

2007 Montana State University Research Plan of Work

Brief Summary about Plan of Work

Montana State University 2007 — 2011 Plan of Work

Situation: Montana is a rural state with a land area of 93 million acres and a population of 909,000. It has a strong crop and livestock industry with annual receipts of nearly \$2.8 billion. Montana ranks 2nd behind Texas in the number of acres devoted to agricultural enterprises in the U.S. Montana ranks 2nd in barley production in the U.S., 3rd in wheat production, and 5th in sugarbeet production. In 2005, Montana had 28,000 farms and ranches on over 60 million acres dedicated to agriculture. Over nine million acres were cropped and the remaining 51 million acres were grazed or used for other agricultural purposes. Small grains represented about 67% of the cropped acres, alfalfa and other hay about 31%, and 15 other crops accounted for the remaining 2%. Wheat and barley represent about 25% of the total agricultural receipts for the state. Over 85% of Montana's raw commodities are exported outside of the state.

Montana ranks 11th among U.S. states in the production of cattle and calves with 11,400 beef cattle enterprises and an inventory of about 2.4 million livestock units. Montana ranks 7th in the production of sheep and lambs at 305,000 livestock units. There are about 19,000 dairy cows and 175,000 hogs. Cattle and calves represent over 88% of the livestock receipts for the state and 55% of the total agricultural receipts for the state.

The College of Agriculture (6 departments and one division) at Montana State University (MSU), headquartered in Bozeman, Montana, is comprised of the Montana Agricultural Experiment Station (MAES) and the College's academic programs (5 departments and one division) in undergraduate and graduate studies. The MAES system is a network of eight Agricultural Research Centers, four farms, and two collaborative research programs with USDA-ARS. In addition, Extension Specialists are in the College of Agriculture in five of seven units. Extension efforts are generally reported separately.

Expanded partnerships include the Montana Extension Service, MSU-Billings, MSU-College of Technology at Great Falls, MSU-Northern at Havre, the 1994 Land Grant tribal colleges, and other state, federal and private institutions in Montana and the region (e.g. North Dakota State University, South Dakota State University, Idaho State University and the University of Wyoming).

Priorities: As a result of the stakeholder input meetings, focus groups and general interactions, MAES received specific suggestions with regard to research and outreach. These were:

- Develop higher yielding solid stem winter wheat varieties
- Enhance the development of agronomically sound hard white wheats
- Provide better marketing of applied research results
- Increase research programs on alternative energy sources
- Expand research on agricultural and natural resource interactions
- Create new business opportunities for rural communities
- Add value to Montana's high quality crop and livestock products
- Explore alternative and new crops
- Improve beef production practices and use genetics to improve herds

Other areas of research that received responses in the high priority rating were natural resources, livestock production and management, crop production and management, range production and management, noxious weed management, animal and livestock diseases, and nutrition and health. These results will likely continue to influence MAES research priority areas into the next decade.

Input Section: Stakeholder input has been solicited in the strategic planning process and continues throughout as programs are developed, implemented and changed as dollars are allocated and reallocated.

The College of Agriculture and MAES have 23 advisory committees and boards with a total of 266 members. These include: The Animal Biosciences Complex Board, Biobased Product Institute, Center for Invasive Plant Management Board, Center for Invasive Plant Management Science Advisory Council, Central Agricultural Research Center Advisory Committee, Eastern Agricultural Research Center Advisory Committee, Foundation Seed Advisory Committee, Joe Skeen Institute for Rangeland Restoration, MAES State Advisory Council, Mint Committee, Montana Agricultural Innovation Center Board, Montana Beef Advisory Committee, Montana Beef Network Advisory Committee, Montana Seed Growers Association Board, Montana Wool Growers Advisory Committee, Northern Agricultural Research Center Advisory Committee, Northwest and Western Agricultural Research Centers Advisory Committee, Potato Certification Board, Southern Agricultural Research Center Advisory Committee, Thermal Biology Institute Scientific Advisory Board, Undaunted Stewardship Guidance Council, Variety Release and Recommendation Committee, and Western Triangle Advisory Committee.

Members of these committees represent farmers and ranchers, tribal councils, county extension agents, financial organizations, communities, scientists, agricultural educators, private citizens, small businesses, conservation groups, reservation groups and agricultural organizations. The College of Agriculture and its MAES faculty respond to input from these stakeholders and state/national/international trends by constantly evolving programs.

Inputs/Funding: The source of funds contributing to the research conducted by MAES faculty include, but are not limited

to: Montana crop and animal agricultural groups, conservation and wildlife groups, other states, private industry, private donations, BIA, BLM, Canadian Provinces, EPA, Montana Board of Research and Commercialization Technology, Montana Department of Agriculture, Montana Fertilizer Advisory Committee, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, National Institute of Health, National Science Foundation, NASA, NRCS, the State of Montana, overhead investments from sponsored programs, USDA and the USFS.

The Montana Wheat and Barley Committee provides about \$500,000 in financial support to MAES scientists annually through a competitive grant process. This financial support helps direct research programs in spring/winter wheat, barley, cereal grain quality, IPM practices, and interactions in small grains and crop rotations. The Montana Noxious Weed Trust Fund provides about \$300,000 annually for community watershed cooperative projects and for competitive education and research funds for COA/MAES scientists.

Outcomes and Impacts: Enhance Economically Viable and Sustainable Agricultural Systems

Develop competitive, sustainable and viable plant and animal systems

Improve fundamental understanding of plant and animal biology

Foster the development of value-added biobased agricultural products

Improve plant and animal health through IPM and other sustainable practices

Improve food safety and quality

Contribute to commodity and product marketing and economic development

Create programs that comprehensively address issues and problems associated with plant and animal systems

Enhance our understanding of rural, urban and disturbed landscapes

Strengthen the Quality of Life for Montana and Its People:

Facilitate the development of educational programs and new delivery systems

Improve recruitment and retention of students.

Develop partnerships to enhance business and community development

Create opportunities for undergraduate and graduate students to engage in research

Each of the seven research centers holds annual field days in cooperation with USDA-ARS programs for the presentation of research information through outreach activities and to collect input on new research directions. These field days are attended by agricultural clientele, elected officials and the general public and have the participation of faculty, staff and students.

Program Areas

Water Quality and Use Situation: Montana is a headwater's state with pristine waters that have scenic value, agricultural and manufacturing applications, and provide recreation for Montanans and visiting tourists. A number of diverse ecological systems either border Montana or are located within the state. These systems provide opportunities for extensive research into how they interact under the climatic conditions and land use practices in Montana. As a semi-arid state, most crops are dependent on irrigation from streams and ground water systems. Stream flow, ground and surface water hydrology, fisheries and wildlife are heavily dependent on snow pack for the continuing adequacy of water supplies.

Montana is in a unique position to understand how land management practices impact ecosystems. Surface landscape practices, including agriculture, energy development, mining and urbanization can severely impact both water quality and quantity. Water usage and water conservation interplay with all Montana cropping and livestock operations. Irrigated agriculture is the largest user of freshwater in Montana with 1.7 million acres under irrigation using approximately 8.9 million acre-feet of water annually. Of these irrigated acres, approximately 500,000 acres are under sprinkler irrigation while 1.22 million acres are surface irrigated. As a result of education and research activities, there has been a general trend toward more efficient irrigation systems. Montanans recognize the importance of having an abundance of quality water sources. In general, research information that includes quality and quantity on watersheds in the Northern Rockies is very limited.

Priorities: Finding crops that require less water per acre and others that will grow in the short growing season require innovative solutions. This can partially be accomplished through crop breeding and changes in management practices. Protecting watersheds will ensure that water supplies are not interrupted due to inappropriate management of this natural resource.

Evaluating watersheds to determine the best approach for raising crops, grazing livestock, and other uses will help protect riparian areas and improve our state's fisheries and wildlife habitat.

Input: Input comes from meetings with conservation and wildlife groups, BIA, BLM, Montana Department of Agriculture, Montana Fish, Wildlife and Parks, NASA, NRCS, the State of Montana, USFS and other organizations interested in water quantity and quality issues. Extensive water monitoring across Montana has helped researchers develop predictive models that help direct future research. Much of the research is in its initial phases and hence of limited value to state conservation planners at this time.

Research Activities:

Soil water is a primary limiting factor for plant growth in semiarid and arid regions like Montana. Mapping soil water content for

site-specific management of farmfields is commonly achieved through grid soil sampling, an effort that requires intensive soil coring, which is destructive and time consuming. If sampling techniques are improved and made cost-effective, precision farming and agricultural research can be more productive and have a dramatic impact on water resources. A new frequency domain approach to measure the static dielectric constant will facilitate measurements with very small probes. This should greatly enhance the practical and commercial utility of the monitoring approach. When this research is complete, investigators will be much closer to the routine estimation of specific surface area in soils for environmental and agricultural monitoring. The results will lead to tools with applications that lower costs and improve monitoring efficiency.

Research is continuing to better understand the relationship between alpine headwaters and valley bottom wetland systems to control streamflow quantity, runoff timing and water quality. Systems are being developed that will better correlate topographic features, riparian zones and landscapes to water features. An understanding of the relationship between water runoff and land features is critical to developing better utilization of limited water resources in Montana. An additional objective is to measure metallic contaminants originating from an alpine source which ultimately leads to impacts in valley streams.

Secondary education science teachers find little time to present more than just basic information on water use and management in their curriculum. The development of a stream-side science program for secondary education students provides a way to introduce children to the basics of natural resource management. MSU is developing a project to develop, deliver and evaluate an on-line, experiential course in the science of water quality for secondary science teachers who may be struggling with other time commitments. A 3-credit, 8-week graduate course, taught via the internet, will be developed as part of MSU's National Teacher Enhancement Network (NTEN). The program will provide secondary science teachers with comprehensive water quality education; provide activities that are transferable to secondary science students and provide rural, place-bound and distant students equal access to experiential water quality education. The course will be modified based on evaluations from the pilot program and offered again the following summer. Feedback will be used to make necessary changes to the course, whereupon the course will be advertised nationally through regional CSREES partners, the Master of Science in Science Education (MSSE) program, NTEN and the Burns Technology Center (BTC).

Integrated Pest Management (IPM) Situation: Montana producers are continually challenged to produce crops with limited resources, especially moisture. Insect, disease and weed pests create additional problems challenging producers to maintain a competitive market position. Producers have relied on traditional pesticides to economically reduce the direct impact pests have on food and fiber production. The pesticides are costly; however delaying or eliminating pest control options may not always be an option. Biological controls for insects, diseases and weeds are becoming more important as traditional chemical control methods and products are scrutinized or cancelled. The increase in public concern about food quality, natural resource biodiversity and sustainability of the quality of soil, air and water is mandating less reliance on traditional pesticides and more research into environmentally friendly systems. There is a very important need to review the number of control options available to producers. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities being exported to their countries.

Priorities: Integrated pest management programs seek to optimize grower profitability and natural resource sustainability through development, selection and implementation of economically sound and environmentally acceptable pest management strategies. Addressing the public's concern about food safety through research into less chemical dependent systems is a priority of several programs. Crop rotation systems, crop production methods and water management issues all are priorities in the production of abundant high quality crops. Unraveling complex ecological relationships is central to understanding pest management systems, implementing biological control and exploring a multitude of science-based options as a part of those systems. Research continues to address both the economic feasibility and environmental impact of biological control.

Economic and environmental data will continue to be essential to produce realistic biologically-based pest management programs for stakeholders.

Inputs: The source of funds contributing to the research conducted by MAES faculty include, but are not limited to: Montana crop and animal agricultural groups, other states, private industry, private donations, Montana Department of Agriculture, Montana Ag Business Association, Montana Fertilizer Advisory Committee, Montana Grain Elevator Association, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, Western Sustainable Agricultural Program, and USDA. Stakeholder input is collected in county- and reservation agent- sponsored stakeholder input meetings, listening sessions during pesticide applicator education programs, and a Farm Bill Forum. The development of more environmentally friendly chemical and non-chemical alternatives requires ongoing interaction with chemical and biological pest control product manufacturers, state and federal agencies, and with researchers in other crop producing states.

Research Activities:

Insect pests reduce alfalfa yields and stand longevity. Managing forage insects while protecting beneficial insects, especially honeybees, is a difficult challenge. There is increasing interest in replacing conventional synthetic insecticides with safer compounds that provide targeted control with little effect on the natural enemy complex. Alfalfa management programs have been initiated to look at traditional use of chemical control methods, non-chemical control methods and cultural management

options. Determining factors that impact beneficial insects and finding options to reduce yield damaging insects are priorities for this project.

There has been a trend to routinely treat small grain fields in Montana with insecticides for control of cereal leaf beetle (CLB), based on regional research. Research is being conducted to evaluate the economic injury level for CLB under Montana conditions and crops. Development of an economic injury level that is more appropriate for Montana producers, and continued emphasis on monitoring and using decision-making guidelines will continue to yield substantial economic benefits as well as optimize the use of costly insecticides for controlling CLB.

Diseases of sugarbeets have caused severe economic losses to producers in the sugarbeet producing areas of the U.S. Management of sugarbeet diseases has been a major focus of research and extension education programs for over ten years. These programs have led to grower implementation of effective, environmentally friendly and economical controls for major diseases. Management of Fusarium yellows, Cercospora leaf spot, Rhizoctonia crown and root rot, and Aphanomyces root rot has increased grower profits on more than 88,000 acres to date in Montana. Additional research into alternative control methods and more widespread adoption of currently successful systems will continue to grow farming profits.

There are limited commercial fungicides available for control of major diseases in potatoes. A new potato fungicide management program was developed by MAES research and used on 1500 acres in 1999 and more than 4,500 acres in 2000 for control of Rhizoctonia black scurf in potatoes. Quadris® fungicide (azoxystrobin) was federally labeled in 2001 based, in part, on data from MSU. Potato yields were increased by an average of 13% for the years 1994–2002 resulting in a net economic return to product users (3,200 acres) in Montana of more than \$300/A or \$990,000. Syngenta Crop Protection reports Quadris® was used on more than 150,000 acres nationwide in 2005. Continuing research into novel disease management systems for potatoes will further reduce grower's dependence on single management tools for protection of their crop.

In Montana, diseases of wheat and barley (especially smuts and bunts) can cause severe economic losses. Research examines two novel strategies for the control of diseases using mating inhibition and the anti-fungal puroindoline proteins. Disruption of the sexual cycle using pheromone analogs potentially is a significant new approach to controlling fungal plant diseases.

Changes in tillage practices bring changes in pest complexes. No-till cereal production practices combined with a conversion from wheat-fallow to annual cropping has led to more intensive disease pressure for Montana producers. Fusarium crown rot and root rot cause an estimated \$50 million in losses annually. Montana research will identify parameters for the development and control of these diseases.

Weed management tools require continual updating due to changes in weed complexes and resistance to herbicides. New weed control management strategies, utilization of herbicide-resistant crops and registration of new chemical compounds will be critical for the future viability of agriculture. Alfalfa, corn, dry beans, barley, wheat and sugarbeets will be planted in trials to evaluate the impact of experimental and registered herbicides on crop vigor. The goal of this project is to provide applied, field-oriented research that will benefit the citizens of Montana, especially those who derive their income from crop production. The molecular processes that underlay the ability of weeds to compete are poorly understood. A project focuses on the comparison of herbicide resistant and non-resistant kochia biotypes. Basic knowledge of the mechanisms of weed resistance helps manufacturers of crop protection products develop herbicides that target specific biochemical processes within the plant. Weed control in Montana crops relies on the identification and treatment of annual or perennial species of grasses and broadleaf weeds. Understanding the role of weed diversity and seedbanks in Montana cropping systems will help producers develop more effective weed control programs. Herbicide screening trials will continue to be established to assess the effectiveness of new and existing herbicides under the range of environmental and crop conditions representative of Montana agricultural systems.

About 90% of the major diseases of the principle crops in the United States are caused by soilborne plant pathogens and result in severe revenue losses estimated to be in excess of \$4 billion/year. Acute diseases such as vascular wilts, take-all of cereals, Phymatotrichum root rot, Verticillium and Phytophthora reduce yields and destroy entire agricultural industries. Some biocontrol agents are now available commercially; however problems with production, storage, delivery, reliability, efficacy, establishment and with understanding the mechanisms of control have prevented most products from reaching commercial sustainability. Research is ongoing to find additional environmentally friendly solutions for management of plant pests.

Biological controls are needed for integrated disease management programs in potatoes and sugarbeets. The purpose of this research project is to identify optimal disease management strategies and integrate biological controls for potato, sugarbeet and other crops. Two Bacillus biological control agents Bacillus mycooides isolate BacJ and MSU 203-7 controlled Cercospora leaf spot of sugarbeet, Corynespora blight of cucumber, early blight of potato and several other diseases. Continuing work will be done to investigate additional disease control approaches with these bacteria and other isolates in field and greenhouse trials.

Exotic noxious weed species seriously decrease the value of rangelands and pasture. Biological control is an important component in the integrated management of spotted knapweed. Montana citizens demand additional non-chemical control

options. This project manages exotic weeds through the introduction of natural enemies. Management of knapweed will increase rangeland productivity and plant diversity, thereby enhancing Montana's economic return from agricultural enterprises while improving wildlife habitat.

Sustainable AgricultureSituation: Researching new crops and finding new markets for existing crops are potential ways to enhance Montana's interest in sustainable agriculture. Montana producers have a greater opportunity to produce commodities in a relatively pest-free environment than many other states due to the extreme winters that kill many pests that may overwinter in other areas of the country. Farmers and ranchers in Montana have historically practiced sustainable activities due to the marginal opportunities for success in a semi-arid climate.

A basic principle of sustainable agriculture is to investigate current agricultural practices and find economically feasible and environmentally friendly alternatives to current agricultural practices. These include optimizing the use of chemicals for pest control, using alternative tillage systems and increasing crop diversity. Goals of sustainable agriculture are to reduce dependence on non-renewable resources (such as fuel, synthetic fertilizer and pesticides), to promote stable and more prosperous farming communities and to provide more farm income. With the continuing rise in fuel prices, farming practices that reduce dependence on fuel will add to the profitability of the enterprise. This factor alone provides incentives to farmers to investigate sustainable agricultural methods.

Priorities: Sustainable agriculture seeks to find ways to provide a more profitable income for farm enterprises, reduce dependence on non-renewable resources (e.g. fuel, synthetic fertilizers and pesticides) and promote stable and prosperous farm families and communities. To decrease Montana's primary dependence on small grains and forage crops, research is being conducted on the feasibility of growing a variety of crops including: pulse crops (pea, lentil, chickpea, soybean), herbs, mustard, safflower, sunflower, canola, turf and specialty grains. We are presently researching alternative pest control practices, including biological pest control for forages, potatoes, small grains and sugarbeets, which are of utmost interest to stakeholders.

Input: Many questions arise at extension and commodity group meetings, conferences and onsite interactions with crop and livestock producers in Montana regarding the use of natural pest control measures and the production of alternative crops. Evaluation surveys of recent farm conferences in Montana highlight strong producer interest in diversified crop rotations. Information and financial assistance comes from Montana Wheat and Barley Committee, Montana Organic Association, crop protection companies, fertilizer advisory committees, conservation tillage equipment companies, alternative energy groups and state agricultural advisory committees.

The effects of MSU research in sustainable agriculture have an immediate impact on crop and livestock planning for Montana producers. The shift to more efficient and profitable specialty crops will continue to generate major interest in the future. The use of the Internet for information dissemination has become an increasingly valuable method to provide stakeholders with materials to assist in their decision-making. While meetings, interviews and focus groups will continue to be used to gather information from stakeholders, the increasing use of computer modeling and surveys will add to data being collected. As technology advances and producers begin to rely more on computer-aided information, the role of MSU research and extension will continue to increase in their importance and impact.

Research Activities:

Cattle and wildlife often compete for the same forage throughout the year, especially in rangeland areas. Study results revealed that competition with elk in spring rangeland can contribute to substantial losses to cattle producers. While deer may be more plentiful, their effect throughout the year is not severe enough to take preemptive measures. In Montana and throughout the U.S., maintaining profitable agricultural enterprises while sustaining ecological systems has become a difficult balancing act that often results in changes in agricultural practices and environmental policy.

Concerns about global warming continue to create challenges and opportunities for crop producers. Current models estimate that agricultural production contributes to the release of nitrous oxide into the environment. Studies to quantify nitrous oxide gas release under several cropping and tillage systems and substantiate releases are less than previously thought. Two-year rotation systems include conventional tillage, no-till, organic, fallow, rotated crops, continuous crops and CRP. Studies will continue to address longer-term questions on agricultural nitrous oxide contributions in addition to addressing water use efficiency and soil quality.

Crop diversity studies continue to show promise for increasing on-farm receipts while reducing dependency on small grains. Winter and spring peas, canola, corn, lentil, mustard, sunflower, triticale and chickpea are included in long-term rotation studies. Pulse crop production dramatically increased to 350,000 acres in 2005 due in part to our research. This represents an important new source of income for Montana farmers and provides opportunities for increasing crop diversity.

Traditional agriculture in Montana typically provides marginally profitable income to be sustainable. In order to provide opportunities for rural development, the introduction of new higher value crops will be needed. This introduction will require training in the production and marketing of new specialty crops to maximize their potential. Research into new crops such as dwarf lawn grasses, essential oils and natural rubber production, will provide opportunities for growers and their communities. Efforts are being made to provide new marketing alternatives that will better utilize commodities produced in the Pacific

Northwest, including Montana, and reduce dependence on external enterprises to add value. The development of specialty crops and products for natural rubber production and bio-energy are examples of our research focus.

Several projects have looked at flora growing in or near the hot springs of Yellowstone National Park. Understanding the mechanisms of growth of these native plants in geothermally-modified soils will help researchers gain insight into how global warming impacts agricultural production. In addition, microbial populations in these environments have shown the capability of either oxidizing or reducing arsenic; this finding can be an important step in the development of bioproducts for decontaminating sites containing arsenic and other hazardous elements/compounds.

Weed management is a major concern of small grain producers in Montana. Research is being conducted to determine and model the dynamics of weed survival and dispersal in small grain fields under established production parameters. Tillage systems, herbicides and fertility will be examined and added to the model. Understanding and interrupting the seed dispersal mechanisms of weeds in small grains can improve weed management recommendations and producer profits.

The wheat stem sawfly continues to limit yields in Montana wheat. In addition to new sawfly-resistant wheat varieties that have been developed, the uses of natural enemies and pathogens are being evaluated to counter the effects of sawfly infestations. Several invasive weeds (especially hoary cress, rush skeletonweed, field bindweed and spotted knapweed) reduce crop and rangeland productivity across much of Montana. Innovations have led to the discovery of several novel products and systems for reducing the overall effects of these weeds.

Many large blocks of rangeland in the West are infested with noxious weeds to the extent that the land will not support grazing by traditional livestock and wildlife. Sheep can be used to manage these weed infestations providing a benefit to the sheep owner while reducing noxious weeds. This research through the Montana Sheep Institute measures the effect that sheep grazing has on the reduction of large infestations of leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea maculosa*). This project focuses on the use of sheep grazing as a tool in natural resource management; develops and implements the selection, nutritional and marketing management strategies for maximizing sheep production; and implements the development of non-traditional lamb and wool marketing strategies.

The objective of the Montana Sheep Institute is to develop and implement nontraditional strategies that will increase the competitiveness of Montana lamb and wool in the world market. Two objectives will focus efforts on sheep grazing as a tool in natural resource management and the reduction of lamb mortality. Additionally, research in the feed and supplements fed to lambs will be conducted with the end result to produce lambs with higher levels of unsaturated fatty acids in the lean tissue. This nutritional alteration could provide significant marketing opportunities for sheep producers.

Biobased Products and Processing Situation: The future of Montana's agricultural economy depends on maximizing net returns per acre or per animal unit with the most efficient use of resources. Value-added, agriculturally-based end products can create unique markets and enhanced revenues for Montana producers. Montana exports approximately 85% of its raw commodities. It is increasingly important to add value to raw agricultural commodities and processed food products before they leave the state in order to capture their inherent economic value. The development of energy alternatives will also provide opportunities for renewable biobased products and will help to reduce the current dependence on fossil fuels. Montana State University is a leader in the development of biobased products and their use in the development of highly desirable products. The goal of the Biobased Products Institute, a unique MAES entity, is to build a biobased economy that provides manufacturing, product development, rural development, job opportunities and an opportunity to increase farm and ranch incomes.

Priorities: The revitalization of agriculture and rural communities in Montana is essential for the state's economic sustainability and competitiveness. A biobased diversified economy will provide in-state manufacturing, product development, rural development and jobs. The Biobased Products Institute through the Board of Directors funds research projects that strives to increase the profitability of Montana agriculture, enhance the health of the human population through enhanced nutrition and reduce our reliance on non-renewable energy by production of biofuels, ethanol and biolubricants. A prime emphasis of our research is to add value to existing Montana products and to commercialize new products, while maximizing limited resources and reducing reliance on commodity agriculture. The Biobased Products Institute currently supports 26 biobased research projects and has developed several high-value biobased products.

The objective of the Institute is to develop an innovative and responsive program to enhance the developing needs of the State of Montana and Pacific Northwest/Northern High Plains regions. It is working to expand development and production of value-added products in Montana and to support food risk assessment research and education. The Biobased Products Institute will provide expertise to growers, researchers and agricultural businesses and assist in development of safe, nutritious, value-added products, risk assessment and marketing.

Input: The Institute will develop value-added, agriculturally based end-use products and provide mechanisms to enhance agricultural production practices to enhance product quality. It will develop systems that ensure food safety and agricultural security while establishing biobased product and food science education and research programs. Enhanced partnerships among faculty across the Montana University System, producers, agricultural industry and other educational institutions across the region are part of the outreach activities related to biobased products and food science. The Institute will use technology and biotechnology to improve plant and animal production systems and will determine strategies for marketing higher value

agricultural commodities, consumer products and alternative crops. The Institute will use science to improve nutrition, add value and improve food security and determine impacts and risks associated with changing technologies.

Research Activities:

Montana's wheat products are important in Asian markets where grain hardness and cereal quality are important considerations. Continued genetic research into the expression of undesirable characteristics in grains will help ensure that the grains will maintain their commanding presence in the market.

Research continues into developing alternative crops in Montana. Canola, chickpea, fenugreek, camelina and assorted herbs have been evaluated for their potential in emerging value-added markets. Oilseeds (including *Camelina sativa*, canola, soybean and safflower) are rapidly emerging as important Montana crops for production of culinary oils, biolubricants, omega-3 oils, feeds and biodiesel.

Over 90 germplasm accessions of *Camelina*, an oilseed, have been evaluated for adaptability, yield potential and fatty acid content. *Camelina* production could significantly reduce the cost of biodiesel from a typical \$2.00 – \$3.00/gallon to an expected \$1.05/gallon. The same crop produces omega-3 oil, which is being evaluated for human consumption. Field tests continue to yield new information that could increase the viability of *Camelina* production in Montana.

The use of transgenic crops presents questions regarding the potential risk to human health and the environment. Computer modeling and data from greenhouse and field experiments will help in risk assessments to estimate what hazards may be associated with transgenic crops. Providing risk assessment information to consumers will help to inform them of the benefits and risks of these crops.

Agronomic and Forage Crops Situation: Montana has limited crop and livestock diversity due to semi-arid conditions, a short growing season and the potential for long and severe winters. Cattle and sheep are the primary livestock enterprises; small grains, forages and short season specialty crops make up the bulk of the cropping activity. With limited diversity, researchers at MSU are able to delve deeper into understanding each entity from production and management studies as well as through plant and animal genomics. Agricultural cash receipts in Montana total over \$2.8 billion annually and are made up of roughly a 50:50 mix of crop and livestock agriculture. Montana is world-renowned for the quality of its wheat and beef cattle.

Research programs range from basic research in genetics and biotechnology to practical applications in rangeland, forest, crop and livestock management systems. Our long-term strategies are designed to make Montana agricultural products more desirable in U.S. and world markets. The end of a seven year drought in 2005 brought higher yields of crops and more available livestock feed, and it improved researchers' opportunities to evaluate crop agriculture and rangeland systems and livestock enterprises under more ideal conditions.

High-value and alternative crop production for Eastern Montana involves close collaboration between research and extension faculty in Montana and North Dakota. Sugarbeets are the high value cash row crop now grown in eastern Montana and the industry provides many production, processing, refinement and marketing jobs to the area. The Lower Yellowstone River Valley consistently produces the highest quality sugarbeets in the United States. A new barley malting facility has been built in central Montana and has created a demand for increasing production acres in Montana, and storage capacity has been expanded.

Priorities: One of the major environmental challenges in Montana is to create better grazing management in concert with the preservation of riparian habitats, wildlife and clean water. Characterization and understanding of the complex interactive components will lead to improved soil, plant and water resources in those ecosystems. The development of higher yielding varieties and the establishment of new value-added crops are priorities among agronomic researchers. The limited water resources and growing season available to producers requires researchers to be innovative in their approach to crop and pest management. Higher disease and insect resistance in wheat and barley, greater nutritional value for forages, and more efficient use of natural resources, especially water, are key priorities.

Inputs: Summaries of survey information from the Montana Weed Coordinators have identified critical local research needs on the management of invasive plants on private, public and agency lands. This has led to new state funding initiatives and research and education alignment with the Montana Weed Management Plan. Each of the seven research centers hold annual field days for the presentation of research and to collect input on new research directions. The Montana Wheat and Barley Committee provides financial support to MAES scientists through a competitive grant process. This financial support helps direct research programs in spring/winter wheat, barley, cereal grain quality, IPM practices and interactions in small grains and crop rotations. The Montana Noxious Weed Trust Fund provides funds for community watershed cooperative projects and for competitive education and research funds for COA/MAES scientists.

Research Activities:

Studies in precision agriculture have led to the development of a tool for a rapid nondestructive characterization of soils for a variety of environmental and agricultural applications and could dramatically increase the availability of soil data for monitoring carbon sequestration in agricultural lands.

An evaluation of the effectiveness of livestock distribution practices on grazed watersheds was a part of an ongoing three-state project that included Montana State University, University of California (Davis), and Oregon State University and the USDA-ARS, Burns, OR. Research from this project has shown the potential to manipulate cattle grazing patterns to protect and

improve fishery and wildlife habitat. Preliminary research from Montana suggests that herding can be a very effective approach to protect riparian areas. The combination of herding and strategic supplement placement can potentially focus cattle grazing on upland areas that typically receive little use. Focused grazing could be used to increase forage quality for elk and other big game.

The ecological role of shrubs is not well understood although they are critical in land management decision-making. Grazing and fire recovery in rangelands are priority issues to be studied in Montana, Yellowstone National Park and Wyoming. Determining successional patterns of sagebrush communities and their interaction with wildlife, such as the sage grouse, will help determine priorities for natural resource managers.

Sustainability of wildlife habitat on ranches is becoming very important. Research is being conducted on elk and cattle habitat use patterns in Montana and Wyoming. Interest in the relationships between beef cattle and elk is fueled by the fact that both beef cattle and elk are vital components of the economy and heritage of the Rocky Mountain West. Because ranching enterprises make major contributions to wildlife habitat, the economic viability of ranching enterprises is important to the preservation of elk and elk habitat.

Beavers have been proposed as habitat restoration agents for aspen and willow communities in areas of heavy wildlife grazing (especially elk, deer and bison). Sage grouse studies will identify which areas are suitable for nesting, brood rearing and winter use. Study results regarding the interactions of aspen, sagebrush and wildlife will be used to give land managers and natural resource agencies viable options for the maintenance of aspen and sagebrush habitat.

Livestock grazing practices are receiving increasing attention because of perceived negative impacts on soils, biodiversity and water quality. By determining the grazing behavior and the subsequent growth of cattle, decisions can be made on the need for supplemental feed over winter months based on models established in the research.

Traditional wheat and barley cropping systems that dominate dryland crop production in Montana are widely held to be economically and environmentally unsustainable. Diversifying dryland cropping systems to include oilseed and pulse crops in sequence with cereal crops is a viable and sustainable approach to farming in Montana and the Great Plains. Additionally, the use of reduced tillage and no-till systems are being evaluated to demonstrate their sustainability.

Plant Breeding, Genetics and Genomics Situation: MSU is a recognized international leader in the development of new varieties of wheat and barley that are sought by buyers around the globe. Montana is a state with limited crop diversity due to semi-arid conditions, a short growing season and the potential for long and severe winters. This limited diversity has made the state a prime area for growing small grains, but restricts the options of producers who may want to grow other crops. Researchers continue to evaluate germplasm and identify traits that will produce higher quality wheat and barley to meet increasing world demands for quality and alternative uses, while maintaining yields.

An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Much of the North Dakota/Minnesota Red River Valley malting barley production is moving to Montana and Idaho, thus increasing the level of research needed to provide suitable varieties for Montana growing conditions that will be approved by the industry. There is also an increasing need for new infrastructure to handle the potential increase in malt barley production and to respond to the marketing needs of producers. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers.

A major effort is underway to characterize and evaluate wheat and barley germplasm and to increase the utilization of world germplasm collections. Databases have been made available for researchers to access information on germplasm. A recently released solid stem winter wheat cultivar, Genou, has improved yield potential especially in wheat stem sawfly-infested areas of Montana. Through stakeholder input we are routinely applying for PVP title V status on all released wheat and barley varieties. Many new improved cultivars are licensed with partnering Montana companies, thus ensuring that Montana stakeholders receive maximum benefit from research discoveries.

Priorities: Montana State University seeks to maintain its role as a leading university in wheat and barley genetics research. Primary breeding objectives include increased yield potential, improved winterhardiness, wheat stem sawfly resistance, imidazolinone herbicide tolerance and enhanced dual-purpose end-use quality. Intensive genomic research will help Montana producers stay competitive and will provide improved cultivars adapted to Montana climatic conditions and cropping systems. Input: Recommendations and priorities are established by foreign trade teams, international trade missions, faculty, staff and students statewide. Farmers cooperate by providing dryland and irrigated fields for variety trials and by providing associated inputs. Research grants and proposals are received from the Montana Wheat and Barley Committee.

Research Activities:

The development and distribution of improved barley varieties that provide the highest possible production from Montana's limited water and soil resources are priorities of barley breeding programs. The program uses quality field research technologies, extensive on-station and on-farm trials and state-of-the-art genomics tools to develop well-adapted, high yielding, improved quality barley varieties. Research results are distributed to farmers, colleagues and stakeholders through technical and non-technical publications, through the release of germplasm and through new genomics tools and techniques. Research will continue to focus on the development of high quality drought tolerant barley lines for the malting, feed and ethanol

industries.

Several biotic and abiotic stresses hinder winter wheat production in the northern Great Plains. The purpose of this research is to develop germplasm with excellent end-use quality and resistance to important environmental stresses. The research results will increase the competitiveness of Montana wheat producers through improved winter wheat varieties with enhanced yield potential, pest resistance and end-use qualities. In addition to improved cultivar characteristics, researchers will evaluate more efficient screening, selection and breeding strategies and procedures to maximize efficiency and genetic progress in winter wheat annual breeding programs.

Hard red spring wheat is the leading crop in Montana. Farmers need new and better varieties to remain competitive. Research objectives are to develop new spring wheat varieties for Montana producers and to contribute to the science of wheat breeding and genetics. Bread making characteristics, especially dough strength and extensibility, are considered when evaluating spring wheat cultivars. New varieties with excellent qualities will ensure that Montana wheat retains or increases its share of Asian and domestic markets. New varieties are expected to be grown on substantial acreage across the state.

Wheat grain hardness is a primary factor in cereal quality. The lipid binding proteins puroindolines PINA and PINB have been identified as being responsible for determining differences between hard- and soft-textured wheat. This research study examines the degree to which the puroindoline proteins control wheat grain hardness and cereal quality and what alterations can be made to generate desired milling and end-product quality. Further research will address the effects that modifying the starch biosynthetic pathway has upon grain hardness, milling quality, yield and end product quality.

Polyphenol oxidases (PPOs) have been implicated in wheat product quality problems, including the undesirable darkening of Asian noodles. The biological basis for variation in this important trait will be established. Molecular markers at the seedling stage for high and low PPO activity in wheat have now been developed, thus making early selection of desirable low-PPO germplasm possible. A long-term goal of this research is the development of low-PPO germplasm with higher commercial value.

Peas are suited for production in the semi-arid northern Great Plains. Some producers have generated impressive net returns from chickpea and other dry pea cultivars. However compared to current small grain crops, producers must accept greater production risks and variable market opportunities. Studies continue to investigate the traits that are available within the pea gene pool to increase the effectiveness of the breeding program and the development of cultivars suitable for growth in Montana and the Great Plains. Gene markers in peas, lentils and common beans are being used to determine the effect different genomes have on desirable traits, such as shatter resistance, yield, stem strength and color.

Animal HealthSituation: Maintaining high quality meat, milk and fiber products from Montana livestock is a major focus of research at Montana State University. Losses due to environmental stresses, diseases and mortality create the need for improved understanding of the factors affecting Montana livestock. Promoting and maintaining animal health (cattle, sheep and wildlife) has led to advances in genetics, performance and reproduction. By understanding immune systems and parasite development in livestock, and by developing novel genes and new biochemical routes of activity for drugs and vaccines, economically important diseases such as coccidiosis, shipping fever and brucellosis may be managed more effectively. Researchers continue to investigate protein antigens for prevention of equine strangles in horses and on the effects insects have on disease transmission.

Despite recent advances in reproductive technology, cattle and sheep producers are still faced with the persistent problem of low fertility. Recent work indicates that the fertility of domestic ruminants, even under optimal conditions, is about 50%. Only one of every two natural or artificial inseminations results in the birth of a healthy calf or lamb. The poor fertility of domestic species is reflective of cumulative loss due to poor fertilization efficiency, high embryo mortality and spontaneous abortion. Research into winter maintenance programs for cattle and sheep often shows that productivity levels decrease substantially. Studies demonstrating the effects of winter stress on cattle productivity may lead ranchers to adopt changes in livestock management practices to prevent losses and manage range resources for improved animal health.

Priorities: Programs in the Montana Sheep Institute are testing new natural oil additives for improving lamb meat characteristics which help to increase the competitiveness of U.S. lamb in the world market. Research in targeted mutagenesis of cells in cattle will make milk and beef production more efficient. MAES researchers collaborated to develop a functional genomics program to study bovine immune cells. Feeding studies have shown that certain cultivars of barley can be more cost-effective than corn for the Montana producer. Improving feed efficiency, managing stress during the winter, lowering production costs, and improving beef genetics continue to be primary projects in animal research programs. Ongoing vaccine trials are now underway with Texas A&M researchers to study brucellosis in bison. Research is continuing in collaborations with researchers at the University of Montana and the NIH Rocky Mountain Lab to form a center for studying emerging infectious diseases in wildlife and livestock. The development and implementation of new management protocols and/or pharmaceutical and nutritional regimens that will increase the fertility of domestic ruminants in the Western region by increasing conception and reducing embryo and fetal loss are multistate collaborative goals. Understanding the breeding characteristics and activity of bulls and cows will lead to improved efficiency in controlling the breeding process.

Input: Stakeholder input has been solicited in the strategic planning process and continues throughout as programs are

developed, implemented and changed as dollars are allocated and reallocated. Valuable input has come from The Animal Biosciences Complex Board, Central Agricultural Research Center Advisory Committee, Montana Beef Advisory Committee, Montana Beef Network Advisory Committee, Montana Wool Growers Advisory Committee and other organizations who have a vital interest in livestock production in Montana.

Research Activities:

Newborn lamb mortality is the biggest production factor reducing profitability in sheep operations. This project examines strategic supplementation of the late gestating ewe to reduce fetal stress and increase survival rates. Factors to be evaluated include: (1) Cold tolerance in newborn lambs; (2) The effects of feeding high levels of supplemental fats/oils, zinc and vitamin E to ewes during late gestation; (3) Forms of zinc and their interaction with Vitamin E supplements; and (4) The influence of feeding high oil safflower seeds on feedlot lamb performance and carcass quality. Results of this study will benefit sheep operations by increasing lamb survival rates.

The determination of the physiological mechanisms and pheromonal pathways by which cows are stimulated to ovulate is important in the cow-calf industry in Montana. This research seeks to determine if bull urine or other aspects of bull exposure to cows is the source of the stimulatory effect and if the chemical compounds responsible can be identified.

Purchased feed is the largest single production expense for cow-calf producers. Increasing the utilization of Montana's most important natural resources (native rangelands and forages) could reduce production input costs and improve the profitability of cow-calf operations. The research measures animal performance, carcass characteristics, nutrient digestibility and net energy values of selected feeds and forages. A direct result of this research would be an increased use of barley grown in the state and a potential increase in acreage.

The beef and sheep industries are important industries to the state of Montana. Producing high quality animals and obtaining the highest profit potential are essential for Montana to maintain or exceed its current ranks in the national cattle and sheep industry. Cattle research will focus on weight relationships between cow herds and their offspring, the physical attributes of bulls and the role scrotal size has in reproductive efficiency, and the effects measured cattle traits have on carcass evaluations. A focus on reproduction and carcass traits will help ensure that Montana meat products continue to maintain the highest standards for the meat industry and consumers.

The annual cost of coccidiosis to livestock producers is in the hundreds of million of dollars. This project explores the molecular relationship of the Toxoplasma cell cycle to parasite development. The research has explored changes in gene expression that occur acro

Estimated number of professional FTEs/SYs to be budgeted for this plan.

Year	Extention		Research	
	1862	1890	1862	1890
2007	6.0	0.0	44.8	0.0
2008	6.0	0.0	44.8	0.0
2009	6.0	0.0	44.8	0.0
2010	6.0	0.0	44.8	0.0
2011	6.0	0.0	44.8	0.0

Merit Review Process

The merit review process that will be employed during the 5-Year Plan of Work cycle

- Internal University Panel
- External Non-University Panel
- Dept. Head External to PI's Dept.

Brief explanation

Hatch Projects are subject to a rigorous review at the department level, followed by a peer review, with final approval at the Director's level. The MAES Director's Office has oversight of this review process. The peer review committee, selected by the Director after consultation with College of Agriculture department heads, includes the principle investigator's (PI) department

head, MAES administrator, one department peer reviewer and two additional faculty external to the PI's department. Seminars are presented to the review committee and to interested stakeholders, including faculty, staff, students and constituents. The seminars are announced to the public on the web so any interested citizen could attend. Reviewers are requested to provide written recommendations on the following items: relevance and importance of the project; relation of the project to previous research; objectives; approach and methods; scientific and technical quality; resources; environmental, economic and/or social impacts. The responses are presented to the PI during a subsequent meeting with the MAES administrator and department head. Projects that do not meet expectations will not be approved and action upon them will be deferred until all of the key elements listed above have been met. Ultimately, Director approved projects are submitted to USDA CSREES for final approval.

In addition, new projects are required to be proposed for a 3-year period, while ongoing projects that receive a favorable merit review can be written for a 5-year period. No Agricultural Experiment Station funds are allocated outside of the College of Agriculture, consequently external expert review occurs with Montana State University-Bozeman faculty external to the College of Agriculture, as a requirement of the review process.

Evaluation of Multis & Joint Activities

1. How will the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?

Planned research programs adhere to regional and Montana protocols and priorities through continual review at regional and State levels. The Western Region of Experiment Station Directors reviews productivity through careful committee analysis of annual results tied back to the regional objectives. Direct ongoing participation of faculty, staff and students on the projects in Montana feed into multi-state projects and objectives. In addition, on a biennial basis the Montana Agricultural Experiment Station is reviewed and funded by the State. In non-legislative years, the Legislative Fiscal Analysis Division reviews goals and performance measures for compliance.

2. How will the planned programs address the needs of under-served and under-represented populations of the State(s)?

Montana has a very small overall population and an even smaller percentage of under-served and under-represented populations. Where applicable and where there is good opportunity for success, we are actively engaging in collaborative research and education that would address Native American issues. We are working closely with Reservation County Agents to identify key problems that, if they align with our expertise and resources, will result in research that addresses key issues and problems. The Montana Agricultural Experiment Station is also working with the USDA ARS on collaborative projects at facilities and associated regions in Sidney and Miles City, Montana. In addition, Bozeman-based faculty members periodically teach at the 1994 Institutions for short periods of time, typically in the summer.

3. How will the planned programs describe the expected outcomes and impacts?

In order to continue receiving State support that is 5 times the amount of federal support (Hatch, Multistate and Animal Health), our research must demonstrate actual or potential to economically impact Montana's economy and solve problems at the local to the state level. In simple terms, this could be the result of increased crop yields or through advances in crop or animal production efficiency. Deriving additional income from value-added and new enterprises helps to diversify risk and create additional opportunities for income. As a result of the new knowledge created through research activities, there potentially can be policy changes that impact agency management decisions. For example, the alternative use of coal bed methane waters for irrigating salt and/or sodium tolerant crops can lead to development of energy resources in an environmentally sound and economically feasible manner. This could lead to new policies on drilling for methane and use of extracted waters. In addition, if a new vaccine is developed for management of brucellosis in bison, the National Park Service would have new options that could lead to more socially acceptable management of bison in Yellowstone National Park.

4. How will the planned programs result in improved program effectiveness and/or efficiency?

The process of problem identification includes meeting with agricultural and natural resource organizations, securing funding for research operations and reporting to state and federal officials. This process assists in modifications that lead to improved program effectiveness in delivering research results that, in many cases, enhance agricultural efficiency through new or alternative practices. Research programs take the inherent initial risk, and stakeholders ultimately weigh in on program effectiveness through adoption of new technologies and approaches that provide additional income, reduce risk and sustain the enterprise. In addition, Montana stakeholders provide the impetus for continued and growing financial support through MAES programmatic emphasis important to the number one basic industry, agriculture.

Stakeholder Input

1. Actions taken to seek stakeholder input that encourages their participation (Check all that apply)

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Other

Brief explanation.

The Montana Agricultural Experiment Station (MAES) and College of Agriculture (COA) obtain stakeholder input on research priorities and programs. New stakeholder committees have been formed that include the College Development Board, Precision Ag Research Association (PARA), sustainable agriculture focus group, MAES Advisory Council, Ag Coalition and other state and local groups. PARA is external to MAES, charges its own dues and conducts quarterly meetings throughout Montana with members and selected professionals. MAES scientists routinely participate with this group and NRCS to provide training and expertise in GPS, GIS and remote sensing with geospatial applications. PARA and MSU have secured a number of USDA, NASA and industry grants to initiate collaborative projects on their property as part of the MSU originated "Learning Groups" concept. The Ag Coalition consists of representation from the Agricultural Business Association, Beef Council, Department of Agriculture, Farm Bureau Federation, Montana Stockgrowers, Montana Farmers Union, Montana Water Users, Montana Wool Growers and the Seed Trade. It meets every six months with the Dean and Director to review program priorities, new initiatives, fundraising efforts and legislative activities.

Stakeholder input is collected in county and reservation sponsored input meetings, listening sessions and a Farm Bill forum. The meetings were organized by County and Reservation Extension Agents under the direction of the Director of Extension. Meetings were advertised via news releases, newsletters, individual letters and announcements at group meetings. Extension agents were instructed to use county profile information to make sure that the people invited to the sessions would reflect the diversity of the area. The advertising and meeting invitations included the statement "Extension agents will also collect input on the research conducted through the Montana Agricultural Experiment Station." MAES responds to stakeholder inputs by considering their proposals at research planning meetings with scientists, advisory groups and administrators. Stakeholder input has been solicited in the strategic planning process and continues throughout as programs are developed, implemented and changed as dollars are allocated and reallocated. A survey of stakeholders was completed in 2001. The purpose of the survey was to collect input from a representative group of stakeholders in Montana. Questions in the survey were based upon the areas of emphasis in the strategic plans of the College of Agriculture/Agricultural Experiment Station and the Extension Service.

2(A). A brief statement of the process that will be used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Open Listening Sessions
- Other

Brief explanation.

Each of the seven agricultural research centers has an advisory group that meets 2–3 times per year. In addition, a State Advisory Committee meets three times per year to discuss program focus and direction, legislative priorities and productivity/impact. All of these meetings are open to the public. Administrators and faculty in the College of Agriculture serve on agricultural association committees that direct and fund research activities that have multiple meetings and communications throughout the year.

2(B). A brief statement of the process that will be used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey specifically with non-traditional groups

Brief explanation

Through our direct participation with agricultural stakeholder groups, broad participation committees and with directed meetings the Montana Agricultural Experiment Station engages in listening to and considering a defined problem or question that can be addressed through our research programs. The Director targets selective meetings with non-traditional groups. Montana has an open meeting law, so all meetings are open to the public and must have a published agenda.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- To Set Priorities

Brief explanation.

As a Land Grant Institution, Montana State University has a solid foundation of past and future program activities that allow stakeholder input and strong interactive dialogue. The College of Agriculture and the Montana Agricultural Experiment Station is the leader in this regard. We are the primary conduit in connection and delivery of education and new knowledge in agricultural activities throughout the rural State of Montana.

1. Name of the Planned Program

Water Quality and Use

2. Program knowledge areas

- 112 Watershed Protection and Management 40 %
- 111 Conservation and Efficient Use of Water 30 %
- 903 Communication, Education, and Information Delivery 30 %

3. Program existence

- Intermediate (One to five years)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

Montana is in a unique position to understand how land management practices impact ecosystems. Surface landscape practices, including agriculture, energy development, mining and urbanization can severely impact both water quality and quantity. Water usage and water conservation interplay with all Montana cropping and livestock operations. Everyone in the state is impacted by water issues, whether it is managing reserves for agricultural production, for recreational use, or for daily consumption.

Research Activities:

Mapping soil water content for site-specific management of farm fields is commonly achieved through grid soil sampling, an effort that requires intensive soil coring, which is often destructive and time consuming. A new frequency domain approach to measure the static dielectric constant will facilitate measurements with very small probes. When this research is complete, investigators will be much closer to the routine estimation of specific surface area in soils for environmental and agricultural monitoring. The results will lead to tools with applications that lower costs and improve monitoring efficiency.

Systems are being developed that will better correlate topographic features, riparian zones and landscapes to water features. An understanding of the relationship between water runoff timing and land features is critical to developing better utilization of limited water resources in Montana.

The development of a stream-side science program for secondary education students provides a way to introduce children to the basics of natural resource management. MSU is developing a project to develop, deliver and evaluate an on-line, experiential course in the science of water quality for secondary science teachers who may be struggling with other time commitments. The program will provide secondary science teachers with comprehensive water quality education; provide activities that are transferable to secondary science students and provide rural, place-bound and distant students equal access to experiential water quality education.

6. Situation and priorities

Montana is a headwater's state with pristine waters that have scenic value, agricultural and industrial applications, and provide recreation for Montanans and visiting tourists. Stream flow, ground and surface water hydrology, fisheries and wildlife are heavily dependent on snow pack for the continuing adequacy of water supplies. A number of diverse ecological systems either border Montana or are located within the state. These systems provide opportunities for extensive research into how they behave under the climatic conditions and land use practices in Montana. As a semi-arid state, most irrigated crops are dependent on water either from streams or underground sources. All Montanans are affected by decisions made to regulate water usage in the state. Farmers are especially dependent on water reserves and stream flow to produce crops requiring higher water use rates. Research investigates alternative cropping systems and identifies ways to measure and predict water availability. Priorities include:

Finding crops that require less water per acre and that will grow in the shortened growing season

Continue crop breeding investigations and changes in management practices

Protect watersheds to ensure that water supplies are not interrupted due to inappropriate management

Evaluate watersheds to determine the best approach for raising crops, grazing livestock and other uses to help protect riparian areas and improve the state's fisheries and wildlife habitat

7. Assumptions made for the Program

Adequate moisture (rainfall, irrigation, snowpack) will be available for the studies to be validated

Funding and technical support will be maintained from partnering institutions and cooperators

Program development will proceed as planned without major interruptions
 Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
 Conservation and wildlife groups, producers, and grain and livestock associations will continue to provide input into priorities and activities
 Drought may impact research results

8. Ultimate goal(s) of this Program

Provide soil water mapping tools with applications that lower costs of water and improve monitoring efficiency
 Provide secondary education students with quality instruction by trained teachers in the understanding and protection of our water resources
 Provide stakeholders with a better understanding of the relationship between water runoff and land features

9. Scope of Program

- In-State Extension
- In-State Research
- Multistate Research

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	1.0	0.0	3.4	0.0
2008	1.0	0.0	3.4	0.0
2009	1.0	0.0	3.4	0.0
2010	1.0	0.0	3.4	0.0
2011	1.0	0.0	3.4	0.0

Outputs for the Program

13. Activity (What will be done?)

Research results will be communicated in meetings with key organizations who impact decisions on water quality and quantity in Montana
 An on-line, experiential course in the science of water quality for secondary science teachers who may be struggling with other time commitments is developed
 Results from research will help to mitigate potential economic losses or disasters from inadequate or excessive water related events
 A new approach for mapping soil water content for site-specific measure will allow measurements with very small probes
 Better utilization of limited water resources in Montana

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● Workshop ● One-on-One Intervention ● Demonstrations 	<ul style="list-style-type: none"> ● Newsletters ● Web sites

15. Description of targeted audience

Organizations to be contacted include U.S. Geological Survey (USGS), National Resources Conservation Service (NRCS), the Montana Department of Natural Resources and Conservation (DNRC), irrigation districts, conservation districts and downstream and instream users
 Secondary education science teachers

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	250	400	0	0
2008	300	400	0	0
2009	350	400	0	0
2010	400	400	0	0
2011	450	400	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	0
2009	0
2010	0
2011	0

18. Output measures

Output Text

Number of research citations.

2007 Target: 10
 2008 Target: 12
 2009 Target: 12
 2010 Target: 14
 2011 Target: 14

Output Text

Successful external grants

2007 Target: 1
2008 Target: 1
2009 Target: 2
2010 Target: 2
2011 Target: 1

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Number of landscape scale datasets created

Outcome Type: Short

2007 Target: 0
2008 Target: 1
2009 Target: 0
2010 Target: 2
2011 Target: 0

Outcome Text

Number of improved prediction capacity models for snowpack/runoff into rivers and for instream flow

Outcome Type: Medium

2007 Target: 0
2008 Target: 0
2009 Target: 0
2010 Target: 1
2011 Target: 1

Outcome Text

Number of land and water use policies and practices developed by providing a scientific basis

Outcome Type: Long

2007 Target: 2
2008 Target: 2
2009 Target: 2
2010 Target: 2
2011 Target: 2

Outcome Text

Number of devices and models created for measuring the transport and fate of compounds

Outcome Type: Short

2007 Target: 0
2008 Target: 1
2009 Target: 0
2010 Target: 2
2011 Target: 0

Outcome Text

Improved management systems for water quality and quantity

Outcome Type: Medium

2007 Target: 0
2008 Target: 0
2009 Target: 0
2010 Target: 1
2011 Target: 1

Outcome Text

Educational programs that address water resource use

Outcome Type: Long

2007 Target: 2
2008 Target: 2
2009 Target: 2
2010 Target: 2
2011 Target: 2

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes
- Government Regulations

Description

Inadequate moisture (rainfall, snowpack, irrigation) to conduct the studies and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Interruptions in program development
Reduced numbers of staff and part time assistants to maintain appropriate progress on the project
Inadequate input from conservation and wildlife groups, producers, and grain and livestock associations

21. Evaluation studies planned

- After Only (post program)
- Retrospective (post program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Sampling
- Journals

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

1. Name of the Planned Program

Integrated Pest Management

2. Program knowledge areas

- 211 Insects, Mites, and Other Arthropods Affecting Plants 30 %
- 212 Pathogens and Nematodes Affecting Plants 30 %
- 215 Biological Control of Pests Affecting Plants 20 %
- 213 Weeds Affecting Plants 20 %

3. Program existence

- Mature (More than five years)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

Montana producers are continually challenged to produce crops under semiarid conditions. The addition of insect, disease and weed pests creates additional problems. Pesticides are costly; however delaying or eliminating pest control options may not always be an option. The increase in public concern about food quality, natural resource biodiversity and sustainability of the quality of soil, air and water is mandating less reliance on traditional pesticides and more research into biological control systems as part of a broader suite of management options. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities being exported to their countries.

Research Activities:

Managing pests in forage crops and small grains under Montana conditions are primary concerns of stakeholders. An emphasis on pest monitoring, using decision-making guidelines and determining economic injury levels will continue to result in substantial economic benefits and optimize the use of pesticides for controlling pests.

Management of diseases of sugarbeets and potatoes has been a major focus of research and extension education programs. Continuing research into novel disease management systems for potatoes will reduce a grower's dependence on a single management tool for protection of their crop. Research will examine the use of two novel strategies for the control of diseases of wheat and barley (especially smuts and bunts) using mating inhibition and anti-fungal purindoline proteins. Research is established that will identify parameters for the development and control of diseases common to no-till cereal production.

New weed control management strategies, utilization of herbicide-resistant crops and registration of new chemical compounds are critical research programs that will provide applied, field-oriented research for Montana producers. Basic knowledge of the mechanisms of weed resistance helps manufacturers of crop protection products develop herbicides that target specific biochemical processes within the plant. Understanding the role of weed diversity and seedbanks in Montana cropping systems will help producers develop more effective weed control programs. Herbicide screening trials will continue to be established to assess the effectiveness of new and existing herbicides under the range of environmental and crop conditions representative of Montana agricultural systems.

Research is ongoing to find additional environmentally friendly solutions for the management of soilborne plant pathogens. Identifying optimal disease management strategies and establishing biological controls are priorities for producing potato, sugarbeet, small grains and other crops in Montana. Increasing management for control of spotted knapweed will increase rangeland productivity and plant diversity, while enhancing Montana's agricultural economic return and improving wildlife habitat.

6. Situation and priorities

In Montana, small grains represent about 67% of the cropped acres, alfalfa and other hay about 31%, and 15 other crops account for the remaining 2%. Montana ranks 2nd in barley production in the U.S., 3rd in wheat production, and 5th in sugarbeet production. Wheat and barley represent about 25% of the total agricultural receipts for the state. Over 85% of Montana's raw commodities are exported outside of the state. Montana producers are continually challenged to produce crops with limited resources, especially moisture. The addition of insect, disease and weed pests creates additional problems challenging producers to maintain a competitive position in the market. Producers have relied on traditional pesticides to economically reduce the direct impact pests have on food and fiber production. The pesticides are costly; however delaying or eliminating pest control options may not always be an option. Biological controls for insects, weeds and diseases are becoming more important as traditional chemical control methods are under scrutiny or cancelled. The increase in public concern about

food quality, natural resource biodiversity and sustainability of the quality of soil, air and water is mandating less reliance on traditional pesticides and more research into environmentally friendly systems. Foreign trade partners especially want decreased pesticide residues in the wheat and barley commodities being exported to their countries. IPM programs at MSU seek to:

- Optimize grower profitability and natural resource sustainability
- Address the public's concern about food safety
- Investigate crop rotation systems, crop production methods and water management
- Implement biological control practices and explore a multitude of science-based options as a part of those systems.
- Address the economic feasibility and environmental impact of biological control practices.

7. Assumptions made for the Program

- Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced
- Funding and technical support will be maintained from partnering institutions and cooperators
- Program development will proceed as planned without major interruptions
- Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
- Grain and livestock associations, chemical companies, and other agencies will continue to provide input and financially support priorities and activities

8. Ultimate goal(s) of this Program

- Provide efficacious and cost effective pest control programs for Montana crop producers
- Improve rangeland management by developing controls for exotic noxious weed species
- Develop novel pest management systems that include biological control options
- Contribute to the understanding of weed resistance through basic research that targets biochemical processes within the plant

9. Scope of Program

- In-State Extension
- In-State Research
- Integrated Research and Extension

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	1.4	0.0	6.1	0.0
2008	1.4	0.0	6.1	0.0
2009	1.4	0.0	6.1	0.0
2010	1.4	0.0	6.1	0.0
2011	1.4	0.0	6.1	0.0

Outputs for the Program

13. Activity (What will be done?)

Research results will be communicated through pesticide workshops and field days held throughout the state
 Publications will be made available in print and online that provide pest control recommendations
 Results will be used to update pesticide applicator training materials
 Research results will be used to support FIFRA Section 18c products labeling requests
 Training materials will be updated for private and commercial applicators of crop protection products
 Regional management guides will be produced and updated

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● Workshop ● Demonstrations 	<ul style="list-style-type: none"> ● Newsletters

15. Description of targeted audience

Crop producers, dealers, distributors and crop protection company representatives
 Private and commercial pesticide applicators
 Crop protection companies registration and research personnel
 Montana crop advisory boards
 State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	200	150	0	0
2008	250	150	0	0
2009	300	150	0	0
2010	350	150	0	0
2011	350	150	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	1
2009	0
2010	1
2011	0

18. Output measures

Output Text

Number of research citations

2007	Target:	10
2008	Target:	10
2009	Target:	10
2010	Target:	10
2011	Target:	10

Output Text

Multidisciplinary journal articles published

2007	Target:	0
2008	Target:	2
2009	Target:	2
2010	Target:	2
2011	Target:	4

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Passing rate percentage for pesticide application licenses

Outcome Type: Short

2007	Target:	70
2008	Target:	70
2009	Target:	70
2010	Target:	70
2011	Target:	70

Outcome Text

Amount of financial support from industry per year for ongoing research (\$)

Outcome Type: Medium

2007	Target:	100000
2008	Target:	100000
2009	Target:	100000
2010	Target:	100000
2011	Target:	100000

Outcome Text

New products registered

Outcome Type: Long

2007 Target: 0
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Quality in-depth training programs for continuing educational on integrated approaches to pest management

Outcome Type: Short

2007 Target: 3
2008 Target: 3
2009 Target: 3
2010 Target: 3
2011 Target: 3

Outcome Text

New IPM options discovered and evaluated per year

Outcome Type: Medium

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Number of broad-ranging stewardship practices implemented

Outcome Type: Long

2007 Target: 0
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes
- Government Regulations

Description

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Major interruptions in program development
Lack of fulltime staff and part time assistants for the projects
Reduced support from grain associations, biological and chemical pest control companies and other agencies

21. Evaluation studies planned

- After Only (post program)
- Retrospective (post program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Sampling
- Journals

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

1. Name of the Planned Program

Sustainable Agriculture

2. Program knowledge areas

- 121 Management of Range Resources 25 %
- 215 Biological Control of Pests Affecting Plants 15 %
- 213 Weeds Affecting Plants 15 %
- 205 Plant Management Systems 15 %
- 132 Weather and Climate 10 %
- 206 Basic Plant Biology 20 %

3. Program existence

- Intermediate (One to five years)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

Montana growers have the opportunity to produce many commodities in a relatively pest-free environment, compared to other states, due to the extreme winters that kill many pests. Farmers and ranchers in Montana have historically practiced sustainable activities due to the marginal opportunities for success in a semi-arid climate. Researching new crops and finding new markets for existing crops are potential ways to enhance Montana's interest in sustainable agriculture. Research Activities:

Rangeland studies have shown that grazing competition with elk in the spring can contribute to substantial losses to cattle producers. More studies will be established to further define grazing parameters that maintain profitable agricultural enterprises while sustaining ecological systems.

Concerns about global warming continue to create challenges and opportunities for crop producers. Studies are established to quantify nitrous oxide gas release under several cropping and tillage systems. Additional studies will address the water use efficiency and soil quality in various crop rotation scenarios.

Crop diversity studies show promise for reducing monocultures of small grains and increasing on-farm receipts. Winter and spring peas, canola, corn, lentil, mustard, sunflower, triticale and chickpea are included in long-term rotation studies. This represents an important new source of income for Montana farmers and provides opportunities for increasing crop diversity. The development of specialty crops and products for natural rubber production and bio-energy are a focus of MSU research. Two additional projects include the development of a dwarf lawn grass species to reduce mowing requirements and the production of essential oils to provide alternatives to growing peppermint, which has suffered from oversupply and reduced prices.

Several projects over the past years have looked at flora growing in or near the hot springs of Yellowstone National Park. Understanding the mechanisms of growth of these native plants in geothermally-modified soils will help researchers understand the limitations and opportunities that global warming may present to agricultural production.

Research is being conducted to determine and model the dynamics of weed survival and dispersal in small grain fields under established production parameters. Tillage systems, herbicides and fertility will be examined and added to the model.

Understanding and interrupting the seed dispersal mechanisms of weeds in small grains can improve weed management recommendations and producer profits.

The wheat stem sawfly continues to limit yields in Montana wheat. In addition to new sawfly-resistant wheat varieties that have been developed, the uses of natural enemies and pathogens are being evaluated to counter the effects of sawfly infestations. Several invasive weeds (especially hoary cress, rush skeletonweed, field bindweed and spotted knapweed) reduce crop and rangeland productivity across much of Montana. Innovations have led to the discovery of several novel products and systems for reducing the overall effects of these weeds.

Research through the Montana Sheep Institute measures the effect that sheep grazing has on the reduction of large infestations of leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea maculosa*).

6. Situation and priorities

Montana is a rural state with a land area of 93 million acres and a population of 909,000. It has a strong crop and livestock

industry with annual receipts of nearly \$2.8 billion. Small grains represent about 66% of the cropped acres, alfalfa and other hay about 32%; 15 other crops account for the remaining 2%. A basic principle of sustainable agriculture is to investigate current agricultural practices and find economically feasible and environmentally friendly alternatives to current agricultural practices. These include optimizing the use of chemicals for pest control, using alternative tillage systems and increasing crop diversity. Goals of sustainable agriculture are to reduce dependence on non-renewable resources (such as fuel, synthetic fertilizer and pesticides), to promote stable and more prosperous farming communities and to provide more farm income. With the continuing rise in fuel prices, farming practices that reduce dependence on fuel will add to the profitability of the enterprise. This factor alone provides incentives to farmers to investigate sustainable agricultural methods. The effects of MSU research in sustainable agriculture have an immediate impact on crop and livestock planning for Montana producers. A shift to more efficient and profitable specialty crops has begun and will continue to generate major interest in the future. The use of the Internet for information dissemination has become an increasingly valuable tool in providing stakeholders with materials to assist in their decision-making. While meetings, interviews and focus groups will continue to be used to gather information from stakeholders, the increasing use of computer modeling and surveys will add to data being collected. As technology advances and producers begin to rely more on computer access to information, the role of MSU research and extension will continue to increase in their importance and impact. MSU priorities are to:

Find ways through sustainable agriculture to provide a more profitable income opportunities for farm enterprises
Reduce dependence on non-renewable resources (e.g. fuel, synthetic fertilizers and pesticides) and maximize efficiencies
Promote stable and prosperous farm families and communities through the development of crop diversity and community agribusiness support
Decrease Montana's primary dependence on small grains and forage crops
Develop grazing recommendations for management of rangeland resources
Conduct research to determine the feasibility of growing a variety of crops including: pulse crops (pea, lentil, chickpea, soybean), herb, mustard, safflower, sunflower, canola, turf and specialty grains.
Research alternative pest control practices, including biological control for pests of forages, potatoes, small grains and sugarbeets.

7. Assumptions made for the Program

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced
Funding and technical support will be maintained from partnering institutions and cooperators
Program development will proceed as planned without major interruptions
Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
Grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

8. Ultimate goal(s) of this Program

Provide sustainable new cropping opportunities for Montana producers
Determine practical rangeland grazing strategies for Montana livestock producers
Find and evaluate alternative sustainable fuel sources from agricultural products grown in Montana
Develop novel pest management systems for controlling insects, diseases, and weeds in Montana crops

9. Scope of Program

- In-State Extension
- In-State Research
- Multistate Extension
- Multistate Research

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	1.6	0.0	3.6	0.0
2008	1.6	0.0	3.6	0.0
2009	1.6	0.0	3.6	0.0
2010	1.6	0.0	3.6	0.0
2011	1.6	0.0	3.6	0.0

Outputs for the Program

13. Activity (What will be done?)

Communicate research results through field days, news releases and presentations at county and state meetings and conventions
 Hold strategic planning meetings with state agricultural groups
 Distribute results of research via the Internet.

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● One-on-One Intervention ● Demonstrations 	<ul style="list-style-type: none"> ● Newsletters

15. Description of targeted audience

Participants in extension and commodity group meetings and conferences
 Crop and livestock producers in Montana
 Montana wheat and barley committees, crop protection companies, fertilizer advisory committees, conservation tillage equipment companies
 Alternative energy groups and state agricultural advisory committees

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	200	100	0	0
2008	300	100	0	0
2009	400	125	0	0
2010	500	125	0	0
2011	600	150	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	0
2009	0
2010	0
2011	0

18. Output measures

Output Text

Number of research citations

- 2007 Target: 5
- 2008 Target: 5
- 2009 Target: 5
- 2010 Target: 8
- 2011 Target: 8

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Number of field days, news releases and presentations at conventions

Outcome Type: Short

- 2007 Target: 5
- 2008 Target: 10
- 2009 Target: 15
- 2010 Target: 20
- 2011 Target: 25

Outcome Text

Number of new producers per year adopting measures to improve agricultural efficiency (e.g. better seed quality, higher numbers of fields with soil tested, optimization of fertilizer use)

Outcome Type: Medium

2007 Target: 100
2008 Target: 100
2009 Target: 100
2010 Target: 100
2011 Target: 100

Outcome Text

Percent increase in acres per year of alternative crops compared to wheat and barley

Outcome Type: Long

2007 Target: 5
2008 Target: 5
2009 Target: 5
2010 Target: 5
2011 Target: 5

Outcome Text

Number of strategic planning meetings with state groups and agencies

Outcome Type: Short

2007 Target: 10
2008 Target: 10
2009 Target: 10
2010 Target: 10
2011 Target: 10

Outcome Text

Number of producers per year implementing new farm management and budgeting practices

Outcome Type: Medium

2007 Target: 100
2008 Target: 100
2009 Target: 100
2010 Target: 100
2011 Target: 100

Outcome Text

The amount of additional funding per year from new sources or increased funding from existing sources (\$)

Outcome Type: Long

2007 Target: 50000
2008 Target: 50000
2009 Target: 50000
2010 Target: 50000
2011 Target: 50000

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes

Description

Inadequate moisture (rainfall, snowpack, irrigation) for crops to be produced creating too much variability

Inadequate funding and technical support from partnering institutions and cooperators

Major interruptions in program development

Lack of fulltime staff and part time assistants for the projects

Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

21. Evaluation studies planned

- Retrospective (post program)
- During (during program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Mail

Description

Data collection will be obtained through surveys, conventions, and advisory boards at meetings and by direct contact.

1. Name of the Planned Program

Biobased Products and Processing

2. Program knowledge areas

- 711 Ensure Food Products Free of Harmful Chemicals, Including Residu 20 %
- 502 New and Improved Food Products 80 %

3. Program existence

- Intermediate (One to five years)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

The future of Montana's agricultural economy depends on maximizing net returns per acre or per animal unit with the most efficient use of resources. Value-added, agriculturally-based end products can create unique markets and enhanced revenues for Montana producers. Montana exports approximately 85% of its raw commodities. It is increasingly important to add value to raw agricultural commodities and processed food products before they leave the state in order to capture their inherent economic value. The development of energy alternatives will also provide opportunities for renewable biobased products and will help to reduce the current dependence on fossil fuels. Montana State University is a leader in biobased research and the development of novel product end-uses.

Research Activities: The Biobased Products Institute currently supports 26 biobased research projects and has developed several high-value biobased products.

Montana's wheat products are important in Asian markets where grain hardness and cereal quality are important considerations. Continued genetic research into the expression of undesirable characteristics in grains will help ensure that the grains will maintain their demanding presence in the market. Research continues into developing alternative crops in Montana. Canola, chickpea, fenugreek, camelina and assorted herbs have been evaluated for their potential in emerging value-added markets.

Oilseeds (including Camelina sativa, canola, soybeans and safflower) are rapidly emerging as important Montana crops for production of culinary oils, biolubricants, omega-3 oils, feeds and biodiesel. Over 90 germplasm accessions of Camelina have been evaluated for adaptability, yield potential and fatty acid content. Camelina production could significantly reduce the cost of biodiesel from a typical \$2.00 – \$3.00/gallon to an expected \$1.05/gallon. The same crop produces omega-3 oil, which is being evaluated for human consumption. Field tests continue to yield new information that could increase the viability of Camelina production in Montana.

The use of transgenic crops presents questions regarding the potential risk to human health and the environment. Computer modeling and data from greenhouse and field experiments will help in risk assessments to estimate what hazards may be associated with transgenic crops. Providing risk assessment information to consumers will help to inform them of the benefits and risks these crops present.

6. Situation and priorities

The revitalization of agriculture and rural communities in Montana is essential for the state's economic sustainability and competitiveness. A biobased diversified economy will provide in-state manufacturing, product development, rural development and jobs. The Biobased Products Institute through the Board of Directors funds research projects that strives to increase the profitability of Montana agriculture, enhance the health of the human population through enhanced nutrition and reduce our reliance on non-renewable energy by production of biofuels, ethanol and biolubricants. A prime emphasis of our research is to add value to existing Montana products and to commercialize new products, while maximizing limited resources and reducing reliance on commodity agriculture.

The priorities of the Institute are to:

Develop an innovative and responsive program to enhance the developing needs of the State of Montana and Pacific Northwest/Northern High Plains regions

Expand development and production of value-added products in Montana

Support food risk assessment research and education

Provide expertise to growers, researchers and agricultural businesses

Assist in development of safe, nutritious, value-added products, risk assessment and marketing.

7. Assumptions made for the Program

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced
 Funding and technical support will be maintained from partnering institutions and cooperator
 Program development will proceed as planned without major interruptions
 Fulltime staff and part time assistants will be available to maintain appropriate progress on the proje
 Corporate funding organizations, grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities
 Montana businesses and state agencies will be interested in commercialization opportunities

8. Ultimate goal(s) of this Program

Build a biobased economy that provides manufacturing, product development, rural development, job opportunities and an opportunity to raise farm and ranch incomes
 Develop safe, nutritious, value-added products for U.S. and world consumers
 Support food risk assessment education and research

9. Scope of Program

- In-State Extension
- In-State Research

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other then formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	0.5	0.0	13.2	0.0
2008	0.5	0.0	13.2	0.0
2009	0.5	0.0	13.2	0.0
2010	0.5	0.0	13.2	0.0
2011	0.5	0.0	13.2	0.0

Outputs for the Program

13. Activity (What will be done?)

Several products are being produced and marketed by private industry, LLC or grower cooperatives in Montana. The Institute has developed additional collaborative relationships with the Montana Ag Innovation Center, MSU TechRanch and MSU TechLink to facilitate technology transfer from the Biobased Institute to the private sector. These collaborators have expertise in incubating new businesses and new products, as well as assisting existing enterprises in product expansion.

The Institute will:

- Develop value-added, agriculturally based end-use products
- Provide mechanisms to enhance agricultural production practices to enhance product quality
- Develop systems that ensure food safety and agricultural security
- Establish biobased product and food science education and research programs
- Enhance partnerships among faculty across the Montana University System, producers, agricultural industry and other educational institutions across the region

Conduct outreach activities related to biobased products and food science
 Use technology and biotechnology to improve plant and animal production systems

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● Group Discussion 	<ul style="list-style-type: none"> ● Newsletters

15. Description of targeted audience

Crop and livestock producers in Montana
 Alternative energy groups and state agricultural advisory committees
 Economic development groups
 State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities
 Participants in extension and commodity group meetings, conventions and conferences

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	100	50	0	0
2008	100	50	0	0
2009	125	50	0	0
2010	150	50	0	0
2011	200	50	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	1
2009	0
2010	1
2011	0

18. Output measures

Output Text

New business partnerships created

2007 Target: 1
2008 Target: 2
2009 Target: 1
2010 Target: 1
2011 Target: 1

Output Text

Number of research citations

2007 Target: 4
2008 Target: 6
2009 Target: 8
2010 Target: 10
2011 Target: 10

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Number of new products with value-added potential evaluated per year within Montana

Outcome Type: Short

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Number of new food safety recommendations developed for consumers, which add value to Montana's agricultural products

Outcome Type: Medium

2007 Target: 2
2008 Target: 2
2009 Target: 2
2010 Target: 2
2011 Target: 2

Outcome Text

New or expand business and/or partnerships created inside and outside of Montana

Outcome Type: Long

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Number of SBIR funding proposals submitted to federal agencies

Outcome Type: Short

2007 Target: 0

2008 Target: 1

2009 Target: 1

2010 Target: 1

2011 Target: 1

Outcome Text

Number of opportunities and value-added programs introduced in Montana through continued education, research and partnering

Outcome Type: Medium

2007 Target: 2

2008 Target: 2

2009 Target: 2

2010 Target: 2

2011 Target: 2

20. External factors which may affect outcomes

- Economy
- Appropriations changes
- Public Policy changes

Description

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Major interruptions in program development
Lack of full-time staff and part time assistants for the projects
Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

21. Evaluation studies planned

- Retrospective (post program)
- During (during program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Unstructured

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

1. Name of the Planned Program

Plant Breeding, Genetics and Genomics

2. Program knowledge areas

- 204 Plant Product Quality and Utility (Preharvest) 50 %
- 202 Plant Genetic Resources 50 %

3. Program existence

- New (One year or less)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

MSU is a recognized international leader in the development of new varieties of wheat and barley that are sought by buyers around the globe. Researchers continue to evaluate germplasm and identity traits that will produce higher quality wheat and barley to meet increasing demands for quality and alternative uses, while maintaining yields.

A major effort is underway to characterize and evaluate wheat and barley germplasm and to increase the utilization of world germplasm collections. Databases have been made available for researchers to access information on germplasm. Many new improved cultivars are licensed with partnering companies, thus ensuring that Montana stakeholders receive maximum benefit from research discoveries.

Research Activities:

The development and distribution of high quality, drought tolerant barley varieties that provide the highest possible production potential is a priority of barley breeding programs. Research will continue to focus on the development of lines for the malting, feed and ethanol industries. Research is being conducted on winter wheat cultivars to develop germplasm with excellent end-use qualities and resistance to important environmental stresses. The research results will increase the competitiveness of Montana wheat producers through improved winter wheat varieties with enhanced yield potential, pest resistance and end-use qualities. Researchers will evaluate more efficient screening, selection and breeding strategies and procedures to maximize efficiency and genetic progress in winter wheat breeding programs. Research projects will develop new hard red spring wheat varieties for Montana producers, contribute to the science of wheat breeding and genetics and improve end-use characteristics. The lipid binding proteins puroindolines PINA and PINB are responsible for determining differences between hard- and soft-textured wheat. Research studies examine the degree to which the puroindoline proteins control wheat grain hardness and cereal quality and what alterations can be made to generate desired milling and end-product quality. Further research will address the effects that modifying the starch biosynthetic pathway has upon grain hardness, milling quality, yield and end product quality.

Polyphenol oxidases (PPOs) have been implicated in wheat product quality problems, including the undesirable darkening of Asian noodles. Molecular markers at the seedling stage for high and low PPO activity in wheat have now been developed, thus making early selection of desirable low-PPO germplasm possible. A long-term goal of this research is the development of low-PPO germplasm with higher commercial value.

Peas are suited for production in the semi-arid northern Great Plains. Studies continue to investigate the traits that are available within the pea gene pool to increase the effectiveness of the breeding program and the development of cultivars suitable for growth in Montana and the Great Plains. Gene markers in peas, lentils and common beans are being used to determine the effect different genomes have on desirable traits, such as shatter resistance, yield, stem strength and color.

6. Situation and priorities

An aggressive plant breeding program ensures development of higher yielding, disease- and insect-resistant wheat and barley cultivars. Much of the North Dakota/Minnesota Red River Valley malting barley production is moving to Montana and Idaho, increasing the level of research needed to provide varieties suitable for Montana growing conditions. There is also an increasing need for new infrastructure to handle the potential increase in malt barley production and to respond to the marketing needs of producers. Additional work in the development of alternative crops continues to produce potential new market opportunities for Montana producers. Commercial buyers from Asian countries assess hard red spring wheats and hard red winter wheats for use in making noodles, steam bread or loaves. Wheats developed at MSU and grown commercially by Montana producers continue to rank in the most preferred category by international customers.

Priorities in the Plant Breeding, Genetics and Genomics Program Area include:

Improve winterhardiness, wheat stem sawfly resistance and imidazolinone herbicide tolerance of small grains

Provide improved cultivars of small grains adapted to Montana climatic conditions and cropping systems
 Increase yield potentials and maintain/improve quality
 Integrate genomic research into breeding programs that will help Montana producers stay competitive

7. Assumptions made for the Program

Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced
 Funding and technical support will be maintained from partnering institutions and agricultural groups
 Program development will proceed as planned without major interruptions
 Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
 Corporate funding organizations, grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

8. Ultimate goal(s) of this Program

Maintain our role as a leading university in wheat and barley genetics research
 Provide improved cultivars of wheat and barley to Montana producers
 Increase yield potential for small grain production in Montana
 Provide genomic research that will help Montana producers stay competitive

9. Scope of Program

- In-State Extension
- In-State Research
- Multistate Research

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	0.0	0.0	4.8	0.0
2008	0.0	0.0	4.8	0.0
2009	0.0	0.0	4.8	0.0
2010	0.0	0.0	4.8	0.0
2011	0.0	0.0	4.8	0.0

Outputs for the Program

13. Activity (What will be done?)

Technical and non-technical publications
 Release germplasm, new varieties and new genomics tools and techniques
 Communication of information on plant breeding and genomics advances through classroom activities, field days, variety trials, news releases, presentations at county and state meetings and conventions
 Strategic planning with state agricultural groups

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Demonstrations 	<ul style="list-style-type: none"> ● Public Service Announcement ● Other 1 (Variety Recommendation Bulletins)

15. Description of targeted audience

Farmers, colleagues and stakeholders
 Grain associations, Montana Department of Agriculture, Montana Wheat and Barley Committee, grain elevators and state commodity groups
 Seed companies
 Domestic and foreign buyers of quality wheat

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	2000	500	0	0
2008	2000	500	0	0
2009	2000	500	0	0
2010	2000	500	0	0
2011	2000	500	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	1
2008	0
2009	1
2010	0
2011	1

18. Output measures

Output Text

Number of foreign trade teams in Montana

2007 Target: 15
2008 Target: 15
2009 Target: 15
2010 Target: 15
2011 Target: 20

Output Text

Number of foreign trade teams at MSU

2007 Target: 4
2008 Target: 4
2009 Target: 4
2010 Target: 4
2011 Target: 4

Output Text

Number of research citations

2007 Target: 10
2008 Target: 12
2009 Target: 14
2010 Target: 16
2011 Target: 18

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Number of elite lines of wheat and barley screened for agronomic and quality characteristics

Outcome Type: Short

2007 Target: 100
2008 Target: 100
2009 Target: 100
2010 Target: 100
2011 Target: 100

Outcome Text

Number of improved variety recommendations by districts across Montana

Outcome Type: Medium

2007 Target: 5
2008 Target: 5
2009 Target: 5
2010 Target: 5
2011 Target: 5

Outcome Text

Planted acreage percentage increase per year (base 2005) of MSU-released small grains in Montana

Outcome Type: Long

2007 Target: 10
2008 Target: 15
2009 Target: 25
2010 Target: 35
2011 Target: 40

Outcome Text

Documents on new cultivars provided to Montana producers to maintain Montana producers' dominance in specialty grain markets

Outcome Type: Short

2007 Target: 100
2008 Target: 100
2009 Target: 100
2010 Target: 100
2011 Target: 100

Outcome Text

The number of new molecular techniques used to enhance breeding results

Outcome Type: Medium

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Average per bushel yield increase of Montana grains while maintaining product quality

Outcome Type: Long

2007 Target: 0
2008 Target: 0
2009 Target: 1
2010 Target: 0
2011 Target: 1

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Other

Description

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Major interruptions in program development
Lack of fulltime staff and part time assistants for the projects
Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

21. Evaluation studies planned

- Retrospective (post program)
- During (during program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals. Additionally, information will be obtained from field days, conversations, direct input, and annual funding discussions with Montana Wheat and Barley Committee.

22. Data Collection Methods

- On-Site
- Unstructured

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

1. Name of the Planned Program

Animal Health

2. Program knowledge areas

- 121 Management of Range Resources 10 %
- 301 Reproductive Performance of Animals 10 %
- 311 Animal Diseases 60 %
- 303 Genetic Improvement of Animals 10 %
- 302 Nutrient Utilization in Animals 10 %

3. Program existence

- New (One year or less)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

Promoting and maintaining animal health (cattle, sheep and wildlife) has led to advances in genetics, improved performance and reproduction. By understanding immune systems and parasite development in livestock and by developing novel genes and new biochemical routes of activity for vaccines, important diseases may be managed more effectively.

Research into winter maintenance programs for cattle and sheep shows that productivity levels decrease substantially. Studies demonstrating the effects of winter stress on cattle productivity may lead ranchers to adopt changes in livestock management practices to prevent losses and manage range resources for improved animal health.

Research Activities:

A project examines supplementation of the late gestating ewes with fats/oils, zinc and vitamin E to reduce fetal stress and increase survival rates, performance, and carcass quality. Cattle research seeks to determine how various aspects of bull exposure cause cows to ovulate.

Cattle research will focus on weight relationships between cow herds and their offspring, the physical attributes of bulls and the effects that parental traits have on offspring carcass evaluations.

Coccidiosis infections cost livestock producers hundreds of million of dollars annually. This project explores the molecular relationships of the *Toxoplasma* cell cycle to parasite development. A mucosal vaccine delivery system is being tested in cattle. Effective stimulation of the immune system by vaccines is dependent upon the proper targeting of immune cells (lymphocytes). A high throughput screening effort has been initiated to discover gamma/delta T cell agonists that could be used as novel "drugs" to enhance innate immunity.

Studies are being conducted to determine the potential for the development of vaccines for West Nile and bluetongue viruses. Research is underway to understand the functions of rotavirus protein in modulating the cellular antiviral signaling pathway and inhibiting the innate antiviral interferon response. Research is being established to understand the cause and development of and immunity to bovine shipping fever and to develop novel strategies for the prevention and control of this disease complex. A project has been established to study the roles of the CWP antigen(s) of *Streptococcus equi* in the development of and acquired immunity to strangles in horses and to develop a safe and effective vaccine.

6. Situation and priorities

Losses due to environmental stresses, diseases and mortality create the need for an improved understanding of the factors affecting Montana livestock. Promoting and maintaining animal health (cattle, sheep and wildlife) has led to advances in genetics, performance and reproduction.

Despite recent advances in reproductive technology, cattle and sheep producers remain faced with the persistent problem of low fertility. Recent work indicates that the fertility of domestic ruminants, even under optimal conditions, is about 50%. Only one of every two natural or artificial inseminations results in the birth of a healthy calf or lamb. The poor fertility of domestic species is reflective of cumulative loss due to poor fertilization efficiency, high embryo mortality and spontaneous abortion. Research priorities include:

Test new natural oil additives for improving lamb meat characteristics to increase the competitiveness of U.S. lamb in the world

market
 Improve milk and beef production by targeting mutagenesis of cells in cattle bovine immune cells
 Evaluate barley cultivars in feeding studies to demonstrate their effect on improving feed efficiency and reducing feed costs
 Demonstrate ways to manage stress in animals during the winter, lower production costs, and improve beef genetics
 Develop and implement new management protocols and/or pharmaceutical and nutritional regimens that will increase the fertility of domestic ruminants
 Develop vaccines for Montana livestock that protect them against debilitating diseases
 Determine how factors, such as herd size and supplement intake, influence growth and development of cattle grazing native rangelands

7. Assumptions made for the Program

Funding and technical support will be maintained from partnering institutions and cooperators
 Program development will proceed as planned without major interruptions
 Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
 Corporate funding organizations, livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

8. Ultimate goal(s) of this Program

Maintain our role as a leading university in animal genetics and rangeland stewardship research
 Provide improved production management recommendations to Montana producers
 Increase discovery of novel vaccines for prevention of livestock diseases
 Provide genomic research that will help Montana producers stay competitive

9. Scope of Program

- In-State Extension
- Integrated Research and Extension
- Multistate Extension

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	0.5	0.0	9.3	0.0
2008	0.5	0.0	9.3	0.0
2009	0.5	0.0	9.3	0.0
2010	0.5	0.0	9.3	0.0
2011	0.5	0.0	9.3	0.0

Outputs for the Program

13. Activity (What will be done?)

Databases that are easily accessible by researchers and producers to make research results more readily available
 Research articles, fact sheets and news releases for university and state media
 Papers and research results at state nutrition conferences, field days, county meetings and state conventions
 Strategic planning meetings with state agricultural groups, including the Montana Stockgrowers Association and the Montana Board of Livestock

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● Workshop 	<ul style="list-style-type: none"> ● Newsletters

15. Description of targeted audience

Ranchers, seedstock industry, colleagues and related stakeholders
 Montana Department of Agriculture, animal health companies, and state commodity groups
 Montana Stockgrowers Association and the Montana Board of Livestock

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	250	100	0	0
2008	250	100	0	0
2009	250	100	0	0
2010	250	100	0	0
2011	250	100	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	0
2009	1
2010	0
2011	1

18. Output measures

Output Text

Number of research citations

2007 Target: 15
2008 Target: 15
2009 Target: 15
2010 Target: 15
2011 Target: 15

Output Text

Building built through donations

2007 Target: 0
2008 Target: 0
2009 Target: 0
2010 Target: 1
2011 Target: 0

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Identify critical infection and resistance processes

Outcome Type: Short

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Number of ranches per year adopting enterprise management of animal health issues

Outcome Type: Medium

2007 Target: 10
2008 Target: 10
2009 Target: 10
2010 Target: 10
2011 Target: 10

Outcome Text

Number of novel vaccines developed per year

Outcome Type: Long

2007 Target: 0
2008 Target: 0
2009 Target: 1
2010 Target: 0
2011 Target: 1

Outcome Text

Number of activities per year that prevent disease outbreaks or manage diseases of Montana livestock

Outcome Type: Medium

2007 Target: 1

2008 Target: 1

2009 Target: 1

2010 Target: 1

2011 Target: 1

Outcome Text

Number of publications or meetings that maintain or enhance Montana's presence in the production of quality meat products

Outcome Type: Long

2007 Target: 1

2008 Target: 1

2009 Target: 1

2010 Target: 1

2011 Target: 1

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes
- Government Regulations

Description

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Major interruptions in program development
Lack of fulltime staff and part time assistants for the projects
Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

21. Evaluation studies planned

- Retrospective (post program)
- During (during program)
- Other

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Sampling
- On-Site
- Journals

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact.

1. Name of the Planned Program

Agronomic and Forage Crops

2. Program knowledge areas

- 112 Watershed Protection and Management 10 %
- 101 Appraisal of Soil Resources 10 %
- 205 Plant Management Systems 50 %
- 121 Management of Range Resources 30 %

3. Program existence

- Intermediate (One to five years)

4. Program duration

- Long-Term (More than five years)

5. Brief summary about Planned Program

Research programs in the College of Agriculture range from basic research in genetics and biotechnology to practical applications in rangeland, forest, crop and livestock management. Our long-term strategies are designed to make Montana agricultural products more desirable in U.S. and world markets.

High-value and alternative crop production for Eastern Montana involves close collaboration between research and extension faculty in Montana and North Dakota. Sugarbeets are a high value cash row crop with the lower Yellowstone River Valley consistently producing the highest quality sugarbeets in the United States. A new barley malting facility has been built, has created a demand for increasing production in Montana, and storage capacity has been expanded.

Research Activities:

Studies in precision agriculture have led to the development of a tool for a rapid nondestructive characterization of soils for a variety of environmental and agricultural applications. This invention could dramatically increase the availability of soil data for monitoring carbon sequestration in agricultural lands.

An evaluation of livestock distribution practices on grazed watersheds was a part of a three-state project (MT, CA, OR). This project has shown the potential to manipulate cattle grazing patterns to protect and improve fishery and wildlife habitat. The combination of herding and strategic supplement placement can potentially focus cattle grazing on upland areas and increase forage quality for elk and other wildlife. The ecological role of shrubs is not well understood although they are critical in land management decision-making. Determining successional patterns of sagebrush communities and their interaction with wildlife will help determine management priorities. Grazing and fire recovery in rangelands are priority issues to be studied in Montana and Wyoming.

Research is being conducted on elk and cattle habitat use patterns in Montana and Wyoming. Beef cattle and elk are vital components of the economy and heritage of the Rocky Mountain West. Livestock grazing practices have perceived negative impacts on soils, biodiversity and water quality. By determining the grazing behavior and the growth of cattle, decisions can be made on the need for supplemental feed over winter months. Beavers have been proposed as habitat restoration agents for aspen and willow communities in areas of heavy wildlife grazing. Study results showing the interactions of aspen, sagebrush and wildlife will be used to give land managers and natural resource agencies viable options for habitat maintenance. Sage grouse studies will identify which areas are suitable for nesting, brood rearing and winter use.

Research continues in the development of alternative crops, including canola, chickpea, fenugreek, camelina and assorted herbs. Diversifying dryland cropping systems to include oilseed and pulse crops in sequence with cereal crops is a viable and sustainable approach to crop production. Additionally, the use of reduced tillage and no-till systems are being evaluated to demonstrate their sustainability.

6. Situation and priorities

Montana has limited crop and livestock diversity due to semi-arid conditions, a short growing season and the potential for long and severe winters. Cattle and sheep are the primary livestock enterprises; small grains, forages and short season specialty crops make up the bulk of the cropping activity. With limited diversity, researchers at MSU are able to delve deeper into understanding each entity from production and management studies as well as through plant and animal genomics. Agricultural cash receipts in Montana total over \$2.8 billion annually and are made up of roughly a 50:50 mix of crops and livestock. In addition, Montana is world-renowned for the quality of its wheat and beef cattle.

The end of a seven year drought in 2005 brought higher yields of crops and more available livestock feed, and it improved researchers' opportunities to evaluate crops and rangeland under more ideal conditions.

Priorities established in this program include to:

- Create better grazing management in concert with the preservation of riparian habitats, wildlife and clean water
- Characterize and understand the complex interactive components of habitats that will lead to improved soil, plant and water resources in those ecosystems
- Develop higher yielding varieties
- Establish new value-added crops
- Develop higher disease and insect resistance in wheat and barley
- Develop greater nutritional value for forages
- Demonstrate innovation in recommended approaches to crop and pest management
- Establish research programs that provide more efficient use of natural resources, especially water

7. Assumptions made for the Program

- Adequate moisture (rainfall, irrigation, snowpack) will be available for crops to be produced
- Funding and technical support will be maintained from partnering institutions and cooperators
- Program development will proceed as planned without major interruptions
- Fulltime staff and part time assistants will be available to maintain appropriate progress on the project
- Corporate funding organizations, grain and livestock associations, chemical companies, and other agencies will continue to provide input into priorities and activities

8. Ultimate goal(s) of this Program

- Create better grazing management recommendations to cattle producers
- Develop higher yielding varieties and introduce new value-added crops
- Develop higher disease and insect resistance in wheat and barley and greater nutritional value for forages
- Provide crop management options and establish research programs that are consistent with environmental and sustainable agricultural objectives

9. Scope of Program

- In-State Extension
- In-State Research
- Multistate Research

Inputs for the Program

10. Expending formula funds or state-matching funds

- Yes

11. Expending other than formula funds or state-matching funds

- Yes

12. Expending amount of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2007	1.0	0.0	4.4	0.0
2008	1.0	0.0	4.4	0.0
2009	1.0	0.0	4.4	0.0
2010	1.0	0.0	4.4	0.0
2011	1.0	0.0	4.4	0.0

Outputs for the Program

13. Activity (What will be done?)

Workshops and meetings with federal and state land management agencies
 Development of research summaries and fact sheets
 Training in cooperation with the Montana Hay Growers Association, Montana Alfalfa Seed Growers Association and Montana Grain Growers Association

14. Type(s) of methods will be used to reach direct and indirect contacts

Extension	
Direct Method	Indirect Methods
<ul style="list-style-type: none"> ● Workshop ● Demonstrations 	<ul style="list-style-type: none"> ● Newsletters

15. Description of targeted audience

Crop and livestock producers in Montana
 State agricultural advisory committees
 State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities
 Participants in extension and commodity group meetings, conferences and field days

16. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2007	100	200	0	0
2008	125	200	0	0
2009	150	200	0	0
2010	175	200	0	0
2011	200	200	0	0

17. (Standard Research Target) Number of Patents

Expected Patents	
Year	Target
2007	0
2008	0
2009	1
2010	0
2011	1

18. Output measures

Output Text

Number of research citations

2007 Target: 6
2008 Target: 8
2009 Target: 10
2010 Target: 12
2011 Target: 14

Outcomes for the Program

19. Outcome measures

Outcome Text: Awareness created

Outcome Text

Number of new crops evaluated per year for adaptation potential in Montana

Outcome Type: Short

2007 Target: 2
2008 Target: 2
2009 Target: 2
2010 Target: 2
2011 Target: 2

Outcome Text

Number of new crops and varieties adopted per year

Outcome Type: Medium

2007 Target: 1
2008 Target: 1
2009 Target: 1
2010 Target: 1
2011 Target: 1

Outcome Text

Increase in acres of non-traditional crops planted in Montana

Outcome Type: Long

2007 Target: 5000
2008 Target: 5000
2009 Target: 5000
2010 Target: 5000
2011 Target: 5000

Outcome Text

Number of routine field crop and forage samples processed by the MSU Seed Laboratory per year

Outcome Type: Medium

2007 Target: 750
2008 Target: 750
2009 Target: 750
2010 Target: 750
2011 Target: 750

Outcome Text

New grazing plans established for livestock and wildlife in rangeland environments

Outcome Type: Long

2007 Target: 10
2008 Target: 10
2009 Target: 10
2010 Target: 10
2011 Target: 10

20. External factors which may affect outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes
- Government Regulations

Description

Inadequate moisture (rainfall, irrigation, snowpack) for crops to be produced and creating too much variability
Inadequate funding and technical support from partnering institutions and cooperators
Major interruptions in program development
Lack of fulltime staff and part time assistants for the projects
Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

21. Evaluation studies planned

- After Only (post program)
- During (during program)

Description

Evaluation studies will be conducted annually through the issuance of surveys, published peer review materials and secured peer reviewed grant proposals.

22. Data Collection Methods

- Mail

Description

Data collection will be obtained through surveys at meetings, conventions, advisory boards and by direct contact