

# 2011 Montana State University Research Plan of Work

Status: Accepted

Date Accepted: 06/09/2010

## I. Plan Overview

### 1. Brief Summary about Plan Of Work

**Situation:** Montana is a rural state with 93 million acres and a population of 967,000. The state has over 29,000 farms and ranches representing over 60 million acres, 66% of its land. Nearly nine million acres are cropped and 56 million acres are grazed or used for other agricultural purposes. Montana ranks 2<sup>nd</sup> in the U.S. in acres devoted to agricultural enterprises with crop and livestock industry annual cash receipts of over \$2.3 billion. The state ranks 2<sup>nd</sup> in the production of edible dry peas, Austrian winter peas, lentils, and safflower, and ranks 3<sup>rd</sup> in the production of canola, barley, and flaxseed. Wheat and barley represented about 47% of the 2008 total agricultural receipts. Flax acreage increased in 2009 by over 20% and production by 30% over 2008. Harvested acres of safflower dropped by 15% in 2009. The production of camelina (*Camelina sativa*) in Montana increased from 450 acres in 2005 to nearly 50,000 acres in 2007. New contracts with biodiesel producers in 2010 will encourage growers to consider camelina as a viable alternative to other dryland crops. The value of Montana's agricultural exports during fiscal year 2008 totaled \$1.2 billion, an increase of \$500 million over 2007. Montana ranks 3<sup>rd</sup> among states exporting wheat and wheat products. The state's livestock industry represents over \$1.2 billion in cash receipts annually and is one of the largest industries. Montana ranks 10<sup>th</sup> in the U.S. in the production of cattle and 7<sup>th</sup> in the production of sheep and lambs. Cattle and calves represented over 85% of the livestock receipts for the state and 35% of the total agricultural receipts in 2008. Montana beekeepers accounted for 6% of the nation's honey in 2008, placing Montana 6<sup>th</sup> among states in honey production. Higher prices for beef, wheat, and barley raised farm and ranch incomes; however, escalating input costs challenged Montana enterprises to increase efficiencies and evaluate new markets.

Native Americans represent the largest group of potentially underserved citizens in Montana and comprise 6.4% of the population of the state. MSU works with tribal councils, colleges in the Rocky Mountain region, and educators to provide programs and educational opportunities for this group of Montana citizens. Cooperative efforts with MAES provide resources and training to Native Americans in the areas of livestock testing, certification, childhood obesity, nutritional recommendations, pasture restoration, environmental stewardship, sustainable agricultural practices, resource and risk management, pesticide certification, and social skill building. Of the 380 American Indian students at MSU, 26 (7%) are enrolled in the COA.

Construction of the new 40,000 square foot Animal Bioscience Complex began in the fall of 2008 and is expected to be completed by September, 2010. The complex represents the most important project to affect and benefit Montana's livestock industry in decades and will provide advanced research laboratories, support rooms, and classrooms. The new facilities will give students access to the latest in research, teaching, and outreach in animal and range sciences. Private funds account for over 50% of the financing followed by support from the State of Montana, exemplifying stakeholder support for our research and teaching programs. The internet has become an increasingly valuable method for disseminating information that provides stakeholders with materials to assist in their decision-making. As technology advances and producers rely increasingly on computer-provided information, electronic dissemination and the results of MSU's research and outreach activities will increase in importance and impact.

Montana is a headwater's state (tributaries of the Missouri, Yellowstone, and Columbia Rivers) with pristine waters that have scenic value, agricultural and manufacturing applications, and that provide recreational opportunities for Montanans and visiting tourists. A number of diverse ecological systems in Montana provide research opportunities for scientists to study climatic conditions and land use practices. Climate change could challenge agriculture, forestry, crop production, and other industries in Montana by the latter half of the 21<sup>st</sup> century and U.S. programs that address carbon sequestration and reduction of greenhouse gasses will become important projects for MSU researchers to consider.

**Priorities:** As a result of stakeholder input meetings, focus groups, and ongoing general public interactions, MAES receives specific suggestions and ongoing support for research and outreach activities. These include:

- Add value to Montana's high quality crop and livestock products
- Create new business opportunities for rural communities
- Develop higher yielding and higher quality cultivars
- Expand research on agricultural and natural resource interactions
- Explore alternative and new crops

- Improve beef production practices and evaluate genetics to improve herds
- Increase research programs on alternative energy sources, including crops for biofuel production

Other research areas that receive high priority responses include management of livestock diseases, crop production, IPM, livestock production and management, natural resources, nutrition and health, food safety, global food security, and range production and management. These results will continue to influence MAES research priority areas in the next decade. The revitalization of agriculture and rural communities in Montana is essential for the state's economic sustainability and competitiveness. The future of Montana's agricultural economy depends on maximizing net returns per crop acre or per animal unit, while using resources efficiently and adding value to raw agricultural commodities and processed foods.

**Input Section:** Stakeholder input is solicited in the strategic planning process and is continually reaffirmed as programs are developed, implemented, and revised and as dollars are allocated. The COA and MAES have 24 advisory committees and boards with more than 250 members. These include: The Animal and Range Science Advisory Committee, Animal Biosciences Complex Board, Center for Invasive Plant Management Board, Center for Invasive Plant Management Science Advisory Council, Central Agricultural Research Center Advisory Committee, Associate Dean's Advisory Council, Associate Dean's Student Advisory Council, Development Board, Eastern Agricultural Research Center Advisory Committee, Equine Advisory Committee, Foundation Seed Advisory Committee, MAES State Advisory Council, Montana Beef Advisory Committee, Montana Farmers Union, Montana Pulse Growers Association, Montana Seed Growers Association Board, Montana Wool Growers Advisory Committee, Northern Agricultural Research Center Advisory Committee, Northwest and Western Agricultural Research Centers Advisory Committee, Organic Certification Association of Montana, Potato Certification Board, Southern Agricultural Research Center Advisory Committee, Thermal Biology Institute Scientific Advisory Board, Variety Release and Recommendation Committee, and Western Triangle Advisory Committee. Members of these committees represent agricultural educators, agricultural organizations, communities, conservation groups, county extension agents, farmers and ranchers, financial organizations, private citizens, reservation groups, scientists, small businesses, and tribal councils. The COA and its MAES faculty respond to input from these stakeholders and state/national/international trends by continually developing new programs. Faculty members also serve on local and state committees.

**Inputs/Funding:** The source of funds contributing to the research conducted by MAES faculty include, but are not limited to: BIA, BLM, Canadian Provinces, conservation and wildlife groups, Montana Board of Research and Commercialization Technology, Montana crop and animal agricultural groups, Montana Department of Agriculture, Montana Department of Environmental Quality, Montana Department of Natural Resources and Conservation, Montana Department of Transportation, Montana Fertilizer Advisory Committee, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, NASA, NIH, NRCS, NSF, other states, overhead investments from sponsored programs, private donations, private industry, the State of Montana, USDA, USEPA, and USFS.

#### **Outcomes and Impacts:**

##### Enhance Economically Viable and Sustainable Agricultural Systems

- Contribute to commodity and product marketing and economic development
- Create comprehensive programs that address issues and problems associated with plant and animal systems
- Develop competitive, sustainable, and viable plant and animal systems
- Enhance our understanding of rural, urban, and disturbed landscapes
- Expand stewardship practices
- Foster the development of value-added biobased products
- Improve food safety and quality
- Improve plant and animal health through integrated pest management (IPM) and other sustainable practices
- Improve the fundamental understanding of plant and animal biology
- Improve value-added crops for sustainable energy production
- Address childhood obesity by developing small grains and value-added crops that help reduce the severity of the problem

##### Strengthen the Quality of Life for Montana and Its People

- Create opportunities for undergraduate and graduate students to engage in research
- Develop partnerships to enhance business and community development
- Facilitate the development of educational programs and new delivery systems
- Improve recruitment and retention of students

Each of the seven agricultural research centers holds annual field days in cooperation with USDA-ARS 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 with participation by faculty, staff, and students.

## **Program Areas**

### **Program # 1 Animal Health**

**Situation:** Infectious disease can cause considerable losses for producers by reducing production and by reducing sales due to food safety concerns. A focus on disease management, reproduction, and carcass traits will help ensure that Montana meat products maintain the highest standards. Promoting and maintaining animal health (cattle, sheep, horses, and wildlife) has led to advances in genetics, improved performance, and increased reproduction success.

**Priorities:** Disease management and research programs that increase the quality of meat, milk, and fiber products continue to evolve. Animal losses due to environmental stresses, disease, and death create the need for an improved understanding of factors affecting Montana livestock. A major effort is being directed to identify alternative solutions to reducing the cost of animal ID technology.

**Input:** Stakeholder input has been solicited in the strategic planning process and continues as programs are developed, implemented, and changed, and as dollars are allocated and re-allocated. Valuable input has come from: The Animal Biosciences Complex Board, Northern Agricultural Research Center Advisory Committee, Montana Beef Advisory Committee, Montana Wool Growers Advisory Committee, USDA-ARS, and other organizations.

**Research Activities:** Specific projects have been established to investigate diseases and animal productivity in cattle, sheep, and bison. Animal health projects at MSU tend to be long-term with little change from year to year. Any advances that can be made in improving cattle and sheep output economically benefits all Montana livestock producers. Over 150,000 "drug-like" candidates have been screened for their activity against agonists in cattle. Infectious diseases caused by coccidian parasites are some of the most important health problems of food animals and humans. In beef and dairy production alone, it has been estimated that over 70 million animals are exposed every year to *Eimeria* spp. parasites. One set of MSU studies is designed to optimize mucosal and systemic antibody responses in heifers to provide passive immunity to newborn calves that are especially susceptible to scours. Investigating the mechanisms by which calves resist lung infections will help us better understand why these calves become susceptible to infection. MSU is testing a mucosal vaccine delivery system to provide the basis for future vaccines.

Calf scours is caused by several infectious agents including viruses, bacteria, and protozoa. Rotavirus is the most important viral agent of neonatal diarrhea and generally affects calves less than six weeks of age. A rotavirus vaccine is commercially available, but is sub-optimal as it fails to protect calves throughout the most susceptible periods. We are investigating new vaccines that have potential to develop into effective controls for these agents. The discovery of novel proteins that are essential to cell division will have a significant impact on the identification of new drug and vaccine targets for control of coccidiosis in livestock.

Mastitis remains one of the costliest diseases of the dairy industry. MSU researchers are developing a better understanding of mammary defense mechanisms to establish effective therapies. Research is continuing in collaboration with researchers at the University of Montana and the NIH Rocky Mountain Lab to study emerging infectious diseases in wildlife and livestock. Research in targeted mutagenesis of cells in cattle will make milk and beef production more efficient, increase the value of cattle-based commodities, and produce herds with improved traits, including disease resistance and increased production. Prion diseases, such as bovine spongiform encephalopathy (BSE) in cattle, scrapie in sheep, and chronic wasting disease (CWD) in deer and elk, are caused by novel infectious agents and result in fatal degeneration of the central nervous system. Research is being conducted to define the pathway of prion agents following infection to improve our understanding of how they spread within a host.

Brucellosis (*Brucella abortus*) remains a threat to the health and well-being of livestock in Montana, Idaho, and Wyoming. Cohabitation of infected wildlife with cattle has compromised Montana's brucellosis-free status. There are no efficacious brucellosis vaccines for bison, and current vaccines are only partially effective in livestock.

Our targeted grazing effort is a cooperative project between Montana Wool Growers Association and MSU dedicated to developing and implementing non-traditional strategies that increase the competitiveness of Montana's lamb and wool in the world market. Our research shows that improved nutrition is a major factor that reduces lamb mortality and improves profitability. The research has focused on nutritional strategies during late gestation that may impact fetal immune functions. Decreasing input costs and increasing production revenues will help producers achieve higher quality products, generate

more income, and maintain Montana's position in the world livestock market. We have developed positive working relationships among stakeholders to improve weed and land management. In addition, sheep grazing protocols and projects have been developed involving 1,000 private landowners, county weed supervisors, and public agencies.

## Program #2 Climate Change

**Situation:** Within the next 100 years, atmospheric CO<sub>2</sub> is projected to double or even triple, mainly due to the burning of fossil fuels. Agriculture in Montana, the central U.S., and other parts of the world is vulnerable to the impacts of climate change. By the latter half of the 21st century, climate change could jeopardize agriculture, forestry, crop production, and other industries dependent on the natural environment. Crop production in the U.S. is especially vulnerable where diminished water resources place constraints on crop growth. As timberlines rise due to climate change, baseline data on declining alpine systems will be valuable.

**Priorities:** Priorities are established to investigate how climate change may affect crop production, water resources, range management, and forestry management over the next 50 years. Models and research projects are being developed to evaluate several scenarios to ensure that producers and land managers have timely and accurate information.

**Input:** Input from focus groups and meetings of stakeholders are used to identify climate change strategies.

**Research Activities:** Scientific interest in the effects of increasing atmospheric CO<sub>2</sub> on plants has motivated us to better understand plant photosynthetic physiology and plant community structure in the high-CO<sub>2</sub> environments of Yellowstone National Park (YNP). Several projects have looked at flora growing in or near the hot springs in YNP. Understanding the mechanisms of growth of native plants in geothermally-modified soils will help researchers gain insight into how climate change may impact agricultural production.

As the climate changes, the need for new cultivars of Montana crops will increase. Barley, the most durable and adaptable of the cereals, will likely see increased production in a warmer, drier world. The barley cultivars we produce are selected to be more productive and to produce higher quality grain in drier climates. A research project is in place that will contribute crop growth data from a water-constrained climatic situation, thus increasing the accuracy and robustness of crop growth models for spring and winter crops. The models will provide key crop growth data for managing cropping system strategies under "most probable" altered climate scenarios for the northern Great Plains region. Understanding the relationships among agriculture-biofuel production, carbon sequestration, and natural resource conservation, as well as traditional commodity production, U.S. agriculture can react effectively and sustainably to climate change, world market dynamics, and world population growth. Because these processes occur over a broad range of time and space, we will study how energy and materials move through agro-ecosystems at multiple scales over the 10-year project period of the research.

## Program # 3 Global Food Security and Hunger

**Situation:** Food safety and security have become important concerns for the beef industry at all production levels. Domestic and international consumers are demanding more information about the source of the meat products they purchase, including the age, health, nutrition, and handling management of the animal. MSU studies help ensure that Montana producers raise safe beef while improving the quality of the beef that is raised. An integrated network is in place to ensure that a quality and consistent beef product is being produced and to enable the tracking of calves from Montana ranches to feedlots and packing plants in other states. Tracking will provide both source and process verification for easy trace-back in case there is a disease outbreak. With the sustainable beef supply (SBS) program, it will be relatively easy for Montana producers to adapt to mandatory country-of-origin labeling (COOL) programs.

**Priorities:** The development of new, highly nutritious crop cultivars with characteristics that improve health and well-being are priorities at MSU. Beef producers must address methods to improve and document ranch biosecurity and biocontainment protocols to prevent perceived food safety events and thus, irreparable harm to beef's market share. MSU researchers work to improve animal and human nutrition, add value to raw products, improve safety of products, and increase product development of biobased chemicals, fuels, lubricants, pharmaceuticals, and nutraceuticals.

**Input:** Partnerships have been created among producers, the agricultural industry, faculty, and other institutions in the region. These partnerships provide outreach activities related to biobased products and food science. Input from focus groups and meetings of stakeholders are used to identify strategies for marketing safe agricultural commodities and consumer products.

**Research Activities:** MSU research provides the technology that improves plant and animal production systems while adding value and improving food security for stakeholders. Initiatives will provide new insights into food safety and risk

assessment. Consumer demand for omega-3 rich products is escalating throughout the U.S. Montana camelina oil is currently being used for commercial production of omega-3 rich pet feeds and supplements, omega-3 rich eggs, cosmetics including lotions, massage oils and soaps, and culinary oils. Omega-3 enriched meat products have higher market value than traditional meat products. Direct return to the poultry industry for omega-3 enriched eggs is 50% higher than for traditional eggs. Research is impacting rural Montana. Several products are being produced and marketed by private industry or grower cooperatives, including PrOatina gluten-free oats to the celiac community and beta-glucan barley to the nutraceutical industry. The Great Northern Grower Cooperative has established an oatmeal processing facility and is distributing high-protein, gluten-free oatmeal. Fenugreek, an annual legume, shows promise as a nutraceutical feed for geriatric and athletic horses. Teff is being developed as a source of gluten-free flour. Canola, chickpeas, fenugreek, camelina, and assorted herbs have been evaluated for their potential in emerging value-added markets. Technology transfer collaborative relationships have been developed. Collaborators have expertise in incubating new and existing products and businesses. Quality of grain for both the domestic and international markets is challenged by insect pests that cause economic losses for wheat producers. Researchers are investigating management practices that reduce pesticide-based treatments. Reducing grain temperature combined with the use of inert dusts has the potential to greatly reduce the use of residual insecticides on wheat while preserving grain quality.

MSU researchers continue to review human and animal nutritional needs involving biochemistry and genetics. Potential new crops (including fenugreek and *Camelina*) are being considered in the effort to reduce obesity and in treatment of other health issues. A newly released cultivar of safflower, Montola 2004, produces oil with less than 6% total saturated fatty acids, no transfats, and over 80% oleic acid. Nutrasaff, a high linoleic safflower (80%) with high seed oil content (46&ndash48%), high meal protein (37&ndash39%), and reduced meal fiber (25&ndash26%) is available as a high-end nutritional supplement to enrich livestock, poultry, fish, bird food, and pet food diets with high levels of linoleic acid, protein, and oil.

Utilizing the processes and organizational structure established by the SBS research and educational programs will continue to address the animal health, biosecurity, and production efficiency concerns expressed by producers and consumers. Traceability of livestock through the production chain is being demanded by the consumer and can add substantially to the cost of production. Methods are being developed that facilitate traceability of livestock at minimal additional expense. A major effort will be directed at identifying alternative solutions to reduce cost of animal ID technology.

#### **Program # 4 Integrated Pest Management (IPM)**

**Situation:** Montana's stakeholders need new and improved methods for controlling insects, weeds, and diseases. Comprehensive programs have been established at MSU to investigate low impact control options and promote sustainable practices. Weeds, diseases, and insects continually challenge Montana producers who are often already producing crops under less than ideal conditions. Difficult-to-control pests require producers and researchers to evaluate new Integrated Pest Management (IPM) methodologies in order to maintain a competitive position in U.S. and world markets while helping to alleviate global hunger. The increase in public concern about food safety, food quality, cost, natural resource biodiversity, and sustainability of the quality of soil, air, and water is mandating less reliance on traditional pesticides and research into more environmentally friendly systems, including biological controls and organic production. Foreign trade partners want decreased pesticide residues in the wheat and barley commodities that they import.

**Priorities:** IPM programs seek to optimize grower profitability and natural resource sustainability through the development, selection, and implementation of economically sound and environmentally acceptable pest management strategies. MSU is continuing research into less chemically dependent systems and is addressing the economic feasibility and environmental impact of biological controls and of growing organic crops. Understanding crop rotation systems, crop production methods, and water management issues is a priority in the production of abundant high quality crops. Unraveling complex ecological relationships is central to understanding pest management systems, implementing biological controls, and exploring a multitude of science-based options.

**Inputs:** Summaries of survey information from the Montana weed coordinators have identified critical research needs in the management of invasive plants on private, public, and agency lands. This has led to new research and educational initiatives that align with the multi-agency and citizen-supported Montana Weed Management Plan. The source of funds contributing to the research conducted include: Montana crop and animal agricultural groups, Montana Ag Business Association, Montana Department of Agriculture, Montana Fertilizer Advisory Committee, Montana Grain Elevator Association, Montana Noxious Weed Trust Fund, Montana Wheat and Barley Committee, other states, private donations, private industry, Western Sustainable Agricultural Program, and USDA. Stakeholder input is collected in county and reservation sponsored 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 states.

**Research Activities:** The wheat stem sawfly is a severe pest of wheat in the northern Great Plains and cannot be managed using conventional tools or agricultural practices. Current management is based primarily on the adoption of solid-stem cultivars that offer partial resistance. Alfalfa hay pest management programs use chemical methods, biological controls, and cultural management options. Our work over the past several years has provided important groundwork through the development of a large reference collection of pollinators, including bee and wasp species, from several Montana locations. We have made substantial progress creating pollen reference collections for several of the sites documenting the local flowering plants at sites where we will be conducting diversity and behavioral studies. Work in seed alfalfa fields addresses the potential use of alternative management options to control alfalfa pests, while minimizing non-target effects on natural enemies and pollinators. In addition, a better understanding of biological control and its implementation will be achieved by monitoring impacts. Incorporating biopesticides into insect management strategies can conserve natural enemies and pollinators.

A multistate partnership focuses on the management and control of insect pests in stored grain. Insecticidal and non-insecticidal approaches are being tested in laboratory and large-scale field trials. The primary focus of entomological research will be to ensure reduction of grain storage losses at a lower cost than conventional chemical methods with less reliance on chemical intervention.

The emergence of West Nile virus in the western U.S. has drawn considerable attention to the science of mosquito control and the safety of management tactics, especially in areas where insecticides traditionally have not been used. Research is being conducted into the use of ultra-low-volume (ULV) methods to reduce costs and environmental concerns. Soil-borne plant pathogens cause about 90% of the major diseases of the principal crops in the U.S. with annual revenue losses in excess of \$4 billion. MSU projects identify effective and economical biological controls for diseases. Growers can then control plant diseases using these methods with low toxicity to humans and the environment. Projects are in place to demonstrate the effectiveness of the integration of biological control agents into potato disease management systems for soilborne, foliar, and virus diseases. Educational programs are being developed to provide grower education for integrating biological controls with conventional disease management practices. No-till cereal production combined with a conversion from wheat-fallow to annual cropping has led to more intensive plant disease pressure. The use of anti-fungal proteins incorporated into transgenic plants is a promising approach to limiting fungal diseases of cereals.

Weed management requires rapid and accurate identification of weedy plants. Improper identification can result in misapplication of herbicides or failure to adequately control the weed when it is most vulnerable to IPM practices. The development of a quick and accurate electronic field identification system will aid growers, crop advisors, extension agents, diagnosticians, and others associated with crop production with a multi-entry, multi-media, commodity-based electronic key to aid in the identification and management of small grain pests. In discussions about problem weeds, stakeholders mention spotted knapweed, Canada thistle, and kochia as their most severe problems, especially in rangelands and pasture. One project looks at managing spotted knapweed through the controlled grazing by sheep and another looks at the introduction of host specific insects to control weeds. MSU continues to conduct herbicide screening trials to assess the effectiveness of new and existing products for weed control in small grains, sugar beets, potatoes, mint, camelina, dry beans, dry peas, safflower, sunflower, and canola.

Natural enemy efficacy studies against invasive weeds will determine the ecological and physiological basis for insect-host interactions. Characterizing the ecological communities in which natural enemies survive is fundamental to developing and understanding natural enemy densities. Identification and testing of various arthropods continues for the biological control of hoary cress, field bindweed, rush skeletonweed, hounds tongue, Russian knapweed, tansy ragwort, and invasive hawkweeds. The combined impacts of seed head insects and root insects are causing the collapse of spotted knapweed populations in many areas of western Montana; the release of two new agents for Russian knapweed is expected in 2010. Research into the mechanisms of weed resistance helps develop herbicides that target specific biochemical processes within the plant.

A diagnostic key for pests of woody ornamentals planted in urban areas is being developed. This project will increase the accurate and appropriate use of pesticides in the home landscape. In addition, this resource will assist in the rapid identification of invasive pests and empower the public to submit samples for proper identification.

### **Program # 5 Plant Breeding, Genetics, and Genomics**

**Situation:** MSU is a recognized international leader in the development of new cultivars of small grains sought by global buyers. Researchers evaluate germplasm and identify traits that produce wheat and barley cultivars that meet increasing world demands for quality, while maintaining yields for producers. An aggressive plant breeding program ensures development of higher yielding, disease and insect resistant wheat and barley cultivars. Research results will increase the

competitiveness of Montana wheat producers through improved winter wheat cultivars with enhanced yield potential, pest resistance, and end-use qualities. Based on average planted acreage and prices, development of an improved winter wheat cultivar that produces an additional one bushel per acre either by enhanced yield or reduced yield loss to disease, insects, or environmental stresses adds \$4&ndash;\$5 million in revenue per year to the Montana economy. Additional work in the development of alternative crops continues to produce new market opportunities.

**Priorities:** MSU seeks to maintain its role as a leading university in small grains genetics research. The agricultural community and allied industries depend on new cultivars to remain competitive in the world marketplace. Primary breeding objectives include increasing yield potential, improving winter hardiness, wheat stem sawfly resistance, imidazolinone herbicide tolerance, and enhanced dual-purpose end-use quality grains. MSU's intensive genomic research will help Montana producers stay competitive and will provide improved cultivars adapted to Montana's climatic conditions and cropping systems. Increased understanding of the molecular biology and biochemistry of cereal grains will lead to the development of products more suited to the requirements of competitive world markets and help alleviate world hunger. Continued productivity of our breeding program will improve our understanding of the genetics of key traits and allow the development of new selection tools. The broader impacts of the work are a larger and higher quality food supply for the world, an improved ability of Montana farmers to compete in a global marketplace, and a strengthening of export markets for U.S. wheat.

**Input:** Recommendations and priorities are established by foreign trade teams, international trade missions, faculty, staff, and students. Farmers cooperate by providing dryland and irrigated fields for cultivar trials and by providing associated inputs. Research proposals are competitively awarded from the Montana Wheat and Barley Committee. Through stakeholder input, we routinely apply for PVP Title V status on all released wheat and barley cultivars, which in turn increases revenues for research.

**Research Activities:** A major effort is underway to characterize and evaluate wheat and barley germplasm and to increase the utilization of world germplasm collections. Montana crop producers want improved hard red and hard white winter wheat cultivars adapted to Montana conditions and suitable for both domestic and export markets. We provide methods to analyze all lines of wheat to detect novel gene expression related to postharvest resistance, which could lead to new strategies for protection in storage from insects. Farmers need new and better hard red spring wheat cultivars with excellent qualities to ensure that Montana wheat retains or increases its share of Asian and domestic markets. The goals of selection are high grain protein and gluten strength, high flour extraction and low ash content, good dough mixing and bread baking quality, and superior noodle color and texture.

Breadmaking characteristics, especially dough strength and extensibility, are considered when evaluating spring wheat cultivars. The Asian noodle market is an important business market. The quality of noodles made from different wheat samples is evaluated on entries from nurseries. MSU research is examining the degree to which 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. In addition to improved cultivar characteristics, researchers are evaluating more efficient screening, selection and breeding strategies to maximize efficiency and genetic progress in breeding programs.

Barley research will continue to focus on the development of high-quality drought tolerant lines for the malting, feed, and ethanol industries. The MSU barley improvement 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 barley cultivars for farmers in Montana and the Western U. S. MSU recently released new feed, forage, and malt barley cultivars for Montana's production environments that will provide added-value to growers throughout the Northern Plains. The replacement of older barley cultivars with new ones (Haxby, Hays, Charles, Craft, and Eslick) should generate a yield improvement of about 15% with a net of about \$45 million per year in added revenue to dryland barley growers. Barley cultivars with improved feed quality could provide sustainable feed and grain markets for regional grain producers and marketing advantages to regional beef producers. Our understanding of the genetic control of traits like winter hardiness, feed quality, malting quality, and drought tolerance has been developed and extended through genetic diversity experiments.

Projects are underway to use plant viruses as biotemplates for the fabrication of nanomaterials with applications in agriculture, medicine, and material sciences. Preliminary results have demonstrated that we can modify plant viruses and other protein cage architectures to impart novel functions as nano-templates for nano-materials fabrication with applications in drug delivery, in Magnetic Resonance Imaging (MRI), and as a new method for hydrogen production. These discoveries significantly contribute to Montana's and the nation's efforts in nanotechnology.

Plant photoreceptors and the light responses they control are critical to growth and development of crop and non-crop

species throughout the world. Developing an understanding of how the phytochrome photoreceptors work is a critical part of the search for new and effective ways to sustain and improve crop performance. By determining the fate of nitrogen in plants from anthesis to plant death, we expect to improve our understanding of the cellular and molecular details of nitrogen remobilization, thus closing an important knowledge gap in modern plant biology. Scientists are working to identify the genes involved in control of inflorescence development to provide new approaches to breeding practices or transgenic manipulation.

### **Program # 6 Sustainable Agriculture**

**Situation:** Basic principles of sustainable agriculture are to investigate current agricultural practices and to find economically feasible and environmentally friendly alternatives to those practices without compromising the ability of future generations to meet their own needs. Montana's limited water resources and short growing seasons require researchers to be innovative in their approach to managing rangeland and crops. These approaches include optimizing the use of chemicals for pest control, using alternative tillage systems, and increasing crop diversity and sustainability. Small grains, forages, and short-season specialty crops make up the bulk of the cropping activity in Montana. Camelina and safflower for oil and meal production have demonstrated high overall adaptation to dryland conditions. The development of high-value food, feed, and biofuel crops involves close collaboration among research and extension faculty in Montana and in neighboring states. Rangelands constitute over 60% of the land mass of Montana and serve as a vital resource to the state's livestock industry. 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. In a semi-arid state most crops are dependent upon irrigation from surface water and groundwater. Stream flow, groundwater, surface water, fisheries, and wildlife are heavily dependent on winter snowpack for their water supplies. 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. Education and research activities have precipitated a general trend toward more efficient irrigation systems and more drought tolerant crops.

**Priorities:** Our long-term strategies are designed to ensure that Montana agricultural products are more desirable in U.S. and world markets. Projects in sustainable agriculture research at MSU have objectives that interconnect with program objectives in plant and animal genomics, global food supply, and sustainable energy. The establishment of new value-added crops for nutritional enhancement and biofuels, and the development of higher yielding and value-added small grain cultivars are priorities among agronomic researchers. Greater disease and insect resistance in wheat and barley, greater nutritional value of forages, and more efficient use of natural resources (especially water) are key priorities. Increasing crop diversity will improve the economic well-being of dryland agricultural producers in Montana and the Northern Plains.

**Input:** Surveys at farm conferences in Montana highlight strong producer interest in increasing crop diversity. Information and financial assistance come from alternative energy groups, conservation tillage equipment companies, crop protection companies, fertilizer advisory committees, Montana Wheat and Barley Committee, Organic Certification Association of Montana, and state agricultural advisory committees. 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. The Montana Wheat and Barley Committee provides financial support through a competitive grant process. This financial support helps direct research programs to improve the quality of spring/winter wheat and barley, and to adopt improved IPM practices. The Montana Noxious Weed Trust Fund provides funds for cooperative community watershed projects and for competitive education and research funds. Pulse crop checkoff funds provide additional research resources. Input also comes from meetings with conservation and wildlife groups, Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), Montana Department of Agriculture, Montana Fish, Wildlife and Parks, NASA, NRCS, State of Montana, USFS, USGS, and other organizations interested in water quantity and quality issues.

**Research Activities:** Research programs in the COA range from genetics and biotechnology to practical applications in rangeland, forest, crop, and livestock management. Research conducted in sustainable agricultural projects support our priority to develop competitive, sustainable, and viable plant and animal systems for Montanans. In order 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 (peas, lentils, chickpeas, and soybeans), herbs, mustard, safflower, sunflower, canola, turf grass, and specialty grains. Winter and spring peas, canola, corn, lentils, mustard, sunflower, triticale, and chickpeas are included in long-term rotation studies. Several new cultivars of *Camelina sativa* have been developed, new uses for camelina oil and meal are being evaluated, two new selections/cultivars of high protein oats have been developed, and new oil products for fuel, food, feed, enzymes, and lubricants are being investigated. While pulse crop production in Montana declined in 2008, oilseed crops continue to represent important new sources of income for farmers and provide opportunities for increasing crop diversity. Research information on water utilization and management in the Northern Rockies is very limited. Finding crops that require less water per acre and will grow in our short growing season requires innovative solutions.



This is being partially accomplished through our crop breeding programs, water management research, the introduction of new drought tolerant crops, and conservation practices.

Evaluating watersheds to determine the best integrated approaches for raising crops, grazing livestock, and other uses will help protect riparian areas and improve our state's fisheries and wildlife habitat. Extensive water monitoring across Montana has helped researchers develop predictive models that help direct future research. An understanding of the relationship between water runoff and land features is critical to developing better utilization of limited water resources. This knowledge aids not only crop and livestock producers, but those involved in city and county planning departments who must establish long-range plans for housing development, waste management, and water usage. Low-stress herding and strategic supplement placement can help protect streams' riparian areas and help increase uniformity of grazing by cattle on extensive pastures with rugged terrain. Integrating multiple distribution management practices may be more beneficial than implementing individual practices.

Two major initiatives address the needs of Montana livestock producers: targeted grazing (TG) and sustainable beef supply (SBS). The beef industry is evolving towards a more consumer-oriented focus with greater emphasis on documented management practices which result in safe and consistent end products. This requires a team effort to deliver educational programs and to develop a data base for documenting best management practices, such as source- and age-verification of calves for export markets. BQA and bio-security are designed to provide production benchmarks to prevent the introduction and spread of common cattle diseases by documenting health and nutritional management.

Research on feed and supplements fed to lambs is being conducted to produce lambs with higher levels of unsaturated fatty acids in the lean tissue. Wool research is designed to develop, evaluate, and implement tools and technology for improving the quality, marketing efficiency, and international competitiveness of U.S. wool. Studies are established to further define grazing parameters in rangeland that maintain profitable agricultural enterprises while sustaining ecological systems. The SBS was established to return additional revenue to cattle producers and meet consumer needs in Montana. Barley cultivars with improved feed and forage quality could provide sustainable seed and grain markets for regional grain producers and marketing advantages to regional beef producers. Because ranching enterprises make major contributions to wildlife habitat, their viability is important to the preservation of wildlife habitat. Research has shown that by manipulating cattle grazing patterns, fisheries and wildlife habitats can be protected and improved. Dryland forage and crop producers need to continually improve on yield and quality if they are to remain economically competitive. Yield performance data provides crucial information for producers' cultivar and species selection.

### **Program # 7 Sustainable Energy**

**Situation:** The development of bio-based fuels is a priority to reduce U.S. dependence on petroleum-based fuels. While current fluctuations in the prices of oils and fuels produced from crops (especially corn, soybeans, and oilseeds) are creating uncertainties in the development of processing plants and in incentives for growers, the long-term opportunities continue to be promising. To help advance biofuel developments, the U.S. Department of Energy and the U.S. Department of Agriculture announced in November, 2009 the availability of \$24 million in grants for biofuels, bioenergy, and other bio-based products. The ethanol and biodiesel industry will have a significant impact on the future of the grain industry. Corn grain is the major feedstock for fuel ethanol production in the U.S., yet little corn grain is produced in Montana. MSU initiatives in the development of sustainable energy alternatives primarily rely on oilseed crops to provide opportunities for creating renewable biobased products.

**Priorities:** Goals are to improve the quality and diversity of agricultural commodities, expand production and pest management strategies with reduced inputs, identify and develop new Montana crops, and develop biofuels and energy alternatives. By increasing productivity in a biobased economy, there is positive effect on manufacturing, product development, rural development, job opportunities, and farm and ranch incomes. Montana State University COA and MAES take the lead in this project, providing administration and research expertise for product development, enterprise budgeting, and marketing.

**Input:** Input from focus groups and meetings of stakeholders is used to identify strategies for marketing higher value agricultural commodities, consumer products, and alternative crops.

**Research Activities:** Research projects strive to increase the profitability of Montana agriculture, enhance the health of the human population, and reduce our reliance on non-renewable energy. The primary objective of our research is to develop value-added, agriculturally-based end-use products with a competitive edge in the global market that are suitable for production in rural Montana. We fund cutting edge research that is innovative and responsive to the needs of the region by: (1) developing value-added end-use products with a competitive edge; (2) enhancing agricultural production approaches; (3) developing systems for food safety and agricultural security; (4) establishing biobased product and food science education and research; (6) enhancing partnerships across the region; and (7) conducting outreach activities related to biobased products and food science for producer and agribusiness.

Initiatives will provide new insights into the use of vegetable oils as feedstock for fuel cells, the development of new wheat cultivars for the production of ethanol, non-corrosive biobased de-icers, and the optimization of ethanol production from other feedstocks. We have been instrumental in identifying potential oilseed crops suitable for production in Montana for use as culinary oils, biolubricants, omega-3 oils, feeds, and production of biodiesel and bioenergy products. Oilseeds (including *Camelina sativa*, canola, soybeans, and safflower) are rapidly emerging as important Montana crops for production of oils. A significant potential exists in the Pacific Northwest for the production of canola seed and its use as a biolubricant. To be viable, canola cultivars need to be developed that can be direct-seeded, and that are winter hardy and drought tolerant.

Alternative feedstocks are being explored for potential fuel ethanol production. For the biodiesel industry, the high cost of feedstocks is the major limiting factor affecting biodiesel production in the U.S. New oilseed crops and cropping systems are being researched to produce low cost feedstocks for biodiesel production. A dual-purpose forage crop study for bio-ethanol feedstock and for livestock feed has been completed, and a new oilseed-cereal rotation project was initiated to investigate the cropping systems for oilseed biodiesel feedstock production. Four new patents have been filed related to the use of camelina in biolubricants. Biobased processed engineered fuels (typically in pellets, briquettes, or logs) can be manufactured to take advantage of materials that are common to local Montana areas.

#### Estimated Number of Professional FTEs/SYs total in the State.

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	240.5	0.0
2012	0.0	0.0	240.5	0.0
2013	0.0	0.0	240.5	0.0
2014	0.0	0.0	240.5	0.0
2015	0.0	0.0	240.5	0.0

## II. Merit Review Process

### 1. The Merit Review Process that will be Employed during the 5-Year POW Cycle

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

### 2. 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 COA 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. 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 COA, consequently external expert review occurs with Montana State University-Bozeman faculty external to the COA, as a requirement of the review process. The seminars are announced on the internet, ensuring broader attendance and input potential. Reviewers are requested to provide written recommendations on the following items: relevance and importance of the project; relationship 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 satisfactorily met. Ultimately, Director-approved projects are submitted to USDA-NIFA for final approval.

### III. 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 selected objectives. In addition, on a biennial basis MAES 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

Montana has a small 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 MAES 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.

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

In order to continue receiving State support that is five times the amount of federal support (Hatch, Multistate, and Animal Health), our research must demonstrate actual or potential economic impact to Montana's economy and solve problems at the local-to-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 products 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 the development of energy resources in an environmentally sound and economically feasible manner. This could lead to new policies on drilling for methane and the use of extracted waters. Many of the coal bed methane sites are located on reservations; working with tribal leaders helps to identify their needs in those locations. 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 emphases important to our number one industry, agriculture.

### IV. Stakeholder Input

#### 1. Actions taken to seek stakeholder input that encourages their participation

- 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 (Educational outreach programs)

**Brief explanation.**

The Montana Agricultural Experiment Station (MAES) and COA obtain stakeholder input on research priorities and programs. Stakeholder committees have been formed that include the College Development Board, sustainable agriculture focus group, MAES Advisory Council, Academic Advisory Council, Ag Coalition and other state and local groups. MAES scientists routinely participate with this group and NRCS to provide training and expertise in GPS, GIS and remote sensing with geospatial applications. 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, Seed 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. Meetings are advertised via news releases, newsletters, individual letters, and announcements at group meetings. Extension agents are instructed to use county profile information to make sure that the people invited to the sessions would reflect the diversity of the area. 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.

**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 (Volunteers, membership on ag. assoc. boards)

**Brief explanation.**

Each of the seven agricultural research centers has a local advisory group that meets multiple 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 COA serve on agricultural association committees that annually direct and fund research activities that have multiple meetings and communications.

**2(B). A brief statement of the process that will be used by the recipient institution to identify individuals and groups who are 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 in committees, and directed meetings, the MAES 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 COA and MAES are leaders in this regard. We are the primary conduit for connection and delivery of education and new knowledge in agriculturally-related activities throughout rural Montana.

**V. Planned Program Table of Content**

<b>S. No.</b>	<b>PROGRAM NAME</b>
1	Animal Health
2	Climate Change
3	Global Food Security and Hunger
4	Integrated Pest Management
5	Plant Breeding, Genetics and Genomics
6	Sustainable Agriculture
7	Sustainable Energy

## V(A). Planned Program (Summary)

### Program # 1

#### 1. Name of the Planned Program

Animal Health

#### 2. Brief summary about Planned Program

**Summary:** Producing high quality animals and obtaining the highest profit potential are essential for Montana. Promoting and maintaining animal health (cattle, sheep, horses, and wildlife) has led to advances in genetics and reproductive science and improved animal performance. 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.

**Research Activities:** Bison research focuses on the development of efficacious brucellosis vaccines. Studies, in cooperation with Texas A&M, have produced new subunit and live brucellosis vaccines that may effectively protect bison and cattle against brucellosis. Formulation trials are underway to make these vaccines available to livestock producers and wildlife managers. In addition, next generation live brucellosis vaccines have been developed and will be tested to determine their potential efficacy. A better understanding of the mechanisms involved in the spread of brucellosis directly addresses concerns of cattle producers in areas near Yellowstone National Park (YNP) and could aid in the management of bison by YNP wildlife managers. Feeding studies with barley, camelina meal, and supplements are in place to evaluate varying rations for calves and cows to continue to produce superior feeder stock to markets outside of Montana. Honey bees are dying across the United State at an unprecedented rate, a phenomenon termed Colony Collapse Disorder (CCD). Successful completion of our research will yield important data regarding the importance of *Nosema ceranae* infections in honeybee health.

Cattle research focuses on disease control, reproductive enhancement, and animal productivity. Programs are in place to investigate vaccines for rotavirus, prion diseases, coccidiosis, herpes viruses, and mastitis in cattle.

Targeted grazing (TG) is developing and implementing non-traditional strategies that will increase the competitiveness of Montana's lamb and wool in the world market. Our goal is to explore integrated pest management (IPM) opportunities to increase the use of sheep in weed management programs, to improve the profitability and competitiveness of the Montana sheep industry, and to provide marketing opportunities for Montana sheep producers. Equine strangles continues to be a problem to horse health and industry, despite the widespread use of commercial vaccines. Researchers are closer to the development of a safe and effective protein-based and/or live vaccine. Research is being devised to understand the cause and development of immunity to bovine shipping fever and to develop novel strategies for the prevention and control of this disease complex.

3. Program existence : Intermediate (One to five years)

4. Program duration : Long-Term (More than five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

**V(B). Program Knowledge Area(s)**

## 1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
121	Management of Range Resources			10%	
301	Reproductive Performance of Animals			10%	
302	Nutrient Utilization in Animals			10%	
303	Genetic Improvement of Animals			10%	
307	Animal Management Systems			10%	
311	Animal Diseases			35%	
315	Animal Welfare/Well-Being and Protection			10%	
902	Administration of Projects and Programs			5%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. 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 technology. To address the needs of our stakeholders and those who rely on our recommendations for animal production in the state, the following priorities have been established:

- 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
- Evaluate barley cultivars in feeding studies to demonstrate their effect on improving feed efficiency and reducing feed costs
- Improve milk and beef production by targeting mutagenesis in cattle bovine immune cells
- Test new natural oil additives for improving lamb meat characteristics to increase the competitiveness of U.S. lamb in the world market

**2. Scope of the Program**

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

**V(D). Planned Program (Assumptions and Goals)****1. Assumptions made for the Program**

- Funding through industry organizations, livestock associations, companies, and other agencies will continue to provide input into priorities and activities
- Fulltime staff and part time assistants will be available to maintain appropriate progress
- Funding and technical support will be maintained from partnering institutions and cooperators



Program development will proceed as planned without major interruptions

**2. Ultimate goal(s) of this Program**

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

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	82.5	0.0
2012	0.0	0.0	82.5	0.0
2013	0.0	0.0	82.5	0.0
2014	0.0	0.0	82.5	0.0
2015	0.0	0.0	82.5	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Databases that are easily accessible by researchers and producers in order to make research results readily available
- Distribution of papers and research results at state nutrition conferences, field days, county meetings and state conventions
- Preparation of research articles, fact sheets and news releases for scientists and state media
- Strategic planning meetings with state agricultural groups

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>• Education Class</li> <li>• Workshop</li> </ul>	<ul style="list-style-type: none"> <li>• Newsletters</li> </ul>

**3. Description of targeted audience**

- State agencies, animal health companies, and state commodity groups
- Ranchers, seedstock industry, colleagues, and related stakeholders

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	250	100	0	0
2012	250	100	0	0
2013	250	100	0	0
2014	250	100	0	0
2015	250	100	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:1                      2012:0                      2013:0                      2014:0                      2015:1**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	5	0	5
2012	5	0	5
2013	5	0	5
2014	5	0	5
2015	5	0	5

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

**2011:15                      2012:15                      2013:15                      2014:15                      2015:15**

- Building built through donations

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Identify critical infection and resistance processes.
2	Number of ranches per year adopting enterprise management of animal health issues.
3	Number of novel vaccines developed per year.
4	Number of activities per year that prevent disease outbreaks or manage diseases of Montana livestock.
5	Meetings that maintain or enhance Montana's presence in the production of quality meat products.

**Outcome # 1****1. Outcome Target**

Identify critical infection and resistance processes.

**2. Outcome Type : Change in Action Outcome Measure**

<b>2011:1</b>	<b>2012:1</b>	<b>2013:1</b>	<b>2014:1</b>	<b>2015:1</b>
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**3. Associated Knowledge Area(s)**

- 303 - Genetic Improvement of Animals
- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2****1. Outcome Target**

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

**2. Outcome Type : Change in Action Outcome Measure**

<b>2011:10</b>	<b>2012:10</b>	<b>2013:10</b>	<b>2014:10</b>	<b>2015:10</b>
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**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 301 - Reproductive Performance of Animals
- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 3****1. Outcome Target**

Number of novel vaccines developed per year.

**2. Outcome Type : Change in Condition Outcome Measure**

<b>2011:1</b>	<b>2012:0</b>	<b>2013:0</b>	<b>2014:0</b>	<b>2015:1</b>
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**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 4**

**1. Outcome Target**

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

**2. Outcome Type : Change in Action Outcome Measure**

<b>2011:1</b>	<b>2012:1</b>	<b>2013:1</b>	<b>2014:1</b>	<b>2015:1</b>
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**3. Associated Knowledge Area(s)**

- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 5**

**1. Outcome Target**

Meetings that maintain or enhance Montana's presence in the production of quality meat products.

**2. Outcome Type : Change in Knowledge Outcome Measure**

<b>2011:1</b>	<b>2012:1</b>	<b>2013:1</b>	<b>2014:1</b>	<b>2015:1</b>
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**3. Associated Knowledge Area(s)**

- 302 - Nutrient Utilization in Animals
- 303 - Genetic Improvement of Animals
- 311 - Animal Diseases
- 315 - Animal Welfare/Well-Being and Protection
- 902 - Administration of Projects and Programs

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

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

**Description**

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

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)
- Other (Review with state agencies)

**Description**

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

**2. Data Collection Methods**

- Sampling
- On-Site
- Journals

**Description**

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

**V(A). Planned Program (Summary)**

**Program # 2**

**1. Name of the Planned Program**

Climate Change

**2. Brief summary about Planned Program**

**3. Program existence :** New (One year or less)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
132	Weather and Climate			50%	
903	Communication, Education, and Information Delivery			50%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)**

**1. Situation and priorities**

**2. Scope of the Program**

- In-State Extension
- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

**2. Ultimate goal(s) of this Program**

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	3.7	0.0
2012	0.0	0.0	3.7	0.0
2013	0.0	0.0	3.7	0.0
2014	0.0	0.0	3.7	0.0
2015	0.0	0.0	3.7	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Evaluate new crops and cultivars for suitability in a warmer and drier climate  
 Investigate practical approaches to carbon sequestration

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>• Workshop</li> <li>• Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>• Newsletters</li> <li>• Web sites</li> </ul>

**3. 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

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

Year	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
	Target	Target	Target	Target
2011	100	150	0	0
2012	100	150	0	0
2013	100	150	0	0
2014	100	150	0	0
2015	100	150	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**



**2011:0**

**2012:0**

**2013:1**

**2014:0**

**2015:0**

**3. Expected Peer Review Publications**

<b>Year</b>	<b>Research Target</b>	<b>Extension Target</b>	<b>Total</b>
2011	5	0	5
2012	8	5	13
2013	10	5	15
2014	10	5	15
2015	10	5	15

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

**2011:5**

**2012:5**

**2013:5**

**2014:5**

**2015:5**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of new drought tolerant crop recommendations for Montana
2	Number of carbon sequestration technologies introduced

**Outcome # 1**

**1. Outcome Target**

Number of new drought tolerant crop recommendations for Montana

**2. Outcome Type :** Change in Action Outcome Measure

2011:0                      2012:1                      2013:1                      2014:0                      2015:1

**3. Associated Knowledge Area(s)**

- 132 - Weather and Climate
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

Number of carbon sequestration technologies introduced

**2. Outcome Type :** Change in Action Outcome Measure

2011:0                      2012:1                      2013:1                      2014:0                      2015:0

**3. Associated Knowledge Area(s)**

- 132 - Weather and Climate
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

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

**Description**

Inadequate funding and technical support from partnering institutions and cooperators  
 Inadequate moisture (rainfall, irrigation, snowpack) for consistent crop production  
 Lack of fulltime staff and part time assistants  
 Major interruptions in program development  
 Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

**V(K). Planned Program (Evaluation Studies and Data Collection)**

## **1. Evaluation Studies Planned**

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

### **Description**

Evaluation studies will be conducted annually through the issuance and collection of surveys, published peer reviewed materials and secured peer reviewed grants.

## **2. Data Collection Methods**

- Sampling
- On-Site
- Journals

### **Description**

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

**V(A). Planned Program (Summary)**

**Program # 3**

**1. Name of the Planned Program**

Global Food Security and Hunger

**2. Brief summary about Planned Program**

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
205	Plant Management Systems			20%	
502	New and Improved Food Products			20%	
503	Quality Maintenance in Storing and Marketing Food Products			20%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			20%	
903	Communication, Education, and Information Delivery			20%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)**

**1. Situation and priorities**

**2. Scope of the Program**

- In-State Extension
- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

**2. Ultimate goal(s) of this Program**

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	21.3	0.0
2012	0.0	0.0	21.3	0.0
2013	0.0	0.0	21.3	0.0
2014	0.0	0.0	21.3	0.0
2015	0.0	0.0	21.3	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Develop systems that ensure food safety and agricultural security
- Develop value-added, agriculturally based end-use products
- 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
- Provide ways to enhance agricultural production practices to enhance product quality
- Develop research summaries and fact sheets
- Conduct training in cooperation with Montana Beef Quality Assurance standards and the SBS program

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>• Education Class</li> <li>• Workshop</li> <li>• Group Discussion</li> <li>• Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>• Newsletters</li> <li>• Web sites</li> </ul>

**3. Description of targeted audience**

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

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	200	200	0	0
2012	250	250	0	0
2013	250	250	0	0
2014	300	300	0	0
2015	300	300	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

2011:0                      2012:0                      2013:1                      2014:1                      2015:1

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	10	0	10
2012	10	0	10
2013	10	0	10
2014	10	0	10
2015	10	0	10

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

2011:10                      2012:10                      2013:10                      2014:10                      2015:10

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of programs established to enhance global food biosecurity
2	Number of new food products created from Montana crops
3	Number of producers that participate in livestock tracking programs



**Outcome # 1**

**1. Outcome Target**

Number of programs established to enhance global food biosecurity

**2. Outcome Type :** Change in Action Outcome Measure

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems
- 502 - New and Improved Food Products
- 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

Number of new food products created from Montana crops

**2. Outcome Type :** Change in Action Outcome Measure

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems
- 502 - New and Improved Food Products
- 503 - Quality Maintenance in Storing and Marketing Food Products
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 3**

**1. Outcome Target**

Number of producers that participate in livestock tracking programs

**2. Outcome Type :** Change in Action Outcome Measure

**2011:10                      2012:10                      2013:20                      2014:20                      2015:30**

**3. Associated Knowledge Area(s)**

- 503 - Quality Maintenance in Storing and Marketing Food Products
- 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other

Sources

- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

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

**Description**

Inadequate moisture (rainfall, irrigation, snowpack) for consistent crop production  
Inadequate funding and technical support from partnering institutions and cooperators  
Major interruptions in program development  
Lack of full-time staff and part time assistants  
Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

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

**Description**

Evaluation studies will be conducted annually through the issuance and collection of surveys, published peer reviewed materials, and secured peer reviewed grants.

**2. Data Collection Methods**

- Sampling
- Unstructured

**Description**

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

**V(A). Planned Program (Summary)**

**Program # 4**

**1. Name of the Planned Program**

Integrated Pest Management

**2. Brief summary about Planned Program**

**3. Program existence :** Mature (More then five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :**Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
211	Insects, Mites, and Other Arthropods Affecting Plants			25%	
212	Pathogens and Nematodes Affecting Plants			25%	
213	Weeds Affecting Plants			10%	
215	Biological Control of Pests Affecting Plants			15%	
216	Integrated Pest Management Systems			25%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)**

**1. Situation and priorities**

**2. Scope of the Program**

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

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

**2. Ultimate goal(s) of this Program**

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	37.0	0.0
2012	0.0	0.0	37.0	0.0
2013	0.0	0.0	37.0	0.0
2014	0.0	0.0	37.0	0.0
2015	0.0	0.0	37.0	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

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

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>• Education Class</li> <li>• Workshop</li> <li>• Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>• Newsletters</li> </ul>

**3. Description of targeted audience**

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

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	350	150	0	0
2012	375	150	0	0
2013	375	150	0	0
2014	400	150	0	0
2015	400	150	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	5	0	5
2012	5	0	5
2013	5	0	5
2014	5	0	5
2015	0	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

**2011:10                      2012:10                      2013:10                      2014:10                      2015:10**

- Multidisciplinary journal articles published

**2011:4                      2012:4                      2013:4                      2014:4                      2015:4**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Quality in-depth training programs for continuing educational on integrated approaches to pest management.
2	New IPM options discovered and evaluated per year.
3	Number of broad-ranging stewardship practices implemented.
4	Passing rate percentage for pesticide application licenses.
5	New products registered.
6	Number of potential products/practices evaluated.

**Outcome # 1**

**1. Outcome Target**

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

**2. Outcome Type : Change in Knowledge Outcome Measure**

**2011:3                      2012:3                      2013:3                      2014:3                      2015:3**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 216 - Integrated Pest Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

New IPM options discovered and evaluated per year.

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 216 - Integrated Pest Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 3**

**1. Outcome Target**

Number of broad-ranging stewardship practices implemented.

**2. Outcome Type : Change in Action Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:0**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 216 - Integrated Pest Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 4**

**1. Outcome Target**

Passing rate percentage for pesticide application licenses.

**2. Outcome Type : Change in Knowledge Outcome Measure**

**2011:70                      2012:70                      2013:70                      2014:70                      2015:70**

**3. Associated Knowledge Area(s)**

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 216 - Integrated Pest Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 5**

**1. Outcome Target**

New products registered.

**2. Outcome Type : Change in Action Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

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



- 216 - Integrated Pest Management Systems

#### 4. Associated Institute Type(s)

- 1862 Research

#### Outcome # 6

##### 1. Outcome Target

Number of potential products/practices evaluated.

##### 2. Outcome Type : Change in Action Outcome Measure

2011:3	2012:3	2013:3	2014:3	2015:3
--------	--------	--------	--------	--------

##### 3. Associated Knowledge Area(s)

- 211 - Insects, Mites, and Other Arthropods Affecting Plants
- 212 - Pathogens and Nematodes Affecting Plants
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 216 - Integrated Pest Management Systems

##### 4. Associated Institute Type(s)

- 1862 Research

#### V(J). Planned Program (External Factors)

##### 1. 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 consistent crop production  
Inadequate funding and technical support from partnering institutions and cooperators  
Lack of fulltime staff and part time assistants for the projects  
Major interruptions in program development  
Reduced support from grain associations, companies, and other agencies

#### V(K). Planned Program (Evaluation Studies and Data Collection)

##### 1. Evaluation Studies Planned

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

##### Description

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

## 2. Data Collection Methods

- Sampling
- Journals

### Description

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

**V(A). Planned Program (Summary)****Program # 5****1. Name of the Planned Program**

Plant Breeding, Genetics and Genomics

**2. Brief summary about Planned Program****Summary:****3. Program existence :** Intermediate (One to five years)**4. Program duration :** Long-Term (More than five years)**5. Expending formula funds or state-matching funds :** Yes**6. Expending other than formula funds or state-matching funds :** Yes**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
201	Plant Genome, Genetics, and Genetic Mechanisms			15%	
202	Plant Genetic Resources			35%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
204	Plant Product Quality and Utility (Preharvest)			30%	
205	Plant Management Systems			10%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities****2. Scope of the Program**

- In-State Research
- Multistate Research

**V(D). Planned Program (Assumptions and Goals)****1. Assumptions made for the Program****2. Ultimate goal(s) of this Program**

**V(E). Planned Program (Inputs)****1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	33.1	0.0
2012	0.0	0.0	33.1	0.0
2013	0.0	0.0	33.1	0.0
2014	0.0	0.0	33.1	0.0
2015	0.0	0.0	33.1	0.0

**V(F). Planned Program (Activity)****1. Activity for the Program**

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

**2. Type(s) of methods to be used to reach direct and indirect contacts****Extension**

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

**3. Description of targeted audience**

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

**V(G). Planned Program (Outputs)****1. Standard output measures****Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	2000	500	0	0
2012	2000	500	0	0

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2013	2000	500	0	0
2014	2000	500	0	0
2015	2000	500	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:1                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	5	0	5
2012	5	0	5
2013	5	0	5
2014	5	0	5
2015	5	0	5

**V(H). State Defined Outputs**

**1. Output Target**

- Number of foreign trade teams in Montana

**2011:20                      2012:20                      2013:20                      2014:20                      2015:20**

- Number of foreign trade teams at MSU

**2011:4                      2012:4                      2013:4                      2014:4                      2015:4**

- Number of research citations

**2011:18                      2012:20                      2013:20                      2014:20                      2015:20**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Electronic documents on new cultivars and Montana district recommendations provided to Montana producers to maintain Montana producers' dominance in small grain markets.
2	The number of new molecular techniques used to enhance breeding results.
3	Average per bushel yield increase of Montana grains while maintaining product quality.
4	Number of elite lines of wheat and barley screened for agronomic and quality characteristics.
5	Number of improved cultivar recommendations by districts across Montana.
6	Planted acreage percentage increase per year of new MSU-released small grains in Montana.

**Outcome # 1****1. Outcome Target**

Electronic documents on new cultivars and Montana district recommendations provided to Montana producers to maintain Montana producers' dominance in small grain markets.

**2. Outcome Type : Change in Condition Outcome Measure****2011:100****2012:100****2013:100****2014:100****2015:100****3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2****1. Outcome Target**

The number of new molecular techniques used to enhance breeding results.

**2. Outcome Type : Change in Condition Outcome Measure****2011:1****2012:1****2013:1****2014:1****2015:1****3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 3****1. Outcome Target**

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

**2. Outcome Type : Change in Condition Outcome Measure****2011:1****2012:0****2013:0****2014:0****2015:1****3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources

- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 4**

**1. Outcome Target**

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

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:100                      2012:100                      2013:100                      2014:100                      2015:100**

**3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 5**

**1. Outcome Target**

Number of improved cultivar recommendations by districts across Montana.

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:5                              2012:5                              2013:5                              2014:5                              2015:5**

**3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 6**

**1. Outcome Target**

Planted acreage percentage increase per year of new MSU-released small grains in Montana.



## 2. Outcome Type : Change in Condition Outcome Measure

2011:3

2012:3

2013:3

2014:3

2015:3

## 3. Associated Knowledge Area(s)

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems

## 4. Associated Institute Type(s)

- 1862 Research

## V(J). Planned Program (External Factors)

### 1. External Factors which may affect Outcomes

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

#### Description

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

## V(K). Planned Program (Evaluation Studies and Data Collection)

### 1. 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.

### 2. Data Collection Methods

- On-Site
- Unstructured

#### Description

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

**V(A). Planned Program (Summary)****Program # 6****1. Name of the Planned Program**

Sustainable Agriculture

**2. Brief summary about Planned Program**

**Summary:** Our long-term strategies are designed to make Montana agricultural products more desirable in U.S. and world markets. Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Researching new crops and finding new markets for existing crops are potential ways to enhance Montana's growth in sustainable agriculture.

**Research Activities:** Projects in the Sustainable Agriculture program area serve to provide new cropping opportunities, increased markets, and substantial economic benefit for Montana growers. The establishment of new value-added crops for nutritional enhancement and biofuels, and the development of higher yielding and value-added small grain cultivars are priorities among agronomic researchers and plant breeders. To decrease Montana's primary dependence on small grains and forage crops, crop diversity studies are being conducted on the feasibility of growing a variety of crops including: pulse crops (peas, lentils, chickpeas, and soybeans), herbs, mustard, safflower, sunflower, canola, turf, and specialty grains. Organic farming represents a new economic opportunity for farmers in the Northern Great Plains because of growing consumer demand. Studies will provide new information to organic growers on strategies for enhancing soil fertility that will enhance the sustainability of organic farming systems in this semiarid region. Maintaining soil fertility without the use of fertilizers represents a challenge to organic growers in the area which is dominated by high pH and calcareous soils that limit the availability of phosphorus. Research in organic farming is aimed at promoting economic and environmental sustainability. Research is providing producers with value-added high oleic and high linoleic safflower cultivars for commercial production of edible oils, cosmetics, biofuel, birdseed, and supplemental fat for livestock rations. Our stakeholders charge us to improve animal health, food safety, quality, and marketing opportunities through sustainable practices. Two major initiatives address the needs of Montana livestock producers with targeted grazing (TG) and sustainable beef supply (SBS) activities. The objective of the TG is to develop and implement nontraditional strategies that will increase the competitiveness of Montana lamb and wool in world markets. SBS was established to return additional revenue to cattle producers and meet consumer needs in Montana through research and education. Research continues into the value of sheep grazing, which currently provides an economically feasible and ecologically sustainable tool to restore landscapes heavily infested with non-native invasive plants and noxious weeds. A major environmental challenge in Montana is the creation of better rangeland management in concert with the preservation of riparian habitats, wildlife, and clean water.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

## 1. Program Knowledge Areas and Percentage

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
121	Management of Range Resources			20%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
204	Plant Product Quality and Utility (Preharvest)			20%	
205	Plant Management Systems			10%	
206	Basic Plant Biology			10%	
213	Weeds Affecting Plants			10%	
215	Biological Control of Pests Affecting Plants			10%	
601	Economics of Agricultural Production and Farm Management			10%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)**

## 1. Situation and priorities

## 2. Scope of the Program

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

**V(D). Planned Program (Assumptions and Goals)**

## 1. Assumptions made for the Program

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

## 2. Ultimate goal(s) of this Program

Determine practical rangeland grazing strategies for Montana livestock producers  
 Develop higher yielding cultivars and introduce new value-added crops  
 Develop higher disease and insect resistance in wheat and barley and greater nutritional value for forages  
 Develop novel pest management systems for controlling insects, diseases, and weeds  
 Find and evaluate alternative sustainable fuel sources from Montana agricultural products  
 Provide sustainable new cropping opportunities  
 Provide crop management options and establish research programs that are consistent with environmental and

sustainable agricultural objectives

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	57.3	0.0
2012	0.0	0.0	57.3	0.0
2013	0.0	0.0	57.3	0.0
2014	0.0	0.0	57.3	0.0
2015	0.0	0.0	57.3	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

Communicate research results through field days, news releases, fact sheets, research summaries, and presentations at county and state meetings and conventions

Distribute results of research via the internet

Hold strategic planning discussions with state agricultural groups including ag associations and federal and state land management agencies

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

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

**3. Description of targeted audience**

Alternative energy groups and state agricultural advisory committees

Crop and livestock producers in Montana

Montana wheat and barley committees, companies, fertilizer advisory committees, conservation tillage equipment companies

State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities

Participants in outreach and commodity group meetings, conferences, and field days

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

	<b>Direct Contact Adults</b>	<b>Indirect Contacts Adults</b>	<b>Direct Contacts Youth</b>	<b>Indirect Contacts Youth</b>
<b>Year</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>	<b>Target</b>
2011	600	150	0	0
2012	700	150	0	0
2013	700	150	0	0
2014	700	150	0	0
2015	725	175	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:1                      2012:0                      2013:0                      2014:1                      2015:0**

**3. Expected Peer Review Publications**

<b>Year</b>	<b>Research Target</b>	<b>Extension Target</b>	<b>Total</b>
2011	5	5	10
2012	5	5	10
2013	5	5	10
2014	5	5	10
2015	5	5	10

**V(H). State Defined Outputs**

**1. Output Target**

- Number of research citations

**2011:8                      2012:10                      2013:10                      2014:12                      2015:14**

**V(I). State Defined Outcome**

<b>O. No.</b>	<b>Outcome Name</b>
1	Number of interactive meetings with state groups and agencies.
2	Number of producers per year implementing new farm management and budgeting practices.
3	Increased number of new crops adapted to Montana through percent acres increased.
4	Number of field days, news releases and presentations at conventions.
5	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).
6	Increase in acres of non-traditional crops planted in Montana.
7	Number of routine field crop and forage samples processed by the MSU Seed Laboratory per year.

**Outcome # 1**

**1. Outcome Target**

Number of interactive meetings with state groups and agencies.

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:2                      2012:2                      2013:2                      2014:2                      2015:2**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

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

**2. Outcome Type : Change in Action Outcome Measure**

**2011:100                      2012:100                      2013:100                      2014:100                      2015:100**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants
- 601 - Economics of Agricultural Production and Farm Management

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 3**

**1. Outcome Target**

Increased number of new crops adapted to Montana through percent acres increased.

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 206 - Basic Plant Biology
- 601 - Economics of Agricultural Production and Farm Management

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 4**

**1. Outcome Target**

Number of field days, news releases and presentations at conventions.

**2. Outcome Type : Change in Knowledge Outcome Measure**

**2011:25                      2012:30                      2013:30                      2014:35                      2015:35**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 5**

**1. Outcome Target**

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).

**2. Outcome Type : Change in Action Outcome Measure**

**2011:100                      2012:100                      2013:100                      2014:100                      2015:100**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems
- 213 - Weeds Affecting Plants
- 215 - Biological Control of Pests Affecting Plants



**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 6**

**1. Outcome Target**

Increase in acres of non-traditional crops planted in Montana.

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:5000                      2012:5000                      2013:5000                      2014:5000                      2015:5000**

**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 7**

**1. Outcome Target**

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

**2. Outcome Type : Change in Action Outcome Measure**

**2011:750                      2012:750                      2013:750                      2014:750                      2015:750**

**3. Associated Knowledge Area(s)**

- 121 - Management of Range Resources
- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. 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  
 Lack of fulltime staff and part time assistants  
 Major interruptions in program development  
 Reduced support from Montana crop and animal agricultural groups, conservation and wildlife groups, private industry, private donations, and other agencies

## **V(K). Planned Program (Evaluation Studies and Data Collection)**

### **1. Evaluation Studies Planned**

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

#### **Description**

Evaluation studies will be conducted annually through the issuance and collection of surveys, published peer reviewed materials, and secured peer reviewed grants.

### **2. Data Collection Methods**

- Mail

#### **Description**

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

**V(A). Planned Program (Summary)**

**Program # 7**

**1. Name of the Planned Program**

Sustainable Energy

**2. Brief summary about Planned Program**

**Summary:**

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
511	New and Improved Non-Food Products and Processes			30%	
605	Natural Resource and Environmental Economics			30%	
903	Communication, Education, and Information Delivery			40%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)**

**1. Situation and priorities**

**2. Scope of the Program**

- In-State Extension
- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

**2. Ultimate goal(s) of this Program**

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	5.6	0.0
2012	0.0	0.0	5.6	0.0
2013	0.0	0.0	5.6	0.0
2014	0.0	0.0	5.6	0.0
2015	0.0	0.0	5.6	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Conduct outreach activities related to biobased products
- Develop value-added, agriculturally based end-use products
- Enhance partnerships among faculty across the Montana university system, producers, the agricultural industry, and other educational institutions across the region
- Develop sustainable fuels from crops grown in Montana

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods
<ul style="list-style-type: none"> <li>• Education Class</li> <li>• Workshop</li> <li>• Group Discussion</li> <li>• Demonstrations</li> </ul>	<ul style="list-style-type: none"> <li>• Newsletters</li> <li>• Web sites</li> </ul>

**3. Description of targeted audience**

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

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

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

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	200	350	0	0
2012	250	350	0	0

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2013	250	350	0	0
2014	250	350	0	0
2015	250	350	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:1                      2013:0                      2014:0                      2015:1**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	5	5	10
2012	5	5	10
2013	5	5	10
2014	5	5	10
2015	5	5	10

**V(H). State Defined Outputs**

**1. Output Target**

- New business partnerships created

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

- Number of research citations

**2011:5                      2012:5                      2013:5                      2014:5                      2015:5**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of biofuels developed from existing crops in Montana
2	Number of new crop options introduced for biofuels in Montana

**Outcome # 1**

**1. Outcome Target**

Number of biofuels developed from existing crops in Montana

**2. Outcome Type : Change in Action Outcome Measure**

**2011:0                      2012:1                      2013:0                      2014:1                      2015:1**

**3. Associated Knowledge Area(s)**

- 511 - New and Improved Non-Food Products and Processes
- 605 - Natural Resource and Environmental Economics
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

Number of new crop options introduced for biofuels in Montana

**2. Outcome Type : Change in Action Outcome Measure**

**2011:0                      2012:1                      2013:1                      2014:0                      2015:0**

**3. Associated Knowledge Area(s)**

- 511 - New and Improved Non-Food Products and Processes
- 605 - Natural Resource and Environmental Economics
- 903 - Communication, Education, and Information Delivery

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. 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 consistent crop production  
 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

## **V(K). Planned Program (Evaluation Studies and Data Collection)**

### **1. Evaluation Studies Planned**

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

#### **Description**

Evaluation studies will be conducted annually through the issuance and collection of surveys, published peer reviewed materials, and secured peer reviewed grants.

### **2. Data Collection Methods**

- Sampling
- Unstructured

#### **Description**

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