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October 20, 1999

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,

