in Entomology	0.3	0	0
Nutritional management of range beef cows and calves	0.2	0	0.2
Spring wheat breeding and genetics	1	1.8	5.5
Sheep nutrition and lamb mortality	0.9	1	0
Characterization of coccidian paranuclear body proteins using toxoplasma as a model system	0.3	0	0
Miscellaneous plant diseases	0.3	2.3	0
Integrated methods of parasite control for improved livestock production	0.3	0	0.5
Control of fungal disease by mating inhibition	0.8	0	0
Analysis of gamma/delta Tcells	0.9	0	0
Breeders seed purification and increase (service project)	0.5	0.8	0.1
Exploratory research in plant, soil and horticultural sciences	1	1.1	0
Breeding and improvement of oilseed crops for eastern Montana	0.3	0	1
Small grain quality and molecular biology	0.8	2	0
Evaluation and improvement of barley for food and feed	0.1	1.9	2
Studies of plants living in extreme environments within Yellowstone National Park	0.2	0	0.3
Genetically engineering plant light responses to improve crop quality	0.2	0	1.7
Population genetics of self-incompatibility in the solanaceae	0.2	0	1
Copper and Zinc for weaned calf production	0.2	0	0
Seed biology, technology and ecology	0	0.1	0
Soil and plant nutrition for Montana agriculture	1	0	0
Development of diagnostic reagents and vaccines for equine protozoal myeloencephalitis	0	0	0
Mucosal immunity and salmonella vaccine delivery	0.3	0.2	0.1
Lamb survivability	0	0	0
Weed biology and methods of control	0.1	0	0

Project Title	SYs	PYs	TYs
Identification of defense related genes in a model plant defense system by serial analysis of gene expression	0	0	0
Genetics of beef efficiency and tenderness	0.6	0.3	0
Miscellaneous investigations	0.5	0	2.5
Reducing neonatal losses in sheep production systems	0.1	0	0
Investigation of the functions of bovine rotavirus nonstructural proteins	0	0	0
Sub-Total	23.3	30.8	28.3

**Goal #1 An Agricultural System that is Highly Competitive in the Global Economy.
Program #2 Crop and Animal Production and Management Systems.**

Project Title	SYs	PYs	TYs
Nutrient management in agricultural systems	1	0	1.5
Marketing and delivery of quality cereals and oilseeds	0.8	1	0
Impact of RWA on wheat and economic benefit of treatments	0.5	0	0.2
Systems analysis of livestock enterprises	0.8	0.3	0
Forage crop production	1.9	1	3.1
Soils and cropping systems	1	1	0
Field crop production	0.1	0	0
Miscellaneous and pulse crop production	0.5	0.5	0.8
Small grain and forage production research for eastern Montana and western North Dakota	1	0	0.7
Winter grazing in Montana	0.5	0.3	0
Efficiency and sustainability of beef cattle production from rangelands	1	1	0.4
Population ecology of birds in the agricultural landscape of southwest Montana: phase III	0.1	0	0
Wildlife and livestock interactions	0.3	0.2	0
Validation and use of multispectral radiometry to measure forage biomass in wildlife livestock studies	0.2	0	0
Innovating site-specific management for farming and ranching	1	0	1
High-value and alternative crop production research for eastern Montana	0.7	0	1.2
Dryland cropping practices	1	0	1
Field crop production	1	0	1
Irrigated and dryland crop production in south central Montana	1	0	0
Livestock behavior and performance	0.2	0	0
Influence of social hierarchy on distribution of rangeland cattle	0.2	0	0
Horticulture crop production	0	0	0
Forage crop production and quality	0.5	0.5	0.8
Pedology and resource inventory methods for evaluating land use potentials, planning site-specific mgmt	0.8	1.5	1.5
Weed and small grain management for western Montana	1	1	1.7
Sub-Total	17.1	8.3	14.9

**Goal #1 An Agricultural System that is Highly Competitive in the Global Economy.
Program #3 Agricultural Finance, Marketing, and Policy.**

Project Title	SYs	PYs	TYs
Agricultural Policy	1.3	0.6	0
Impact analysis and decision strategies for agricultural research	0	0	0
Agricultural finance and farm and ranch management	1.7	0.1	0
Agricultural marketing, price analysis and trade problems in dynamic markets	0.8	0.3	0
Sub-Total	3.8	1.0	0.0

**Goal #2 A Safe and Secure Food and Fiber System.
Program #4 Plant Genetic Resource Conservation and Utilization.**

Project Title	SYs	PYs	TYs
Plant genetic resource conservation and utilization	0.7	0	0
State Seed Testing Laboratory (service project)	0	1.7	0
Sub-Total	0.7	1.7	0.0

**Goal #2 A Safe and Secure Food and Fiber System.
Program #5 Food System Performance.**

Project Title	SYs	PYs	TYs
Private strategies, public policies, and food system performance	0	0	0
Sub-Total	0.0	0.0	0.0

**Goal #3 A Healthy, Well Nourished Population.
Program #6 Improving Human Foods and Health.**

Project Title	SYs	PYs	TYs
Endophytes of plants: their biology, economic value and potential use	0.9	3	0.7
End-use properties of wheat and barley	0	1	2
Sub-Total	0.9	4.0	2.7

**Goal #4 An Agricultural System which Protects Natural Resources and the
Environment.
Program #7 Integrated Pest Management.**

Project Title	SYs	PYs	TYs
Ecology of weeds in small grain production systems of Montana	0.1	2.6	0
Wheat stem sawfly management	1	0	1
Biological control in pest management systems of plants	0.4	1	1
Integrated management for spotted knapweed infested rangeland	0.4	2.4	0.7
Integrated management of annual grass weeds in small grain	0.1	0	0
Biological control of rangeland weeds	0	0	0
Integrated management to reduce winter injury in woody ornamental plants	0.2	0	0.1
Biological control of rangeland weeds and insect pests	0.4	0.3	0.9
Biological and ecological basis for a weed management decision support systems to reduce herbicide use	1	0.4	0
Ecology of phyllosphere and rhizosphere and their role in biological control of disease	0.4	0	0
Biological control in pest management systems of plants	0	1	3.5
Ecology and behavior of rangeland insects	0.8	0	0
Natural products chemistry as a resource for biorational methods of insect control	0.4	0	0
Evaluation of gall mites as biological control agents of weeds	0.1	0.5	0.5

Project Title	SYs	PYs	TYs
Containment, augmentation and release of exotic biocontrol agents through quarantine	0	0.5	0.5
Integrated pest management of Montana field and forage crops	0.2	0.5	0.6
Sub-Total	5.5	9.2	8.8

Goal #4 An Agricultural System which Protects Natural Resources and the Environment.

Program #8 Improving Soil, Plant, and Water Resources in Ecosystems.

Project Title	SYs	PYs	TYs
Enhancing irrigation system performance with reclaimed water	0.5	0	0
Managing plant microbe interactions in soil to promote sustainable agriculture	0.8	0.5	0
Biosynthesis, structure, function, and regulation of metalloenzymes in denitrification	0	0	0
Shrub ecology and forage relationships	0.6	0.3	0
Characterization of successional processes in Western Montana riparian zones	0.6	0	0
Fate and transport of chemicals in soils	0.6	2.8	1
Biogeochemistry and management of salts and trace elements in arid-zone soils, sediments and waters	0.1	0	0
Interactions of vegetation, grazing, and watershed processes on Montana rangelands	0.6	0	0
Improved characterization and quantification of flow and transport processes in soils	0.1	0.3	0
Constructed wetlands for water quality remediation	0.5	0	0
Soil water and soluble chemical dynamics	0.6	1.9	0
Pesticides and other toxic organics in soil and their potential for ground and surface water contamination	0.2	0.3	0
Exploratory research in chemistry	0	0	0
The grass flora of Montana and integrating phylogenetic methods into studies of crop plants	0	0	0
Managing plant-microbe interactions in soil to promote sustainable agriculture	1	0	3
Sub-Total	6.2	6.1	4.0

Goal #4 An Agricultural System which Protects Natural Resources and the Environment.

Program #9 Economics and Sustainability of Public and Private Lands.

Project Title	SYs	PYs	TYs
Climate change and the economic sustainability of Montana and great plains agriculture	1.3	0.8	0
Benefits and costs of resource policies affecting public and private land	1	0	0
Sub-Total	2.3	0.8	0.0

Goal #5 Enhanced Economic Opportunity and Quality of Life for Americans.

Program #10 Survey Methods and Communities.

Project Title	SYs	PYs	TYs
Improvement of rural and agricultural sample survey methods	0.1	0	0
Family business: viability in economically vulnerable communities	0	0	0
Sub-Total	0.1	0.0	0.0

	SYs	PYs	TYs
Total	59.9	60.9	56.7

APPENDIX 3 – MAES External Linkages

Major Montana Commodity Groups or Committees

Alfalfa Seed Growers Association
American Feed Industry Association
American Forage & Grasslands Council
American Malting Barley Association
American Sugar Beet Growers Association
Beef Improvement Federation
Christmas Tree Growers Association
Eastern Montana Durum Growers
Grain Elevator Association
Hill County Seed Association
Mint Growers Association
Missouri River Alfalfa Marketing Association
Monfort Integrated Genetics
Montana Agricultural Business Association
Montana Alfalfa Seed Association
Montana Bankers Association Ag Credit Conference Committee
Montana Beef Council
Montana Dakota Beet Growers Association
Montana Farm Bureau Federation
Montana Farmers Union
Montana Feed Association
Montana Fertilizer Advisory Committee
Montana Grain Growers Association
Montana Hay Growers Association
Montana Hereford Assoc
Montana Mint Committee
Montana Native Plant Society
Montana Noxious Weed Trust Fund Council
Montana Nursery and Landscape Association
Montana Potato Improvement Association
Montana Pulse Growers Association
Montana Salers Assoc
Montana Salinity Control Association
Montana Seedgrowers Association
Montana Stockgrowers Association
Montana Turfgrass Association
Montana Weed Control Association
Montana Weed Trust Council
Montana Wheat and Barley Committee
Montola Growers Inc.
National Assoc. of Wheat Growers
National Association of Wheat Growers

National Barley Growers Association
 National Barley Improvement Council
 National Dry Pea and Lentil Association
 National Grain Growers
 National Grain Trade Council
 National Wheat Improvement Council
 National Wheat Quality Council
 NC213 Grain Quality and Marketing Committee
 NCBA (National Cattle Beef Association)
 North Central Montana Stockgrowers
 Northern Crop Institute
 Northern Crops Institute, Fargo, North Dakota
 Pacific Northwest Oilseed Association
 Peaks and Prairies Golf Course Superintendents Association
 Red River Valley Potato Growers Association
 U.S. Canola Association
 U.S. Durum Growers Association
 U.S. Wheat Associates
 Western Sugar Research Committee
 Western Wheat Workers
 Women in Farm Economics

Federal or State Agencies

Agriculture & Agri-Food Canada, Lethbridge, AB
 Alberta Environmental Centre, Vegreville, AB
 Bureau of Indian Affairs
 Bureau of Land Management
 Bureau of Reclamation
 CABI Bioscience, Delemont, Switzerland
 California Department of Food and Agriculture
 Coconino National Forest, Flagstaff, AZ
 Cody Conservation District, Cody Wyoming
 Colorado Department of Agriculture, Palisades, CO
 Consolidated Farm Services
 Cooperative Extension Service
 Environmental Protection Agency
 Farm Service Agency State Committee
 Federal Crop Insurance Corporation
 Fort Keogh Livestock and Range Research Laboratory, Miles City, Montana
 Helena National Forest
 Institut Economie Rurale Bamako, Mali
 Ministry of Forests, British Columbia
 Montana Agricultural Statistics Service
 Montana Bureau of Mines and Geology
 Montana Cooperative Extension Service
 Montana Department of Agriculture

Montana Department of Commerce
Montana Department of Environmental Quality
Montana Department of Natural Resource and Conservation
Montana Department of State Lands
Montana Fish Wildlife and Parks
Montana Noxious Weed Trust Fund
Montana Salinity Control Association
Montana State Dept. of Agriculture
Montana State Diagnostic Laboratory
Montana State University-Northern
Montana Weed Control Association
National Aeronautics and Space Administration
National Atmospheric Deposition Program
National Institutes of Health
National Institutes of Health
National Institutes of Health-Panel on Natural Products
National Oceanic and Atmosphere Administration - National Weather Service
National Park Service
National Science Foundation-EPSCoR
National Science Foundation-Panels in Integrative Plant Biology, Systematics and
Population Biology, and Plant and Microbial Development
National Weather Service
Natural Resources and Conservation Service
Natural Resources Conservation Service
Oregon Department of Agriculture, Salem, OR
Plant Materials Center
Sheridan and Richland County Conservation Districts
Soil, Water and Biocontrol Research Laboratory, Sidney, Montana
South Dakota Department of Agriculture
Townsend Ranger district, Townsend, MT
U.S. Fish and Wildlife Service, CMR Refuge, Lewistown, MT
U.S. AID
U.S. Department of Defense
U.S. Department of Energy
U.S. Department of Interior-Bureau of Land Management
U.S. Department of the Interior
U.S. Fish and Wildlife Service
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Forest Service - Forestry Sciences Lab
U.S. Geological Survey
University of Montana - School of Forestry
University of Montana - School of Pharmacy
Upper Midwest Aerospace Consortium
USDA Agencies (FS, CAPS, etc.)
USDA-Animal and Plant Health Inspection Service

USDA-APHIS, Biological Control Laboratory
 USDA-APHIS, PPQ, Billings, MT
 USDA-APHIS-PPQ-SS, Riverdale, MD
 USDA-ARS Commodity Quarantine lab, Fresno, CA
 USDA-ARS European Biological Control Laboratory
 USDA-ARS Grain Marketing, Production, and Research Lab.
 USDA-ARS Northern Regional Utilization Lab.
 USDA-ARS Southern Regional Research Lab,
 USDA-ARS, Sidney, MT
 USDA-Farm Service Agency—Montana state office
 USDA-Forest Service
 USDA-Fund for Rural America
 USDA-National Forest Service
 USDA-National Research Initiative
 USDA-National Resource Conservation Service
 USDA-National Western Technical Center
 USDA-Natural Resources Conservation Service—Montana state office
 USDA-Western Regional IPM
 USDA-Western Regional IPM Coordinating Committee
 Western Sustainable Agriculture Research and Education
 Wyoming Weed & Pest Control Association

Food Producer Groups

Aero, Helena, MT
 Agripro Wheat
 American Inst. of Baking, Manhattan, KS
 Amilar, Int.
 Arrowhead Mills, Herford, TX
 Aviko USA L.L.C.
 Busch Agricultural Resources
 ConAgra (United Ag. Products Div.)
 Coors
 Great Northern Botanicals Association
 Hill County Seed Growers Assoc
 Holly Sugar Corporation
 J. R. Simplot Company
 MacIntosh Seeds
 Montana Merchandising, Inc. Conrad, MT
 Montana Wheat, Big Sandy, MT
 Montola Growers, Incorporated
 National Association of Wheat Growers
 NW Plant Breeders
 Purity Foods, Inc. Okemos, MI
 Resource Seeds
 Simmental Assoc.
 South Devon Assoc.

Sunbeam Extracts, Spelt
United Ag Products
US Corn Growers
US Wheat Growers
Western Plant Breeders

Other

AgPro Systems
AgrEvo Chemical Company
Agriculture Canada
Agrium, Inc
Alberta Agriculture
Alternative Energy Resources Organization
American Association of Wetland Scientists
American Breeders Service
American Gelbvieh Association
American Simmental Association
American Society of Agronomy
American Society of Microbiologists
American Society of Surface Mining and Reclamation
American-International Charolais Association
Area school Vo-Ag Programs (Hobson, Denton, Winifred, Lewistown)
Bayer
Bayer Chemical
Baylor University
Billings Gazette
Bitterroot Restoration
Bristol Myers Squibb
British Columbia Ministry of Forests
Bureau of Reclamation Buford-Trenton Bottoms
Busch Agriculture Research
CAB International Institute of Biological Control
Cannon Laughlin Assoc.
Cargill
Cargill-Nutrena
Case Corporation
Cenex
Cenex Land O'Lakes
Center for Plant Conservation, St Louis, MO
Certified Angus Beef
Columbia Grain
ConAgra
Conklin-AgroVantage
Coors
County 4-H groups
Crop Development Center, U. Sask.

Crow Tribal Business Information Center, Little Big Horn College
Cytoclonal Pharmaceutical
Donlar Corp
Dupont Ag. Chemicals
Ecological Society of America
Eden BioScience Co
Eli Lilly
European Biological Control Laboratory, Montpellier, France
Experiment Station Committee on Operations and Policy - Working Group on Biological Control
Farmers Union Oil
Flathead Noxious Weed Board
Forage Genetics
Forage Genetics, Inc.
Fort Assiniboine Preservation Association
General Mills
Genzyme Molecular Oncology
Great Falls Tribune
Gustafson
Harvest States Coop
Heartland Seed
Helena Chemical
Hounds Tongue Biological Control Consortium (multi-group)
Hubbard Feed Company
Huntley Project Irrigation District
Huntley Project Lions Club
Huntley Project Museum for Irrigated Agriculture
Industry:
IntegraSeed
International Certified Crop Advisers
International Mountain Section - Society for Range Management
Intrastate Seed
Johnson and Johnson
Judith Basin Weed Control Board
KMON
KUSM-public television
Legume Logic
Ligocyte Pharmaceuticals, Inc.
Lima Grain
Local commercial TV—Fox and NBC
Lower Missouri Garrison Development Board
Lower Yellowstone Irrigation Project
Martin Marietta Aggregates
Mathias Kolding, OR
McLaughlin Institute
Monsanto

Monsanto Chemical Company
Montana Dakota Water Irrigation Coalition
Montana Farmer-Stockman
Montana Hail and Wind Insurance Adjusters
Mycotech, Inc
National Crop Insurance
National Research Council
Nature Conservancy
North Central Region 180
North Dakota Economic Development and Finance
North Dakota State Board of Agricultural Research
North Dakota State University, Fargo, North Dakota
 Entomology Research Laboratories
 Spring Wheat, Winter Wheat and Durum Breeding Programs
 Plant Pathology Department
 Engineering Department
 Range and Animal Science Department
 Ag Economics Department
 Williston Research Extension Center, Williston, North Dakota
 Dickinson Research Extension Center, Dickinson, ND
 Hettinger Research Extension Center, Hettinger, ND
Oakes Irrigation Research Station, Oakes, North Dakota
Northern Ag Broadcasting Network
Novartis
Novartis Seeds
Nutralyx Corp.
Pepsi Co.
Pfizer Pharmaceuticals, Inc.
Pioneer HiBred, Inc.
Prairie Star
Precision Ag Resources Association
Precision Agriculture Research Assoc.
Proseeds, Inc
Ravali Sportsman
Richland Economic Development
Rocky Mountain Elk Foundation
Rohm and Haas
Russian Knapweed Biological Control Consortium (multi-group)
Salish-Kootenai (S-K Holding Co., Inc.)
Skyline Sportsman Club
Society for Range Management
Soil Science Society of America
South Central Montana Antique Tractor Club
Spokane Seed
Stanford University
State veterinarians

Sumitomo Corp of America
Svalof Weibull
Textron Systems
Timeless Seeds
Toadflax Consortium
United Ag Products
University of Alabama
University of Minnesota.
University of Montana
University of Pennsylvania
University of Wyoming Sheridan Research Center
Upper Midwest Space Consortium
W-185 Western Region Committee – Biological Control in Pest Management Systems
of Plants
Washington State University
Weed Science Society of America
Weedy Mustards Biological Control Consortium (multi-group)
West Bench Land
Western and Holly Sugar
Western Beef Producer
Western Montana Weed Council
Western Plant Breeders
Western Regional Graduate and Pre-veterinary Programs of the Western Interstate
Commission for Higher Education
Western Society of Weed Science
Wilbur Ellis
Williston Area Economic Development
Williston Community Economic Development Task Force
Williston State College, Williston, North Dakota
WRCC-1
WRCC-110
Yellowstone Ecosystem Studies
Yellowstone Interagency Remote Sensing Working Group
Yellowstone Public Radio
Zeneca
Zinpro Corp.